Susquehanna Headwaters Baseline Water Quality Monitoring

Prepared by:

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Introduction

The following is a preliminary report of water quality data collected between May 2009 and May 2010 at the outflow of Otsego County's fourteen 11-digit Hydrologic Unit Codes watersheds (HUC's). While extensive water quality monitoring is currently taking place in Otsego County, NY in specific waterbodies, this effort is meant to be a first step towards characterizing baseline water quality in the headwaters of the Susquehanna River (SR) by means of direct measurement.

Otsego County is 1,007 square miles in area. Estimates of land use are 71% forest, 27% in agriculture and 2% other (urban/developed). From the 11-digit HUC perspective, that area is divided between 14 distinct watersheds. The boundaries of these watersheds extend beyond the County borders and total an area of 1,390 square miles that all drain to the Susquehanna River and, ultimately, to the Chesapeake Bay.

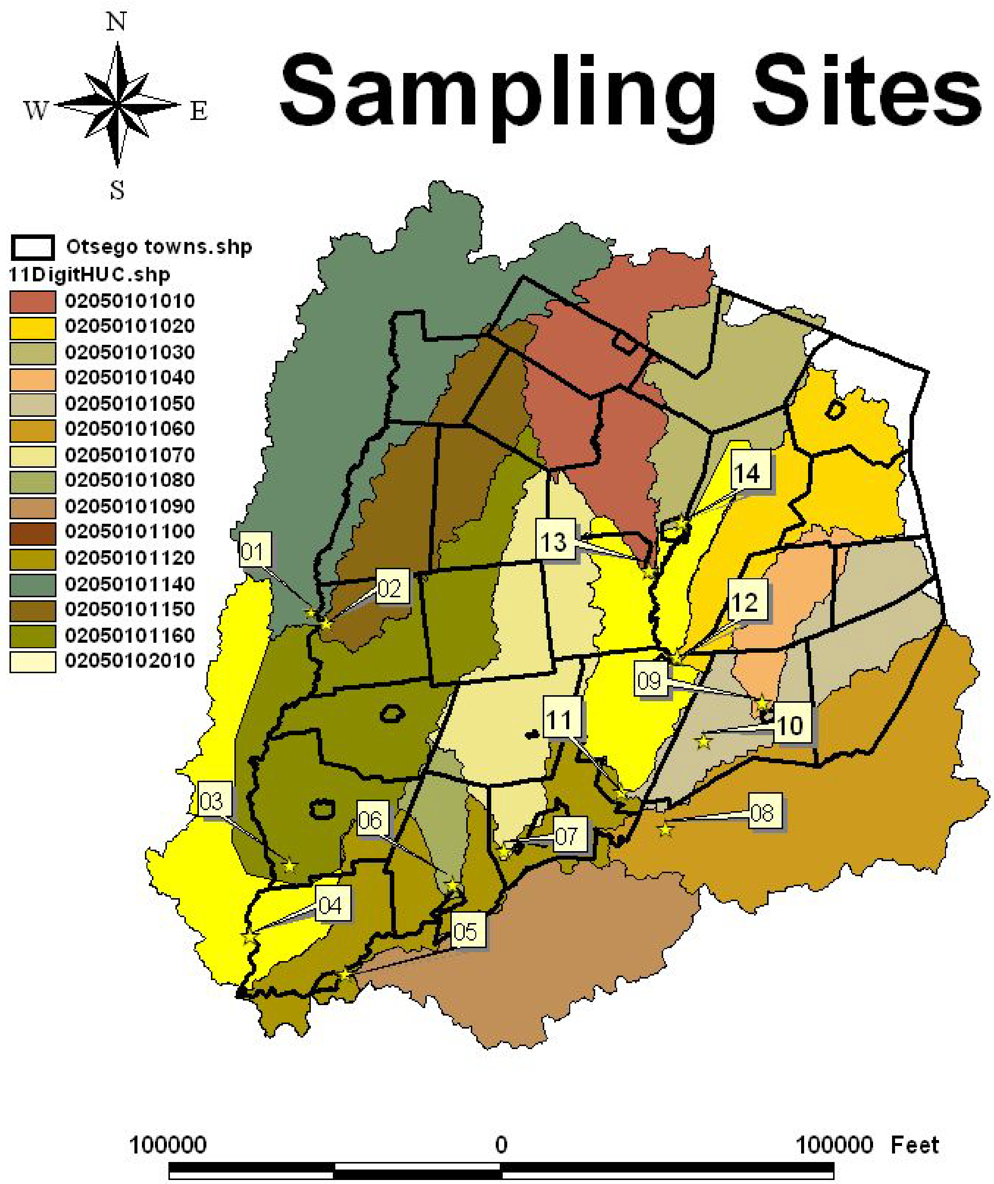
An exception to the 11-digit HUC approach is the Butternut Creek & Lower Unadilla watersheds. At the 11 HUC level, the Butternut is limited to the area above Morris, NY with the lower portion being considered part of the Lower Unadilla watershed. In order to capture watershed specific data to the greatest extent possible, the Butternut was sampled upstream of its confluence with the Unadilla River. The area for each of these watersheds was recalculated based on this sampling point.

The names of each watershed sampled, along with their HUC number and area, are provided in the table below. Sample locations are shown in Map 1.

SR Headwatersheds: 11-Digit Hydrologic Unit Code

11 Digit HUC	Watershed Name	Area (square miles)
2050101140	Upper Unadilla	172
2050101150	Wharton Creek	93
2050101160	Butternut Creek	130*
2050101180	Lower Unadilla	108*
2050101120	Middle Susquehanna River	109
2050101080	Otsdawa Creek	20
2050101070	Otego Creek	109
2050101060	Charlotte Creek	176
2050101040	Elk Creek	33
2050101050	Schenevus Creek	86
2050101030	Upper Susquehanna River	82
2050101020	Cherry Valley Creek	92
2050101010	Oaks Creek	102
2050101035	Otsego Lake	78

Table 1. Code, Name and Area of Otsego County's fourteen 11-digit HUCS's.
* Area adjusted to reflect sampling points



Map 1. Sample locations, HUC number and watershed name of the 14 11-digit HUCs sampled in Otsego County, NY.

Methodology

Sampling Protocol - Grab samples were retrieved monthly (with the exception of January 2010) with a plastic bucket from the road bridges nearest the outflow of each watershed (Map 1). The samples were then transferred to a 250 ml, acid washed high density polyethylene bottle, transported back to the SUNY Oneonta Biological Field Station (BFS) and refrigerated immediately. If analysis of all chemical parameters (see below) did not take place within 72 hours, samples were acidified with 0.2 % H_2SO_4 and kept refrigerated until analysis could be performed (EPA 1984).

The parameters measured were: ammonium (NH3), nitrite + nitrate (NOx), total nitrogen (TN) and total phosphorus (TP).

Lab analysis - Nitrate+nitrite (NOx) analysis was performed using a Lachat Auto Analyzer (QuickChem® method 10- 107-04-1-C). Ammonium (NH4) analysis was performed using a Lachat Auto Analyzer (QuickChem® method 10- 107-06-1-J). Total nitrogen (TN) analysis was performed by determining NO3, as described above, after Persulfate digestion (Ebina *et al*., 1983). Total phosphorus analysis was performed by persulfate digestion (APHA, 1992).

Results

Results are expressed in concentrations (mg/L or ug/L in the case of TP). All data are provided in Appendix 1.

Nitrogen - Descending mean NOx concentrations and standard deviations (n=12 months) are show below in Table 1. NOx concentrations for each watershed over time are shown in Graph 1. TN data are similarly shown in Table & Graph 2.

All NOx samples collected were ≤ 1.40 mg/L. Except for the Upper Unadilla and Elk Creek watersheds, most values were below 0.6 mg/L. The Upper Unadilla had the highest concentrations for 7 of the 12 months monitored. (avg 0.73 ± 0.19). The Elk Creek watershed had the highest concentrations in July and August and had concentrations above the 0.6 mg level in 5 other months.

Three NOx samples collected were below detection (0.02 mg/L). These samples were taken from the Butternut, Otsdawa and Oaks Creek watersheds on 7/22, 5/25 and 5/25 respectively. The Otsdawa Creek Watershed had the lowest average concentration over the 1 year period.

TN data for the August 2009 and May 2010 sampling dates are not reported. Most TN samples collected were ≤ 1.00 mg/L. Similar to NOx concentrations, the Upper Unadilla and Elk Creek watersheds had the highest mean concentrations and were the only watersheds to consistently approach or exceed 1.00 mg/L over the year.

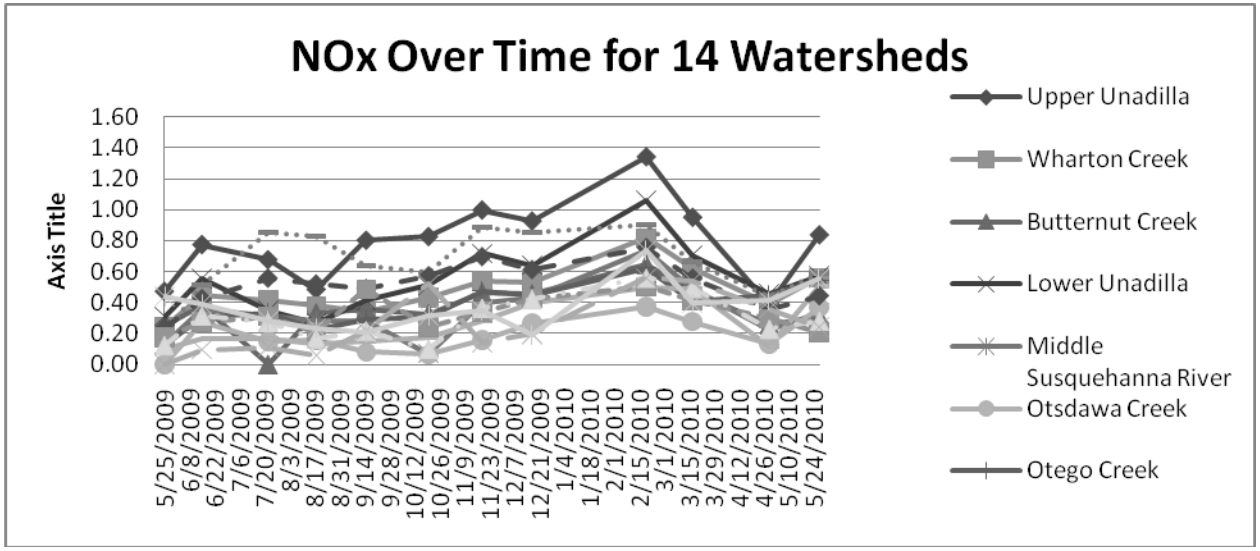
The ranking of watersheds from highest to lowest for mean NOx and TN concentrations matches the 4 highest ranking watersheds and the 4 lowest. For most of the samples collected NOx represents over 50% of the TN in the sample.

Nitrate+Nitrite (mg/L) - May 2009 to May 2010		
- Watershed (11 Digit HUC)	Mean (n=12)	- STDV
Upper Unadilla	0.79	0.26
Elk Creek	0.66	0.21
Lower Unadilla	0.54	0.23
Schenevus Creek	0.52	0.14
Wharton Creek	0.48	0.15
Butternut Creek	0.40	0.11
Otego Creek	0.38	0.14
Otsego Lake	0.36	0.15
Middle Susquehanna River	0.34	0.17
Upper Susquehanna River	0.32	0.11
Cherry Valley Creek	0.30	0.14
Oaks Creek	0.28	0.19
Charlotte Creek	0.26	0.16
Otsdawa Creek	0.20	0.10

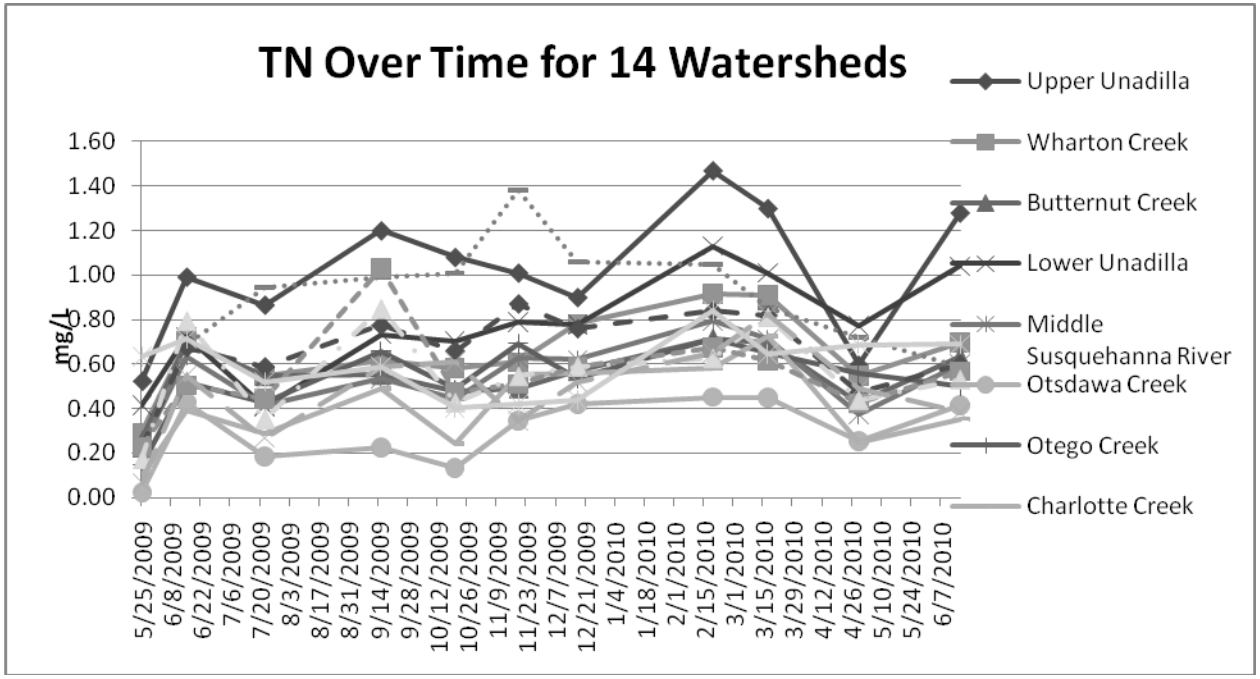
Table 1. Descending mean NOx concentrations and standard deviations (n=12 months) for fourteen 11-Digit HUC watersheds in Otsego County, NY.

Total Nitrogen (mg/L) - May 2009 to June 2010		
Watershed (11 Digit HUC)	Mean (n=12)	STDV
Upper Unadilla	1.02	0.29
Elk Creek	0.86	0.31
Lower Unadilla	0.75	0.22
Schenevus Creek	0.67	0.20
Wharton Creek	0.65	0.18
Middle Susquehanna River	0.61	0.28
Otsego Lake	0.59	0.14
Cherry Valley Creek	0.56	0.21
Butternut Creek	0.55	0.13
Upper Susquehanna River	0.55	0.20
Otego Creek	0.54	0.16
Oaks Creek	0.48	0.21
Charlotte Creek	0.41	0.19
Otsdawa Creek	0.29	0.15

Table 2. Descending mean TN concentrations and standard deviations (n=7 months) for fourteen 11-Digit HUC watersheds in Otsego County, NY.



Graph 1. Monthly NOx concentrations from fourteen 11-Digit HUC watersheds in Otsego County, NY



Graph 2. Monthly TN concentrations from fourteen 11-Digit HUC watersheds in Otsego County, NY

Phosphorus - Descending mean TP concentrations and standard deviations (n=12 months) are show below in Table 3. TP concentrations for each watershed over time are shown in Graph 3.

Total Phosphorus (ug/L) - May 2009 to May 2010		
Watershed (11 Digit HUC)	Mean (n=12)	STDV
Upper Unadilla	26.40	17.95
Middle Susquehanna River	23.58	8.98
Elk Creek	23.52	22.06
Cherry Valley Creek	23.34	21.46
Lower Unadilla	22.78	14.60
Oaks Creek	22.64	18.60
Butternut Creek	20.33	10.61
Wharton Creek	19.22	15.62
Otego Creek	17.65	14.34
Charlotte Creek	16.59	10.41
Upper Susquehanna River	15.91	6.73
Schenevus Creek	15.73	10.09
Otsego Lake	13.38	7.16
Otsdawa Creek	10.97	4.71

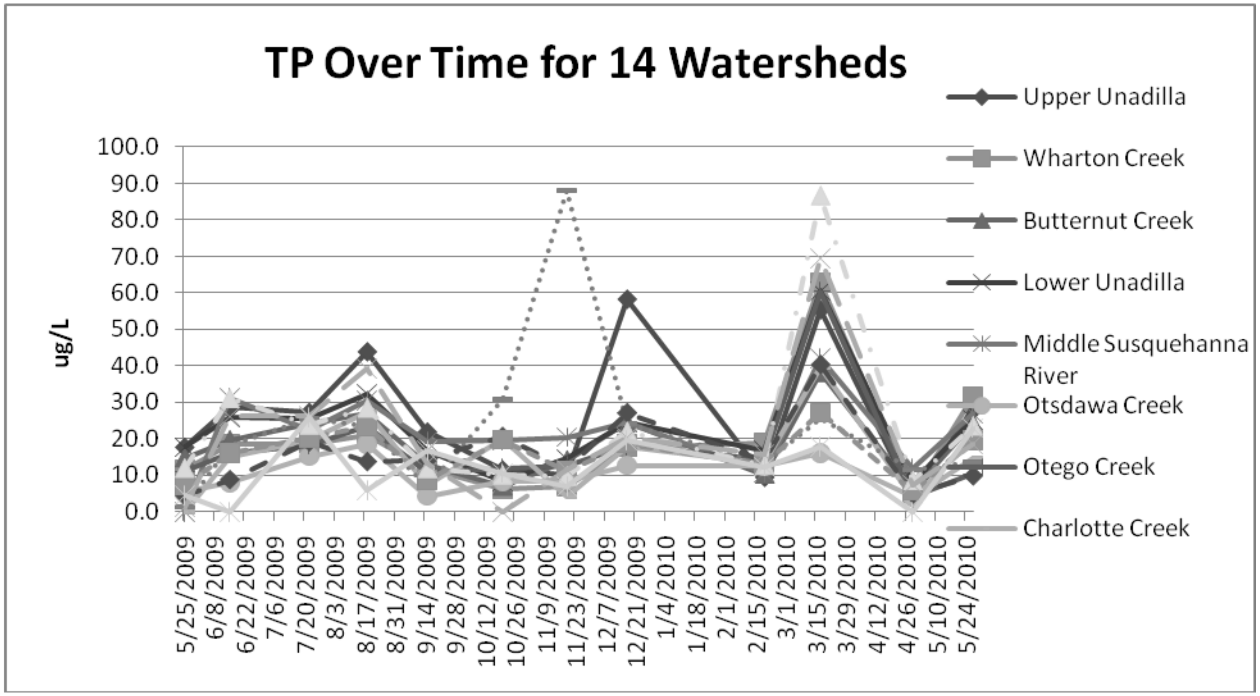
Table 3. Descending mean TP concentrations and standard deviations (n=8 months) for fourteen 11- Digit HUC watersheds in Otsego County, NY.

All but three samples collected over the eight month period had TP concentrations less than 40 ug/L. Exceptions to this are 8 samples collected on March 17th during a month long increase in flow from beginning on March 11th.

Elk Creek had the highest single concentration (87 ug/L) but was otherwise at or below 30 ug/L. The Upper Unadilla River watershed had the two other concentrations above 40ug/L but otherwise was below 30 ug/L for the remaining 6 months sampled.

The Otsego Lake and Otsdawa Creek watersheds had the lowest concentrations over time neither watershed exceeding 26 ug/L in any month.

During the March runoff event, Cherry Valley Creek had the highest concentration of 86.7 ug/L. Oaks Creek, Otego Creek, Lower Unadilla and Wharton Creek all had concentrations between 60 and 70 ug/L. Otsdawa Creek and Otsego Lake had the lowest concentrations; 16 & 17.8 mg/L respectively.



Graph 3. Monthly TP concentrations from fourteen 11-Digit HUC watersheds in Otsego County, NY

Discussion

With the exception of the March 2010 sampling date, all data presented here reflects baseline conditions. Considering that all but 4 of the 14 watersheds are headwaters (the Middle and Upper Susquehanna and Lower and Upper Unadilla receive waters from other watersheds) and the nature of the land use throughout the watersheds (approximately 73% forest and 25% agriculture) the low concentrations recorded for all the parameters measured should be expected.

While nutrient concentrations are a reflection of inputs, they are also a function of volume which makes comparisons of water quality between watersheds difficult. Larger volumes of water from larger watersheds will dilute nutrients given equal inputs but can have higher total export as a function of volume. Even smaller watersheds with relatively high concentrations will still have lower total export when compared to larger watersheds with lower concentrations because of volume; large watersheds with relatively high concentrations can be expected to also have the highest export.

As noted above, the Middle and Upper Susquehanna and Lower and Upper Unadilla all receive waters from other watersheds. As such, the concentrations are a reflection of the all the watersheds that drain into those watersheds in addition to the land within their own specific watershed. For example, the Upper Susquehanna River sampled in Colliersville is representative of the area within the Upper Susquehanna watershed, but it also includes water from Otsego Lake, Oaks Creek, Cherry Valley Creek, Elk Creek and Schenevus Creek.

Additionally, most water in a given year will pass through a watershed during rain events and the first flush of spring runoff. Concentrations of TP typically increase at the beginning of such events as flow increases as seen in the March - April event.

The cost associated with directly measuring both flow and sampling rain events is greater than what is currently available. However, real-time flow data is collected locally at the USGS flow station located in Rockdale on the Unadilla River. This station captures 520 square miles of the Upper and Lower Unadilla River watershed.

There are 3 USGS flow stations in the Upper Susquehanna in NY that capture flow data before the inclusion of water from the Chemung River. These stations are in Rockdale, Conklin and Waverly, NY. When the cubic feet per second are compared for each of these sites over time (Graph 5), it can be observed that each hydrograph is similar.

This is due to the nested nature of watersheds with the smaller watersheds being within the larger. The Rockdale site captures 520 square miles of of the Upper Susquehanna watershed. Further west, the Conklin site captures the area captured at the Rockdale site and an additional 1,712 square miles of watershed and further west still, the Waverly site includes both areas and an additional 2,541 square miles of watershed.

Aside from concentrations, it is often useful to consider total export (mass) as a measurement of water quality. In other words, knowing how many tons of N, P are moving out of a particular watershed as erosion and leaching take place on the landscape. This particularly true for these watersheds given the proposed designation of the entire Upper Susquehanna River watershed as a Total Maximum Daily Load waterbody by the US Environmental Protection Agency in 2011.

Estimates of total export for each watershed are possible given available data; those reported above and discharge data as recorded at Rockdale during the sampling timeframe (not reported here). The two assumptions in the following calculation are linearity in nutrient concentration between sample dates and the nested nature of watershed hydrology extends towards smaller watersheds.

By dividing the cubic feet of water passing by the Rockdale site per day by the square miles of the area captured, cubic feet of water per square mile is calculated. This number can then be multiplied by the number of square miles in any watershed to represent flow in those watersheds. The result is an estimate of daily flow of water in each watershed sampled.

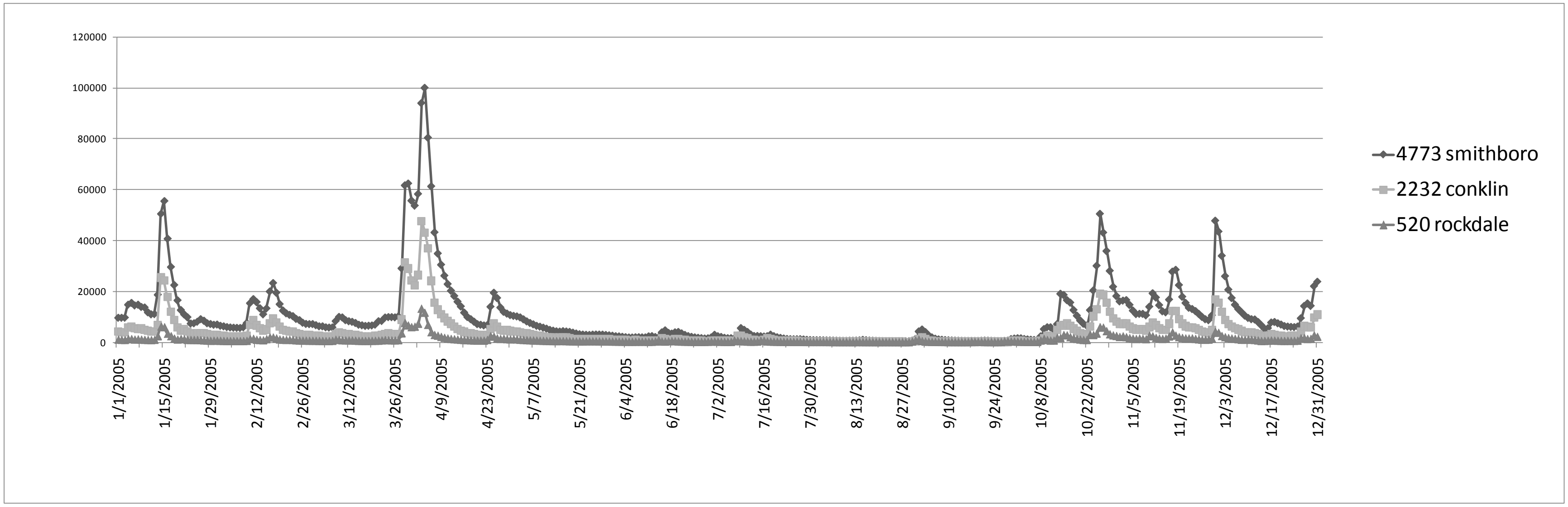
Also, by assuming linearity in concentration between sample dates, concentrations can be estimated for all days within the sample period. Further, multiplying volume (daily flow) by daily concentration calculates mass for that day and daily mass can be summed to produce an estimate of total export of the parameters measured. Load estimates for the 14 11-digit HUC's sampled are provided in Graphs 6, 7, & 8 (TN, NOx and TP respectively). By dividing the estimated load by the acres of a watershed, an estimate of nutrient flux on a per acre basis can be calculated (Table 4).

These calculations have several serious caveats that should be considered when interpreting the resulting estimates. First is the assumption that rain events recorded at the USGS Rockdale site also occurred throughout all the watersheds. As described above, this assumption is valid when comparing watersheds at an increasing scale, but may not be as valid as watersheds are compared at a decreasing scale. For example, a rain event over the Unadilla watershed (as recorded in Rockdale) may not occur over the Schenevus watershed. Conversely, it is possible that a rain event over the Schenevus watershed may not occur over the Unadilla.

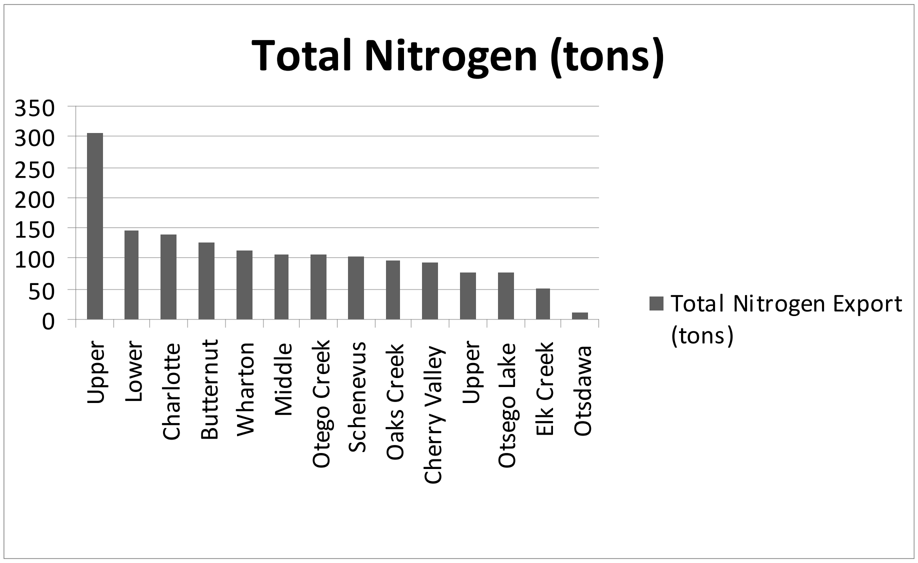
Secondly, most water samples were not collected in conjunction with rain events. Typically, some parameter concentrations, such as TP, are likely to increase during rain events as soil is eroded from the landscape and stream banks; such as was recorded on the March sampling date. Others, such as N, could be lower because of low availability and N in solution is diluted, although this was not clearly recorded in March.

While the hydrology for rain events is included in the estimate, the estimates for TP are likely to be low and those for N could be high, because they do not include the event specific concentrations.

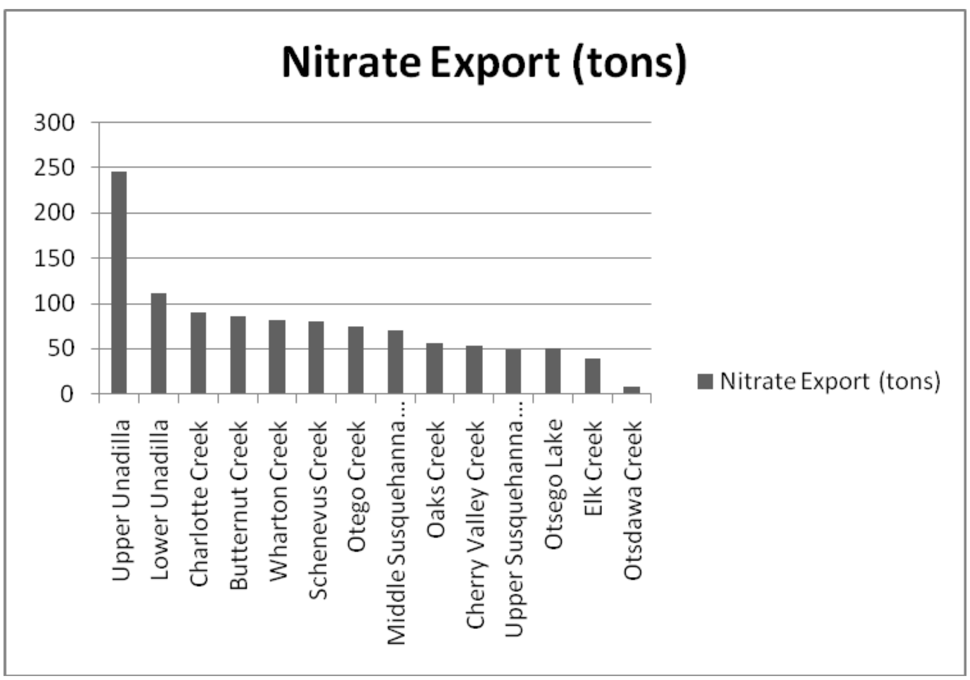
Hydrograph for 3 USGS Sites Recorded in 2005



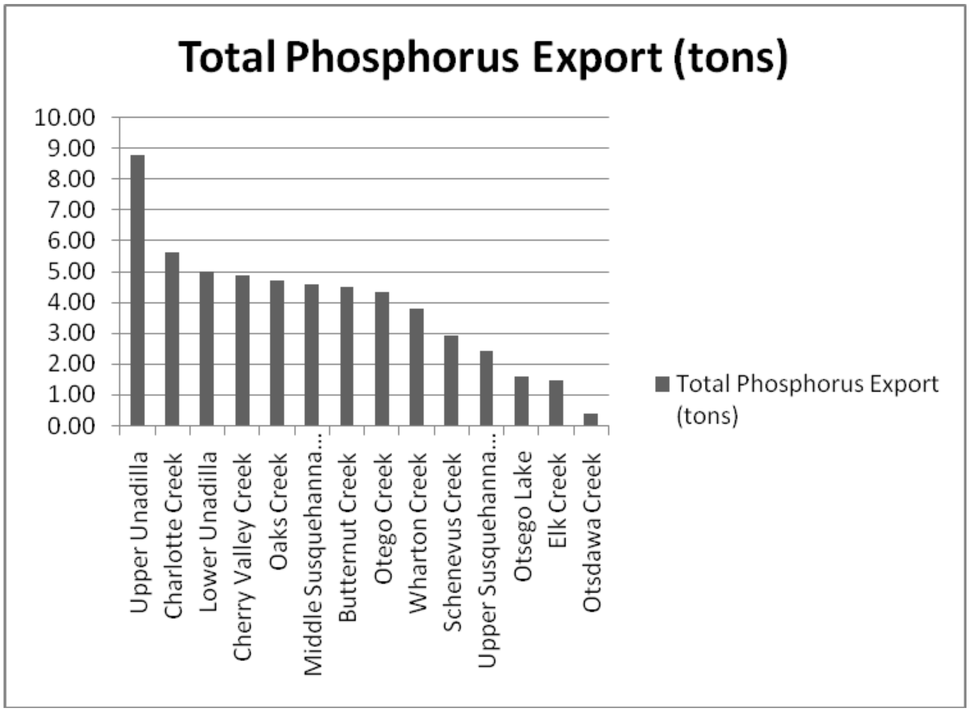
Graph 5. Daily flow measurements (cubic feet per second) for the Smithboro, Conklin and Rockdale USGS flow stations recorded in 2005.



Graph 6. Estimated TN load (for 12 months and in tons) exported from the fourteen 11-digit HUC's in Otsego County, NY.



Graph 7. Estimated NOx load (for 12 months and in tons) exported from the fourteen 11-digit HUC's in Otsego County, NY.



Graph 8. Estimated TP load (for 8 months and in tons) exported from the fourteen 11-digit HUC's in Otsego County, NY.

Estimated Nutrient Export Calculated Per Pound Per Acre				
11 Digit HUC	Watershed Name	TN export lbs/acre	NOx export lbs/acre	TP export lbs/acre
2050101010	Oaks Creek	3	1.7	0.14
2050101020	Cherry Valley Creek	3	1.8	0.17
2050101030	Upper Susquehanna River	3	1.9	0.09
2050101035	Otsego Lake	3	2.0	0.06
2050101040	Elk Creek	5	3.7	0.14
2050101050	Schenevus Creek	4	2.9	0.11
2050101060	Charlotte Creek	2	1.6	0.1
2050101070	Otego Creek	3	2.1	0.12
2050101080	Otsdawa Creek	2	1.1	0.06
2050101120	Middle Susquehanna River	3	2.0	0.13
2050101140	Upper Unadilla	6	4.5	0.16
2050101150	Wharton Creek	4	2.8	0.13
2050101160	Butternut Creek	3	2.1	0.11
2050101180	Lower Unadilla	4	3.2	0.14

Table 4. Estimated nutrient export per pound per acre for each of the watersheds monitored. Watersheds are shown in desending order by HUC number.

It is suggested that future efforts attempt to sample a number of rain events in each watershed, include recording of pH and conductivity and make Total Suspended Sediment a regular part of the sampling regime.

Acknowledgements

Thanks go to the Otsego County Water Quality Coordinating Committee for funding the lab analysis, the SUNY Oneonta Biological Field Station for performing the lab analysis, to the Otsego County Soil and Water Conservation District for collecting the samples and preparing the report and the Upper Susquehanna Coalition for support.

APPENDIX 1: All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC 1	0.47	0.52	17.8
6/15/2009	HUC 1	0.77	0.99	28.5
7/22/2009	HUC1	0.68	0.87	27.4
8/18/2009	HUC1	0.48	N/A	43.9
9/15/2009	HUC1	0.80	1.20	22.0
10/20/2009	HUC1	0.83	1.08	11.6
11/19/2009	HUC1	1.00	1.01	10.1
12/17/2009	HUC1	0.93	0.9	58.3
2/19/2010	HUC1	1.34	1.47	10
3/17/2010	HUC1	0.95	1.30	55
4/29/2010	HUC1	0.39	0.60	4
5/27/2010	HUC1	0.84	N/A	28
	avg	**0.79**	**1.23**	**26.40**
	stdev	**0.26**	**0.62**	**17.95**
	min	**0.39**	**0.52**	**3.87**
	max	**1.34**	**2.53**	**58.30**

5/25/2009	HUC2	0.24	0.29	11.6
6/15/2009	HUC2	0.45	0.71	18.6
7/22/2009	HUC2	0.42	0.55	18.7
8/18/2009	HUC2	0.38	N/A	20.8
9/15/2009	HUC2	0.34	0.62	11.8
10/20/2009	HUC2	0.43	0.582	6.3
11/19/2009	HUC2	0.54	0.608	7.0
12/17/2009	HUC2	0.53	0.781	17.6
2/19/2010	HUC2	0.82	0.92	19
3/17/2010	HUC2	0.62	0.91	63
4/29/2010	HUC2	0.39	0.55	5
5/27/2010	HUC2	0.56	N/A	32
	avg	**0.48**	**0.85**	**19.22**
	stdev	**0.15**	**0.50**	**15.62**
	min	**0.24**	**0.29**	**5.00**
	max	**0.82**	**1.90**	**62.74**

bd - below detection

APPENDIX 1 (continued) : All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC3	0.25	0.26	14.8
6/15/2009	HUC3	0.38	0.70	19.6
7/22/2009	HUC3	bd	0.55	24.2
8/18/2009	HUC3	0.33	N/A	26.8
9/15/2009	HUC3	0.36	0.55	13.0
10/20/2009	HUC3	0.33	0.48	7.0
11/19/2009	HUC3	0.46	0.491	14.1
12/17/2009	HUC3	0.45	0.569	24.4
2/19/2010	HUC3	0.65	0.72	10
3/17/2010	HUC3	0.47	0.70	38
4/29/2010	HUC3	0.26	0.43	6
5/27/2010	HUC3	0.31	N/A	24
	avg	**0.39**	**0.71**	**18.54**
	stdev	**0.12**	**0.41**	**9.43**
	min	**0.25**	**0.26**	**6.01**
	max	**0.65**	**1.56**	**38.24**

5/25/2009	HUC4	0.31	0.42	17.7
6/15/2009	HUC4	0.56	0.72	25.7
7/22/2009	HUC4	0.35	0.41	25.7
8/18/2009	HUC4	0.27	N/A	32.3
9/15/2009	HUC4	0.41	0.73	16.7
10/20/2009	HUC4	0.51	0.702	8.3
11/19/2009	HUC4	0.72	0.79	14.5
12/17/2009	HUC4	0.64	0.778	24.4
2/19/2010	HUC4	1.06	1.13	17
3/17/2010	HUC4	0.71	1.01	61
4/29/2010	HUC4	0.45	0.77	8
5/27/2010	HUC4	0.57	N/A	25
	avg	**0.55**	**0.88**	**22.98**
	stdev	**0.22**	**0.38**	**13.94**
	min	**0.27**	**0.41**	**8.04**
	max	**1.06**	**1.71**	**60.54**

bd - below detection

APPENDIX 1 (continued) : All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC5	0.13	0.23	bd
6/15/2009	HUC5	0.36	0.64	31.2
7/22/2009	HUC5	0.31	0.41	22.4
8/18/2009	HUC5	0.28	N/A	30.5
9/15/2009	HUC5	0.29	0.54	19.3
10/20/2009	HUC5	0.07	0.445	19.5
11/19/2009	HUC5	0.40	0.625	20.4
12/17/2009	HUC5	0.43	0.62	24.5
2/19/2010	HUC5	0.74	0.79	11
3/17/2010	HUC5	0.49	0.71	42
4/29/2010	HUC5	0.22	0.38	12
5/27/2010	HUC5	0.33	N/A	27
	avg	**0.34**	**0.70**	**23.58**
	stdev	**0.17**	**0.42**	**8.98**
	min	**0.07**	**0.23**	**10.66**
	max	**0.74**	**1.69**	**42.04**

5/25/2009	HUC6	bd	0.02	5.6
6/15/2009	HUC6	0.28	0.43	8.1
7/22/2009	HUC6	0.15	0.19	15.2
8/18/2009	HUC6	0.16	N/A	18.4
9/15/2009	HUC6	0.08	0.23	4.3
10/20/2009	HUC6	0.06	0.133	8.4
11/19/2009	HUC6	0.16	0.344	8.5
12/17/2009	HUC6	0.27	0.42	12.7
2/19/2010	HUC6	0.37	0.45	13
3/17/2010	HUC6	0.28	0.45	16
4/29/2010	HUC6	0.13	0.25	4
5/27/2010	HUC6	0.37	N/A	20
	avg	**0.21**	**0.50**	**11.12**
	stdev	**0.11**	**0.56**	**5.39**
	min	**0.06**	**0.02**	**4.16**
	max	**0.37**	**2.12**	**19.60**

bd - below detection

APPENDIX 1 (continued) : All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC7	0.13	0.14	11.1
6/15/2009	HUC7	0.30	0.52	16.1
7/22/2009	HUC7	0.33	0.43	18.4
8/18/2009	HUC7	0.22	N/A	23.3
9/15/2009	HUC7	0.29	0.66	10.9
10/20/2009	HUC7	0.31	0.487	11.9
11/19/2009	HUC7	0.48	0.691	12.7
12/17/2009	HUC7	0.44	0.536	18.2
2/19/2010	HUC7	0.62	0.72	14
3/17/2010	HUC7	0.41	0.65	60
4/29/2010	HUC7	0.45	0.56	4
5/27/2010	HUC7	0.55	N/A	10
	avg	**0.38**	**0.60**	**17.65**
	stdev	**0.14**	**0.21**	**14.34**
	min	**0.13**	**0.14**	**4.00**
	max	**0.62**	**0.97**	**60.44**

5/25/2009	HUC8	0.10	0.10	bd
6/15/2009	HUC8	0.16	0.39	14.9
7/22/2009	HUC8	0.16	0.29	19.6
8/18/2009	HUC8	0.13	N/A	27.4
9/15/2009	HUC8	0.15	0.49	7.4
10/20/2009	HUC8	0.17	0.244	20.0
11/19/2009	HUC8	0.28	0.554	4.1
12/17/2009	HUC8	0.40	0.561	17.9
2/19/2010	HUC8	0.49	0.58	13
3/17/2010	HUC8	0.49	0.72	39
4/29/2010	HUC8	0.12	0.25	4
5/27/2010	HUC8	0.50	N/A	15
	avg	**0.26**	**0.69**	**16.59**
	stdev	**0.16**	**0.67**	**10.41**
	min	**0.10**	**0.10**	**3.85**
	max	**0.50**	**2.20**	**39.44**

bd - below detection

APPENDIX 1 (continued) : All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC9	0.20	0.19	1.3
6/15/2009	HUC9	0.51	0.69	18.2
7/22/2009	HUC9	0.85	0.95	25.6
8/18/2009	HUC9	0.83	N/A	23.4
9/15/2009	HUC9	0.64	0.99	6.9
10/20/2009	HUC9	0.59	1.01	30.8
11/19/2009	HUC9	0.89	1.38	87.9
12/17/2009	HUC9	0.85	1.06	24.2
2/19/2010	HUC9	0.90	1.05	13
3/17/2010	HUC9	0.66	0.85	26
4/29/2010	HUC9	0.44	0.72	12
5/27/2010	HUC9	0.58	N/A	14
	avg	**0.66**	**1.04**	**23.52**
	stdev	**0.21**	**0.59**	**22.06**
	min	**0.20**	**0.19**	**1.35**
	max	**0.90**	**2.67**	**87.90**

5/25/2009	HUC10	0.24	0.23	4.4
6/15/2009	HUC10	0.42	0.68	8.8
7/22/2009	HUC10	0.56	0.59	19.2
8/18/2009	HUC10	0.52	N/A	13.7
9/15/2009	HUC10	0.49	0.78	14.2
10/20/2009	HUC10	0.57	0.659	20.6
11/19/2009	HUC10	0.70	0.871	11.8
12/17/2009	HUC10	0.61	0.76	27.1
2/19/2010	HUC10	0.75	0.84	14
3/17/2010	HUC10	0.56	0.82	40
4/29/2010	HUC10	0.36	0.47	5
5/27/2010	HUC10	0.44	N/A	10
	avg	**0.52**	**0.88**	**15.73**
	stdev	**0.14**	**0.52**	**10.09**
	min	**0.24**	**0.23**	**4.40**
	max	**0.75**	**1.95**	**40.24**

bd - below detection

APPENDIX 1 (continued) : All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC11	0.18	0.23	7.2
6/15/2009	HUC11	0.27	0.51	16.1
7/22/2009	HUC11	0.31	0.45	20.4
8/18/2009	HUC11	0.21	N/A	23.4
9/15/2009	HUC11	0.49	1.03	8.7
10/20/2009	HUC11	0.24	0.474	19.7
11/19/2009	HUC11	0.34	0.51	11.3
12/17/2009	HUC11	0.43	0.587	18.7
2/19/2010	HUC11	0.50	0.67	13
3/17/2010	HUC11	0.41	0.62	27
4/29/2010	HUC11	0.30	0.42	6
5/27/2010	HUC11	0.21	N/A	20
	avg	**0.32**	**0.65**	**15.91**
	stdev	**0.11**	**0.30**	**6.73**
	min	**0.18**	**0.23**	**5.71**
	max	**0.50**	**1.18**	**27.14**

5/25/2009	HUC12	0.12	0.17	11.9
6/15/2009	HUC12	0.31	0.79	31.0
7/22/2009	HUC12	0.27	0.35	23.8
8/18/2009	HUC12	0.17	N/A	28.4
9/15/2009	HUC12	0.22	0.85	11.8
10/20/2009	HUC12	0.10	0.428	10.0
11/19/2009	HUC12	0.37	0.546	9.7
12/17/2009	HUC12	0.42	0.59	22.0
2/19/2010	HUC12	0.56	0.63	13
3/17/2010	HUC12	0.50	0.81	87
4/29/2010	HUC12	0.23	0.44	9
5/27/2010	HUC12	0.28	N/A	24
	avg	**0.30**	**0.71**	**23.34**
	stdev	**0.14**	**0.46**	**21.46**
	min	**0.10**	**0.17**	**8.50**
	max	**0.56**	**1.98**	**86.74**

bd - below detection

APPENDIX 1 (continued) : All data from all sites.

Date	Watershed	NOx (mg/L)	TN (mg/L)	TP (ug/L)
5/25/2009	HUC13	bd	0.07	1.3
6/15/2009	HUC13	0.09	0.55	26.1
7/22/2009	HUC13	0.11	0.27	26.2
8/18/2009	HUC13	0.06	N/A	39.2
9/15/2009	HUC13	0.22	0.59	13.2
10/20/2009	HUC13	0.52	0.609	bd
11/19/2009	HUC13	0.14	0.346	11.6
12/17/2009	HUC13	0.20	0.517	20.3
2/19/2010	HUC13	0.56	0.65	16
3/17/2010	HUC13	0.54	0.82	69
4/29/2010	HUC13	0.36	0.49	7
5/27/2010	HUC13	0.24	N/A	19
	avg	**0.28**	**0.64**	**22.64**
	stdev	**0.19**	**0.43**	**18.60**
	min	**0.06**	**0.07**	**1.28**
	max	**0.56**	**1.80**	**69.44**

5/25/2009	HUC14	0.44	0.63	4.5
6/15/2009	HUC14	0.39	0.71	bd
7/22/2009	HUC14	0.28	0.52	25.9
8/18/2009	HUC14	0.24	N/A	5.9
9/15/2009	HUC14	0.21	0.59	16.8
10/20/2009	HUC14	0.32	0.404	10.6
11/19/2009	HUC14	0.35	0.422	6.9
12/17/2009	HUC14	0.19	0.438	19.6
2/19/2010	HUC14	0.74	0.84	12
3/17/2010	HUC14	0.39	0.65	18
4/29/2010	HUC14	0.41	0.69	bd
5/27/2010	HUC14	0.55	N/A	23
	avg	**0.38**	**0.77**	**14.33**
	stdev	**0.15**	**0.51**	**7.39**
	min	**0.19**	**0.40**	**4.49**
	max	**0.74**	**2.27**	**25.85**

bd - below detection