

# Long Island Pine Barren Ponds: Water Quality

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## Abstract

Ponds in the Pine Barren complex at Brookhaven National Laboratory (BNL), Near Road Ponds (NRP), Calverton Ponds (CP), Sears Bellow County Park Ponds (SBP), and ponds of the Long Pond Greenbelt (GP) of Suffolk County, NY were studied. A Magellan eXplorist 200 Global Positioning System (GPS) was used to mark each pond. A YSI 650 MDS Probe was used to measure the real-time data on temperature, pH, dissolved oxygen (DO), conductivity, and turbidity of the water. This study is specifically focused on the alkalinity, acidity, and the buffering capabilities of ponds within the Pine Barrens. We have collected three random surface water samples directly into 500 mL Nolegn bottles and one random water sample at two feet deep, from each pond of a total of 33 ponds located on and around BNL's site and of Suffolk County, NY, using a Plano Horizontal Polycarbonate Water Sampler. Water samples were analyzed using Hach Digital Titrator and TitraVer Solutions and were tested for acidity, alkalinity, calcium (Ca) and magnesium (Mg) hardness, and total hardness. The water temperature of each pond was greatly affected because some ponds were shaded by surrounding forest trees, while other ponds were directly exposed to the Sun. One of the goals of this project was to obtain the results of the physico-chemical analyses of water samples and focus on the most pressing water quality of pond problems in Long Island, NY. This study also gives a look at the variations of the pH levels of each pond and how they are affected by the atmospheric acid deposition. The results of this research show that there is no correlation between near-road ponds and off-road ponds. Results of this study will assist ecologists on how to manage the habitats of wildlife in the Long Island Pine Barren ponds.

## Introduction

Due to native acid conditions in Pine Barren ecosystems, ecologists are concerned about increased acid deposition from atmospheric sources, impacts on the local ponds, and effects on wildlife and local habitat. Acidity of water will have a greater impact on water quality and sediments. Eventually acidity due to natural and anthropogenic causes will have drastic effects on biota including some rare and endangered species of these pristine natural habitats, Long Island Pine Barren aquatic ecosystems. Water and sediment quality in wetlands of northeastern regions of the USA has been documented [1]. Several investigative reports were published on impact of acid rain and other man-made causes on loss of equilibrium in buffering mechanisms in wetlands of North America and Canada [2, 3, 4]. We have investigated a total of 33 ponds across the Suffolk County and collected data on limnological factors such as pH, acidity, alkalinity, calcium and magnesium hardness, total hardness and aluminum in water samples. Historical data of DOE at Brookhaven National Laboratory (BNL) indicated the presence of organic and approximately 14 inorganic contaminants (methyl mercury, copper-Cu, mercury-Hg, lead-Pb, silver-Ag, and iron-Fe) in the sediments of the PR complex, due to the laboratory practices during the 1940's through the 1980's [5, 6].

No peer-reviewed literature in the recent past, published in scientific journals, is available on limnological issues on the Long Island Pine Barren Ponds. Hence, the purpose of this research was to collect scientific ecological data on water from both on- and off-site experimental areas of BNL and to establish a database for future studies and management of natural resources on Long Island. The specific objectives were to: (a) analyze samples for physico-chemical factors; (b) compile and analyze data statistically; and (c) identify the interrelationships between abiotic factors such as pH and Ca, Mg, and Al. Our hypothesis is that the Long Island Pine Barren pond waters would be acidic, nutrient poor, and free of contaminants. There would be no significant difference in means (<0.05 and 0.01) of physico-chemical factors between and within the groups. We have investigated a total of 33 ponds in two major sections of the Long Island Pine Barrens (LIPB): on-site zone (BNL: P1-10&P21-24) and off-site zone (Near Road Ponds-NRP: P11-13; Calverton Ponds-CP: P14-16&P25-28; Sears Bellow Ponds-SBP: P17-20; and Greenbelt Ponds-GP: P29-33) as shown in Figure 1. The experimental sites are located between 18.679729-18.727803 E and 45.27356-45.40748 N.

## Materials and Methods

Three random surface water samples and one random water sample at 2' deep, using a Plano Horizontal Polycarbonate Water Sampler were collected and directly placed into 500 mL Nolegn polyethylene bottles. Acidity, alkalinity, calcium hardness, magnesium hardness, and total hardness in water were determined using Hach's Digital Titrator and TitraVer Solutions. Real-time field data on temperature, pH, dissolved oxygen (DO), conductivity, and turbidity were collected using a portable YSI 650 MDS Probe. Samples were stored on ice and analyzed immediately (<24 hrs.) for Ca and Mg hardness and total hardness, acidity, and alkalinity. Samples were acidified to pH <2 with 1:1 HNO<sub>3</sub> and preserved in 125 mL Nolegn polyethylene bottles for further analysis of aluminum concentrations using Direct Coupled Plasma (DCP) spectrometer following EPA 3050B method.

## Results

Results on water quality are summarized in Figures 2 to 4. Among all groups studied, GP study sites have higher pH values, close to neutral (6.8±0.13) and the minimum mean pH was recorded at BNL sites (5.5±0.25). Alkalinity readings varied between 27.9±1.69 to 82.9±23.5 ppm at BNL and GP, respectively. Calverton Pond sites have minimum amount of DO compared to Sears Bellow Pond site samples (4.1±0.89 vs. 6.9±0.55 ppm). NRP site samples have maximum concentrations of Ca (5.55±1.64 ppm) and the lowest mean acidity was recorded at SBP sites (13.7±0.69 ppm). Among various physico-chemical factors analyzed using one-way ANOVA, mean differences between groups (df = 4) for DO, acidity, and Al were significant (P<0.05). Two-tailed Pearson correlations indicated significant relationships between various physico-chemical factors at P<0.05, as shown in Table 2. There is no significant difference in data between surface water samples and 2' deep water samples.

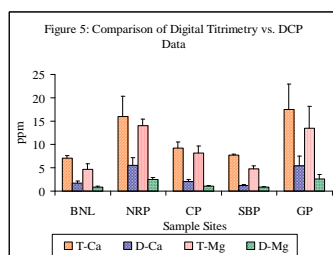
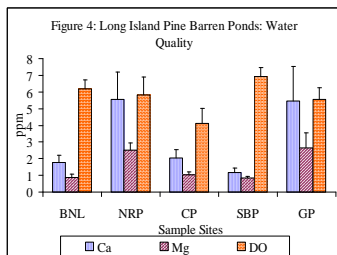
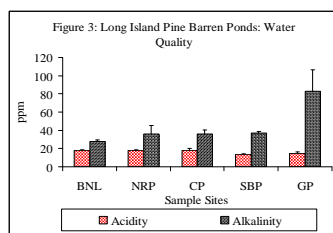
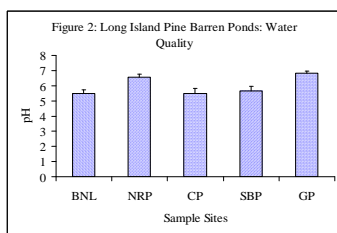
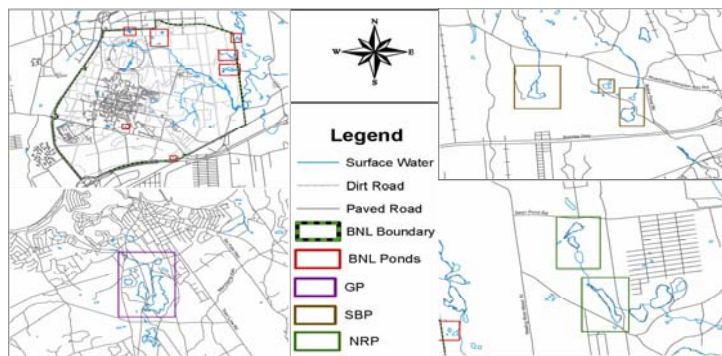


Figure 1. Experimental Sites



## Statistical Analysis

Mean, variance, standard deviation, standard error, Pearson two-tailed correlations, and one-way ANOVA were applied to measure difference in means and their significance levels between groups (BNL-n = 14; NRP-n = 3; CP-n = 3; SBP-n = 4; and GP-n = 5) using SPSS 10.0 version. Outputs of statistical analyses are summarized in Tables 1 & 2.

Table 1. One-way ANOVA (p < 0.05\*)  
(\*Equal mean variances Assumed)

		SS	F	Sign.
Ca	BG	86	4.058	0.01
	WG	149		
Mg	BG	17	4.764	0.005
	WG	25		
Alkalinity	BG	11475	6.241	0.001
	WG	12871		
Acidity	BG	95	2.028*	0.118
	WG	328		
Al	BG	0	0.354*	0.839
	WG	0		
pH	BG	9	3.621	0.017
	WG	18		
DO	BG	27	1.861*	0.145
	WG	101		

Table 2. Pearson Correlations (\*P<0.05; \*\*P<0.01) Sediments

Ca	Mg	0.960**
Ca	Alkalinity	0.799**
Ca	Al	-0.367
Ca	pH	0.669**
Mg	Alkalinity	0.812**
Mg	Al	-0.438
Mg	pH	0.680**
Alkalinity	pH	0.481**
Acidity	Al	0.474**
pH	Al	-0.35

## Discussion and Conclusion

BNL has a long history on inorganic and organic contaminants in sediments (1940s-1980s) and is listed as one of the US Environmental Protection Agency's (EPA) National Priorities List. It is necessary to quantify the extent of risks of these contaminants to BNL's aquatic sites and to its biota (plants, animals, microbes). In the current research project, we attempted to investigate several ponds (on-site and off-site) to identify the interrelationships between pH, Al, Ca and Mg hardness to understand the quality of water in test sites. Our results indicated that Ca, Borg (1987) made similar observations that surface water in North America has become acidic due to acid compounds and metals [7]. Stow (2001) reported that symptoms of excessive eutrophication are algal blooms, low dissolved oxygen, fish kills and outbreaks of toxic microorganisms in the Neuse River, North Carolina [8]. Ramachandran *et al* (1997) reported that carbon dioxide concentrations are higher in the summer, which can lead to the cause of the water being very acidic. They have also observed that the suspended solid concentrations were higher in the summer when compared to autumn [9]. Experimental results indicated that all our study sites have low DO without any visible fish, with a few encounters of frogs, and excessive amounts of tannins and suspended solids in acidic waters. Low pH can have a negative impact on metabolic processes of biota, biodiversity, excess amount of toxic metal accumulation in sediments, which in turn have bioaccumulation of metals in biotic tissues. Kessel-Taylor (1985) has proposed wetland-sensitivity rating to classify wetlands [10]. Based on his classification, most of the ponds that we studied currently fall under category # 4 in which we found low pH, low alkalinity, nutrient poor waters ultimately have an impact on buffering capacities. High acidic soils facilitate the mobility of elements such as Al, Ca, Mg and may enhance leaching activities. This may eventually cause ground water and surface water pollution during rains and snowmelt [4]. Kulp (2007) reported that a pH of 5 occurs approximately when the acid-neutralizing capacity of the lake equals zero and hence the lake is considered "acid"[11]. Most of the current study sites fall under this category. We observed an inverse interrelationship between DO (4.12±0.89 ppm) and total suspended solids (14.67±2.49 ppm) in sample sites of CP. This finding is in direct agreement with report published by Task Force on Water Quality Guidelines of the Canadian Council of Resource and Environment Ministers, 1979 [12].

In conclusion, experimental results were in partial agreement with our hypothesis (nutrient poor, low DO and pH). However, we reject null hypothesis, since our hypothesis was proven wrong regarding contaminants (such as Al) and mean differences among the groups of data sets.

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