A Comparison of Water Chemistry between Natural, Modified, and Manmade Ponds within Brookhaven National Laboratory

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Abstract

Brookhaven National Laboratory (BNL) is located in the center of the Long Island Pine Barrens. Within BNL's 5,265-acre site there are 26 wetlands. Included are coastal plain ponds, vernal ponds, recharge basins, and streams, making it an ideal ecological site to study water chemistry. We tested water samples from seven coastal plain ponds on BNL: four natural (BP1, BP2, BP6, BP9), one man-modified (BP7), and two manmade (BP13a, Meadow Marsh). Five water samples were collected from each pond. An eTrex Vista Cx Global Positioning System (GPS) was used to mark each water sample point. A YSI 659 MDS meter fitted with a multiprobe was utilized to determine temperature, pH, dissolved oxygen, conductivity, and turbidity at each sample point. Water samples were analyzed for sulfate, nitrate, iron, phosphorus, chlorine, calcium, magnesium, copper, tannin-lignin, chromium, molybdenum, aluminum, and suspended solids using Hach DREL/2000 and CEL/890 water test kits. Water samples were also analyzed for eleven different elements using an ICP-AES. The pH in the anthropogenic ponds was found to be more basic than that of natural ponds. Phosphorous, tannin-lignin, and hardness were elevated in the natural ponds when compared to manmade and modified ponds, but only the difference in tannin-lignin content proved statistically significant. The natural ponds were shaded by the canopy of the surrounding forest while the manmade and modified ponds where located directly in the sun. This had a affect on water temperature. The results of this research will give environmental scientists an insight into water chemistry and interrelationships between abiotic and biotic factors and will enable BNL to optimize the management of amphibian and reptile habitats.

Introduction

Long Island, New York embodies the essence of the Pine Barrens region, from its sandy, well drained, nutrient poor soils to its abundance of pines. The Long Island Pine Barrens support a number of distinct natural communities including dwarf pine plains, oak-pitch pine forest, and pitch pine-heath forest. Pitch pine (*Pinus rigida*) is the dominant tree species in the Pine Barrens; the shrub layer is dominated by scrub oak, black huckleberry (*Gaylussacia baccata*), and hillside blueberry (*Vaccinium pallidum*)[1]. Coastal plain ponds and vernal ponds are two types of wetland structures that are found throughout the Pine Barrens region. Vernal ponds, unlike coastal plain ponds, dry out completely in the summer. These ponds are basin depressions lacking outlets, filling with water during periods of precipitation, and offering permanent or temporary habitat to a variety of species [2]. Over recent decades an increase in population and pollution has resulted in habitat loss for species such as the tiger salamander (*Ambystoma tigrinum*), northern cricket frog (*Acris crepitans*) and mud turtle (*Kinosternon subrubrum*) causing them to be placed on New York state's endangered species list [4]. BNL contains approximately 22 of the 91 known active breeding sites for tiger salamanders on Long Island. Testing the water chemistry of different ponds at BNL, in combination with soil and vegetation data, will help environmental scientists determine what conditions are most suitable for tiger salamanders. This information will give natural resource managers better guidelines on how to maintain habitats so as to prevent extinction of this species on Long Island.

Methods and Materials

A track of each pond was collected using an eTrex Vista Cx Global Positioning System (GPS). The information from the GPS unit was then downloaded into a Geographic Information System (GIS) program, which determined the midpoint of each pond (Figure1).

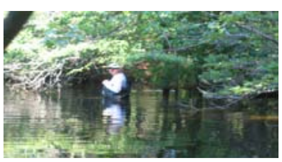

Figure 1

Stakes were used to mark sampling points on the north, south, east, and west sides of the pond three meters in from the shore. GPS was used to record the location of each sampling point. An additional stake was placed at the middle of each pond. The ponds were left to settle for twenty-four hours before sampling was carried out (Figure 2).

Figure 2

A Yellow Springs Instruments (YSI) multiprobe meter was utilized to measure pH, temperature, turbidity, conductivity, and dissolved oxygen at each point. Three successive readings were taken for each parameter at 30-60 second intervals (Figure 3).

Figure 3

From each point a water sample was collected and placed on ice to minimize any chemical reaction while in the field. Each sample was analyzed for nitrate, iron, copper, chlorine, aluminum, sulfate, total chromium, molybdenum, phosphorus, tannin-lignin, suspended solids, and total hardness using Hach DREL/2000 and CEL/890 water test kits (Figure 4). A subsample was preserved with nitric acid and analyzed on an ICP-AES for eleven different elements.

Figure 4

Results

SAMPLE	Mo (ug/g)	Cu (ug/g)	Ag (ug/g)	Cr (ug/g)	Al (ug/g)	Fe (ug/g)	Mg (ug/g)	Mn (ug/g)	Pb (ug/g)	Cd (ug/g)	K (ug/g)
BP6 SOIL	3.220	25.732	7.261	12.221	4548.300	2131.700	399.920	145.710	38.578	0.506	369.400
BP6 SEDIMENT	0.000	11.208	3.210	30.968	26948.000	6788.000	1089.200	86.200	150.080	0.000	438.400
BP6 WATER	0.000	0.018	0.008	0.000	0.491	1.131	0.574	0.326	0.000	0.000	1.894
BP7 SOIL	0.000	44.328	0.000	22.231	8934.000	8924.000	892.200	104.050	73.059	0.000	126.090
BP7 SEDIMENT	5.800	195.040	0.000	87.680	22124.000	21760.000	2650.000	180.360	25.940	1.570	519.600
BP7 WATER	0.000	0.000	0.001	0.003	0.083	0.191	0.191	0.225	0.073	0.000	0.000
BP9 SOIL	5.015	6.591	1.907	4.966	2905.900	2007.900	139.547	66.110	63.594	1.288	129.811
BP9 SEDIMENT	0.000	0.000	0.000	14.708	2138.000	1119.600	85.000	62.480	111.080	0.000	86.160
BP9 WATER	0.000	0.000	0.000	0.001	0.320	1.004	0.312	0.107	0.000	0.000	0.817
BP13a SOIL	0.000	7.841	0.000	13.801	6696.000	8346.000	741.400	109.840	84.630	0.280	199.890
BP13a SEDIMENT	11.752	24.776	0.000	36.092	21116.000	20448.000	2242.000	169.600	258.040	0.000	603.200
BP13a WATER	0.000	0.000	0.001	0.009	0.963	3.659	0.683	0.265	0.198	0.000	1.042
MM SOIL	0.000	17.985	0.750	20.115	7285.333	9606.667	698.800	133.707	22.080	0.252	198.693
MM SEDIMENT	0.000	15.620	13.644	0.000	5796.000	8708.000	673.200	193.120	0.000	3.524	257.320
MM WATER	0.000	0.003	0.000	0.000	0.198	0.167	1.649	0.247	0.000	0.005	0.957
BP1 WATER	0.000	0.000	0.000	0.000	0.258	0.292	0.342	0.264	0.162	0.000	0.787
BP2 WATER	0.000	0.016	0.000	0.024	0.273	0.440	0.357	0.287	0.125	0.000	0.453

Figure 5. ICP-AES results

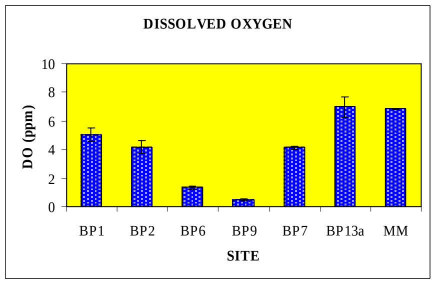

Figure 6

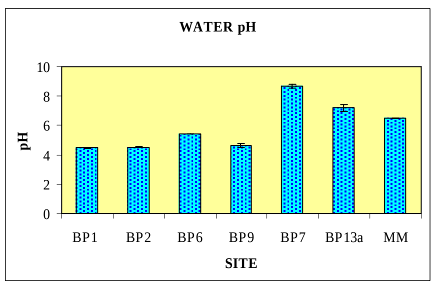

Figure 7

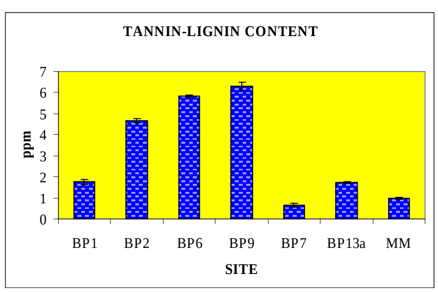

Figure 8

Location	Sulfate	Nitrate	Iron	Phosphorous	Total Chlorine	Hardness :Magnesium	Hardness:Calcium	Copper
BP7	0.4 (0.89)	0.08 (0.08)	0.55 (0.11)	0.154 (0.09)	0.012 (0.02)	3.88 (0.48)	0.798 (0.38)	0.022 (0.05)
BP6	0.275 (0.61)	0.06 (0.09)	0.49 (0.12)	0.2 (0.08)	0.024 (0.03)	1.806 (0.19)	1.724 (0.37)	0.014 (0.03)
BP9	0 (0)	0.28 (0.29)	0.902 (0.26)	0.236 (0.17)	0.044 (0.09)	1.076 (0.13)	1.456 (0.29)	0.024 (0.04)
BP2	1.6 (1.16)	0.02 (0.45)	0.374 (0.07)	0 (0)	0.028 (0.06)	1.376 (0.12)	0.916 (0.11)	0.01 (0.02)
MM	1 (0.7)	0.04 (0.05)	0.248 (0.04)	0.222 (0.15)	0.032 (0.03)	3.446 (0.65)	0 (0)	0.046 (0.05)
BP1	0.2 (0.45)	0.2 (0.17)	0.386 (0.12)	0.142 (0.10)	0.02 (0.03)	1.366 (0.11)	1.118 (0.39)	0.066 (0.06)
BP13a	0.2 (0.44)	0 (0)	2.568 (0.24)	0.246 (10)	0.048 (0.04)	1.832 (0.20)	1.364 (0.38)	0.058 (0.03)

Figure 9. Nutrient table (mg/l)

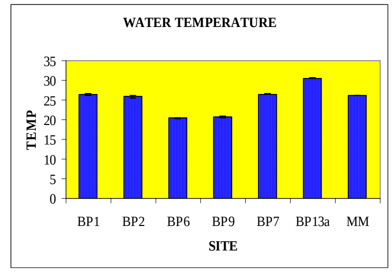

Figure 9

Discussion

The canopy that surrounds the natural ponds (BP1, BP2, BP6 BP9) provides them with shade, which was reflected in a lower water temperature when compared to the manmade and man-modified ponds. The manmade and man-modified ponds were located directly in the sun, resulting in temperatures between 25 and 26 degrees Celsius, whereas in the natural ponds the temperature ranged from 20 to 26 degrees Celsius (Figure 9). The natural ponds as a group had a pH (4.77) significantly lower than that of the man-modified and manmade ponds (7.45) (Figure 7). A lot of decaying matter such as tree branches and leaves was observed in the natural ponds. This was absent in the manmade and man-modified ponds due to the absence of surrounding trees and shrubs. This could explain why the pH levels in the natural ponds were lower than the pH levels in the manmade and man-modified ponds. Decaying oak leaves and pine needles release organic acids that result in a low pH and an increase in tannin-lignin content within a pond. Tannin-lignin was significantly higher in the natural ponds when compared to the manmade and man-modified ponds (Figure 8). Collectively, the dissolved oxygen levels in the natural ponds was lower than that of manmade and man-modified ponds, but this difference was not statistically significant (Figure 6). This difference could also be explained by the presence of decaying organic matter, possibly along with a reduced rate of photosynthesis due to shading.

Figure 10
Natural Pond (BP2)

Figure11
Man-modified
(BP7)

Figure 12
Manmade
Pond(MM)

References

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