Report on Nutrient Synoptic Surveys in the Lower Monocay River Watershed, Frederick County, Maryland, April 2003 as part of the Watershed Restoration Action Strategy.

Maryland Department of Natural Resources
Watershed Services
Landscape and Watershed Analysis
Management Studies
November, 2003

Acknowledgements

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This work supports Department of Natural Resources Outcomes –
#2 Healthy Maryland watershed lands, streams, and non-tidal rivers.
#3 A natural resources stewardship ethic for Marylanders.
#4 Vibrant local communities in balance with natural systems.

Significant field collection assistance was provided by Jennifer Rusko Rebecca Zeiber, Matt Evans, and Kevin R. Coyne of MD Dept of Natural Resources, Watershed Services, Landscape and Watershed Analysis, Management Studies.

Cover photo: Unnamed tributary to South Fork Linganore Cr. by Niles Primrose

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Executive Summary

A nutrient synoptic survey was conducted during April, 2003 in the Lower Monocacy watershed as part of the Lower Monocacy WRAS. Samples were analyzed from 77 sites throughout the watershed. Sampling was focused in the Linganore Creek and Bennett Creek watersheds, with additional samples collected at the outlets of other major tributaries. Biological samples were collected at nine of the nutrient sites. Nitrate/nitrite concentrations were found to be excessive in eight subwatersheds, high in twenty-seven, moderately elevated in thirty-nine others, and baseline in the remaining four subwatersheds. Nitrate/nitrite yields were found to be excessive in thirty-eight subwatersheds, high in fifteen, moderately elevated in sixteen, and baseline in the remaining 8. Excessive concentrations of orthophosphate were found in eight subwatersheds, high concentrations in six, moderate concentrations in eighteen, and the remaining forty-five below baseline. Orthophosphate yields were found to be excessive in one subwatershed, high in one subwatershed, moderate in four, and baseline in the remainder. The majority of the elevated nitrate/nitrite concentrations and/or yields appear to be associated with animal and row crop agriculture. The elevated orthophosphate concentrations and yields appear to be associated with phosphorus rich soils in systems that had fine suspended sediment loads lingering in the water column several days after rain events possibly due to drainage from ponds. No anomalies were found in the insitu measurements of dissolved oxygen, or temperature. Twenty-one subwatersheds had relatively high conductivity (>300mmhos/cm) associated with limestone influence. Elevated pH values generally followed the high conductivity for the same reason. Benthic macroinvertebrate community Index of Biotic Integrity ranged from good to very poor at the nine sites sampled. The degradation in the benthic community was attributed to degraded habitat associated with storm water flows. Fish communities at the two sites sampled could be considered poor due to influences from Lake Linganore.

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Introduction

A nutrient synoptic survey was conducted during April, 2003 in the Lower Monocacy watershed as part of the Lower Monocacy Watershed Restoration Action Strategy.

Nutrient synoptic sampling was scheduled for early spring to coincide with the period of maximum nitrogen concentrations in the free flowing fresh water streams. The major proportion of the nitrogen compounds are carried dissolved in the ground water rather than in surface runoff. The higher nitrogen concentrations in the late winter and early spring reflect the higher proportion of nitrogen rich shallow ground water present in the base flow at this time of year. Nitrogen concentrations are reduced in summer as the proportion of shallow ground water is reduced through plant uptake, and replaced by deeper ground water that may have lower nitrate concentrations, or has been denitrified through interaction with anoxic conditions in the soils below the streambed. Point sources can also contribute to in stream nitrate concentrations.

Orthophosphate is generally transported bound to suspended sediments in the water column. In stream orthophosphate concentrations can also be produced through mobilization of sediment bound phosphorus in anoxic water column and/or sediment conditions, sediment in surface runoff from areas having had surface applied phosphorus, ground water from phosphorus saturated soils, and point source discharges.

Ranges used for nutrient concentrations and yields (Table 1) were derived from work done by Frink (1991). The low end values are based on estimated nutrient exports from forested watersheds, and the high end values are based on estimated nutrient exports from intensively agricultural watersheds. As an additional benchmark, the Chesapeake Bay Program uses 1 mg/L total nitrogen as a threshold for indicating anthropogenic impact. The dissolved nitrogen fraction looked at in these synoptic surveys constitutes approximately 50% to 70% of the total nitrogen.

Table 1. Nutrient Ranges and Rating

Rating	NO2+NO3 Concentration mg/L	NO2+NO3 Yield Kg/ha/day	PO4 Concentration mg/L	PO4 Yield Kg/ha/day
Baseline	<1	<.01	<.005	<.0005
Moderate	1 to 3	.01 to .02	.005 to .01	.0005 to .001
High	3 to 5	.02 to .03	.01 to .015	.001 to .002
Excessive	>5	>.03	>.015	>.002

A Note of Caution

Estimates of annual dissolved nitrogen loads/yields from spring samples will result in inflated load estimates, but the relative contributions of subwatersheds should remain reasonably stable. More accurate nitrate/nitrite load/yield estimates need to include sampling during the growing season to account for potential lower concentrations and discharges. Storm flows can also significantly impact loads delivered to a watershed outlet.

The tendency of orthophosphate to be transported bound to sediments makes any estimates of annual orthophosphate loads/yields derived from base flow conditions very conservative. More accurate estimates of orthophosphate loads/yields in a watershed must include samples from storm flows that carry the vast majority of the sediment load of a watershed. Residual suspended sediments from recent rains, or instream activities of livestock or construction can produce apparently elevated orthophosphate concentrations and yields at base flow.

METHODS

Water Chemistry Sampling

Synoptic water chemistry samples were collected in early spring throughout the watershed. Sampling was halted for a minimum of 24 hours after rainfall events totaling more than .25 inches. Grab samples of whole water (500 ml) were collected just below the water surface at mid-stream and filtered using a 0.45 micron pore size (Gelman GF/C) filter. The samples were stored on ice and frozen on the day of collection. Filtered samples were analyzed by the Nutrient Analytical Services Laboratory at the University of Maryland's Chesapeake Biological Laboratory (CBL) for dissolved inorganic nitrogen (NO_3, NO_2), and dissolved inorganic phosphorus (PO_4). All analyses were conducted in accordance with U.S. Environmental Protection Agency (EPA) protocols. Stream discharge measurements were taken at the time of all water chemistry samples. Water temperature, dissolved oxygen, pH, and conductivity were measured in the field with a Hydrolab Surveyor II at selected sites at the time of water quality collections. Watershed areas used to calculate nutrient yields per unit area were determined from a digitized watershed map using Arcview software.

Where sites are nested in a watershed the mapped concentration data for the downstream site is shown only for the area between the sites. Yield calculations for a downstream site are based on the entire area upstream of the site, but are mapped showing just the area between sites. The downstream sites therefore illustrate the cumulative impact from all upstream activities.

Benthic Macroinvertebrate Sampling

Aquatic macroinvertebrates were collected at the time of water chemistry samples during the spring to be within the MBSS spring index period. Macroinvertebrate collections were made over a $2m^2$ area of the best available habitat using a 0.3m wide dip net with a mesh size of 500 microns. The best available habitats include: gravel riffles, snags, submerged vegetation and root mats. Habitats were sampled in the proportion to their occurrence at the station. Samples were composited in a sieve bucket, fine sediments washed out, and large debris rinsed and discarded. The remaining sample was preserved in 70% ethanol and returned to the laboratory for subsampling. Subsampling was done using a gridded tray. Grids were chosen at random until the grid with the 100th organism had been completed. Organisms were identified to genus, recorded on a bench sheet, and archived for future reference. Insitu water quality data (dissolved oxygen, pH, conductivity, temperature) were collected during each sampling episode with a Hydrolab Surveyor II. A macroinvertebrate index of biotic integrity (IBI)(MD DNR, 1998) was calculated to facilitate ranking of site quality.

Fish Sampling

Fish were sampled during the summer to coincide with the MBSS index period for fish sampling. Backpack electroshockers were used for two passes through a 75 meter reach of stream with block nets at each end of the reach. All species were enumerated and weighed to obtain taxa richness and biomass estimates.

Results

A nutrient synoptic survey was conducted during April, 2003 in the Lower Monocacy watershed as part of the Lower Monocacy WRAS. Samples were collected at 78 sites throughout the watershed. The sample from one site was lost in transit to the laboratory. Sampling was focused in the Linganore Creek and Bennett Creek watersheds, with additional samples collected at the outlets of other major tributaries. Station locations are listed in Table 2 and mapped in Figure 1. The nutrient concentration and yield data is shown in Table 3.

Nitrate/nitrite concentrations were found to be excessive in eight subwatersheds, high in twenty-seven, moderately elevated in thirty-nine others, and baseline in the remaining four subwatersheds (Figure 2). Nitrate/nitrite yields were found to be excessive in thirty-eight subwatersheds, high in fifteen, moderately elevated in sixteen, and baseline in the remaining 8 (Figure 3). Excessive concentrations of orthophosphate were found in eight subwatersheds, high concentrations in six, moderate concentrations in eighteen, and the remaining forty-five below baseline (Figure 4). Orthophosphate yields were found to be excessive in one subwatershed, high in one subwatershed, moderate in four, and baseline in the remainder (Figure 5). No anomalies were found in the insitu measurements of dissolved oxygen, or temperature (Table 4). Twenty-one subwatersheds had relatively high conductivity (>300mmhos/cm) associated with limestone influence (Figure 6). Elevated pH values generally followed the high conductivity for the same reason (Figure 7).

Biological samples were collected at nine of the nutrient sites. Benthic macroinvertebrate community Index of Biotic Integrity ranged from poor to very poor at the nine sites sampled (Table 5). The degradation in the benthic community was attributed to degraded habitat associated with storm water flows. Fish communities at the two sites sampled could be considered poor due to influences from Lake Linganore such as the introduction of sunfish and large mouth bass to the system (Table 6).

Discussion

The elevated nitrate/nitrite concentrations and/or yields appear to be associated with animal and row crop agriculture in the majority of the watershed. Application of manure for soil nutrient amendment in conjunction with direct animal access to streams is extensive throughout the watershed. These practices are known to contribute significantly to soil and water nutrient levels. The nitrate/nitrite contribution from septic system leach fields is also part of the source and could be significant in areas that have concentrated small lot development on well and septic, such as upper Bennett and Fahrney Branches. This latter association has been seen in a number of unsewered suburban areas.

Table 1. Lower Monocacy WRAS Nutrient Synoptic Survey
April, 2003
Station Location

Station Number	Location	Sample Type	lat		long	
1	UT to Linganore Cr at Linganore Rd	N	39	40.955	77	36.088
2	UT to Linganore Cr at Plantation Rd	N	39	41.532	77	33.457
3	UT to Linganore Cr below pond at Woodland Pl	N	39	41.664	77	32.693
4	Linganore Cr below lake	N	39	41.633	77	33.224
5	UT to Linganore Cr at Woodland Pl	N,B	39	42.081	77	32.365
6	UT to Lake Linganore off Vantage Pt Ct	N,B	39	41.599	77	31.483
7	UT from Lake Merle off Balmoral Ridge Rd	N,B	39	41.853	77	30.296
8	UT to Lake Linganore off Meadow Pt End	N,B	39	41.853	77	30.296
9	UT to Linganore Cr at Gas House Pike	N	39	42.728	77	28.156
10	Linganor Cr at Gas House Pike	N				
13	UT at Old Annapolis Rd	N	39	45.287	77	29.717
14	Linganore Cr at Old Annapolis Rd	N	39	44.147	77	26.910
15	UT at Alton Rd	N	39	45.957	77	26.482
15A	UT at Alton Rd	N	39	45.452	77	27.155
16	Town Br at Artie Kemp Rd	N,B	39	45.723	77	25.203
17	Dollyhyde Cr. at Rt 75	N	39	44.676	77	24.788
18	Linganore Cr at Rt 75	N	39	44.676	77	24.788
19	Dollyhyde Cr at Dollyhyde Rd	N	39	47.086	77	22.852
20	Dollyhyde Cr at Rt 26	N	39	48.209	77	22.715
21	Oldfield Br at Rt 26	N	39	47.961	77	20.834
27	UT to Woodville Br at Bottom Rd	N	39	41.572	77	19.540
28	Woodville Br at Bottom Rd	N,B	39	41.565	77	18.779
29	UT to Woodville Br off Mattie Haines Rd	N	39	40.115	77	17.035
31	South Fork at Woodville Rd	N	39	42.854	77	18.034
33	South Fork at Shirley Bohn Rd	N	39	41.046	77	15.877
35	UT to South Fork at Buffalo Rd	N	39	41.943	77	14.574
36	UT to South Fork at Woodville Rd	N	39	43.869	77	17.947
37	Talbot Br at Emerson Burrier Rd	N	39	45.795	77	19.153
38	North Fork at Woodville Rd	N	39	46.368	77	18.926
39	UT to North Fork at Unionville Rd	N	39	47.532	77	18.659
40	Weldon Br at Rt 26	N	39	47.317	77	16.253
41	Weldon Cr at Barnes Rd	N	39	47.871	77	11.898
42	Talbot Br at Black Ankle Rd	N	39	45.557	77	15.996
43	Talbot Br at Buffalo Rd	N	39	44.539	77	12.699
44	Bens Rn at Sanandrew Dr	N,B	39	42.021	77	28.439
47	UT to Bens Rn at Rt 75	N	39	41.994	77	25.307
48	Bens Br at Rt 75	N	39	41.994	77	25.307
49	UT to Bens Br at Rt 75	N	39	42.138	77	25.298
52	Bens Br at Jesse Smith Rd	N	39	39.082	77	22.156
53	Bens Br at Woodville Rd	N	39	38.605	77	20.115

Table 2 continued

54	UT to Hazelnut Br at Crickenberger Rd	N	39	40.592	77	27.784
55	Hazelnut Rn of Crickenberger Rd	N	39	40.592	77	27.784
57	UT to Lake Linganore off Eaglehead Dr	N,B	39	40.300	77	30.426
58	UT to Linganore Cr at Spring Ridge Pkwy	N	39	40.519	77	34.677
61	Long Br at Ijamsville Rd	N	39	39.016	77	32.499
62	Long Br at Quinn Rd	N	39	39.750	77	35.320
63	UT to North Fork at Unionville Rd	N	39	47.454	77	18.575
64	Town Br at Rt 75	N	39	47.340	77	24.731
65	Bennett Cr below Lili Pons	N	39	29.862	77	42.705
66	Bennett Cr at Mt Ephram Rd	N	39	29.354	77	40.652
67	Bear Br at Mt Ephram Rd	N	39	29.284	77	40.668
68	N Br Bennett Cr at Peters Rd	N	39	30.511	77	39.362
69	Bennett Cr at Peters Rd	N	39	30.511	77	39.362
70	Urbana Br at Peters Rd	N	39	30.168	77	38.388
71	Bennett Cr at Thurston Rd	N	39	29.410	77	36.256
72	Fahrney Br at Big Woods Rd	N	39	31.813	77	32.645
73	Bennett Cr at Big Woods Rd	N	39	31.813	77	32.645
74	Fahrney Br at Prices Distillery Rd	N	39	33.110	77	30.477
75	Bennett Cr at Rt 75	N	39	30.877	77	29.868
76	Bennett Cr at Barnes Rd	N	39	30.498	77	25.577
77	Little Bennett at Covel Rd	N	39	28.097	77	35.873
78	Furnace Br off Rt 28	N	39	24.381	77	43.491
79	Bush Cr at Reels Mill Rd	N	39	35.954	77	36.833
80	Israel Cr at Stauffer Rd	N	39	46.724	77	34.535
81	Glade Cr at Retreat Rd	N	39	47.690	77	38.311
82	Israel Cr at Cash Smith Rd	N	39	54.105	77	30.190
83	Tuscarora Cr at Island Pkwy	N	39	45.812	77	38.806
84	Carroll Cr at WWTP drive	N	39	42.706	77	38.194
85	Ballenger Cr at WWTP	N	39	36.480	77	41.373
86	Rocky Fountain Rn off Michaels Mill Rd	N	39	33.142	77	42.390
87	Linganore Crk at Linganore Rd.	N	39	40.955	77	36.088
88	Town Crk at North St, Libertytown	N	39	48.590	77	24.308
90	North Fork at Dollyhyde Rd.	N,B	39	45.154	77	20.990
92	Bush Creek at County Landfill	N	39	36.484	77	35.175
93	Bush Creek west of Prices Distillery Rd	N	39	35.927	77	32.390
94	Fahrney Br. at Md. Rt. 75	N	39	33.947	77	27.007
95	Pleasant Br at Windsor Knolls MS	N	39	32.291	77	28.116
96	Town Br. at Jones Rd	N	39	48.111	77	24.538

* N= Nutrients, B= Benthic, F= Fish

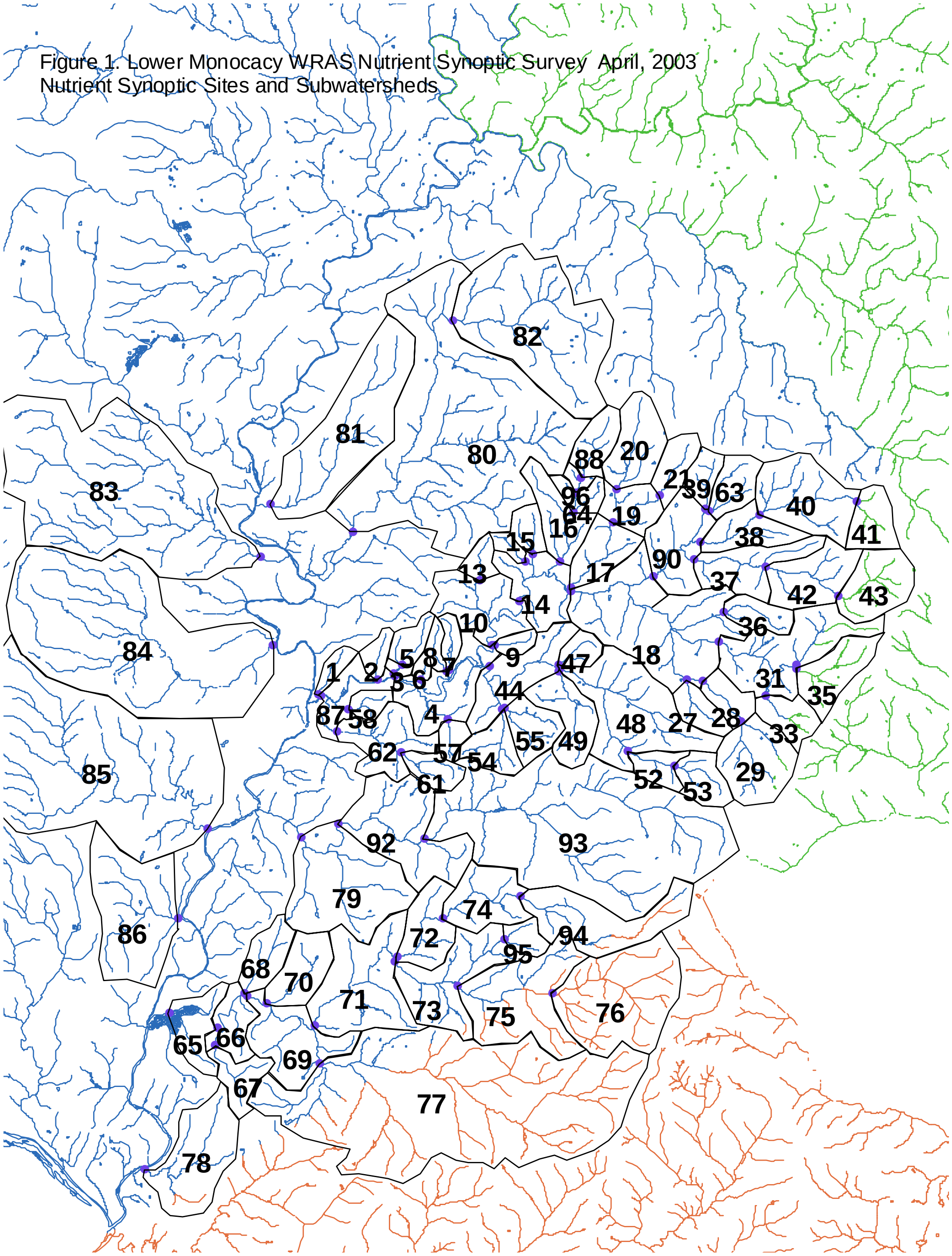


Figure 1. Lower Monocacy WRAS Nutrient Synoptic Survey April, 2003
Nutrient Synoptic Sites and Subwatersheds

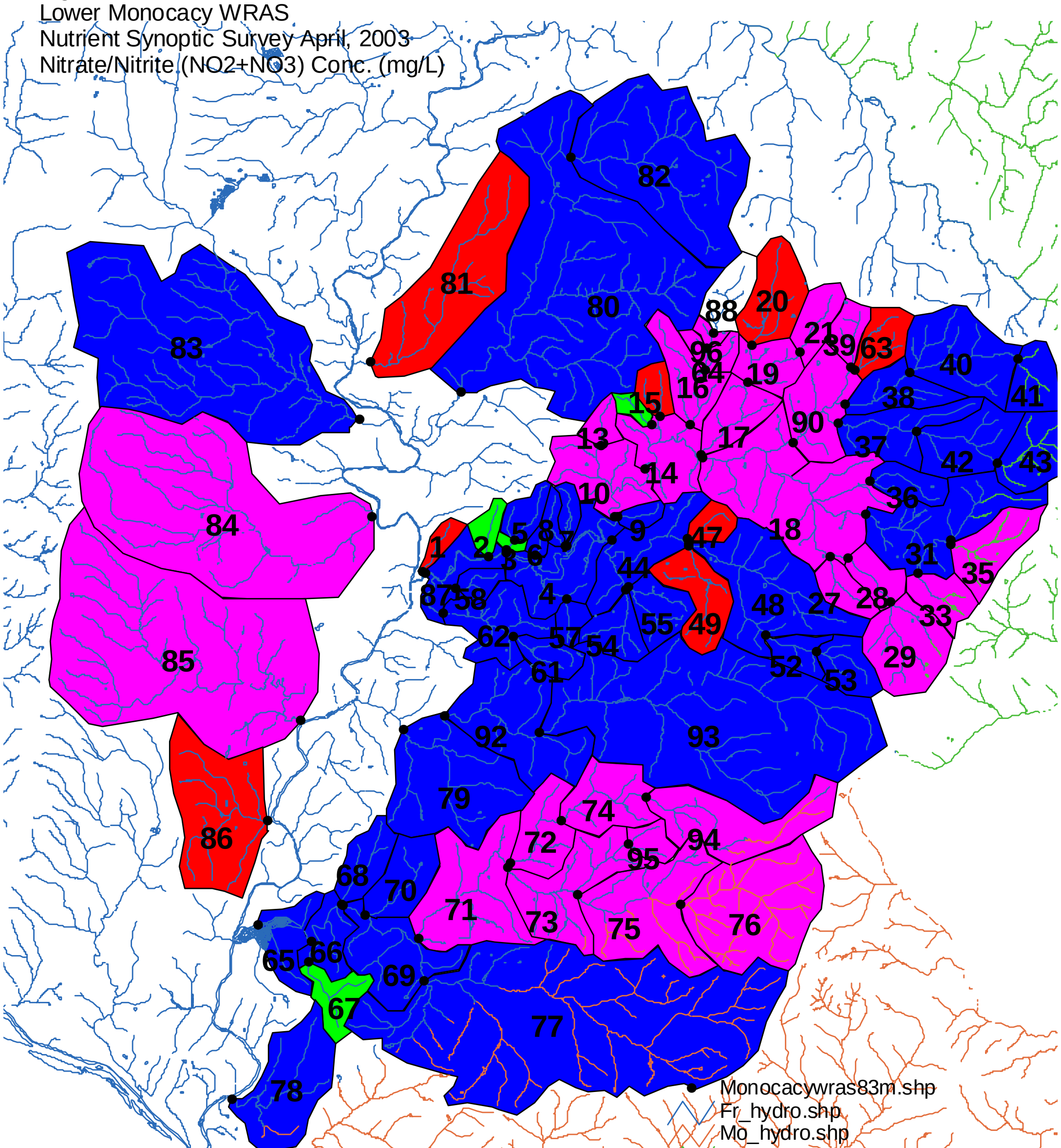
Table 3. Lower Monocacy WRAS Nutrient Synoptic Survey April, 2003 Dissolved Nutrient Concentrations and Yields

Station Number	Sampling Date	PO_4 mg/L	$NO_2 + NO_3$ mg/L	Watershed Area hectares	Discharge L/sec	PO_4 kg/h/d	$NO_2 + NO_3$ kg/h/d
1	28-Apr-03	0.407	5.98	130	4	0.001068	0.015699
2	28-Apr-03	0.004	0.17	152	8	0.000018	0.000749
3	29-Apr-03	0.002	0.80	255	26	0.000018	0.007010
4	28-Apr-03	0.003	2.59	22856	2303	0.000026	0.022544
5	29-Apr-03	0.003	1.99	210	21	0.000027	0.017578
6	29-Apr-03	0.004	1.14	59	3	0.000019	0.005409
7	29-Apr-03	0.010	2.87	131	15	0.000102	0.029188
8	29-Apr-03	0.018	1.54	110	18	0.000258	0.022081
9	28-Apr-03	0.004	1.47	115	12	0.000035	0.012767
10	5-May-03	0.009	3.20	14906	1681	0.000088	0.031170
13	29-Apr-03	0.027	4.43	163	6	0.000082	0.013443
14	28-Apr-03	0.008	3.47	1901	1752	0.000637	0.276319
15	29-Apr-03	0.051	7.09	196	16	0.000363	0.050506
15A	29-Apr-03	0.003	0.39	93	6	0.000016	0.002121
16	29-Apr-03	0.023	3.88	498	94	0.000373	0.062967
17	5-May-03	0.005	4.92	1714	151	0.000038	0.037452
18	5-May-03	0.007	3.10	10650	1317	0.000075	0.033117
19	29-Apr-03	0.003	4.92	1280	1672	0.000339	0.555182
20	29-Apr-03	0.010	5.54	614	65	0.000091	0.050688
21	29-Apr-03	0.006	4.53	304	20	0.000034	0.025704
27	28-Apr-03	0.004	4.65	263	43	0.000056	0.065061
28	5-May-03	0.003	3.74	1043	155	0.000038	0.047911
29	5-May-03	0.003	4.39	515	99	0.000050	0.072975
31	5-May-03	0.003	2.69	1651	233	0.000037	0.032800
33	28-Apr-03	0.002	3.69	318	63	0.000034	0.063457
35	28-Apr-03	0.003	3.12	525	108	0.000053	0.055629
36	28-Apr-03	0.002	2.21	383	47	0.000021	0.023322
37	2-May-03	0.004	2.05	618	210	0.000117	0.060186
38	2-May-03	0.012	2.87	440	246	0.000580	0.138625
39	2-May-03	0.006	3.01	220	22	0.000052	0.025933
40	2-May-03	0.007	2.84	1333	184	0.000083	0.033842
41	2-May-03	0.003	1.19	375	47	0.000032	0.012871
42	2-May-03	0.003	2.00	1264	229	0.000047	0.031368
43	2-May-03	0.003	2.48	621	112	0.000047	0.038548
44	5-May-03	0.005	2.95	3575	370	0.000045	0.026372
47	28-Apr-03	0.012	5.63	180	65	0.000375	0.176075
48	28-Apr-03	0.003	2.70	1976	247	0.000032	0.029138
49	28-Apr-03	0.003	6.42	563	12	0.000006	0.012138
52	28-Apr-03	0.003	2.32	1324	79	0.000016	0.011992
53	28-Apr-03	0.002	1.44	341	30	0.000015	0.011077

Table 3 continued

54	5-May-03	0.003	1.27	336	16	0.000013	0.005364
55	5-May-03	0.003	2.83	381	31	0.000021	0.019779
57	5-May-03	0.004	1.39	150	11	0.000026	0.009087
58	28-Apr-03	0.003	2.38	151	12	0.000020	0.016182
61	1-May-03	0.003	1.26	167	12	0.000018	0.007529
62	1-May-03	0.002	1.46	902	60	0.000011	0.008383
63	2-May-03	0.007	6.47	342	38	0.000068	0.062749
64	29-Apr-03	0.096	3.88	606	57	0.000775	0.031333
65	30-Apr-03	0.003	2.28	16167	1852	0.000030	0.022571
66	1-May-03	0.003	1.96	15731	1800	0.000030	0.019377
67	1-May-03	0.006	0.14	324	49	0.000078	0.001816
68	1-May-03	0.002	1.99	376	44	0.000020	0.020093
69	1-May-03	0.002	2.43	14659	1730	0.000020	0.024781
70	1-May-03	0.003	1.89	502	51	0.000026	0.016520
71	1-May-03	0.003	3.26	7279	987	0.000035	0.038200
72	1-May-03	0.006	4.22	1869	262	0.000073	0.051035
73	1-May-03	0.004	3.25	4126	573	0.000048	0.038968
74	2-May-03	0.011	4.40	1330	236	0.000168	0.067343
75	2-May-03	0.003	3.20	2972	450	0.000039	0.041836
76	2-May-03	0.007	3.12	1628	233	0.000087	0.038625
77	1-May-03	0.003	1.87	181	550	0.000787	0.490863
78	30-Apr-03	0.004	1.58	1035	129	0.000043	0.017021
79	1-May-03	0.006	2.43	7289	888	0.000063	0.025571
80	30-Apr-03	0.015	2.56	8549	772	0.000117	0.019975
81	30-Apr-03	0.003	8.84	1897	246	0.000034	0.099140
82	30-Apr-03	0.009	2.05	2488	163	0.000051	0.011625
83	30-Apr-03	0.008	1.79	4558	558	0.000085	0.018945
84	30-Apr-03	0.004	3.12	4530	430	0.000033	0.025566
85	30-Apr-03	0.002	3.81	5060	573	0.000020	0.037245
86	30-Apr-03	0.002	8.52	1504	334	0.000038	0.163588
87	28-Apr-03	0.003	2.53	24000	2699	0.005382	0.024585
88	29-Apr-03	0.000	0.00		43	0.000000	0.000000
90	2-May-03	0.008	3.09	4926	623	0.000087	0.033768
92	1-May-03	0.007	2.28	2488	798	0.000194	0.063180
93	2-May-03	0.020	2.54	4753	670	0.000244	0.030954
94	2-May-03	0.005	4.75	1010	207	0.000089	0.084177
95	2-May-03	0.003	4.86	181	29	0.000042	0.068275
96	29-Apr-03	0.018	3.50	416	45	0.000168	0.032624

Figure 2.
Lower Monocacy WRAS
Nutrient Synoptic Survey April, 2003
Nitrate/Nitrite (NO2+NO3) Conc. (mg/L)



L mon subsheds.shp
no sample
baseline < 1
moderate 1-3
high 3-5
excessive > 5

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Figure 3.
Lower Monocacy WRAS
Nutrient Synoptic Survey April, 2003
Nitrate/Nitrite (NO2+NO3) Yield (KG/H/D)

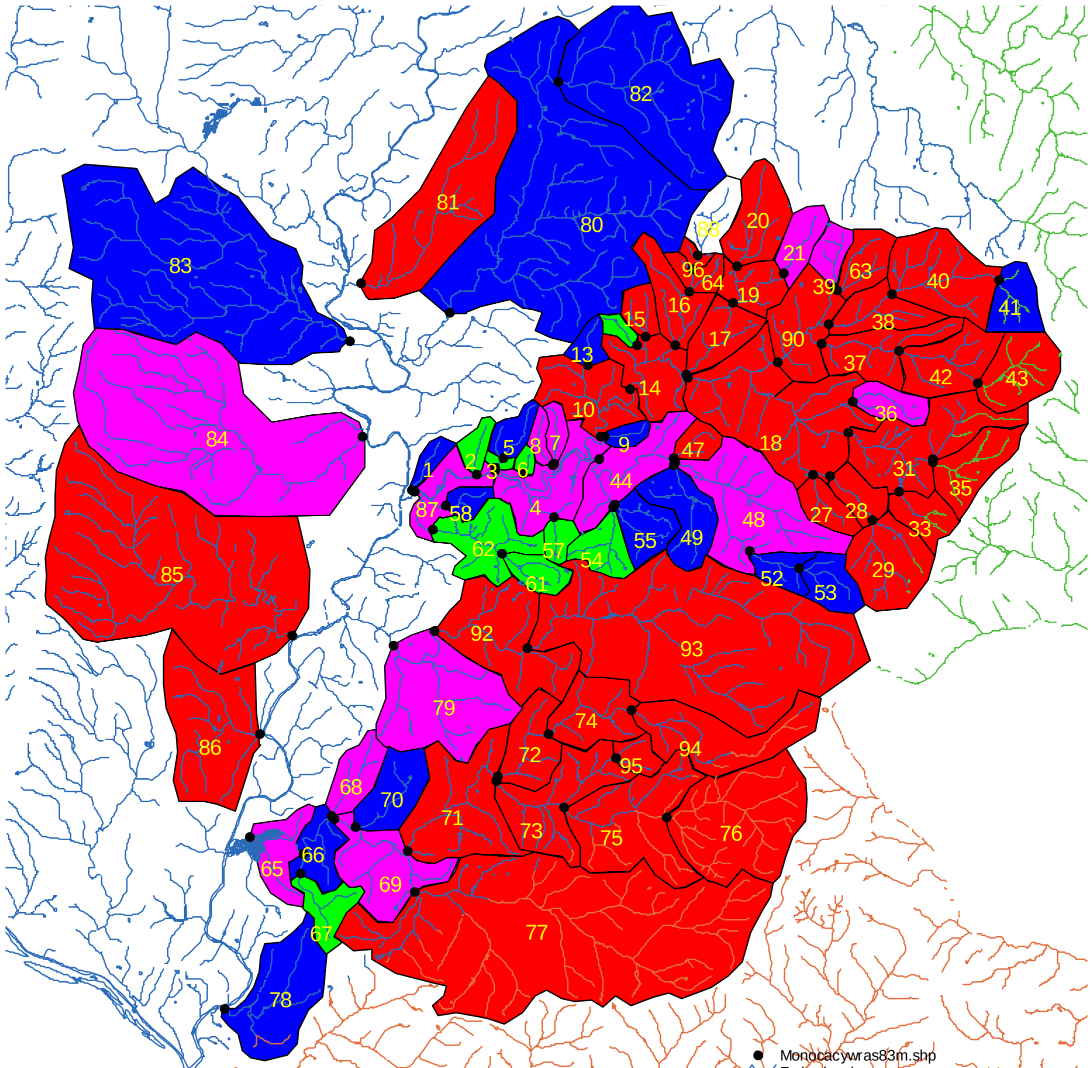

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Figure 4.
Lower Monocacy WRAS
Nutrient Synoptic Survey April, 2003
Orthophosphate PO4 Conc. (mg/L)

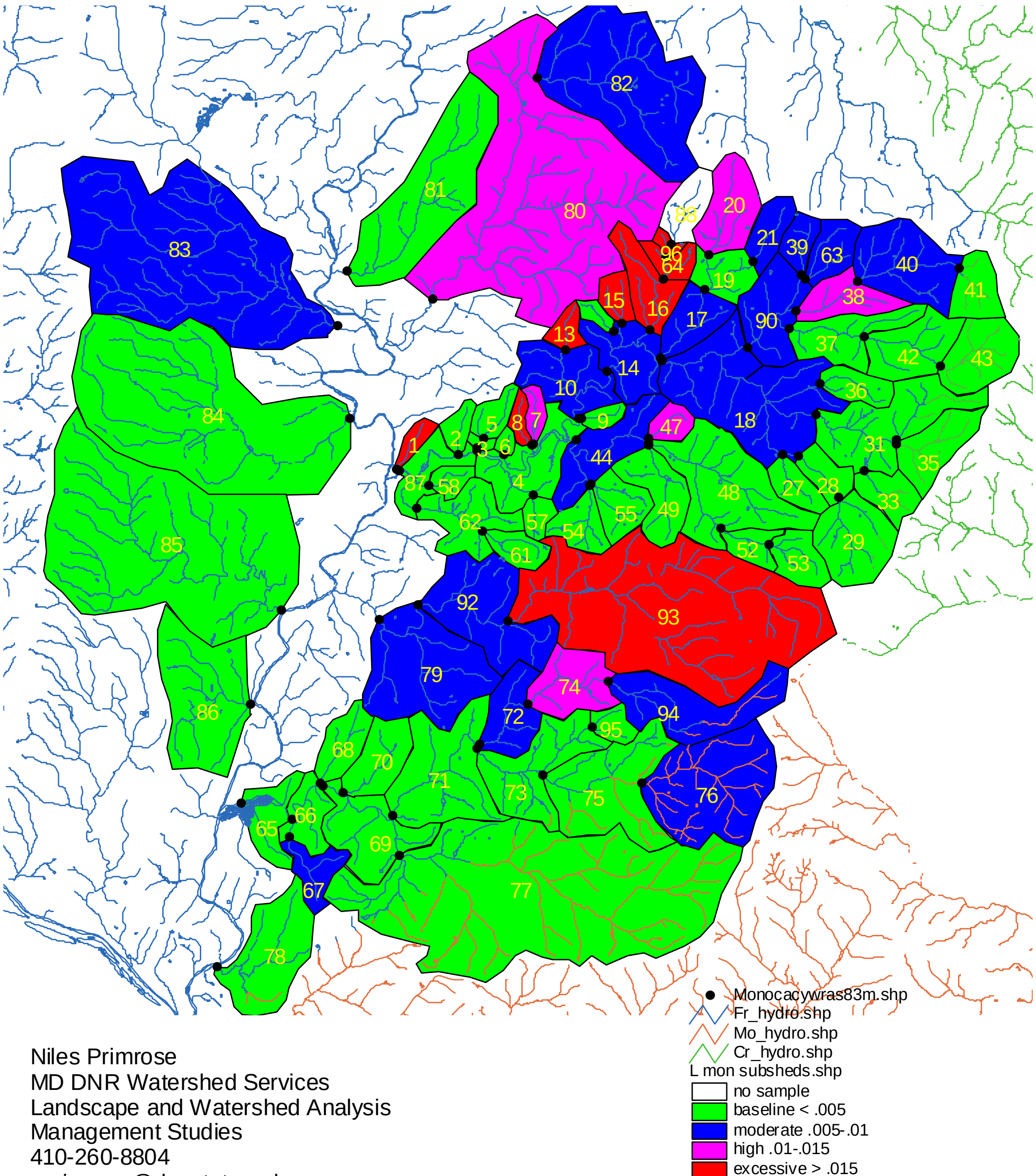

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Figure 5.
Lower Monocacy WRAS
Nutrient Synoptic Survey April, 2003
Orthophosphate (PO4) Yield (Kg/H/D)

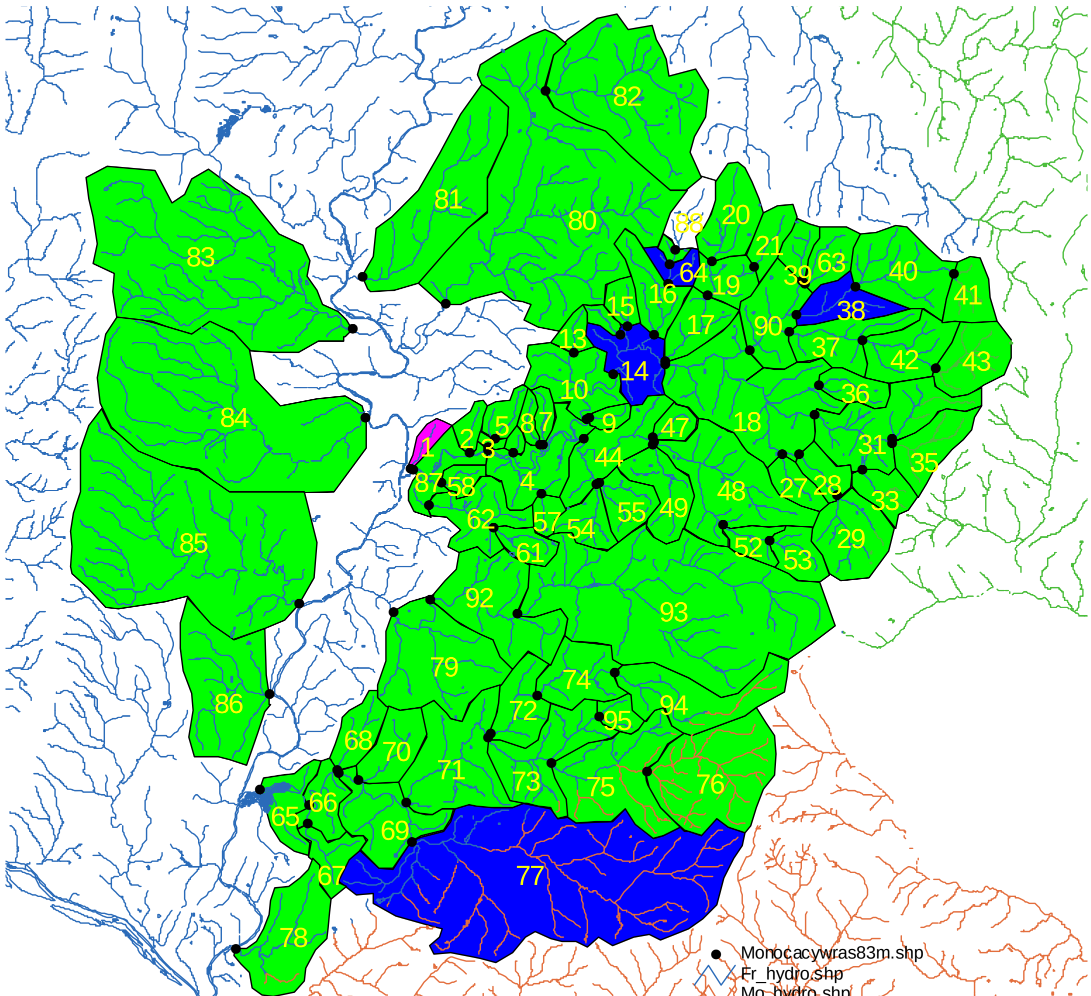

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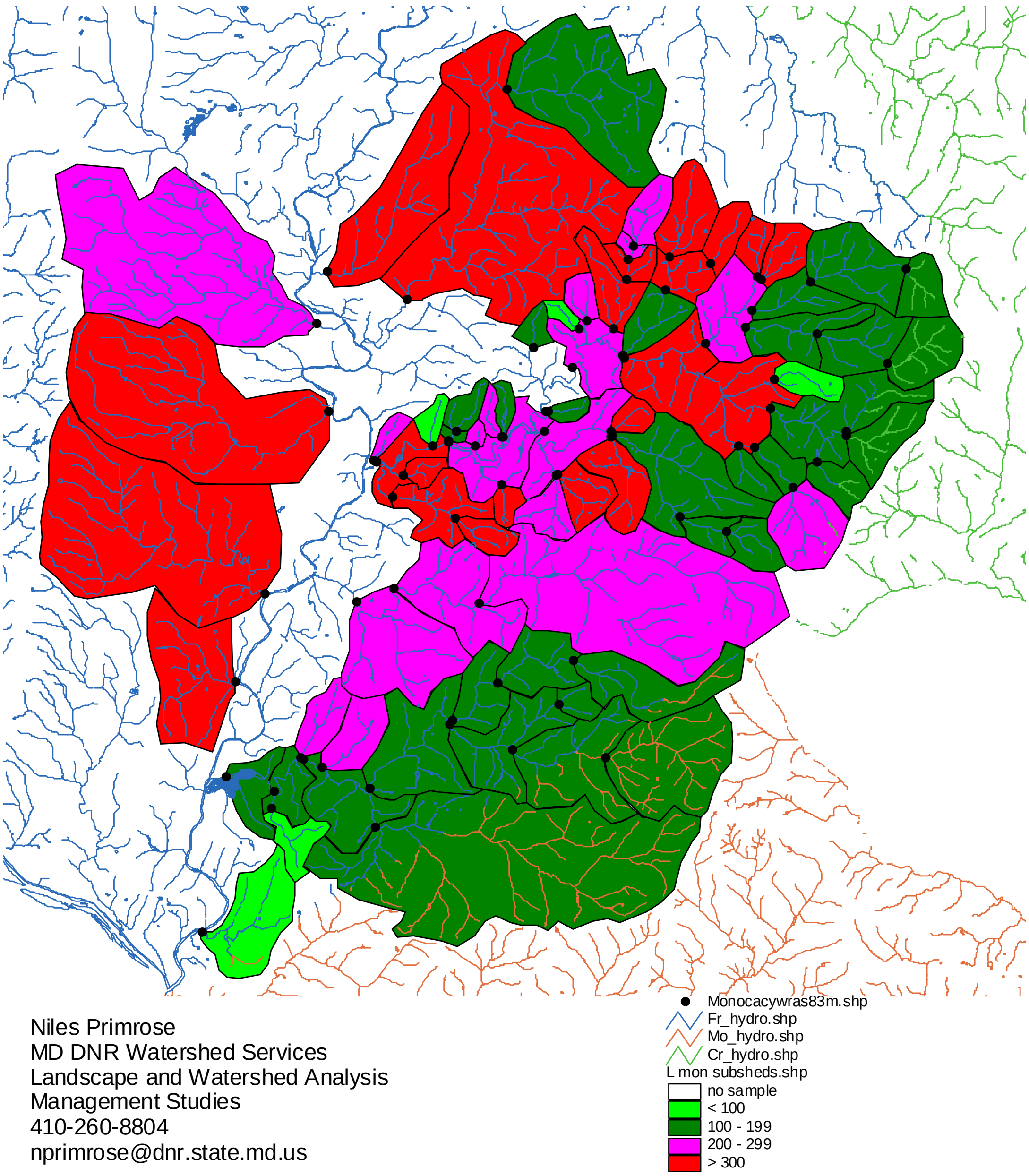
Table 4. Lower Monocacy WRAS Nutrient Synoptic Survey
April, 2003
Insitu Water Quality

Station	Date	Time	Temp	pH	DO	Cond
1	28-Apr-03	1435	20.45	7.7	8.6	438
2	28-Apr-03	1340	17.32	7.63	9.14	93
3	29-Apr-03	1050	16.01	7.71	9.91	112
4	28-Apr-03	1350	16.72	8.3	10.34	204
5	29-Apr-03	1115	13.18	7.74	10.45	108
6	29-Apr-03	1015	12.53	7.56	9.79	275
7	29-Apr-03	930	13.07	7.75	9.89	188
8	29-Apr-03	940	15.42	7.61	8.98	220
9	28-Apr-03	1315	17.11	7.96	10.3	197
10	5-May-03	1200				
13	29-Apr-03	1230	12.64	7.27	10.51	140
14	28-Apr-03	1250	14.92	8.13	11.7	206
15	29-Apr-03	1250	14.12	7.24	10.72	252
15A	29-Apr-03	1230	12.45	7.12	9.92	84
16	29-Apr-03	1300	15.57	8.27	12.63	313
17	5-May-03	930	11.16	7.64	10.16	178
18	5-May-03	945	10.6	7.65	10.77	346
19	29-Apr-03	1415	16.45	8.65	12.13	332
20	29-Apr-03	1430	16.82	8.53	12.12	330
21	29-Apr-03	1445	16.17	8.5	11.92	377
27	28-Apr-03	1030	12.35	6.88	10.48	107
28	5-May-03	830	1036	7.5	10.84	169
29	5-May-03	815	10.54	7.67	10.75	269
31	5-May-03	850	10.31	7.39	10.95	123
33	28-Apr-03	945	11.61	7.06	11.16	129
35	28-Apr-03	925	11.67	6.67	10.92	182
36	28-Apr-03	1010	12.11	7.03	10.86	79
37	2-May-03	955	16.23	7.77	10.1	129
38	2-May-03	1110	16.96	7.57	10.02	164
39	2-May-03	910	17.01	7.22	9.11	328
40	2-May-03	1215	17.24	7.45	10.22	145
41	2-May-03	1245	16.61	7.34	9.15	116
42	2-May-03	1140	16.95	7.5	9.68	134
43	2-May-03	1315	17.68	7.2	9.19	166
44	5-May-03	1135	11.65	8.01	11.15	243
47	28-Apr-03	1145	15.6	7.84	11.22	366
48	28-Apr-03	1155	15.53	7.48	11.53	160
49	28-Apr-03	1220	19.35	7.92	10.19	462
52	28-Apr-03	1055	12.56	6.92	10.61	103
53	28-Apr-03	1115	13.81	6.93	10.38	114

Table 4 Continued

54	5-May-03	1055	14.09	7.83	10.94	270
55	5-May-03	1040	11.01	7.78	11.04	331
57	5-May-03	1115	11.06	7.86	10.56	343
58	28-Apr-03	1520	20.1	8.28	11.66	491
61	1-May-03	1545	22.3	7.9	9.8	338
62	1-May-03	1515	20.88	8.04	9.8	346
63	2-May-03	920	15.56	7.57	9.96	407
64	29-Apr-03	1345	14.96	7.88	10.25	360
65	30-Apr-03	1345	16.15	7.82	10.32	174
66	1-May-03	1300	17.98	7.98	10.77	158
67	1-May-03	1250	17.9	7.89	9.45	86
68	1-May-03	1125	16.85	8.15	11.21	226
69	1-May-03	1135	17.93	8.03	10.9	172
70	1-May-03	1215	18.05	8.22	10.46	279
71	1-May-03	1100	15.98	7.77	11.03	170
72	1-May-03	900	15.08	7.4	9.88	171
73	1-May-03	905	14.78	7.47	10.75	153
74	2-May-03	1530	20.77	7.59	9.44	158
75	2-May-03	1510	19.11	7.35	9.8	135
76	2-May-03	1415	19.29	7.45	9.8	147
77	1-May-03	1015	15.22	7.52	10.23	173
78	30-Apr-03	1315	15.8	8.04	13.32	82
79	1-May-03	1340	19.1	8.58	11.71	282
80	30-Apr-03	945	14.49	7.64	9.45	330
81	30-Apr-03	1020	14.75	7.83	13.05	582
82	30-Apr-03	930	12.9	7.63	10.66	195
83	30-Apr-03	1045	14.14	7.97	11.43	233
84	30-Apr-03	1130	16.55	8.17	11.29	635
85	30-Apr-03	1230	15.91	7.67	9.7	591
86	30-Apr-03	1250	16.61	7.83	10.46	642
87	28-Apr-03	1450	18.63	8.45	10.6	214
88	29-Apr-03	1400	17.67	7.68	9.53	266
90	2-May-03	1025	16.34	7.47	9.8	202
92	1-May-03	1430	19.25	9.01	12.45	251
93	2-May-03	1625	19.32	8.61	11.48	262
94	2-May-03	1600	19.06	7.43	9.9	144
95	2-May-03	1445	17.55	7.23	9.78	143
96	29-Apr-03	1320	15.16	7.82	9.61	295

Figure 6.
Lower Monocacy WRAS
Nutrient Synoptic Survey April, 2003
Conductivity (micromohs/cm)



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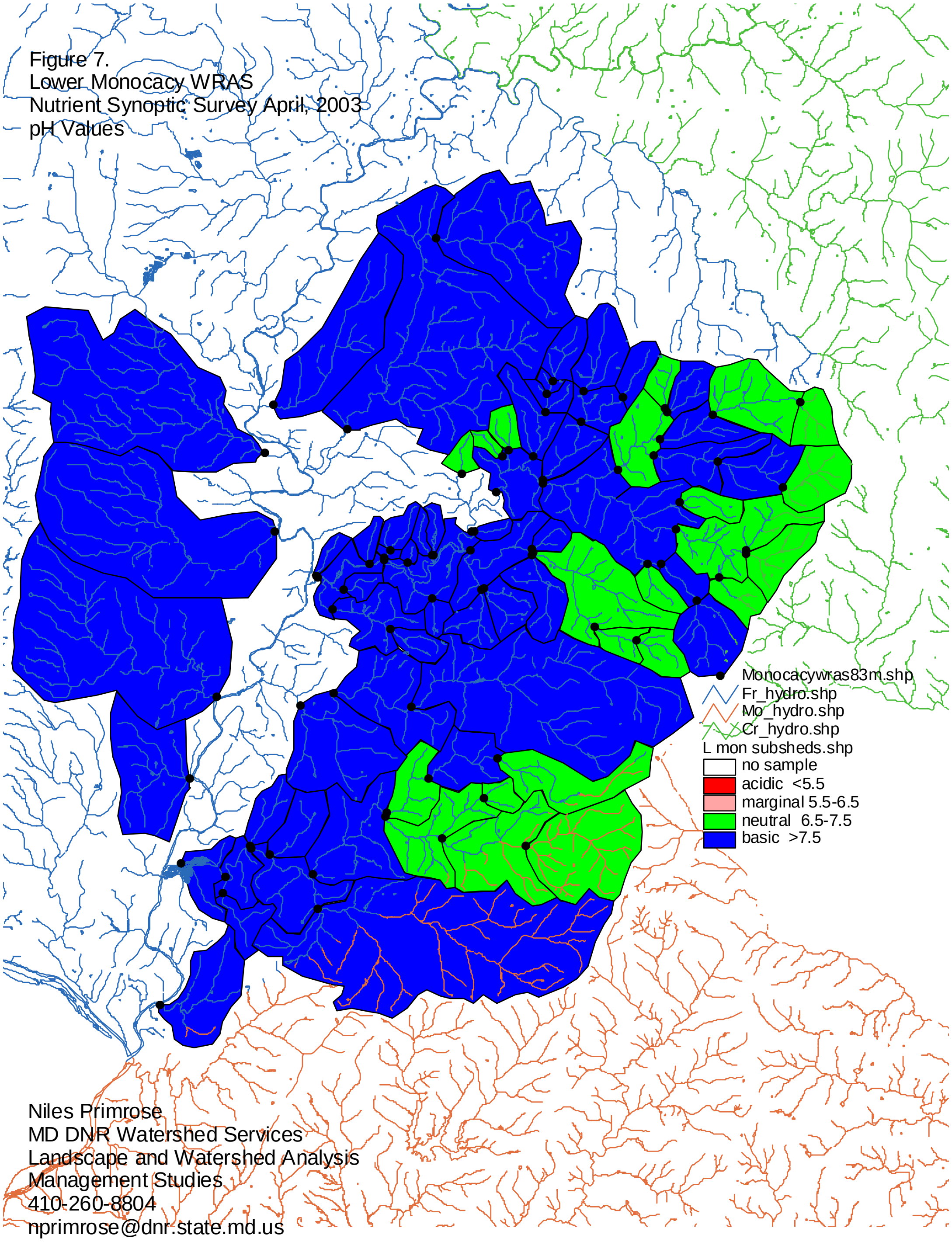
Figure 7.
Lower Monocacy WRAS
Nutrient Synoptic Survey April, 2003
pH Values
Monocacywras83m.shp
Fr_hydro.shp
Mo_hydro.shp
Cr_hydro.shp
L mon subsheds.shp
no sample
acidic <5.5
marginal 5.5-6.5
neutral 6.5-7.5
basic >7.5
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Table 5. Lower Monocacy Synoptic Survey April, 2003
Benthic Macroinvertebrate IBI Scores

Station	#	#	#	#	%	%	#	%	%		IBI
	Taxa	EPT	Ephem	Dipt	Ephem	Tanyta	Intoler	Tolerant	Collect	Total***	Score
5	12*/1**	7/3	3/3	4/1	7/3	0/1	2/1	80/1	3/1	15/9	1.6
6	12/1	5/3	1/1	5/1	1/1	0/1	6/3	60/1	10/1	13/9	1.4
7	15/1	7/3	4/3	5/1	32/5	0/1	5/3	32/3	12/1	21/9	2.3
8	11/1	4/1	3/3	7/3	3/1	0/1	5/3	85/1	2/1	15/9	1.6
16	10/1	3/1	0/1	7/3	0/1	0/1	3/3	78/1	2/1	13/9	1.4
28	12/1	5/3	2/3	7/3	2/1	0/1	5/3	65/1	3/1	17/9	1.9
44	11/1	3/1	1/1	9/3	1/1	0/1	3/3	89/1	12/1	13/9	1.4
57	11/1	4/1	0/1	7/3	0/1	0/1	4/3	35/3	15/3	17/9	1.9
90	17/3	4/1	3/3	8/3	8/3	0/1	3/3	85/1	5/1	19/9	2.1

*value **score total score/# of metrics

Table 6. Lower Monocacy WRAS Nutrient Synoptic Survey April, 2003
Fish Species totals by site

Common name	Genus	species	Linganore 57	Linganore 8
Blacknose dace	*Rhinichthys*	*atratulus*	383	139
Creek chub	*Semotilus*	*atromaculatus*	17	8
Bluntnose minnow	*Pimephales*	*notatus*	1	-
Yellow bullhead	*Amerius*	*natalis*	1	2
Largemouth bass	*Micropterus*	*salmoides*	2	-
Green sunfish	*Lepomis*	*cyanellus*	19	2
Bluegill	*Lepomis*	*macrochirus*	-	1
Sunfish (Juvenile)	*Lepomis*	spp.	17	-
Fantail darter	*Etheostoma*	*flabellare*	17	4

The elevated orthophosphate concentrations and yields appear to be associated with phosphorus rich soils in systems that had fine suspended sediment loads lingering in the water column several days after rain events possibly due to drainage from ponds and /or riparian wetlands. The phosphorus saturated soils could be the result of continued application of manure as a nitrogen source with no management for the phosphorus content of the manure.

Looking at the watershed as a whole, average nutrient concentrations were similar to other agricultural watersheds in the piedmont and coastal plain as determined from other synoptic surveys (Table 7).

Table 7. Annual & Spring Nutrient Concentration Averages from Other Nutrient Synoptic Surveys

Mg/L	Piney	German Br.	Pocomoke	**Lower Monocacy**	Western Branch	Upper Patuxent	Choptank	Liberty
NO2+NO3 Spring	3.742	3.832	3.734	**3.11**	0.214	0.439	2.892	3.410
NO2+NO3 Annual	4.823	4.704	2.384					
PO4 Spring	0.800	0.043	0.028	**0.013**	0.005	0.012	0.023	0.004
PO4 Annual	1.177	0.067	0.022					

Conclusions

The subwatersheds with excessive nitrate/nitrite and orthophosphate concentrations should be the first watersheds to be investigated for significant nutrient sources such as animal operations and/or concentrations of septic systems. The Town Creek and Dollyhyde Creek appear to be a locus of both elevated nitrate/nitrite and orthophosphate.

Literature Cited

Chesapeake Bay and Watershed Programs, Monitoring and Non-Tidal Assessment, 1998. *Development of a Benthic Index of Biotic Integrity for Maryland Streams*. CBWP-MANTA – EA-98-3

Frink, Charles R.. 1991. *Estimating Nutrient Exports to Estuaries*. Journal of Environmental Quality. 20:717-724.