Long Island Pine Barren Ponds: Water Quality

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August 10, 2007

Prepared in partial fulfillment of the requirements of the Office of Science, Department of Energy's Community College Institute of Science and Technology (CCI) Program under the direction of Dr. Murty S. Kambhampati, Professor of Biology at Southern University at New Orleans and Dr. Timothy Green, Natural Resources Manager in the Environmental and Waste Management Division at Brookhaven National Laboratory.

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ABSTRACT

Long Island Pine Barren Ponds: Water Quality. SHAKERA PINDER (Tallahassee Community College, Tallahassee, FL 32304) MURTY S. KAMBHAMPATI (Southern University at New Orleans, New Orleans, LA 70126) TIMOTHY GREEN (Brookhaven National Laboratory, Upton, NY 11973).

Ponds in the Pine Barren complex at Brookhaven National Laboratory (BNL), Near Road Ponds (NRP), Calverton Ponds (CP), Sears Bellows 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, the acidity, and the buffering capabilities of ponds within the Pine Barrens. We have collected three random surface water samples directly into 500 mL Nalgene bottles and one random water sample at approximately two feet deep, from each pond for 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 provides a look at the variations of pH within 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 and its 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 may have drastic effects on biota including some rare and endangered species of these pristine natural habitats of the 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 Suffolk County, NY and collected data on limnological factors such as pH, acidity, alkalinity, calcium and magnesium hardness, total hardness and aluminum in water samples.

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 45.27536-45.40748 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 Nalgene 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_3 and preserved in 125 mL Nalgene polyethylene bottles for further analysis of aluminum concentrations using Directly 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.

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 =7; SBP-n = 4; and GP-n = 5) using SPSS 10.0 version. Outputs of statistical analyses are summarized in Tables 1 & 2.

DISCUSSION AND CONCLUSION

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 [5]. 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 [6]. 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 [7]. 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 [8]. Based on his classification, most of the ponds that we studied currently fall under category # 4 in which we found low pH, low alkalinity, and 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” [9]. 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 [10].

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.

ACKNOWLEDGEMENTS

This work was supported by Brookhaven National Laboratory, Department of Energy, Tallahassee Community College, Florida A&M University, and The National Science Foundation. I thank Tim Green, Bruce Horwith, Marilyn Jordan, and Murty Kambhampati for providing transportation to all of the pond sites and all their hard work in making this research a huge success. Thanks also to Noel Blackburn, Wilburt Butler, Daniel Carrero, Jen Clodius, Amy Demarco, Byron Green, Kathy Gurski, Scott McLennon, Calandra Walker, Tabatha Wyche, and

fellow students for all their hard work and support in making this internship a great experience and enjoyable. Maps of the study sites were prepared by Ha'Wanna St. Cyr and Jennifer Higbie.

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Tables

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

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

Table 2. Pearson Correlations between various limnological factors (*P<0.05; **P<0.01)

Figures

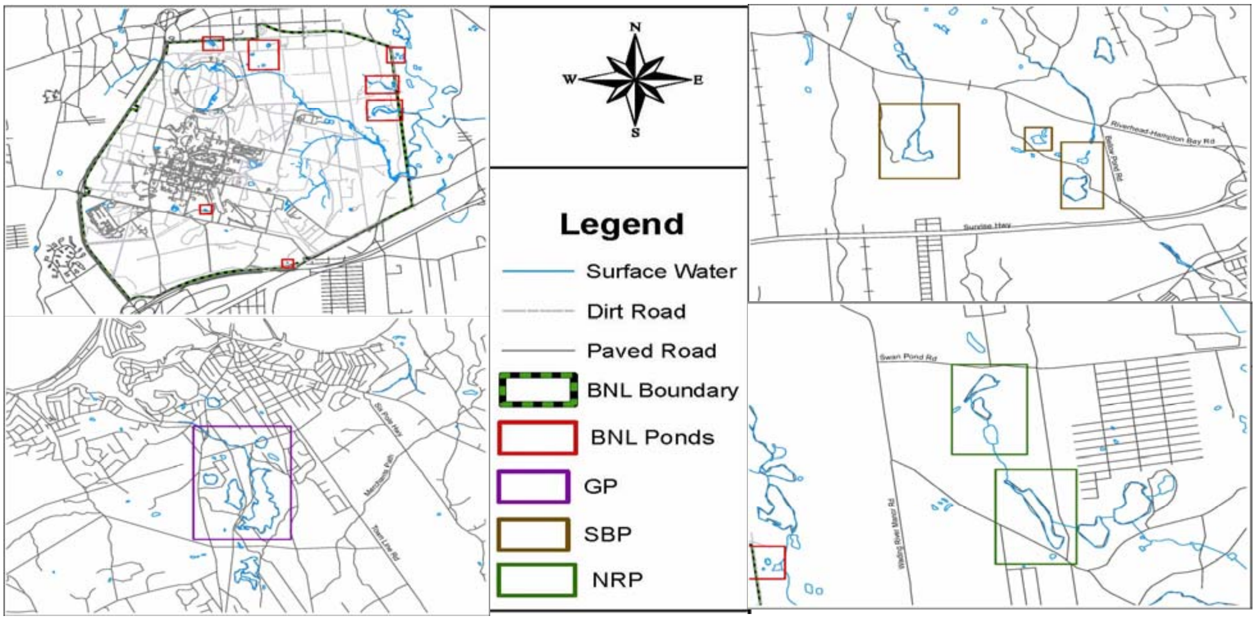

Figure 1. The Long Island Pine Barren Ponds: Experimental Sites.

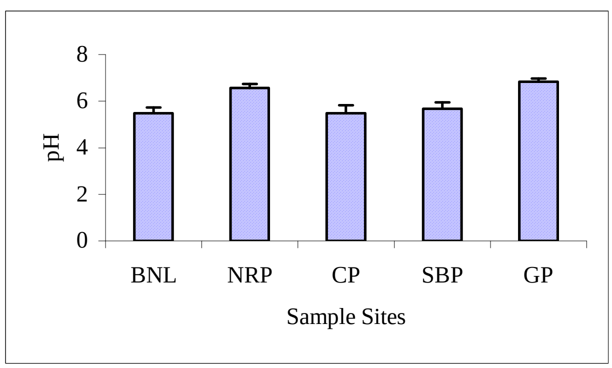

Figure 2. The Long Island Pine Barren Ponds Water Quality by Groups: pH

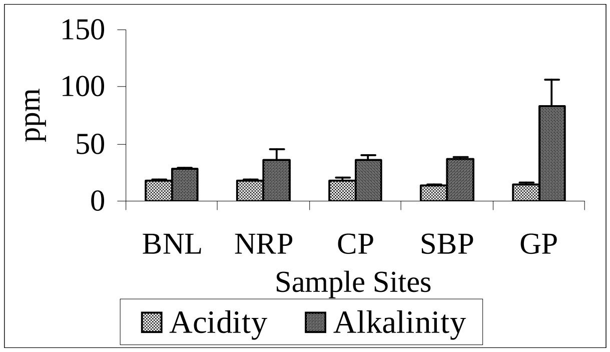

Figure 3. The Long Island Pine Barren Ponds Water Quality by Groups: Acidity and Alkalinity (ppm)

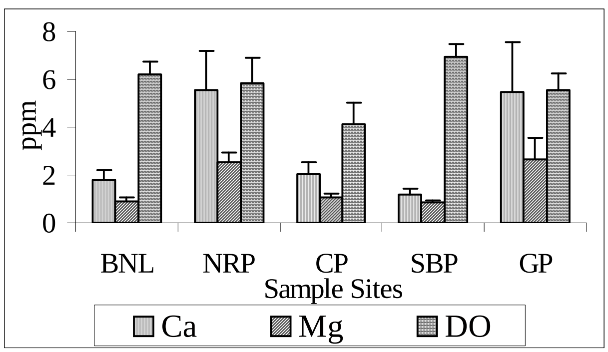

Figure 4. The Long Island Pine Barren Ponds Water Quality by Groups: Calcium and Magnesium Hardness and Dissolved Oxygen (ppm)

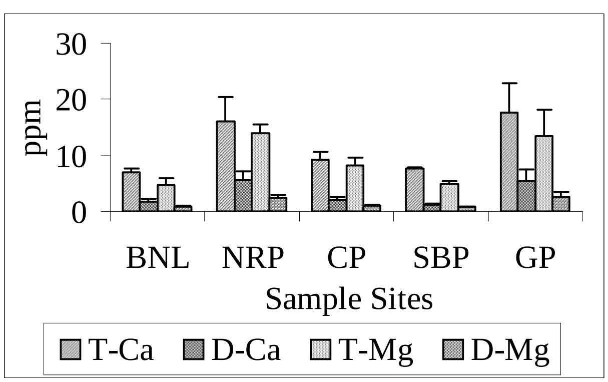

Figure 5. The Long Island Pine Barren Ponds Water Quality by Groups: Calcium and Magnesium Hardness (ppm) Comaprisons in Data Obtained by Digital Titrator and DCP