A Study of Variations in Soil and Water Chemistry of Selected Ponds at Brookhaven National Laboratory

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ABSTRACT

A Study of Variations in Soil and Water Chemistry of Selected Ponds at Brookhaven National Laboratory. JAMIE S. BRUNGARD, NINA S. KEAN, GEORGIA L. SAWYER, ROY COOMANS (North Carolina A&T State University, Greensboro, NC 27411), TIMOTHY GREEN (Brookhaven National Laboratory, Upton, NY 11973).

Brookhaven National Laboratory (BNL), a 5,265 acre site, contains a variety of wetlands; included are coastal plain ponds, vernal pools, recharge basins, and streams. Wetland habitats in Pine Barren communities are not well researched and little is known about their ecology. Survey techniques were used to gather information on soil and water chemistry of seven ponds at BNL: four natural ponds (BP 1, BP 2, BP 6, BP 9), two modified ponds (BP 7, BP 13a), and one man-made pond (Meadow Marsh). Each pond was tracked using Global Positioning System (GPS) technology and mapped using ArcGIS. Five water samples and nine soil samples were collected at each pond. Water samples were analyzed for iron, sulfate, total chlorine, copper, aluminum, nitrate, phosphorus, tannin-lignin, suspended solids, hardness, total chromium, and molybdenum using HACH DREL/2000 and HACH CEL/890 water test kits. Soil samples were analyzed for pH, nitrate nitrogen, phosphorus, potassium, aluminum, ferric iron, magnesium, sulfate, calcium, and chloride using LaMotte soil test kits. A YSI 650 MDS meter with multi-probe was used to field-test water temperature, pH, dissolved oxygen, turbidity, and conductivity at each sample point. The soil and water chemistry of the ponds was affected by surrounding vegetation and the level of exposure to solar radiation; the natural ponds were provided with more vegetation and shading than the

modified and manmade ponds. Water tests for hardness and tannin and lignin of the modified and manmade ponds showed higher levels than those of the natural ponds. pH All other parameters for water and soil tended to be similar for the pond types. The results of this study provide baseline data for monitoring pond health in the future and for assessing the suitability of ponds as breeding sites for the state endangered tiger salamander (*Ambystoma tigrinum*).

INTRODUCTION

Pine Barrens are a type of temperate coniferous forest found in southern New Jersey, Long Island, New York, and Cape Cod, Massachusetts [1]. Several distinct natural communities recognized by the New York Natural Heritage Program are present in the Central Pine Barrens of Long Island: Pitch pine-oak forest, Pitch pine-oak-heath woodland, and Dwarf pine plains [1, 2]. Pine Barrens develop on soils that are nutrient poor and acidic, with a high percentage (80-96%) of well-drained sand [3]. Pine Barrens are maintained by periodic natural wildfires and without them their distinctive vegetation is replaced by hardwood forest and weedy species [1, 4]. Pitch pine (*Pinus rigida*) is the dominant tree species of the Pine Barrens. Pitch pine requires bare mineral soil for establishment from seed, is relatively shade-intolerant, and possesses adaptations to survive the fires that frequent the Pine Barrens [5]. Various oaks, including white oak (*Quercus alba*), scarlet oak (*Q. coccinea*), black oak (*Q. velutina*), and red oak (*Q. rubra*), can also be an important element of the canopy. The openness of the canopy allows abundant sunlight to penetrate, promoting the development of a dense understory of scrub oak (*Quercus ilicifolia*) and heath species such as black huckleberry (*Gaylussacia baccata*), blueberries (*Vaccinium* spp.), and wintergreen (*Gaultheria procumbens*) [3].

A variety of wetland communities occur within Pine Barrens including vernal ponds, coastal plain ponds, Atlantic white cedar swamps, pine barrens savannas, streams, and rivers [6]. Vernal ponds and coastal plain ponds are confined wetland depressions, either natural or man-made, lacking a permanent outflow [7]. The water level in coastal plain ponds fluctuates seasonally and annually. Ponds that dry up completely in summer are referred to as intermittent or vernal ponds [6]. Vernal ponds and coastal plain ponds play an important role in Pine Barrens communities. They provide breeding habitat for frogs, toads, and salamanders, including the New York state endangered tiger salamander (*Ambystoma tigrinum*) [6, 7]. They also support populations of rare species of Odonata (dragonflies and damselflies) and Lepidoptera (butterflies and moths) [6]. There are also a number of rare plant species associated with vernal ponds and coastal plain ponds, including several that are globally rare [6]. Coastal plain ponds and vernal ponds, like other isolated wetlands, serve other important ecosystem functions: water storage, replenishment of the aquifer, nutrient retention and cycling, and in arid and semi-arid habitats they can be an important water source and refuge for resident and migrating wildlife [8, 9].

Brookhaven National Laboratory (BNL) is located in the Central Pine Barrens of Long Island, New York. The laboratory is a 5,265 acre site, of which approximately 1,500 acres are developed. The site contains a variety of wetlands including vernal ponds, coastal plain ponds, recharge basins, and streams. Included on site are 22 of the 91 known breeding ponds for tiger salamanders (*Ambystoma tigrinum*) in New York [10, 11]. Although many studies have been carried out in the Central Pine Barrens, little is known about the soil and water chemistry of these critical breeding sites. In light of this a study was initiated to investigate several coastal plain ponds on BNL, both natural and man-made or man-modified. The information provided by this research will: 1.) serve as baseline data for future monitoring, 2.) better inform environmental services as to what features characterize ponds that serve or may serve as breeding sites for tiger salamanders, and 3.) elucidate differences between natural and man-made or man-modified ponds.

MATERIALS AND METHODS.

Study Sites

Seven ponds on Brookhaven National Laboratory were selected for sampling. They were designated BP1, BP2, BP6, BP7, BP9, BP13a, and Meadow Marsh. BP1, BP2, BP6 and BP9 are natural ponds in a forested landscape. They have an overhanging canopy and a dense thicket of shrubs (primarily *Vaccinium corymbosum*) and vines (*Smilax* sp.) along the shoreline. BP7 was a recharge basin which was modified and now is a coastal plain pond which continues to serve as a recharge basin. It receives runoff from adjacent land via a culvert. It is surrounded by herbaceous vegetation (grasses, sedges, rushes and dicotyledonous herbs) but has a small area of woody shrubs at one end. BP13a is a recharge basin in an open grassy area. Meadow Marsh is a man-made coastal plane pond with a liner. It occurs in an open meadow and has a shoreline of sedges, rushes, cattails and other herbaceous aquatic vegetation.

Water Procedure

A track of each pond was taken using an eTrex® Vista Cx Global Positioning System (GPS) unit. These were downloaded into ArcGIS. Four sampling points were staked on the north, south, east, and west sides of the pond 3 meters from the shoreline. Using these a fifth sampling point was established at the approximate center of the pond. The water was then given time to settle overnight prior to sampling the following day. Water samples were collected at each point, put in an ice chest, and transported to the laboratory for testing. A YSI 650 MDS meter with multi-probe was used to determine temperature, pH, dissolved oxygen, turbidity, and conductivity. At each sample point three readings were taken for each parameter at thirty second to one minute intervals. Numbers used for calculations and presented in the results are an average of those three readings. Water samples brought back to the laboratory were analyzed for iron, sulfate, total chlorine, copper, aluminum, nitrate, phosphorus, tannin-lignin, suspended solids, hardness, total chromium, and molybdenum using HACH DREL/2000 and HACH CEL/890 water test kits. One 100 ml bottle of water collected from the center of the pond was preserved with nitric acid and subsequently filtered using Whatman 541 paper. This sample was then tested for molybdenum, copper, silver, chromium, iron, magnesium, manganese, aluminum, lead, cadmium, and potassium using an Inductively Coupled Plasma – Atomic Emission Spectroscope (ICP-AES).

Soil Procedure

Soil samples were collected from five of the seven study sites: BP6, BP7, BP9, BP13a and Meadow Marsh. Sample points were established on the north, south, east, and west sides of the pond two meters from the shoreline in line with the water sample points. Four additional sample points were placed midway between those sample points (northwest, southwest, southeast, northeast), again two meters from the shoreline. The ninth soil sample was collected from the bottom of the pond at the water sampling point in the center. At each of the eight terrestrial sampling points a circular plot representing $1/20^{th}$ of an acre was set out and five randomly selected points within the plot were marked. At each of the five points approximately 20 grams of soil was collected; these were mixed to create an approximately 100 gram sample from each plot. In the laboratory, 10 grams of each sample cleaned of roots, rocks, and debris was placed in a drying oven for 24 hours at 65^{o}C, then reweighed to determine soil moisture content. The remainder of the sample was air dried then sieved (2 mm. mesh) to remove roots, pebbles and debris. Soil color of both the wet and dry soil was determined using Munsell Soil Color Charts. Air dried soil was tested for pH, nitrate nitrogen, potassium, phosphorus, magnesium, calcium, chloride, ferric iron, sulfate, and aluminum using LaMotte soil test kits. Five grams of each soil sample was digested using EPA method 3050B for Acid Digestion of sediments, sludge, and soils and the filtrate tested for molybdenum, copper, silver, chromium, iron, magnesium, manganese, aluminum, lead, cadmium, and potassium using an ICP-AES.

RESULTS

in preparation

DISCUSSION AND CONCLUSION

in preparation

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REFERENCES

[1] E. Dinerstein, S. Buttrick, M. Davis, and B. Eichbaum. "Atlantic coastal pine barrens", July 2006, http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0504_full.html.

[2] Reschke, "Ecological Communities of New York State", New York State Department of Environmental Conservation, 1990, http://www.dec.state.ny.us/website/dfwmr/heritage/EcolComm.htm

[3] "Ecosystems Overview" in Central Pine Barrens Comprehensive Land Use Plan, Central Pine Barrens Joint Planning and Policy Commission, Great River, NY, July 2006, http://pb.state.ny.us/cpb_plam_vol2/vol2_chapter05.htm.

[4] J. F. Cryan, "An Introduction to the Long Island Pine Barrens", in The Heath Hen, Vol. 1(1), 1980, pp. 3-13.

[5] "Pine Barrens" in Reconciling the Effects of Historic Land Use and Disturbance on Conservation of Biodiversity in Managed Forests in the Northeastern United States, July 2006, http://www.unh.edu/ncssf/results-pine-barrens.htm.

[6] "Rare Natural Community and Habitat Types" in Significant Habitats and Habitat Complexes of the New York Bight Region, U. S. Fish and Wildlife Service, Southern New England – New York Bight Coastal Ecosystems Program, Charlestown, Rhode Island, July 2006, http://training.fws.gov/library/pubs5/web_link/text/toc.htm.

[7] R. G. Lathrop, P. Montesano, J. Tesauro, and B. Zarate, "Statewide mapping and assessment of vernal pools: A New Jersey case study" in J. of Environmental Management, Vol. 76(3), 2005, pp. 230-238.

[8] R. W. Tiner, "Geographically isolated wetlands of the United States", in Wetlands, Vol. 23(3), 2003, pp. 494-516.

[9] R. W. Tiner, , H. C. Bergquist, G. P. DeAlessio and M. J. Starr, "Geographically Isolated Wetlands: A Priliminary Assessment of their Characteristics and Status in Selected Areas of the united States", U. S. Department of the Interior, Fish and Wildlife Service, Northeast Region, Hadley, MA., July 2006, http://www.fws.gov/nwi/Pubs_Reports/isolated/report.htm.

[10] V. Titus, Personal communication, 2006.

[11] "Eastern Tiger Salamander Fact Sheet", New York State Department of Environmental Conservation, July 2006, http://www.dec.state.ny.us/website/dfwmr/wildlife/endspec/tisafs.html