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

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ABSTRACT

A Comparison of Litter Densities in Six 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) ARIANNA BREISCH, M.S. (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. The purpose of this ten year longitudinal study 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. Litter densities from Pitch Pine, Pine-Oak, Oak-Pine, Coastal Oak, Scrub Oak, and Dwarf Pine 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 twenty five by sixteen meter plots of land were selected throughout eastern Long Island and then thoroughly surveyed. Litter and duff depth data were collected at four 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 6.12 centimeters. Pine-Oak forests have an average litter depth of 6.03. Oak-Pine and Coastal Oak forests have comparable litter depths. Oak-Pine forests have an average litter depth of 5.01 while Coastal Oak forests have an average litter depth of 4.82. Scrub Oak lands have almost no litter with an average depth of 3.63 while Dwarf Pine Forests have an average litter depth of 2.49. A comparison of

the vastly different litter densities of the six 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. Data collected under the Central Pine Barrens Monitoring Program was used to determine a threshold for litter density, 4.82 cm. However, this trend is only from the first two years of research. In the future, a more accurate threshold can be determined 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 [4]. A major project of FERN is the Central Pine Barrens Monitoring Program. The goal of this longitudinal 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 summers of 2005 and 2006. Pitch Pine, Pine-Oak, Oak-Pine, Coastal Oak, Scrub Oak, and Dwarf Pine community types 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 (Gaylussacia baccata), blueberry (Vaccinium sp.), and scrub oak (Quercus ililcifolia). 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." Scrub Oak forests have a canopy of less than 59% that consist of primarily pitch pine trees and some oak trees. There is generally a continuous layer of scrub oak and scattered huckleberry and blueberry. Dwarf Pine

forests lack canopy cover and contain Pitch Pine and Dwarf Pines that are about two meters tall. The presence of scrub oak is nearly continuous [3].

In order to validate the succession of the Pine Barrens and determine a threshold for litter density, litter was measured in each of the six 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.

To establish transects, 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 phenology (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 and ruler were 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.

A total of 91 plots were measured, however 3 were excluded from this study due to the vagueness of the actual community type. The breakdown of the 88 plots included for data analysis is noted in Table 2. Litter depth and seedling data for each plot (the 88 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 as well as the average number of tree oak and pine seedlings per plot. The range of average litter depth for the 88 plots is [1, 10.95 cm]. This wide range is

better depicted in Table 3 and Figure 2, which show the average litter depth for each community type. Pitch Pine forests have the most litter, with an average depth of 6.12 centimeters (cm) and standard deviation of 2.24 cm. Pine-Oak forests have an average litter depth of 6.03 cm and standard deviation of 2.66 cm. Oak-Pine and Coastal Oak forests have comparable litter depths. Oak-Pine forests have an average litter depth of 5.01 cm and standard deviation of 0.86 cm while Coastal Oak forests have an average litter depth of 4.82 cm and standard deviation of 1 cm. Scrub Oak forests have an average litter depth of 3.63 cm and standard deviation of 1.66 cm. Dwarf Pine forests have an average litter depth of 2.45 cm and standard deviation of 1.14 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. Because of this, the data is statistically significant and therefore information can be gathered from it.

In Table 4 and 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. Pitch Pine forests have 12.3 tree oak seedlings on average with a standard deviation of 12.76, while only 5.76 pine seedlings on average with a standard deviation of 7.69. Pine-Oak forests have 20.67 tree oak seedlings on average with a standard deviation of 16.89, while only 2.83 pine seedlings on average with a standard deviation of 5.08. Oak-Pine and Coastal Oak

forests have outstanding regeneration. Oak-Pine forests have an average of 24.5 tree oak seedlings with a standard deviation of 18.03 and 2.77 pine seedlings per plot with a standard deviation of 5.26. Coastal Oak forests have an average of 27.11 tree oak seedlings with a standard deviation of 13.92 and less than one pine seedling per plot with a standard deviation of 1.69. Scrub Oak forests have 5.71 tree oak seedlings on average with a standard deviation of 10.5, while only less than one pine seedling on average with a standard deviation of 0.17. Dwarf Pine forests have 0 tree oak seedlings on average with a standard deviation of 0 and less than one pine seedling on average with a standard deviation of 0.5.

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. Scrub Oak Shrubland and Dwarf Pine Plain forests show lower average litter depths and are not necessarily part of the normal forest succession. 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, Pitch 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. "Many seedlings have grown to more than six feet tall in the areas burned by the 1995 (Sunrise) fires" [9]. Pitch Pine and Scrub Oak forests are endangered community types and since these forests support uncommon species of plants and animals, it is beneficial to preserve the lands.

From the data findings of the Central Pine Barrens Monitoring Program in 2005 and 2006, a litter depth threshold of 4.82 cm. was determined. This piece of data enables

prescribed fires to be properly timed for maximum conservation efforts. Resource managers of the New York State Department of Environmental Conservation can control forest fires in areas of Coastal Oak (and some Oak-Pine) forest with a litter depth of about 4.82 cm. This will jump start the forest succession and initiate more pitch pine tree growth and therefore rejuvenate the forest and help to save the endangered forest types (Pitch Pine, Scrub Oak, and Dwarf Pine)[9].

The baseline data of this research shows an abundance of Coastal Oak and Oak Pine forests as well as little regeneration in the areas of concern. Without prescribed fires it seems more than likely that the endangered community types of the Long Island Central Pine Barrens will gradually disappear.

When this project is continued in ten years, a new threshold of litter depth should be determined. Since the lands will have changed dramatically, this will help restore and manage the Pine Barrens in the most efficient way.

Prescribed forest fires should be planned and started as soon as possible so that future generations can enjoy the unique and fascinating resources that the Long Island Central Pine Barrens holds.

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TABLES

Plot #	Community Type	Avg. Litter depth (in cm.)	Avg. # of tree oak seedlings	Avg. # of pine seedlings	Plot #	Community Type	Avg. Litter depth (in cm.)	Avg. # of tree oak seedlings	Avg. # of pine seedlings
1	Pine-Oak	5.94	43	0	46	Oak-Pine	5.31	43	11
2	Oak-Pine	5.38	39	0	47	Pine-Oak	6.39	4	2
3	Oak-Pine	5.5	1	0	48	Oak-Pine	5.94	17	1
4	Scrub Oak	6.19	29	0	49	Pine-Oak	4.56	13	0
5	Oak-Pine	4.65	13	0	50	Pine-Oak	5.49	16	0
6	Coastal Oak	5.09	57	0	51	Pine-Oak	6.47	21	0
7	Coastal Oak	6.38	15	1	52	Pine-Oak	7.03	26	0
8	Coastal Oak	5.56	18	0	53	Oak-Pine	5.07	0	0
9	Pitch Pine	8.65	11	0	54	Oak-Pine	3.93	16	0
10	Coastal Oak	5.14	17	0	55	Oak-Pine	4.64	39	0
11	Pine-Oak	7.77	18	0	56	Oak-Pine	5.31	26	0
12	Coastal Oak	5.55	50	0	57	Oak-Pine	5.84	33	0
13	Coastal Oak	5.41	20	0	59	Oak-Pine	4.84	3	0
14	Pitch Pine	6.13	31	2	61	Pitch Pine	8.35	4	3
15	Pine-Oak	8.01	21	0	62	Pitch Pine	7.69	15	1
16	Pitch Pine	8.55	16	0	63	Pitch Pine	5.76	19	8
17	Pitch Pine	10.95	50	0	64	Oak-Pine	4.44	22	17
18	Coastal Oak	3.49	22	7	65	Oak-Pine	4.29	78	0
19	Coastal Oak	4.6	38	0	66	Pitch Pine	3.51	3	4
20	Coastal Oak	4.13	29	0	67	Oak-Pine	4.4	26	1
21	Coastal Oak	6.45	8	1	68	Oak-Pine	4.25	1	10
22	Oak-Pine	7.43	44	1	69	Pitch Pine	3.65	2	0
23	Coastal Oak	5.43	28	3	70	Pitch Pine	5.86	0	25
24	Oak-Pine	5.6	24	0	71	Pitch Pine	3.91	5	15
25	Coastal Oak	3.68	44	3	72	Pitch Pine	3.38	2	11
26	Coastal Oak	3.4	33	0	73	Pitch Pine	4.1	8	18
27	Coastal Oak	5.02	15	0	74	Scrub Oak	1.64	3	9
28	Oak-Pine	5.55	36	0	75	Scrub Oak	2.59	6	1
29	Oak-Pine	4.11	44	0	76	Scrub Oak	3.4	0	0
30	Oak-Pine	5.234	16	0	77	Oak-Pine	4.49	0	0
31	Coastal Oak	3.59	25	2	78	Scrub Oak	5.0	0	4
32	Coastal Oak	3.35	11	2	79	Pitch-Pine	3.84	13	0
33	Oak-Pine	5.3625	42	1	80	Pitch-Pine	6.94	0	0
34	Oak-Pine	5.99	46	0	81	Oak-Pine	5.24	3	1
35	Oak-Pine	6.43	27	0	82	Oak-Pine	5.49	6	0
36	Pine-Oak	8.2	29	0	83	Dwarf Pine	2.63	0	0
37	Oak-Pine	3.99	22	1	84	Scrub Oak	2.13	0	4
38	Oak-Pine	3.69	24	0	85	Scrub Oak	4.43	2	1
39	Coastal Oak	4.96	18	7	86	Dwarf Pine	2.57	0	0
40	Oak-Pine	3.74	14	14	87	Dwarf Pine	3.78	0	0
41	Pine-Oak	4.5	57	2	88	Dwarf Pine	1	0	1
42	Coastal Oak	5.5	40	0	89	Pine-Oak	2.55	0	0
43	Oak-Pine	4.2	30	12	90	Pine-Oak	5.43	0	0
44	Pitch Pine	5.46	17	22	91	Pitch Pine	7.24	13	0

Table 1. The community, average litter depth, and average number of tree oak and pine seedling results of each plot. Average litter depth = average of the 40 measured litter depths. Average seedling number per plot =average of the 4 belt transects.

Plant Community	**Number of plots**
Dwarf Pine	4
Scrub Oak	7
Pitch Pine	17
Pine-Oak	12
Oak-Pine	30
Coastal Oak	18

Table 2. The community type breakdown of the 91 plots used in this research.

	Dwarf Pine	Scrub Oak	Pitch Pine	Pine-Oak	Oak-Pine	Coastal Oak
Litter Depth (cm)	2.45	3.63	6.12	6.03	5.01	4.82
Standard Deviation	1.14	1.66	2.24	2.66	0.86	1
Variance	1.31	2.75	5.02	2.75	0.74	1

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.

Community Type	Average Number of Tree Oaks seedlings per plot	Standard Deviation for Tree Oak Seedlings	Average # of Pine seedlings per plot	Standard Deviation for Pine Seedlings
Dwarf Pine	0	0	<1	0.5
Scrub Oak	5.71	10.5	0.29	0.17
Pitch Pine	12.29	12.76	5.76	7.69
Pine-Oak	20.67	16.89	2.83	5.08
Oak-Pine	24.5	18.03	2.77	5.26
Coastal Oak	27.11	13.92	<1	1.69

Table 4. The average number of tree oak and pine seedlings for each community type. Standard deviation is shown for each mean.

FIGURES

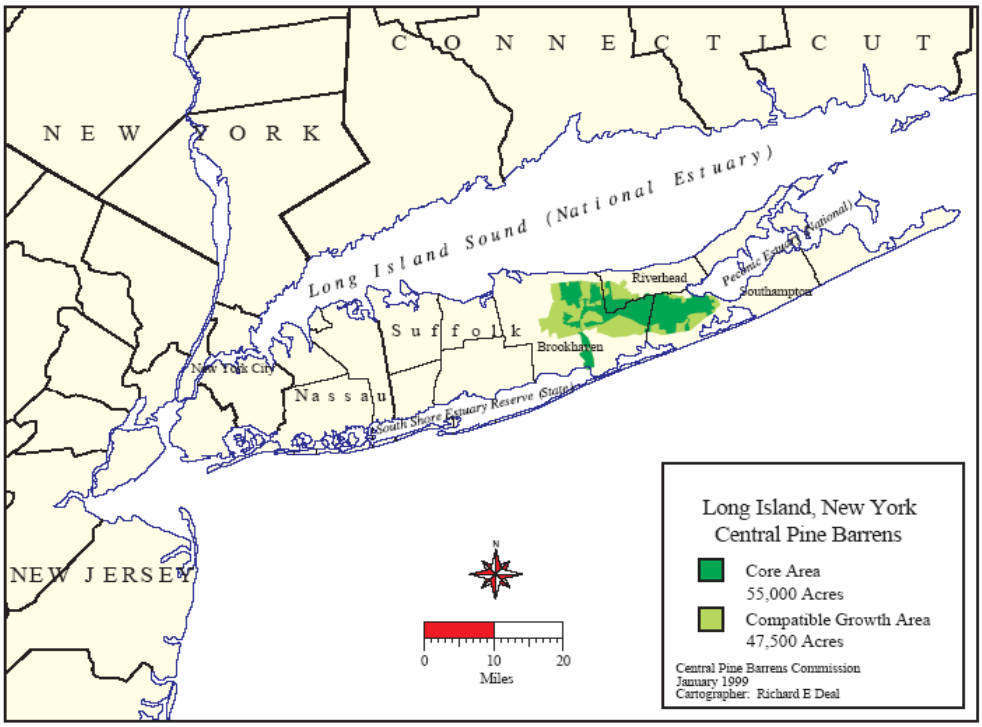

Figure 1. A map of the Central Long Island Pine Barrens indicating the core preservation area.

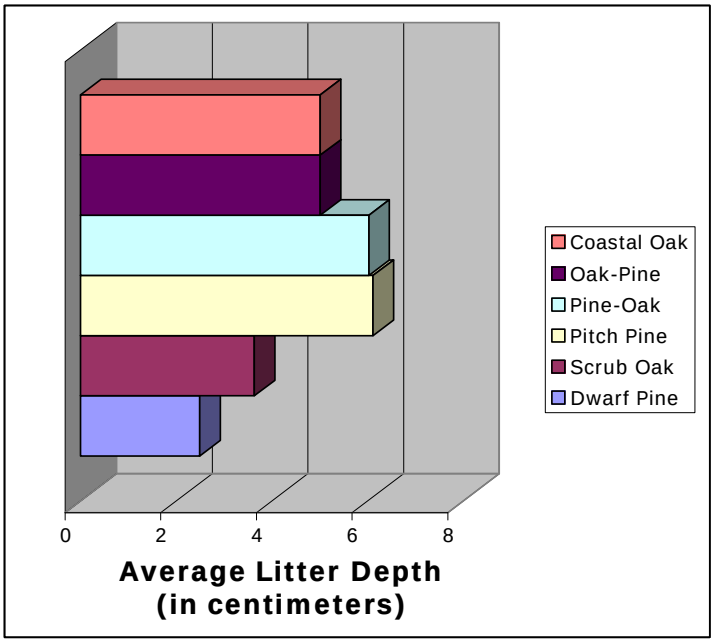

Figure 2. A comparison of average litter depth by community type.

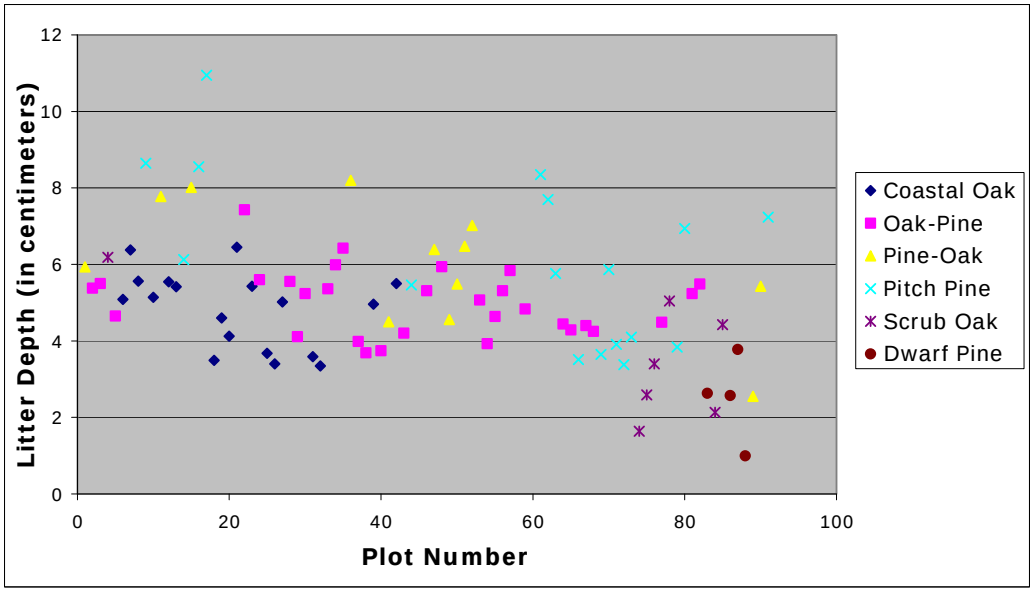

Figure 3. The average litter depth of each plot graphed to show variation in results for each community type.

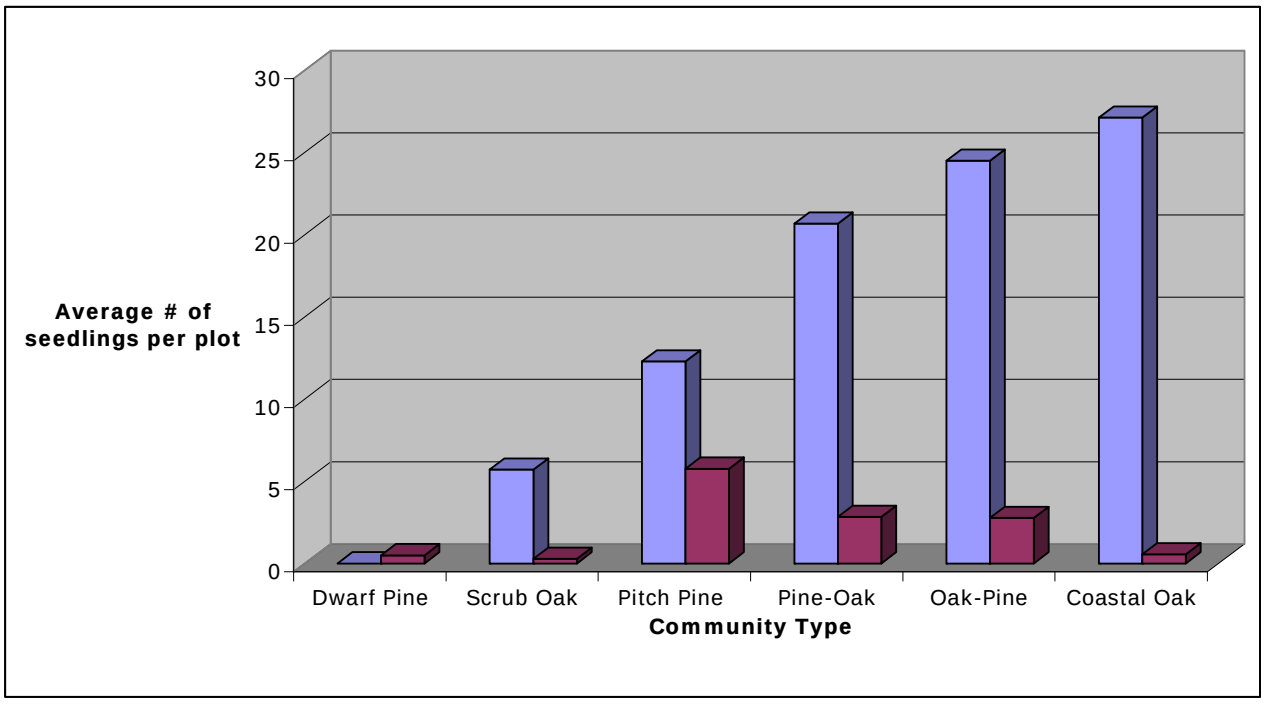

Figure 4. A comparison of the average number of tree oak seedlings to pine seedlings for each community type.

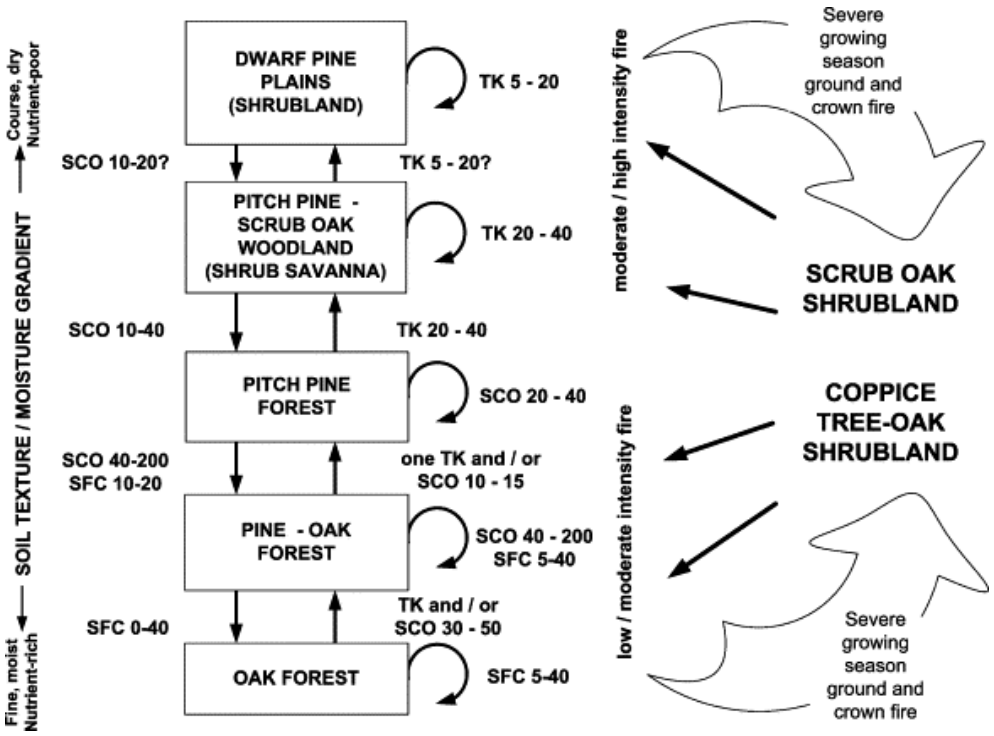

Figure 5. The already determined succession of the Long Island Pine Barrens [7].