

A Chemical Snapshot of Provincetown Ponds, July 2001

Lindsay Dubbs and Kristen Novotny
Barnstable County AmeriCorps-Cape Cod
Cape Cod National Seashore
Summer 2001

Introduction

Ponds within the Cape Cod National Seashore are a unique resource for monitoring changes in water quality due to atmospheric and anthropogenic influences. Historically, the glacially formed kettle ponds in the towns of Wellfleet and Truro have been the source for long-term ecological studies (Portnoy et al. 2001). The freshwater ponds in Provincetown are less frequently monitored than the kettle ponds, but provide similarly valuable information about chemical changes in the environment. Five ponds in Provincetown were chosen for chemical analysis based on their proximity to possible anthropogenic influences and the direction of groundwater flow in relation to those influences (Lepore et al. 1990, Winkler 1990). The goal of this study was to conduct a preliminary chemical survey of Bennett, Duck, Clapps, Great and Beech Forest Parking lot ponds. This information can be used to compare the different ponds to each other based on their increasing anthropogenic influences. It also provides an ecological baseline for future water quality monitoring studies of these ponds.

Materials and Methods

Water samples were collected at midday on June 19, 2001 and June 23, 2001 from open water of five Provincetown Ponds: Duck Pond, Bennett Pond, Great Pond, Clapps Pond, and the pond adjoining the beech forest parking lot (see map). GPS information was recorded from the entrance to the sampling site of each of the ponds. Sampling sites in the ponds were chosen based on accessibility to the site from the pond's edge. In addition, the site was chosen to be away from grasses. The GPS coordinates of these sites were also recorded (Table 1). In some cases, sediment in deeper waters was stirred up when walked on and methane gas was released. For this reason, color and anion samples were taken a week later than the original sampling (June 23) closer to shore where the sediment was more stable and shallow.

Equipment List for Field Sampling

15 Filter holders (at least three marked as chlorophyll filter holders)
Autopipette (1.0 ml) and tips
Forceps
60-ml sterile syringe (1 per pond)
Luer-lock/threaded stainless steel adapter
Millipore filters (type HA 0.45- μ m) *bring extra into field
60-ml pre-acidified bottles (3 per pond)
60-ml amber HDPE bottles (3 per pond) without acid
70-ml glass test tubes (3 per pond)
250-ml plastic bottles (1 per pond), if doing pH and alkalinity on same visit
H₂SO₄ (30% trace metal grade)
Ammonium persulfate solution

Bottle of distilled water
Cooler and ice packs
GPS unit
Paper (waterproof if possible)
Chest Waders

*In future studies, advise using boat or raft to reduce stirring of sediment and chance of drowning

Sharpie markers
Large field bag (will get wet)

Field Sampling Methods

Sample collection and preservation for alkalinity, pH and conductivity (in triplicate)

For alkalinity, pH, and conductivity samples, water is collected from a 0.5 m depth by rinsing a 500-mL clear plastic bottle with pond water, and filling the bottle to the top, i.e. no air in head space. Samples are kept cold in a cooler, or refrigerated, and analyzed within 24 hours of collection.

Sample collection and preservation for NH_4 , NO_3 and major cations (in triplicate)

For cation, nitrate and ammonium samples, collect with a 60 ml syringe from a depth of 0.5 m. Discharge each water sample through a 47-mm filter holder with 0.45- μm membrane filter (Millipore HA) into a pre-acidified (0.5 ml of 2N trace metal grade HCl) 60-ml clear plastic bottle. Samples are stored on ice or refrigerated.

Sample collection and preservation for total P samples (in triplicate)

For total phosphorus samples, test tubes (70-ml etched glass tubes) should be washed with HOT phosphate free soapy water and triplicate flushed with dH_2O and then acid washed and triplicate rinsed with dH_2O before use. They should also be stored capped until day of sample collection. For collection of samples, use a clean syringe to collect water from a depth of 0.5 m and add 50 ml to each of the 80-ml test tubes. Samples immediately receive 1 ml 30% trace metal grade sulfuric acid and 2 ml ammonium persulfate (20 mg in 100 ml distilled water, prepared daily). Samples are digested the same day of collection by pressure cooking at 15 psi for 30 min and then stored at room temperature for no more than 28 days.

Sample collection and preservation for anions and color (in triplicate)

For anion samples, collect water with a 60 ml syringe from a depth of 0.5 m. Discharge each water sample through a 47-mm filter holder with 0.45- μm membrane filter (Millipore HA) into an distilled-water rinsed 60-ml amber polyethylene bottle. **Do not acid wash!** Samples are stored on ice or refrigerated.

Lab Analysis Methods

<u>Variable</u>	<u>Method</u>	<u>Time of analysis</u>
Conductivity	Altex conductivity bridge	Day of collection
PH	Beckman meter with glass KCl-filled electrode, calomel junction	Day of collection
Alkalinity	Potentiometric titration using Beckman meter (above)	Day of collection
Ammonium	Phenolate method, flow injection analysis (FIA-Lachat,)	N/A
Nitrate	Cadmium reduction (FIA-Lachat)	N/A
Total phosphorus	Acid persulfate digestion followed by molybdate blue FIA	N/A
Major anions	Turbidimetric method for sulfate and mercuric nitrate for chloride	N/A
Major cations	Atomic absorption spectrometry	N/A

Laboratory methods for conductivity analysis

Use Specific Conductance Std, 1 (NADP/NTN Central Analytical Laboratory) to calibrate the Altex conductivity bridge. Rinse with distilled water. Run samples.

Laboratory methods for pH analysis and alkalinity titration (potentiometric, low-level)

Portnoy et al., pp. 18-19.

Laboratory methods for NO₄ and NO₃ analysis(Cadmium reduction method).

Portnoy et al., p. 21.

Laboratory Methods for Ammonium Ananlysis

Portnoy et al., p. 20.

Laboratory methods for major cation analysis

(Adapted from Perkin Elmer AA300 Standard Operating Procedure)

Principle

The electron configuration of an element changes from a "ground state" to an "excited state" when energy is applied to an atom. Upon return of the electron to its "ground state", light energy of a particular wavelength specific to each element is emitted. The intensity of the emission is based on the number of excited electrons that emit that wavelength. The "ground state" atom also absorbs light of a particular wavelength as it becomes "excited." The amount of atoms of an element determines the quantity of light of that particular wavelength absorbed.

Analysis

Use the Perkin Elmer AA300 to assess the emission of Na and K and the absorption of Fe and Mg using AA standards and distilled water to calibrate the machine.

Laboratory methods for total P analysis

Laboratory methods for Cl analysis

Chloride content of the water was analyzed in accordance with Standard Methods (4500-Cl- C., p4-68, 1998) and the endpoint was realized upon the first change of color from blue to purple.

Laboratory methods for SO₄ analysis

Sulfate analysis was conducted in accordance with Standard Methods (4500-So₄ E., p4-178, 1998) and absorbance was measured using the Spectronic 21. Correction for sample color and turbidity was made.

Laboratory methods for color analysis

Color of the samples was assessed using the visual comparison method found in Standard Methods (2120 B., p. 2-2,3, 1998) except the original sample pH was used. Color was also assessed by measuring the absorbance of the samples on the Spectronic 21 at 440 nm through a 1 cm light path.

Data Management

All data can be found in:

Y:/labusers/Krista/Water Quality/ProvincetownPonds/2001 Data.

Table 1. GPS coordinates for entrance points to the sampling sites along the pond's edge and sampling sites.

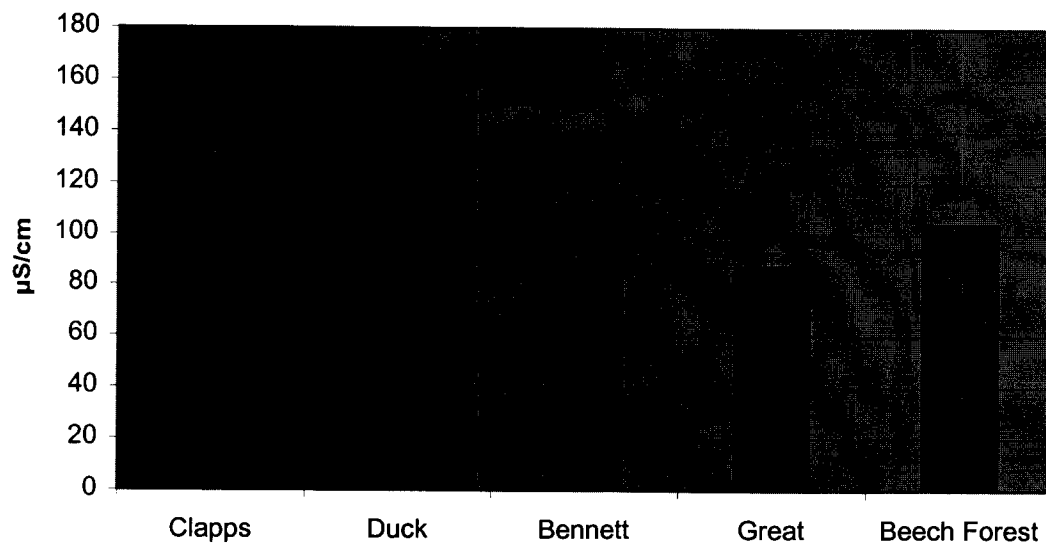
<u>Pond</u>	<u>X Coordinate</u>	<u>Y Coordinate</u>
<u>Duck</u>		
- entrance to sample site	0401197	4656737
- sample site	0401176	4656738
<u>Great (Provincetown)</u>		
- entrance to sample site	0400844	4657784
- sample site	0400827	4657755
<u>Bennett</u>		
- entrance to sample site	0400866	4656905
- sample site	0400848	4656940
<u>Beech Forest</u>		
- entrance to sample site	0401184	4657887
- sample site	0401177	4657899
<u>Clapps</u>		
- entrance to sample site	0399904	4656064
- sample site	0399884	4656072

Table 2. Results from Pond Chemical Analyses for July 2001.

	Conductivity μs/cm	pH	Alkalinity mg/L	Ca mg/L	Mg mg/L	K mg/L	Na mg/L	SO ₄ mg/L	Color Pt-Co	Color A(440)	Cl mg/L	TP uM	NH ₄ uM	PO ₄ uM	NO ₃ uM
Clapps	130.87	4.95	0.375	0.754	1.846	1.029	20.040	11.905	203	0.172	29.67	0.66	2.62	0.46	0.41
std dev	33.84	0.43	0.177	0.011	0.030	0.011	0.098	0.595	25	0.011	1.53	0.21	0.32	0.03	0.35
Duck	126.38	5.32	1.500	2.313	2.453	1.718	21.470	0.000	273	0.243	33.33	0.95	21.95	0.31	2.08
std dev	1.47	0.01	0.250	0.029	0.159	0.005	0.151	0.000	12	0.005	0.58	0.22	15.45	0.01	0.94
Bennett	90.44	4.55	0.000	1.040	1.613	0.919	17.470	7.717	170	0.158	22.00	1.14	12.45	0.25	1.47
std dev	0.90	0.01	0.000	0.000	0.000	0.000	0.000	0.100	17	0.005	1.00	0.26	13.58	0.01	0.88
Great	87.31	6.39	3.750	1.971	1.422	0.544	18.110	9.873	80	0.061	22.67	0.97	2	0.62	0.39
std dev	5.65	0.08	0.250	0.022	0.011	0.010	0.035	0.935	0	0.002	2.08	0.08	0.66	0.03	0.41
Beech Forest	104.11	4.63	0.000	0.778	2.251	1.164	19.150	9.810	100	0.087	28.00	0.22	5.98	0.15	1.14
std dev	0.34	0.03	0.000	0.116	1.382	0.020	0.046	0.252	0	0.003	1.00	0.19	4.41	0	1.03

*raw data found in Y:/labusers/Krista/Water Quality/ProvincetownPonds/2001 Data

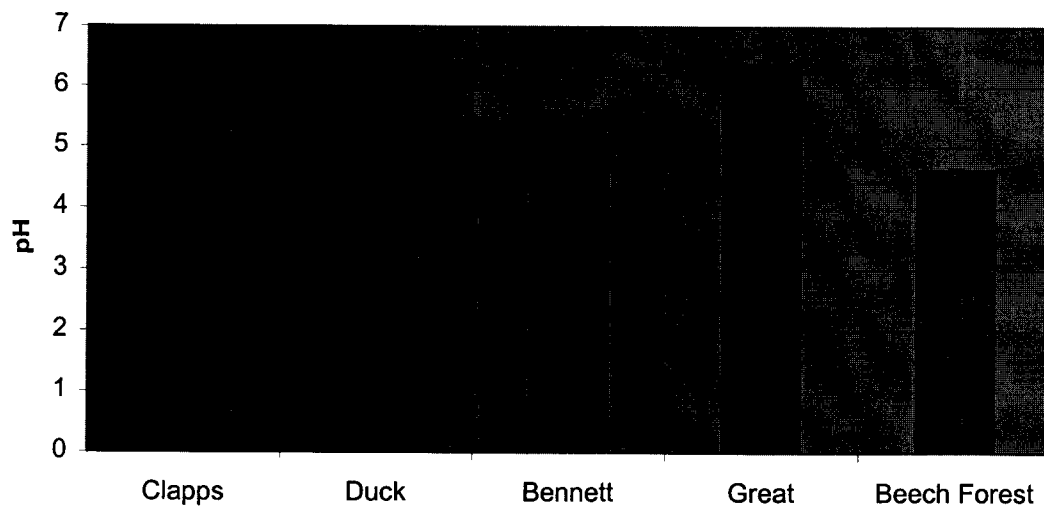
Conductivity of Provincetown Ponds July 2001



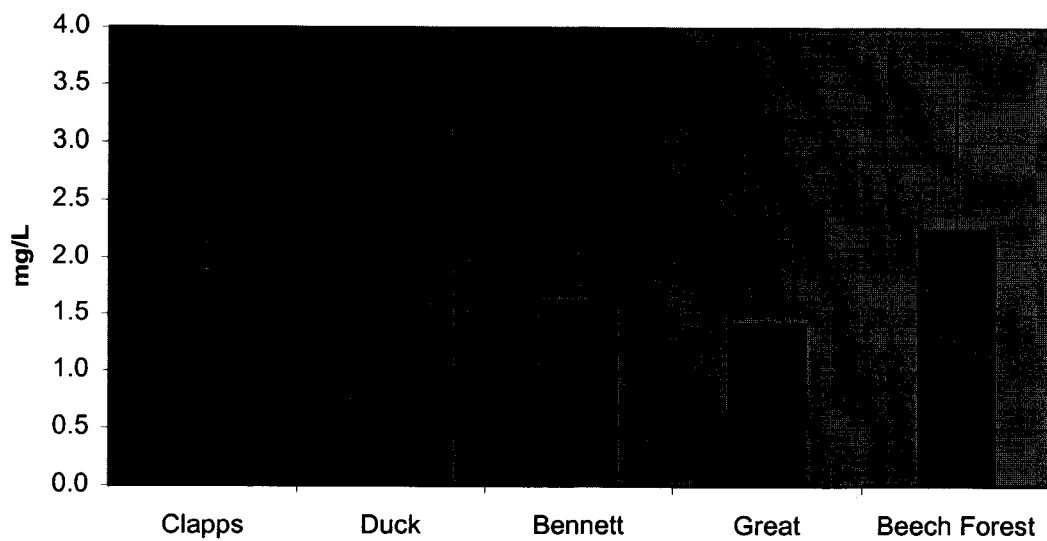
Alkalinity of Provincetown Ponds July 2001



pH of Provincetown Ponds July 2001



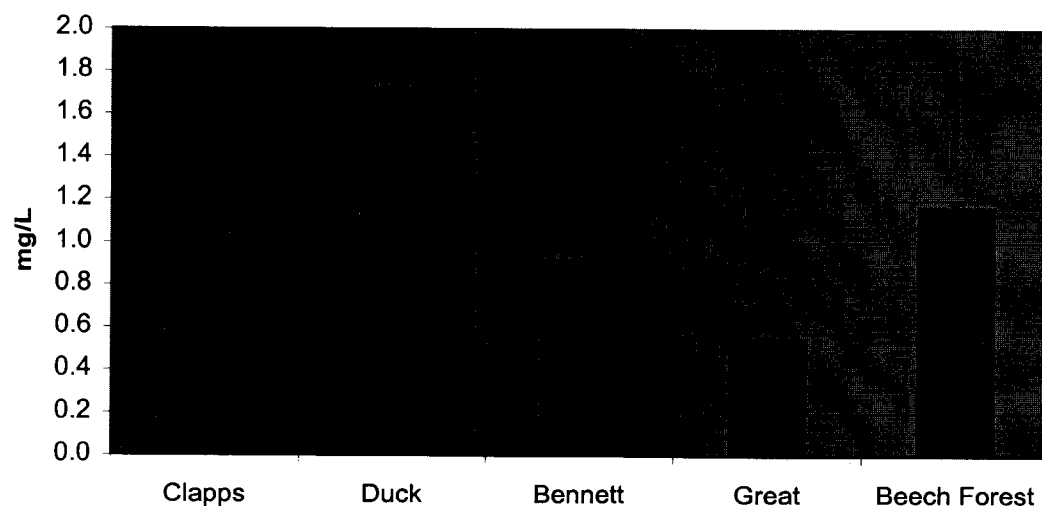
**Magnesium Concentration of Provincetown Ponds
July 2001**



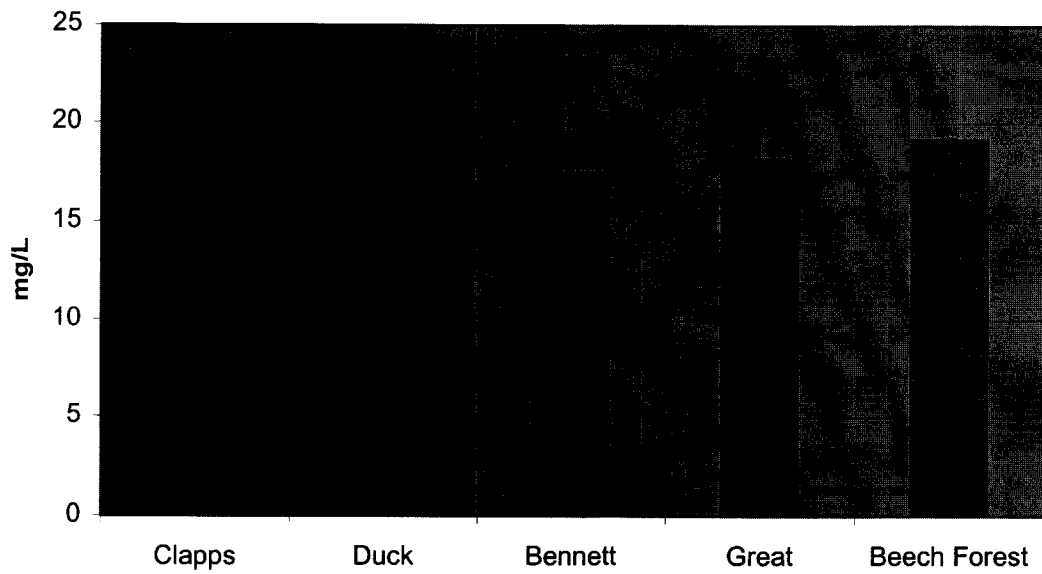
Calcium Concentration of Provincetown Ponds July 2001



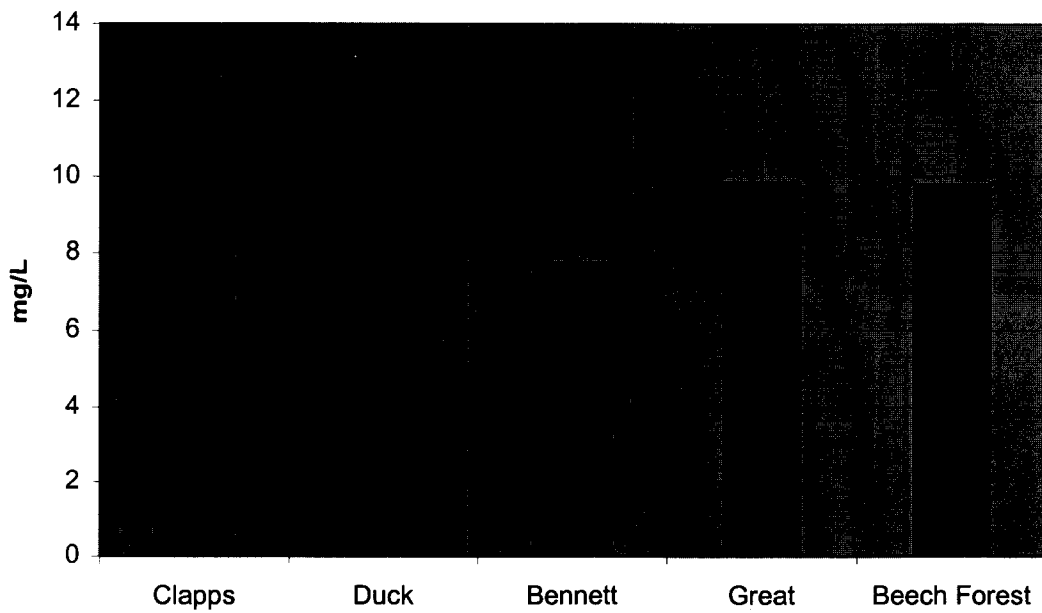
Potassium Concentration of Provincetown Ponds July 2001



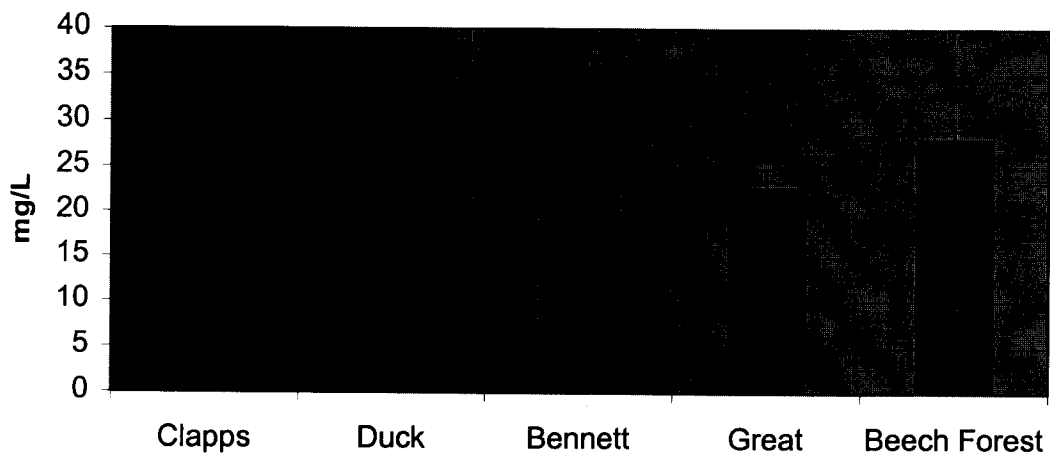
**Sodium Concentration of Provincetown Ponds
July 2001**



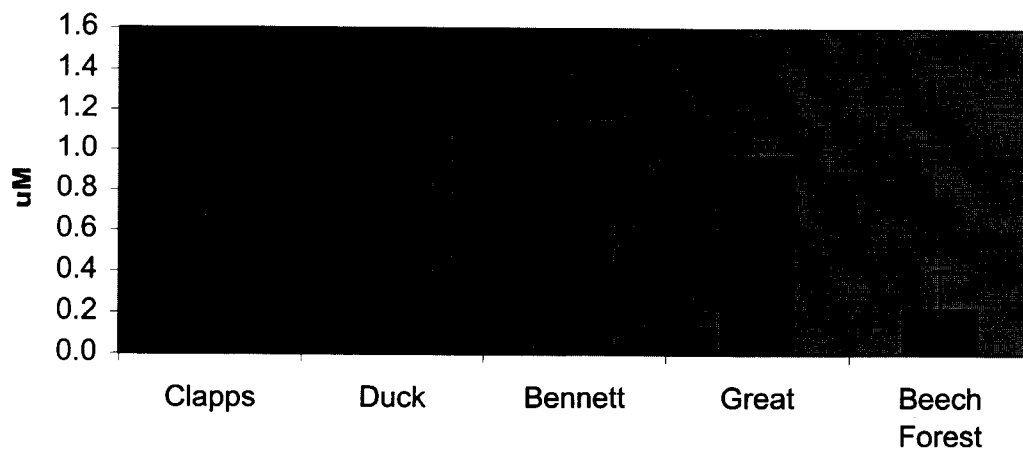
Sulfate Concentration of Provincetown Ponds July 2001



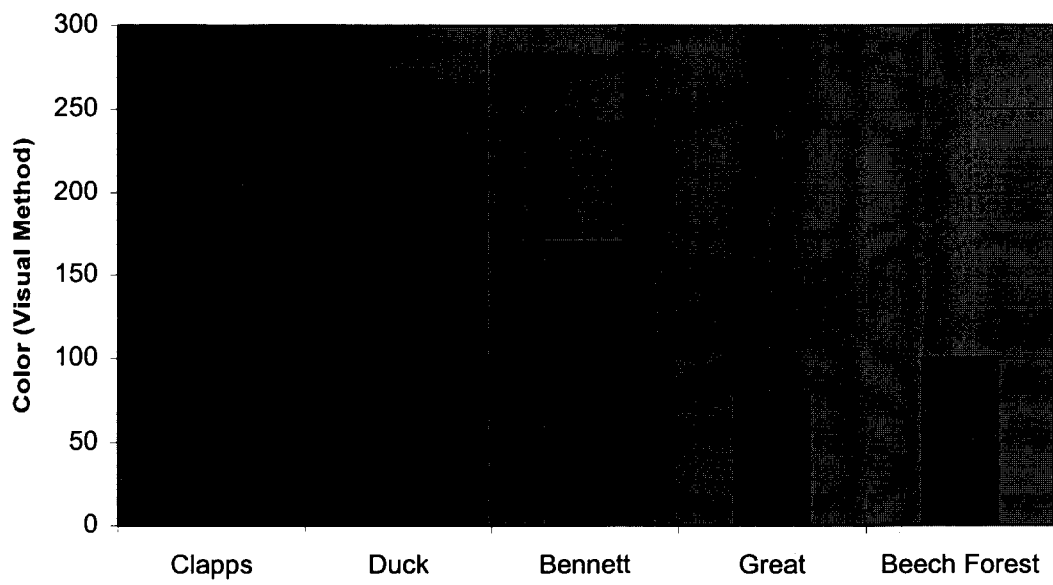
Chloride Concentration in Provincetown Ponds July 2001



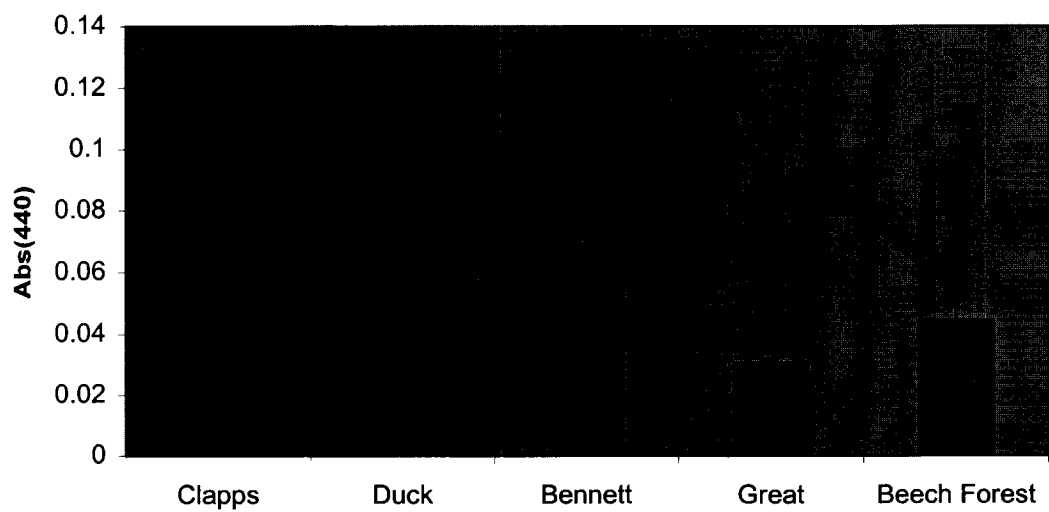
Total Phosphorous Concentration in Provincetown Ponds July 2001



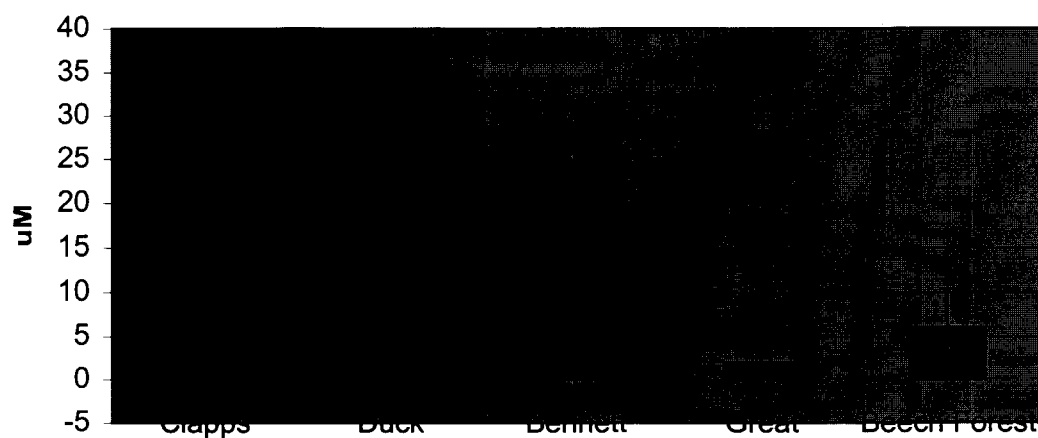
Color of Provincetown Ponds July 2001



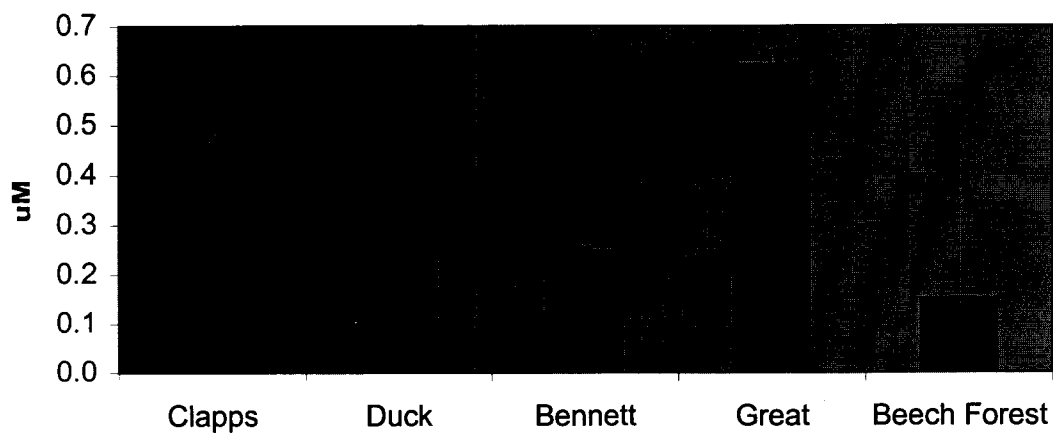
Color of Provincetown Ponds July 2001



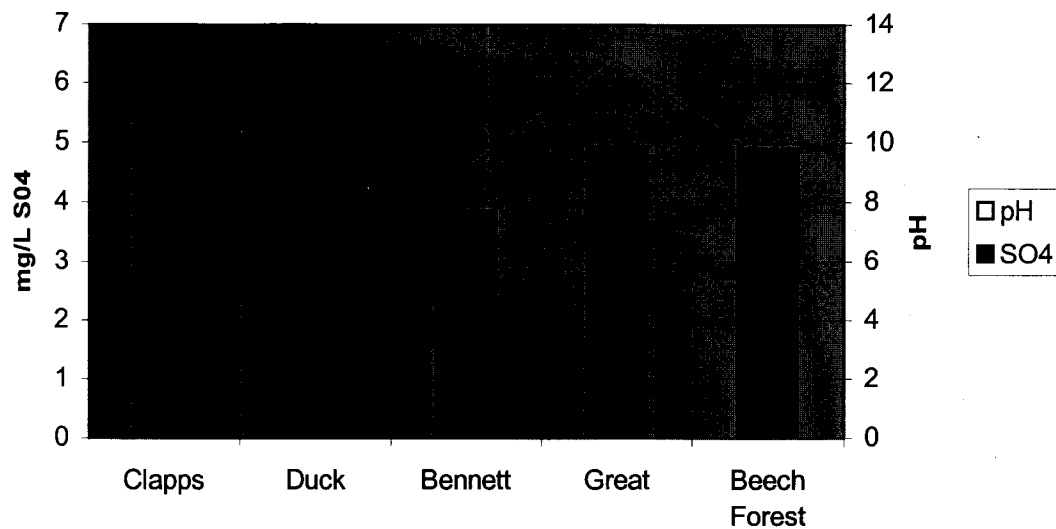
Ammonium Concentration in Provincetown Ponds July 2001



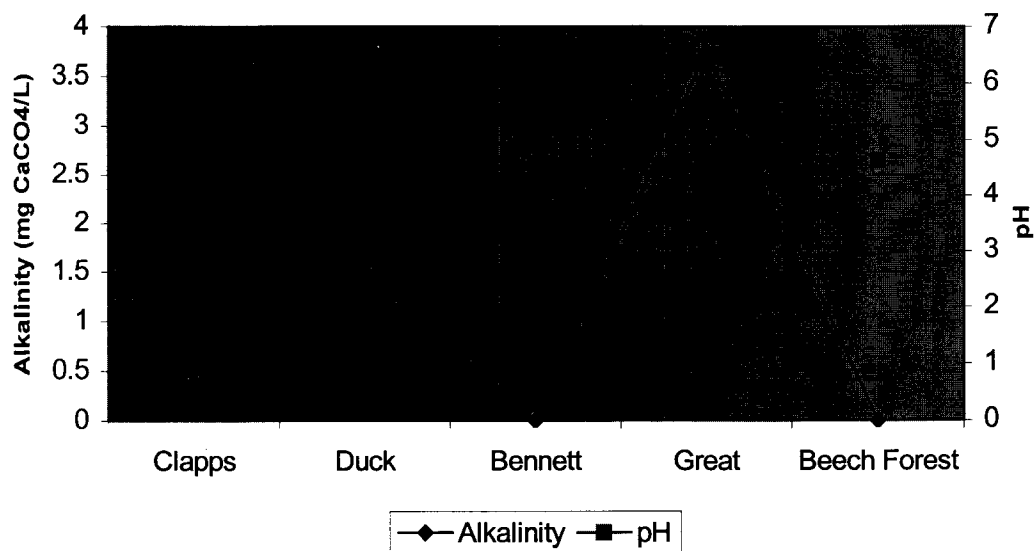
Phosphate Concentration in Provincetown Ponds July 2001



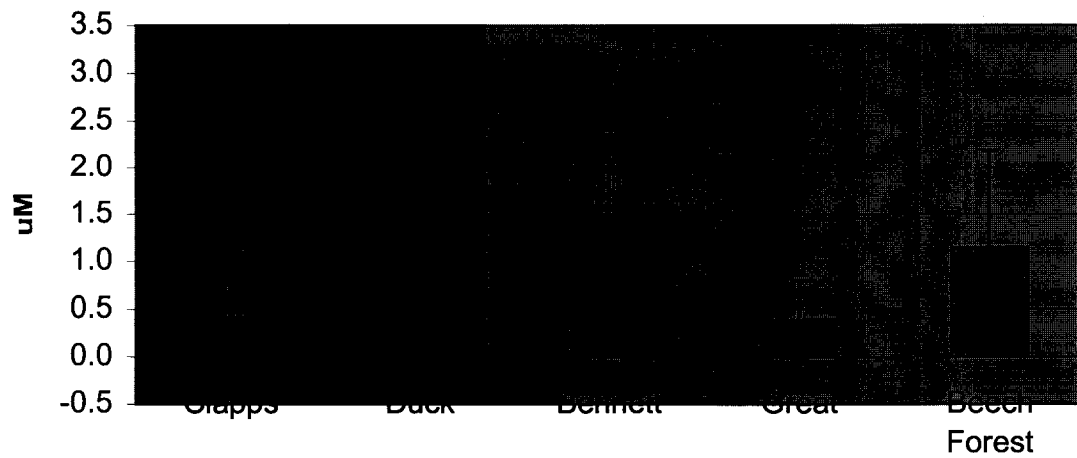
SO₄ Concentration and pH Trends of Provincetown Ponds July 2001



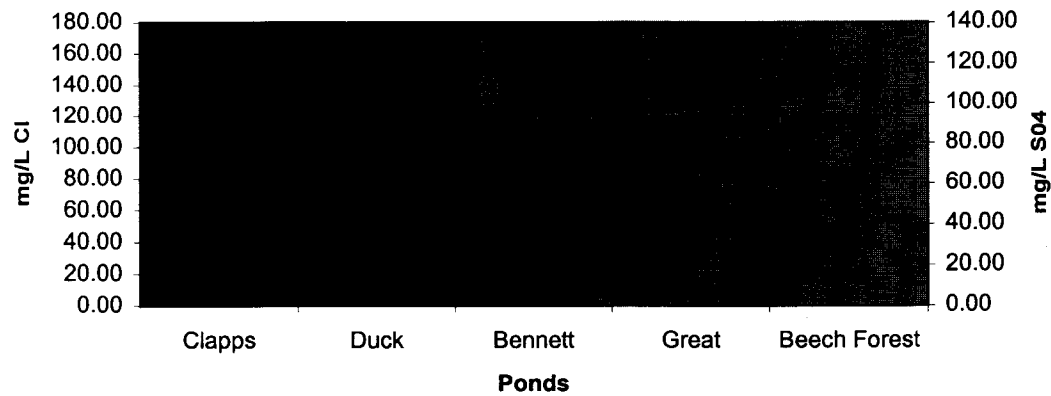
Trends in Alkalinity and pH of Provincetown Ponds July 2001



Nitrate Concentration in Provincetown Ponds July 2001



Chloride vs. SO₄ Concentrations in Provincetown Ponds July 2001



Literature Cited

- Lepore, J.V., C.D. Rugge and R.C. Ahlert. 1990. Provincetown Municipal Landfill Contaminant Assessment, final report for National Park Service. Department of Chemical and Biochemical Engineering, Rutgers University, New Jersey.
- Portnoy, J., J. Cote and K. Lee. 2001. Water Quality Monitoring for Kettle Ponds at the Cape Cod National Seashore.
- Winkler, M. 1990. Recent Changes in Tropic Status of Duck and Bennett Ponds Relative to Possible Landfill Enrichment, report for National Park Service. Center for Climatic Research, Institute for Environmental Studies, University of Wisconsin-Madison, Wisconsin.
- Standard Methods for the Examination of Water and Wastewater, 1998. 20th edition, American Public Health Association, American Water Works Association, and Water Environment Federation.