Baseline pH and the Variability of pH within Plots and Community Types of the Central Pine Barrens.

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ABSTRACT

Baseline pH and the Variability of pH within Plots and Community Types of the Central Pine Barrens. NEAL JACK (The Pennsylvania State University, University Park, PA 16801) TIMOTHY GREEN, PhD (Brookhaven National Laboratory, Upton, NY 11973).

The Long Island Central Pine Barrens (CPB) is a valuable natural resource for its beauty, natural water aquifer and for being the habitat of many endangered and threatened species of plants animals and insects. The Foundation for Ecological Research in the Northeast (FERN) is an organization committed to the preservation of the Pine Barrens ecosystem by maintaining or improving the health of the forests located in the CPB. FERN, in conjunction with other organizations, implemented a ten-year longitudinal study on the health of the CPB. Data collected on the pH of the soil will provide a piece of the baseline health record for this ten-year longitudinal study. To establish a baseline health record for each forest type, several 16 x 25m plots were set up, according to established protocols, within each forest community type. Using a Kelway HB-2 Soil pH meter / moisture tester the pH of the soil was taken at eight points within each plot. The average pH of the forest types were 6.3 for Coastal Oak, Pitch Pine 5.9, Pine-Oak 6.0, Oak-Pine 5.9, Pitch Pine Scrub Oak 6.1, and 6.1 for Dwarf Pine. Analyzing this data and data collected at the end of the ten-year study will be valuable in determine the long-term health of the forest as well as the effect of human intervention such as acid rain pollution.

INTRODUCTION

The Long Island Central Pine Barrens (CPB) is a valuable natural resource for its beauty, natural water aquifer and for being the habitat of many endangered and threatened species of plants, animals and insects. In 2005 the Foundation for Ecological Research in the Northeast (FERN) began research with funding provided by The Central Pine Barrens Joint Planning and Policy Commission to collect and monitor the forests in the CPB. The research was continued in 2006 to ensure enough data was collected to establish a baseline health record. In ten years the research will be repeated at the same plots that were studied in 2005 and 2006. This ten year longitudinal study is expected to provide enough data to detect small changes in the forests health.

There are several measures of forest health including, but not limited to, flora and fauna diversity, litter, canopy cover and pH of the soil. Soil pH is important because it has a role in determine what is able to survive in the soil. The pH of the soil will vary within a single plot, between different plots of the same community type and within different forest community types. Soil acidity will vary within a plot because of the flora that provide the canopy and the organic matter on the ground [1].

The purpose of this research was to establish baseline pH levels for the CPB and to determine the correlation between pH and the surrounding environment such as flora and fauna. This research may help gain insight into both the reasons for changes in forest community types as well as helping to determine a timeline for the changes.

MATERIALS AND METHODS

The data used in this research was collected in the summers of 2005 and 2006 in the Long Island CPB using protocols established in the Monitoring Protocols for Central Pine Barrens Field Plots [2]. Using Geographic Information System (GIS) software, orthophoto quad satellite maps of Long Island were examined and random numbers were assigned to plots where a particular forest type was thought to be located. After the random numbered sites were located an initial assessment was completed to make sure the plot was in fact the expected forest type. If so, the plot was established.

The rectangular plot was first outlined with tapes running 16 and 25 meters in length with the tapes being held by stakes at the four corners. Next ten transects were run starting from a randomly picked number and continued down the 16-meter side every 1.5 meters. According to the protocols, each transect had a randomly selected starting point and 20 readings 1 meter apart. Measurements taken included; canopy cover, ground cover, litter depth, duff depth, number of trees and saplings, size of trees, and pH of the soil. All these measurements were not taken at every point but were taken at the assigned points in the protocols. Within the plots a total of eight pH measurements were taken, four near the edges of the plot and four near the center to ensure comprehensive data. The points were points 3 & 18 on transect 1 & 7 and points 8 & 13 on transects 3 &5 which is illustrated in Figure 1. All data was written on the field forms and then transcribed to the FERN Forest Health database [2].

The data used was collected from 90 plots; 18 from Pitch Pine, 18 Coastal Oak, 31 Oak-Pine, 12 Pine-Oak, 4 Dwarf Pine and 7 Pitch Pine Scrub Oak. The minimum

number of plots for each community type was decided based on the relative percentage of each community type in the CPB with consideration of statistics and having enough data to ensure an accurate representation of the CPB.

Using Microsoft Access and Excel, the data was analyzed to find the average pH for the community type, average pH for the plots in a community type (minimum/maximum plot avg. pH), minimum/maximum pH readings within a community type, standard deviation of average pH, variance between plots in a community type and variance between community types were all found.

Results

For the purpose of accuracy, the averages contain all data collected from both 2005 and 2006. However for the variability in pH only plots that contained eight pH readings were included unless no plots within that community type contained eight. The average pH values for the different community types are shown in Table 1 with 6.0 Pine-Oak, 5.9 Oak-Pine, 5.9 Pitch Pine, 6.3 Coastal Oak, 6.1 Pitch Pine Scrub Oak and 6.1 Dwarf Pine with the maximum pH value collected was 7 and the minimum 4.2.

Within the three community types with canopies greater than 5 meters (Pitch Pine, Oak-Pine and Pine-Oak) the pH values are consistent throughout the community types. The only variability is with the plot averages. For minimum plot average pH there is a difference of 1.0 between Pitch Pine and both Pine-Oak & Oak-Pine, with 0.5 difference in maximum average pH.

The three remaining community types Coastal Oak, Dwarf Pine and Pitch Pine-Scrub Oak all have very similar pH readings. The greatest difference in readings is the

maximum plot average pH (the plot within the community type with the highest average pH) of 0.4 and the minimum pH reading.

In Table 2 the average pH values of the soil under different tree species in the three communities with canopies are listed. The differences in the soil pH below oak trees in Pine-Oak compared to Oak-Pine forests were 0.2 while under pines it was 0.6. Also listed are the pH values of the soil in relation to the canopy cover for the point. For Pitch Pine the pH range was from 6.0 under the trees to 5.7 at the edge and 5.8 under no canopy. With Oak-Pine the pH average was 5.8 under the tree and at the edge.

DISCUSSION AND CONCLUSION

The average pH values measured in this research are higher than averages measured in other forests with the same tree species present. The difference in soil pH was 0.4 higher in the Oak-Pine forests of the CPB than the Oak forests studied in Massachusetts (4.3-5.5 pH) [3]. Pitch Pines measured 0.8 higher than other Pitch Pine forests that were studied in New Jersey (3.5-5.1) [4]. The standard deviation values on Table 1 can account for some of the differences in measured pH values since the standard deviation for both forest types are about 0.3. Factoring this in makes the values within 0.2 of the averages measured elsewhere.

Possible reasons that the community types in the CPB are higher could be due to the unique location of the CPB, soil make-up and method of testing. Location could play a role in varying pH because Long Island has many different natural features not present in other Pine Barren locations such as the Atlantic Ocean, Long Island Sound, topography, geographic location etc. These features are possible in other locations but

the combination is unique. The soil make-up for each plot in a community was similar, however the litter and duff depth vary from plot to plot [5]. A variance in soil make-up, such as differences in litter depth, affects soil acidity [1].

Overall, the method of testing appears to have the largest variability. The Kelway HB-2 Soil Acidity and Moisture Tester was a very easy instrument to use and maintain to gain a rough estimate of soil acidity. However according to J. Peters the Kelway HB-2 provided accurate results on soils close to pH 7.0 [6]. The error involved using this tester is 0.2 pH. The article went on to say that the pH readings were inaccurate due to soil texture, rainfall and manure. Litter depth, duff, mineral soil, wild animals and proximity to farms using fertilizer varied from plot to plot. The article also explored variances due to the amount of water used while testing the pH. The more water used the more chance for inaccurate pH readings due to an increase in electrical conducting materials. This is possible because the pH meter relies on two metal plates and the electrical potential between the plates [6]. Other methods exist to test pH including those discussed by Cedar McKay in his article about controlled burning [7]. The method used by McKay appears to have less variability in readings. This is accomplished by controlling the water content in the soil by first drying the sample and adding a constant amount to each before testing. Although the pH may not be exact because of the water altering the readings, the readings will be comparable with each sample having the same error due to water. To improve the quality of the data collected it may be beneficial to take the soil moisture content and compare only the data with similar moisture content.

Within the three community types with canopies all the readings and averages are consistent except the minimum and maximum plot averages because they average the

plot pH. This is important because on a day-to-day, week-to-week basis the soil composition will change. One scenario is conducting all research for Oak-Pines during rainy June week while conducting research for Pine-Oaks during a dry hot July week. The soil in June will contain more water than the soil in July because the sun will dry out the soil. Although water is added during pH testing the soil may not have time to absorb the water for a consistent reading.

The minimum and maximum pH values listed in Table 1 and the pH values for the soil under different canopy types in Table 2 are important because they show the variability in the plots. An example is the Pitch Pine Scrub Oak forests where the minimum pH is 5.4 and the maximum is 6.8. This is for the whole community type but each plot has a difference in pH readings of at least 0.2. This variability may be from the method of testing discussed earlier, the soil content and/or the canopy and shrub cover [1]. Canopy and soil composition have a role in soil acidity because the pH of rainfall is altered when it runs off leaves and the stems of plants. In northeastern Mexico the rainfall pH was measured when it had no contact with foliage, contact with the leaves and needles only (throughfall) and near the stem (stemflow)[8]. The pH of the throughfall in pine was 6.2, oak 6.3 and pine-oak 6.3 were higher then the rain without foliage contact at 6.6. Pine trees had stemflow of pH 3.7 and oak 6.0 [8]. The varying pH in rain would affect the soil pH from near the stem to near the edge of the canopy to a clearing in the forest. This affect would explain some of the variation of the soil pH within a plot.

To complete the ten-year longitudinal study the same pH testing method should be used because it would provide a consistent measuring standard. Further suggested research would be to collect samples under particular trees to determine the effect of

canopy cover on soil pH. For future research, it would be advisable to consider the use of a new method of testing pH in which the testing method is more consistent and less field dependant. Other related research would be to connect research on seedling and sapling quantities to pH and other soil properties to determine if conditions can be altered to assist seedling viability.

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TABLES

Community Type	Pine-Oak	Oak-Pine	Pitch Pine	Coastal Oak	Pitch Pine Scrub Oak	Dwarf Pine
Avg. pH	6.0	5.9	5.9	6.3	6.1	6.1
St. Dev.	0.39	0.34	0.27	0.3	0.18	0.25
Minimum pH	5.2	4.4	4.2	5	5.4	5.3
Maximum pH	6.8	6.9	6.8	7	6.8	7
Minimum Plot Avg. pH	5.7	5.5	4.7	5.6	5.7	5.7
Maximum Plot Avg. pH	6.0	6.5	6.5	6.8	6.6	6.4

Table 1. The Avg. pH, Standard Deviation, Minimum pH, Maximum pH, Minimum Plot Avg. pH and Maximum Plot Avg. pH for each community type.

Community Type	Pine-Oak	Oak-Pine	Pitch Pine
Avg. pH under Oak	5.9	5.7	-
Avg. pH under Pine	5.2	5.8	6
Edge of Tree	-	5.8	5.7
Sky	-	-	5.8

Table 2. Average soil pH in relation to canopy type for different canopy community types.

FIGURES

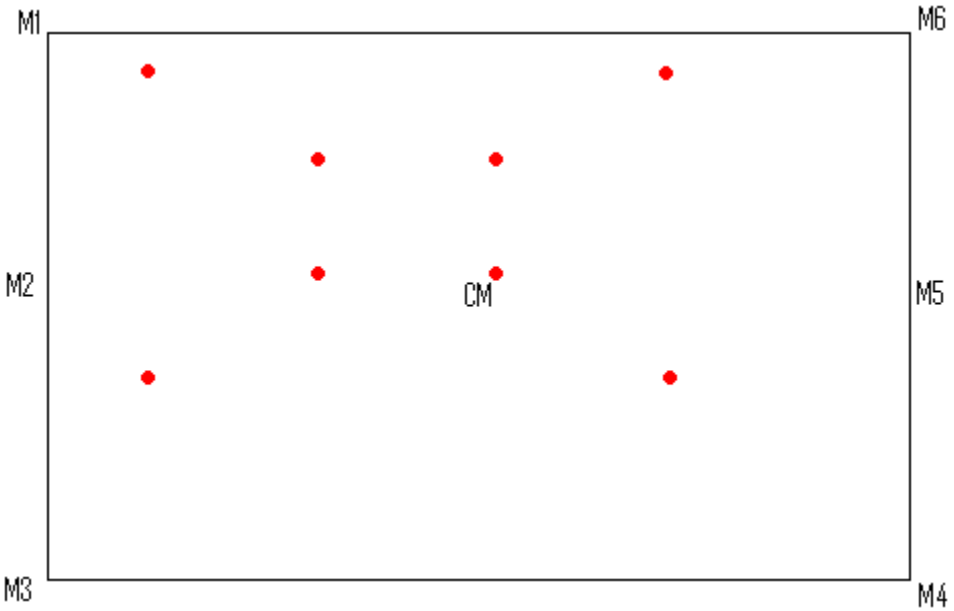

Figure1 Layout of a plot with red dots indicating where pH readings are taken