A Comparison of Litter Densities in Four Community Types of the Long Island Central Pine Barrens

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ABSTRACT

A Comparison of Litter Densities in Four Community Types of the Long Island Central Pine Barrens. DANA TIEVSKY (University of Rochester, Rochester, NY 14627) TIMOTHY GREEN, PhD (Brookhaven National Laboratory, Upton, NY 11973).

The condition of the Long Island Central Pine Barrens has been an area of ecological concern for the past three decades. In 2003, the Foundation for Ecological Research in the Northeast (FERN) was founded to support scientific research in the Pine Barrens. FERN's groundbreaking project is the Central Pine Barrens Monitoring Program, for which field research began during the summer of 2005 at Brookhaven National Laboratory. The purpose of this research is to determine the current status of forest health in order to promote longevity and conservation in the Pine Barrens, as well as to learn what research should be done in the future. Specifically, litter densities from Pitch Pine, Pine-Oak, Oak-Pine, and Coastal Oak habitats were compared in order to justify the succession of the Pine Barrens and prepare for future prescribed forest fires. Using Geographic Information System (GIS) and Global Positioning System (GPS) technology, random plots of land were selected throughout eastern Long Island. These twenty-five by sixteen meter plots of land were then thoroughly surveyed. As part of the protocol, litter and duff depth data were collected at twenty points along each of the ten line transects in the plot. Pitch Pine forests were found to have the most litter, with an average depth of 8.58 centimeters (cm). Pine-Oak forests have an average litter depth of 7.48 cm. Oak-Pine and Coastal Oak forests have comparable litter depths. Oak-Pine forests have an average litter depth of 4.81 cm while Coastal Oak forests have an average litter depth of 4.41 cm. A comparison of the vastly different litter densities of the four community types yields results that are consistent with the previously determined succession of the

Pine Barrens and shows that litter density plays a key role in aiding forest succession. In the future, data collected under the Central Pine Barrens Monitoring Program can be used to determine a threshold for litter density in order to prescribe forest fires at appropriate times and preserve the Pine Barrens in the most effective manner.

INTRODUCTION

The Long Island Pine Barrens Society was founded in 1977 in order to bring attention to the depleting natural resources of the Pine Barrens. In the 1970's, with the realization that residential and commercial development was disturbing and potentially destroying the area, conservation efforts began. Initial preservation attempts to provide core or "greenbelt" areas, shown in figure 1, during the late 1970's and early 1980's did not alleviate threats to the Pine Barrens ecosystem. After many failed attempts, protective legislation was enacted in 1993, with the establishment of the Comprehensive Management Plan in 1995 [1, 2].

In 2003 the Foundation for Ecological Research in the Northeast (FERN) was founded to fund ecological and environmental research at Brookhaven National Laboratory [4]. The primary project of FERN is the Central Pine Barrens Monitoring Program. The goal of this project is to track the current and future health of the Pine Barrens so that future research needs and priorities can be identified [3]. Since little is known about the exact ecological status of the Pine Barrens, it is anticipated that this data will be crucial to a wide spectrum of residents and organizations including researchers, developers, environmentalists, and state and local government. Since the Pine Barrens is a natural feature unique to Long Island, it is critical to keep this resource healthy and thriving.

It is anticipated that the results of this research will provide data relevant to the determination of appropriate timing for prescribed forest fires. Properly timed wildfires benefit the Pine Barrens. Reduction of litter (which is composed of leaves, twigs, pine needles, and other dead vegetation) and canopy cover in the forest provides for direct sunlight on the soil and triggers new tree growth. Furthermore, pitch pine cones' germination is augmented after fires. Melting of the resin coating enables the cone to burst open and scatter seeds directly on bare soil [5, 6]. Knowing the right time to prescribe forest fires would not only better the health of the Pine Barrens, it would also increase their longevity.

Baseline data for this longitudinal study were collected during the summer of 2005 at Brookhaven National Laboratory. Pitch Pine, Pine-Oak, Oak-Pine, and Coastal Oak forests were targeted at this time. Pitch Pine forests commonly have a canopy cover of nearly 100 percent pitch pine trees while Pine-Oak and Oak-Pine forests have a canopy of mixed pitch pine and oak trees. All these community types include a shrub layer consisting of huckleberry, blueberry, and scrub oak. Coastal Oak forests typically contain a canopy of various tree oaks and little to no pitch pines in addition to "a nearly continuous shrub layer of huckleberry and blueberry" [3].

In order to validate the succession of the Pine Barrens, litter was measured in each of the four community types.

MATERIALS AND METHODS

Plots in the Central Pine Barrens throughout eastern Long Island were randomly selected using a Geographic Information System (GIS). Each plot was first located using a Global Positioning System (GPS) to insure that it was in the targeted community type

and more than 50 meters from disturbed areas, such as roads, wetlands, and other plots. Once the 16 x 25 meter plot was accepted, the boundaries were marked with measuring tapes. The 25-meter edge was placed parallel to any apparent data-influencing factor such as topography and human disturbance. A sighting compass and laser rangefinder were used to assure precise measurements.

Next a random starting point was chosen along the 16-meter tape to position the first of ten line transects, each 1.5 meters apart. Another random number determined the starting point for data collection on each transect. Shrub, tree, and herbaceous cover was recorded at twenty points, each one meter apart, along every transect. A narrow tent pole was used to determine each "hit" point and the phrenology (fruiting, flowering, or neither) of each plant was recorded the first time it was "hit" on each transect. A densitometer was used at each point to determine an exact reading of the canopy cover. The canopy cover was recorded as "pine," "hardwood," "both," or "nothing. Litter and duff depths were measured to the nearest millimeter at points 3, 8,13, and 18 along each transect. Litter was measured by dropping a ruler into the ground until a firm surface was reached. A soil corer was used to measure the duff layer. (The duff layer is a dark brown soil resulting from decomposed stems, roots, and charcoal between the litter and the mineral soil, which is usually gray or yellow.)

Belt transects were completed following the line transects. Tapes were placed at two, four, six, and eight meters along the sixteen-meter edge of the plot so that seedling and sapling data could be collected for four belt transects. Saplings that were >2.0 meters tall and ≤2.5 centimeters diameter at breast height (dbh) were tallied separately from those that were between 0.5 and 2.0 meters tall. Tree seedlings less than 0.5 meters tall

were recorded by species and placed into the following categories: “1-5,” “5-10,” and “>10.” Since more than 10 seedlings per belt transect corresponds to exceptional regeneration, 11 was the cap counted per species. Multiple stem plants were only counted once and scrub oak seedlings were not counted.

Next, data on trees, snags, and downed logs were collected. The diameter at breast height (dbh) was measured for all trees >10 centimeters dbh and data were recorded by species. Trees >2.5 centimeters and <10 centimeters dbh were tallied by species. Trees with multiple stems were counted as one tree, but the dbh of both trunks was measured and recorded. Downed logs greater than one meter in length and 10 centimeters dbh were measured in length and dbh at the middle and both ends.

Before leaving the plot, we estimated the percent cover and average height of each stratum including trees, shrubs, vegetation, and epiphytes. The slope and aspect of the plot were also measured using a clinometer and a compass. The edges and center of the plot as well as a witness tree were marked so that the plot can be located in the future. Digital photographs were also taken from the center to each corner of the plot.

A total of 40 plots were measured, however 10 were excluded from the study due to the vagueness of the actual community type. The breakdown of the 30 plots included for data analysis is noted in table 2. Litter depth data for each plot (the forty points sampled) was averaged to create a mean litter depth for each plot. This data was then sorted by community type and graphically analyzed.

RESULTS

Table 1 illustrates the community type and average litter depth of each plot used for this research. The range of average litter depth for the 30 plots is [3.25, 10.95 cm]. This wide range is better depicted in figure 2, which shows the average litter depth for

each community type. Pitch Pine forests have the most litter, with an average depth of 8.58 centimeters (cm) and standard deviation of 1.94 cm. Pine-Oak forests have an average litter depth of 7.48 cm and standard deviation of 1.04 cm. Oak-Pine and Coastal Oak forests have comparable litter depths. Oak-Pine forests have an average litter depth of 4.81 cm and standard deviation of 0.82 cm while Coastal Oak forests have an average litter depth of 4.41 cm and standard deviation of 0.81 cm.

There was some variance in the average plot litter depths for each community type, which can be seen in table 3 and figure 3. Table 3 shows the standard deviation and variance for each community type. The graph in figure 3 shows that the trends are still evident even though litter depth data differed from plot to plot. Since all of the plot average litter depths are within two standard deviations of the average litter depth for the corresponding community, the variance in the data can be considered usual.

In figure 4, the average number of tree oak seedlings per plot was compared to the average number of pine seedlings. This data was then graphed by community type. Pitch Pine and Pine-Oak forests had similar results; with 15.75 and 18.75 tree oak seedlings per plot respectively. Both had an average of less than one pine seedling per plot. Oak-Pine forests have outstanding regeneration, with an average of 32.83 tree oak seedlings and 6.10 pine seedlings per plot. Coastal Oak forests have an average of 25.36 tree oak seedlings and less than one pine seedling per plot.

DISCUSSION AND CONCLUSION

By comparing the data in figure 1 to the forest succession diagram in figure 5, it is evident that litter depth plays an important role in the transitions of forest succession. The early stages of succession, Pitch Pine and Pine-Oak, have a high average litter depth

per plot whereas the later stages of succession, Coastal Oak and Oak-Pine, have lower litter depths. Figure 1 directly correlates to figure 5, the already determined succession of the Pine Barrens. This data can be considered statistically significant since the data for each community type is within two standard deviations of its' corresponding mean. Even though there was slight variation in the data due to inaccuracy of measuring and other factors (as shown in figure 3) the data collected is still usable.

Furthermore, this research demonstrates better regeneration in the later stages of succession. Figure 4 shows that Coastal Oak and Oak-Pine forests have a higher density of seedlings per plot than Pine-Oak and Pitch Pine forests. The likely explanation is that relatively shallow litter depth permits sunlight to directly reach the soil for better tree regeneration. In fact, the tree oaks most common to the Pine Barrens (*Quercus alba*, *Quercus velutina*, and *Quercus coccinea*) require light litter cover and full to partial sun for seedling establishment [7, 8]. This coincides with findings of a higher density of tree oaks in areas of reduced litter depth.

Similarly, pine (*Pinus rigida*) requires exposed mineral soil, i.e. absence of litter, and partial to full sun for seedling growth. This is also reflected in the results since pine seedlings were only found in areas of light litter. However, it should also be noted that pitch pine cones can require exposure to fire in order to spread the pine seeds for growth. After a period of 10 to 20 years without occurrence of fire, the oak canopies close, restricting the soils' access to sunlight. The pine trees in the canopy can persist, but pine seedlings cannot germinate with the excessive litter and lack of sunlight [7].

Furthermore, community transitions because of succession occur at a very slow rate without initiation by fire. Therefore, it is sometimes necessary to prescribe forest

fires and establish and maintain them safely and correctly. In the near future, researchers should use the data findings of the Central Pine Barrens Monitoring Program to determine a litter depth threshold. This would enable prescribed fires to be properly timed for maximum conservation efforts. Restoration and management of the Pine Barrens should be established and started as soon as possible so that future generations can enjoy the unique and fascinating resources that it holds.

ACKNOWLEDGMENTS

This research was conducted at Brookhaven National Laboratory. I would like to thank my mentor Timothy Green and my advisor Robert Anderson for all of their direction and guidance during the course of the summer. Additionally, I thank the U.S. Department of Energy, Office of Science, and the SULI program for allowing me the opportunity to participate in such an exceptional and fulfilling internship program. Special thanks also goes to the other members of the program crew: Kathryn Gutleber, Andrew Siefert, Matthew Kull, Miranda Davis, and Chauncey Leahy.

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TABLES

Plot #	Community Type	Average Litter depth (in centimeters)
1	Pine-Oak	5.935
2	Oak-Pine	5.38
3	Oak-Pine	5.5
4	Pitch Pine	6.1875
5	Oak-Pine	4.65
9	Pitch Pine	8.65
10	Coastal Oak	5
11	Pine-Oak	7.7725
13	Coastal Oak	5.325
15	Pine-Oak	8.0125
16	Pitch Pine	8.55
17	Pitch Pine	10.95
18	Coastal Oak	3.4625
19	Coastal Oak	4.6
23	Coastal Oak	5.475
24	Oak-Pine	5.6
25	Coastal Oak	3.675
26	Coastal Oak	4.05
27	Coastal Oak	5.075
29	Oak-Pine	4.1625
30	Oak-Pine	4.8375
31	Coastal Oak	3.5875
32	Coastal Oak	3.25
33	Oak-Pine	5.3625
34	Oak-Pine	5.9875
36	Pine-Oak	8.2
37	Oak-Pine	3.9875
38	Oak-Pine	3.6875
39	Coastal Oak	4.9625
40	Oak-Pine	3.74

Table 1. The community and average litter depth results of each plot. Average litter depth = average of the 40 measured litter depths.

Plant Community	Number of plots
Pitch Pine	4
Pine-Oak	4
Oak-Pine	11
Coastal Oak	11

Table 2. The community type breakdown of the 30 plots used in this research.

	Pitch Pine	Pine-Oak	Oak-Pine	Coastal Oak
Litter Depth (cm)	8.5844	7.48	4.8086	4.4057
Standard Deviation	1.9448	1.0448	0.8151	0.8181
Variance	3.7822	1.0915	0.6644	0.6692

Table 3. The average litter depth of each community type (the mean of the average litter depth for each plot by community type). Standard deviation and variance of each mean is also displayed.

FIGURES

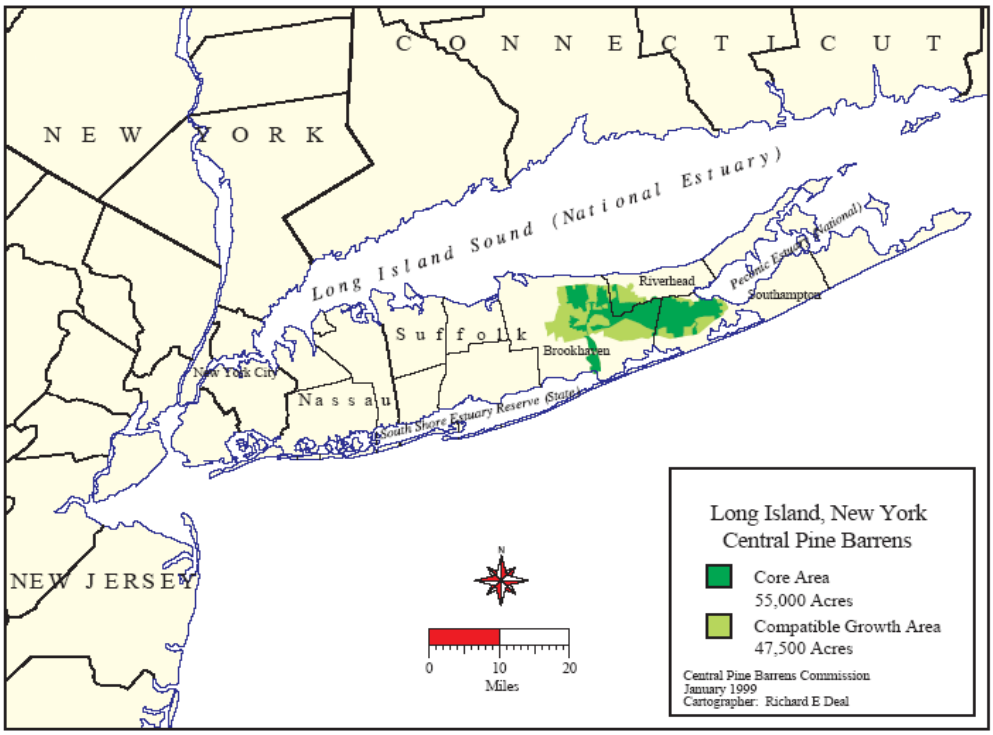


Figure 1. A map of the Central Long Island Pine Barrens indicating the core preservation area.

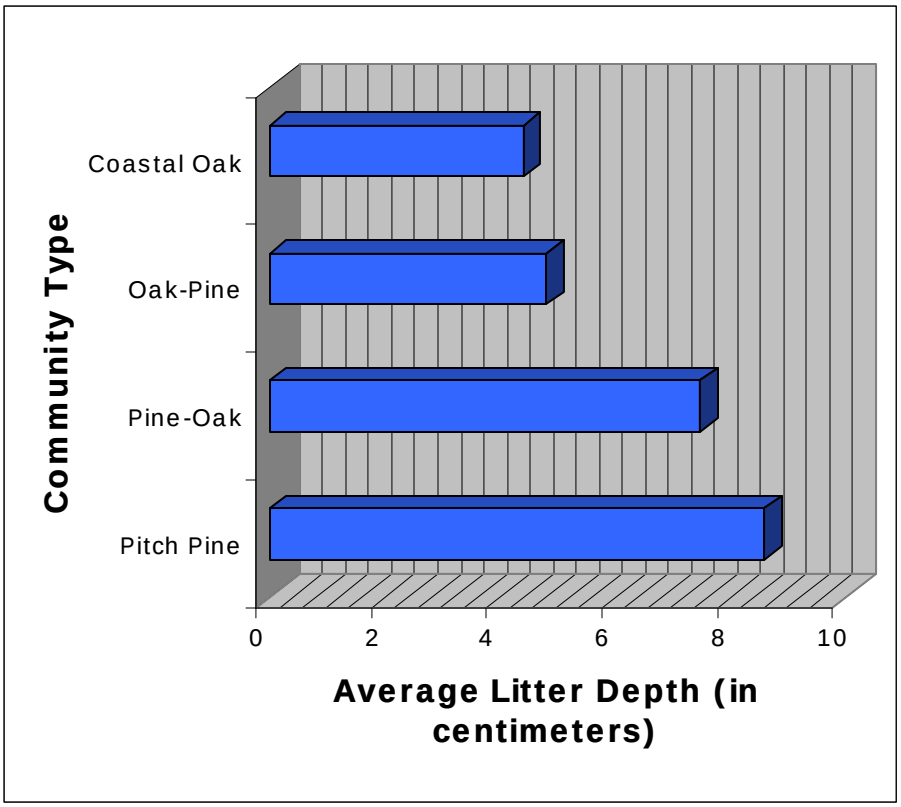


Figure 2. A comparison of average litter depth by community type.

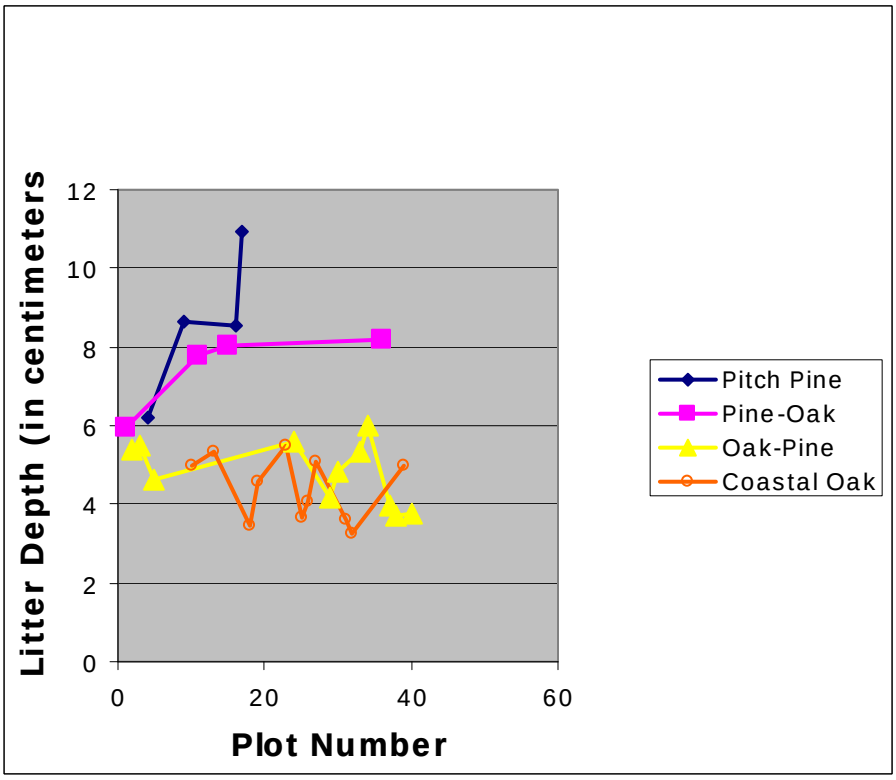
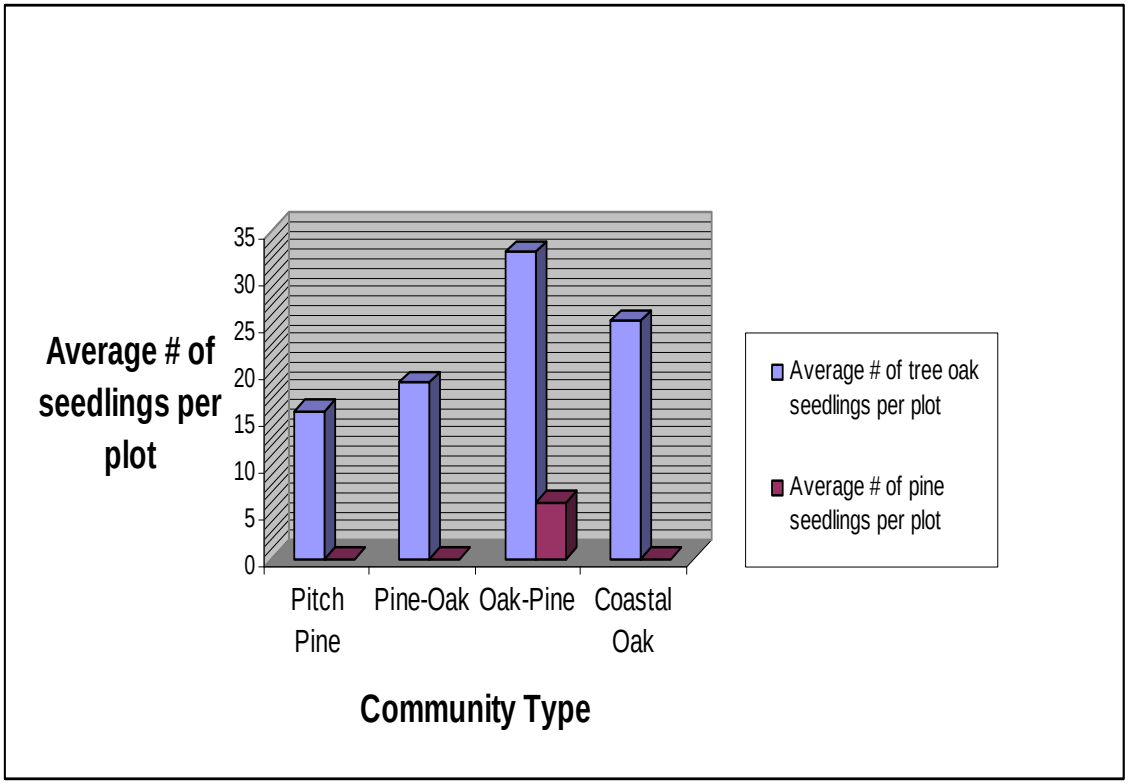


Figure 3. The average litter depth of each plot graphed to show variation in results for each community type.



Community Type	Average Number of Tree Oaks seedlings per plot	Average # of Pine seedlings per plot
Pitch Pine	15.75	<1
Pine-Oak	18.75	<1
Oak-Pine	32.82	6.1
Coastal Oak	25.36	<1

Figure 4. A comparison of the average number of tree oak seedlings to pine seedlings for each community type (in table and graph form).

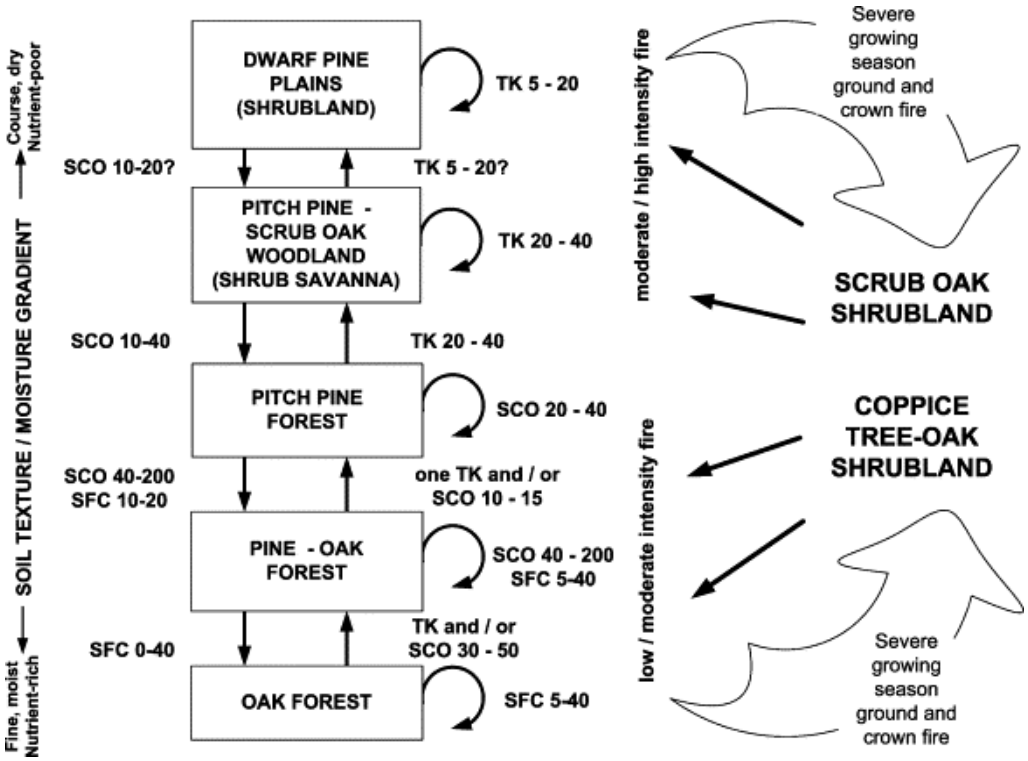


Figure 5. The already determined succession of the Long Island Pine Barrens [7].