Ambient Groundwater Chemistry in the Catskills Based on Sampling of Trailside Springs

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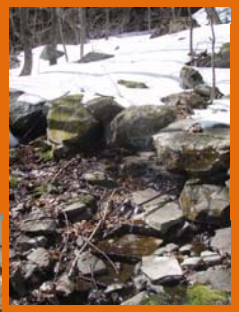
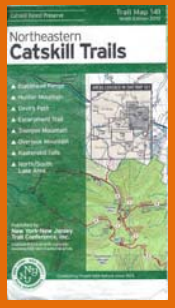
Background and Study Objectives:

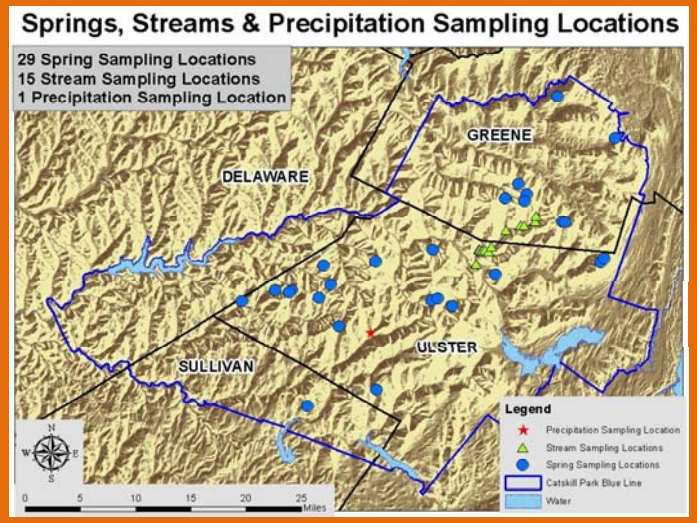
Extensive water quality research and monitoring has been conducted in the Catskills but the focus has been primarily on surface water. Review of the literature indicates limited availability of data on groundwater in the Catskills. Trailside springs used by hikers are widely distributed and easily accessed, providing an opportunity for use as sampling points in groundwater chemistry studies. Our objective was to characterize ambient groundwater chemistry for the region using samples collected at a representative number of groundwater springs.

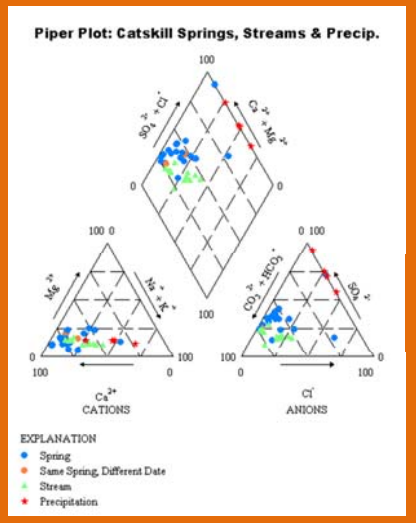


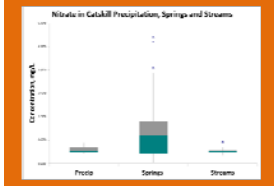


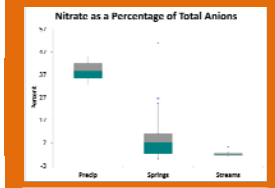
Methods:

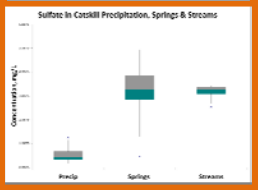
From March 2011 to May 2012, the authors collected water samples at 29 trailside springs. Springs were located using hiking maps published by the NY/NJ Trail Conference as well as NYSDOT planometric maps. Field parameters included temperature, pH, dissolved oxygen and conductivity. In the laboratory, samples were analyzed by ion chromatography for major ions including Ca, Mg, K, Na, NH_4, NO_3, Cl and SO_4. Alkalinity was measured by Gran titration. Ten of the 29 samples showed a charge balance error (CBE) greater than 20% and were excluded from further evaluation. Groundwater chemistry data from this study was compared with precipitation chemistry data from National Atmospheric Deposition Program/National Trends Network collected at Biscuit Brook during 2010. Comparisons were also made with stream chemistry data collected in the Stony Clove Creek and its tributaries as part of the Research Experiences for Undergraduates (REU) program carried out by SUNY-New Paltz and NYCDEP in the summer of 2011 and funded by the National Science Foundation.











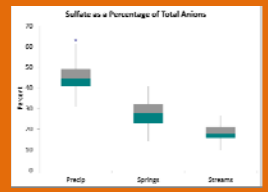
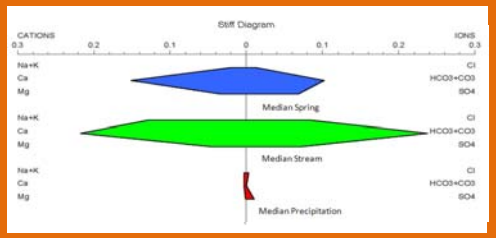


Table 1. Catskill Springs, Streams & Precipitation - Major Ions expressed in mg/L

	ID	Ca	Mg	K	Na	NH_4	NO_3	Cl	SO_4	HCO_3	TDS
Springs	S9	1.649	0.246	0.088	0.544	0.008	0.023	0.454	3.692	6.102	12.8
	S10	2.202	0.345	0.106	0.256	0.003	1.142	0.413	3.399	6.102	14.0
	S11	2.590	0.262	0.540	0.400	0.007	1.459	0.819	2.881	6.102	15.1
	S12	6.044	0.407	0.140	0.270	0.009	0.744	0.290	4.586	18.306	30.8
	S13	5.885	0.425	0.155	0.203	0.000	1.237	0.288	3.856	12.200	24.2
	S14	2.937	0.591	0.187	0.320	0.006	0.373	0.303	3.375	12.200	20.3
	S17	1.826	0.529	0.228	0.876	0.000	1.486	0.567	4.022	6.100	15.6
	S18	2.112	0.453	0.170	0.870	0.054	1.562	0.646	2.738	6.100	14.7
	S20	6.097	1.011	1.371	0.148	0.042	0.136	0.501	4.261	16.000	29.6
	S23	5.744	0.752	0.469	0.241	0.000	1.838	0.375	4.980	12.000	26.4
	S24	8.143	0.711	2.524	0.346	0.000	2.270	4.198	4.820	12.000	35.0
	S26	3.600	0.237	0.095	0.105	0.000	1.740	0.280	3.076	12.204	21.3
	S28	2.977	0.613	0.198	0.357	0.014	0.455	0.339	2.280	6.102	13.3
	S29	2.349	0.545	0.522	4.052	0.000	0.382	10.800	3.715	6.102	28.5
	S30	3.473	0.458	0.469	0.384	0.016	0.238	0.347	2.866	6.102	14.4
	S33	1.084	0.053	0.394	0.232	0.020	0.078	0.450	0.499	3.051	5.9
	S34	1.255	0.384	0.509	0.629	0.019	0.441	1.114	2.392	4.360	11.1
	S35	3.070	0.350	0.180	0.300	0.000	4.060	0.520	3.220	6.100	17.8
	S36	4.590	0.230	0.600	0.900	0.030	5.170	1.710	2.910	9.150	25.3
	S38	3.680	0.300	0.270	0.470	0.000	5.380	0.630	2.670	0.000	13.6
	Med	3.023	0.416	0.249	0.351	0.006	1.190	0.477	3.298	6.102	16.7
Streams	R1	4.903	0.545	0.344	2.737	0.009	0.445	2.728	3.386	16.271	31.4
	R2	4.718	0.548	0.222	2.674	0.025	0.496	2.962	3.432	14.233	29.3
	R3	3.648	0.548	0.213	0.899	0.009	0.324	0.522	3.050	12.200	21.4
	R4	5.349	0.588	0.272	3.042	0.021	0.446	3.146	3.353	18.300	34.5
	R5	5.078	0.585	0.235	2.980	0.053	0.518	3.132	3.282	16.335	32.2
	R6	5.361	0.559	0.238	2.922	0.031	0.562	3.007	3.397	14.167	30.2
	R7	6.386	0.581	0.262	2.905	0.006	0.445	3.116	3.096	30.500	47.3
	R8	4.284	0.496	0.231	1.078	0.026	0.537	0.815	3.197	14.233	24.9
	R9	4.441	0.530	0.234	3.166	0.009	0.510	3.608	3.312	16.269	32.1
	R10	3.788	0.451	0.243	3.760	0.017	0.411	4.880	3.336	14.270	31.2
	R11	3.681	0.453	0.198	0.834	0.004	0.884	0.676	3.450	10.167	20.3
	R13	3.421	0.388	0.168	0.504	0.002	0.547	0.347	3.405	14.238	23.0
	R14	2.611	0.292	0.090	0.565	0.002	0.351	0.325	2.569	10.167	17.0
	R15	3.835	0.431	0.176	2.988	0.025	0.490	3.600	3.084	12.303	26.9
	Med	4.362	0.538	0.233	2.821	0.013	0.493	2.985	3.324	14.236	29.8
Precip.	P1	0.020	0.006	0.005	0.063	0.040	0.400	0.120	0.210	0	0.864
	P2	0.060	0.014	0.019	0.060	0.110	0.470	0.140	0.440	0	1.333
	P3	0.070	0.010	0.009	0.031	0.270	0.860	0.070	1.290	0	2.610
	P4	0.060	0.013	0.010	0.078	0.140	0.610	0.130	0.510	0	1.551
	Med	0.060	0.012	0.010	0.071	0.125	0.540	0.125	0.475	0	1.442

Notes: 1. Samples with charge balance errors > 20% were excluded from this table and from the graphs. 2. Non-detects were assigned a values of zero. 3. Spring samples S9 and S20 were collected from the same location but at different seasons (spring and summer, respectively). 4. Precipitation values are weighted mean concentrations for each season: P1 = winter; P2 = spring; P3 = summer and P4 = fall.



Results & Conclusions:

Based on the results of this study, ambient groundwater in the Catskill region varies between a calcium-bicarbonate type water and a calcium-bicarbonate-sulfate type water. Precipitation is a mixed type with the most dominant cation being either ammonium or sodium and the most dominant anion being either nitrate or sulfate, depending on the season. Surface water is consistently a calcium-bicarbonate type water. Total dissolved solids as well as most individual ions have the lowest concentrations in precipitation and the highest concentrations in surface water, with intermediate concentrations in groundwater. The exceptions are nitrate and potassium which have higher median concentrations in groundwater than in either surface water or precipitation and ammonium which is highest in precipitation. Relatively high concentrations of ammonium, nitrate and sulfate in all sample types reflect continuing impacts of air pollution from sources to the west. Nitrate and sulfate start out as a high percentage of total anions in precipitation and decrease in percentage with a concomitant increase in bi-carbonate through the hydrologic cycle from precipitation to groundwater and from groundwater to surface water.