Report on Nutrient Synoptic Surveys in the Middle Chester River Watershed, Kent County, Maryland, March/April 2001 as part of the Watershed Restoration Action Strategy.

Maryland Department of Natural Resources
Chesapeake and Coastal Watershed Service
Watershed Restoration Division
Watershed Evaluation Program
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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.

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Executive Summary

A nutrient synoptic survey was completed in the Middle Chester River watershed in late March/early April 2001. Thirty-five potential sampling sites were identified from the Kent County ADC map. The majority of the higher nitrate concentrations (6 to 9 mg/L) are in the upper Radcliffe Creek and middle Morgan Creek watersheds, although the highest nitrate concentration (19.1 mg/L) was found at site 34, outside both of these watersheds. Watershed yields of nitrate tended to follow the concentrations, with the highest yields coming from the Radcliffe and middle Morgan areas. From windshield surveys, it appeared that both of these areas are home to a number of dairy operations. Nitrate concentrations are very similar to those found in German Branch, a tributary of the Tuckahoe, and comparable to those found in the Pocomoke and St. Martins (coastal bays) watersheds. Orthophosphate concentrations did not follow the same pattern as the nitrate, having higher values scattered throughout the watershed. The middle Chester orthophosphate concentrations are towards the low end of the scale found during other nutrient synoptic surveys.

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Introduction

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 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 bench mark, 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. For ease of discussion, the four divisions within the concentration and yield ranges will be considered *background, moderate, high,* and *excessive* (Table 1.).

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.*

Additional analysis that draws in existing and planned land use, and tax map information, can be a useful watershed planning tool to determine what areas might be targeted for protection or remediation.

METHODS

Synoptic water chemistry samples were collected in early spring throughout the watershed. 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 the time of all 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.

Results

A nutrient synoptic survey was completed in the Middle Chester River watershed in late March/early April 2001. Thirty-five potential sampling sites were identified from the Kent County ADC map (Table 2., Figure 1.). Five sites were found to be dry at sampling time. One was immediately upstream of another site a was considered redundant, and four sites were considered inaccessible.

Results of the March 2001 synoptic are shown in Table 3.. Nitrate concentration (mg/L) and yield data (kg/hectare/yr) are presented spatially in Figures 2 and 3. Orthophosphate concentration and yields are show spatially in Figures 4 and 5. Please note that the annual yield figures are estimated from a single grab sample and instantaneous discharge. The normally higher nitrate concentrations and stream discharges in the spring would tend to foster an over estimation of annual yields from this one sample. Orthophosphate yields would tend to be underestimated from the single baseflow sample, because concentrations are generally driven by surface runoff, rather than ground water. Field parameters of water temperature, pH, dissolved oxygen (mg/L), and conductivity (mmohs/cm) are presented in Table 4.

The majority of the higher nitrate concentrations (6 to 9 mg/L) are in the upper Radcliffe Creek and middle Morgan Creek watersheds, although the highest nitrate concentration (19.1 mg/L) was found at site 34, outside both of these watersheds. Watershed yields of nitrate tended to follow the concentrations, with the highest yields coming from the Radcliffe and middle Morgan areas. From windshield surveys, it appeared that both of these areas are home to a number of dairy operations. Table 5 and Figure 6 shows how the nitrate concentrations in the middle Chester compare to other Eastern Shore watersheds sampled in spring nutrient synoptic surveys. Outside of the extreme value found at site 34, nitrate concentrations are very similar to those found in German Branch, a tributary of the Tuckahoe, and comparable to those found in the Pocomoke and St. Martins (coastal bays) watersheds.

Table 2. Middle Chester Nutrient Synoptic Sample Site Locations and Sampling Status

Site #	Location	Status
1	Rt 297 nr Chinquapin	Sampled
2	Worton/Lynch Rd nr rr track	Dry, no Sample
3	Rt 213 nr Hassengers Crnr (south)	Redundant to site 4, no sample
4	off Riley's Mill Rd.	Sampled
5	Rt 213 nr Hassengers Crnr (north)	Sampled
6	Urieville Lake outfall Rt 213	Sampled
7	Big Woods Rd.	Sampled
8	Hassengers Rd. nr Lynch	Dry, no sample
9	RR track between Hassenger and Still Pond Rds.	No access, no sample
10	Stillpond Rd. (East fork Urieville Pond)	Sampled
11	Stillpond Rd. (West fork Urieville Pond)	Sampled
12	Stillpond/Harmony Woods Rd	Sampled
13	Morgnec/Kennedyville Rd.	Sampled
14	298 South of Harmony Corner	Sampled
15	298 further south of Harmony Corner	Dry, no sample
16	Comegy's Rd nr Morgnec Rd.	Sampled
17	Comegy's Rd nr Morgnec Rd.	Sampled
18	Kennedyville/Morgnec Rd	Sampled
19	Kennedyville/Morgnec Rd	Sampled
20	Wallis Rd nr gauge	Sampled
21	Perkins Mill	Dry, no sample
22	Perkins Mill	Dry, no sample
23	Perkins Mill (gauge)	Sampled
25	Radcliffe off Dixon Dr	Sampled
26	Rt 20	Sampled
27	Cromwell Clark Rd (east)	Sampled
28	Cromwell Clark Rd (west)	Sampled
29	Farm Rd off Rt 297 nr Hopewell	No access, no sample
30	Morris Rd. (middle)	Sampled
31	Morris Rd. (east)	Sampled
32	RR track nr South Meadowview Dr.	No access, no sample
33	RR track South of Morris Rd	No access, no sample
34	Lovers Lane	Sampled
35	Morris Rd. (east)	Sampled

Orthophosphate concentrations did not follow the same pattern as the nitrate, having higher values scattered throughout the watershed. Site 1 had an extremely high concentration value that appeared to be related to the discharge from a polishing pond at a manufacturing facility just south of Worton. This same watershed produced the highest yield of orthophosphate in the study area. The watershed draining to site 30 also had relatively high orthophosphate concentrations and yields. Table 4 and Figure 7 provides a comparison of middle Chester orthophosphate concentrations with other streams on the Eastern Shore. The primary figure indicates that all but the extreme value are very similar to these other watersheds. The extreme value is removed in the inset figure, and illustrates more clearly that the middle Chester orthophosphate concentrations are towards the low end of the scale found during other nutrient synoptic surveys.

Figure 1. Site Locations, Middle Chester Nutrient Synoptic, Spring, 2001

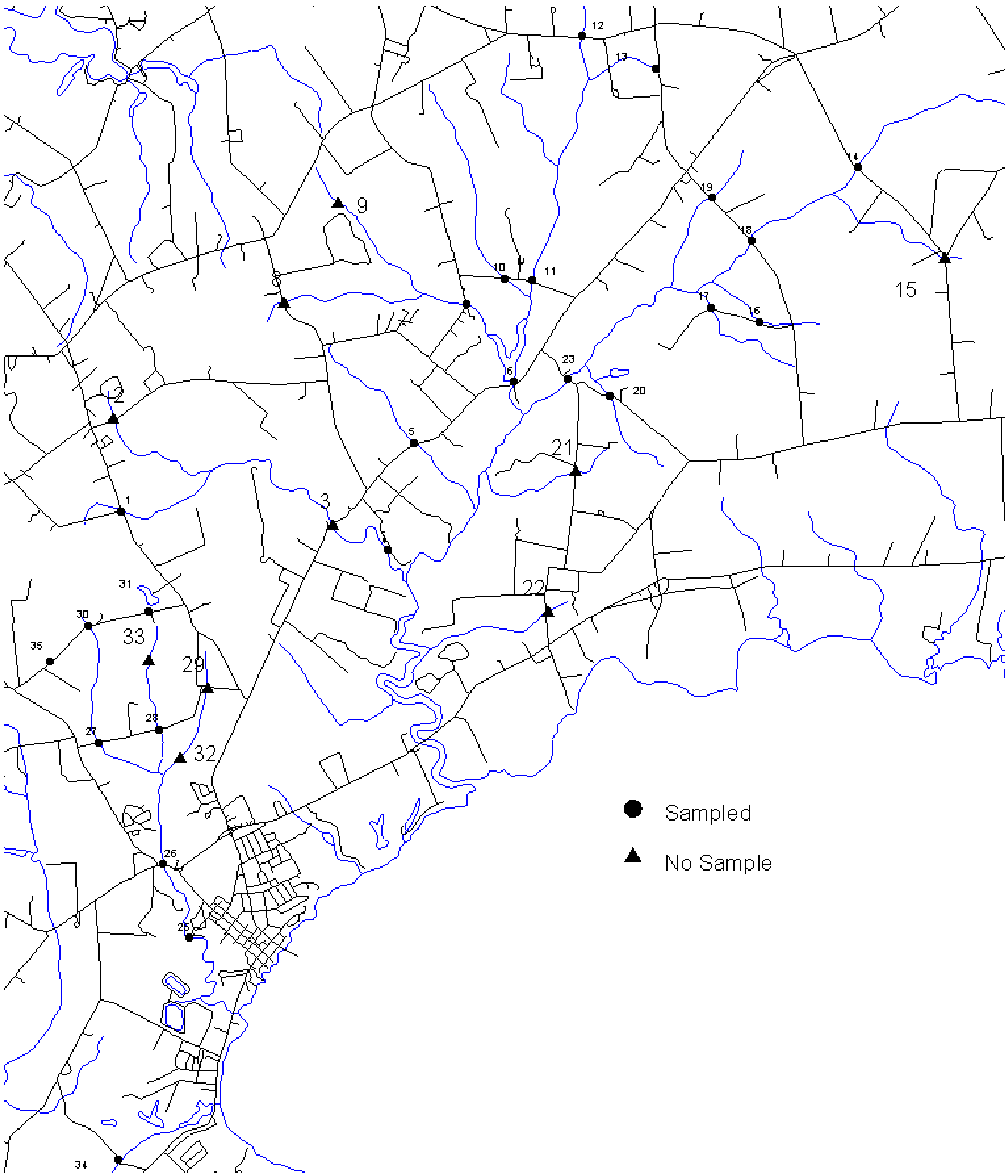


Table 3. Middle Chester Nutrient Synoptic Survey, Spring 2001, Nutrient Results.

DATE	SAMPLE Site #	Area hectares	Discharge (L/sec)	Conc. PO4 mg PO4/L	Yield PO4 Kg/hec/yr	Conc. NO23 mg NO23/L	Yield NO23 Kg/hec/yr
02/28/01	MC 01	132	1.8408	2.47	1.087	0.12	0.053
03/01/01	MC 04	1217	123.42	0.010	0.032	3.91	12.506
03/01/01	MC 05	268	28.77	0.003	0.010	8.51	28.815
03/01/01	MC 06	1582	212.57	0.006	0.025	4.77	20.218
02/28/01	MC 07	710	1.77	0.008	0.001	6.90	0.543
02/28/01	MC 10	364	36.45	0.007	0.022	4.57	14.423
02/28/01	MC 11	2564	108.37	0.004	0.005	3.54	4.718
02/28/01	MC 12	84	1.00	0.007	0.003	7.62	2.855
02/28/01	MC 13	136	4.16	0.007	0.007	3.06	2.954
02/28/01	MC 14	597	63.40	0.004	0.013	2.30	7.709
02/28/01	MC 16	133	4.10	0.003	0.003	3.89	3.778
02/28/01	MC 17	295	10.48	0.004	0.004	3.79	4.253
02/28/01	MC 18	1231	77.35	0.007	0.014	2.70	5.352
02/28/01	MC 19	208	0.50	0.016	0.001	5.64	0.427
03/01/01	MC 20	189	23.97	0.003	0.012	1.72	6.866
03/01/01	MC 23	2603	167.08	0.003	0.006	3.04	6.152
02/28/01	MC 25	1043	197.14	0.005	0.030	3.09	18.420
02/28/01	MC 26	824	137.64	0.003	0.016	3.90	20.534
02/28/01	MC 27	321	39.47	0.005	0.019	2.50	9.710
02/28/01	MC 28	211	11.69	0.006	0.010	5.00	8.742
02/28/01	MC 30	111	8.11	0.093	0.214	8.33	19.152
02/28/01	MC 31	84	0.50	0.009	0.002	1.15	0.216
02/28/01	MC 34	148	0.95	0.003	0.001	19.10	3.873
02/28/01	MC 35	49	5.21	0.007	0.023	7.84	26.101

Figure 2. Middle Chester Spring 2001 Nutrient Synoptic Survey. NO23 Concentrations (mg/L).

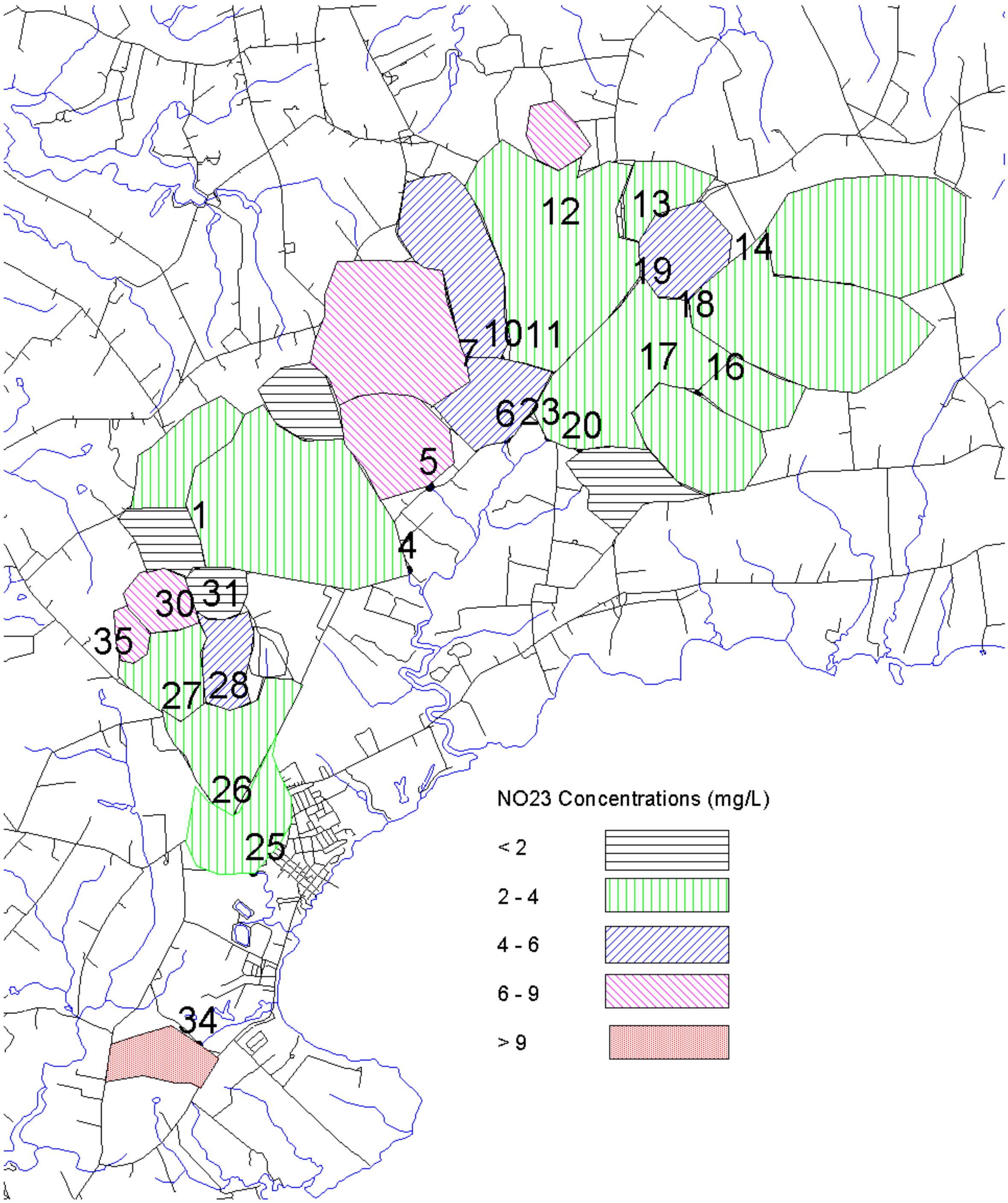


Figure 3. Middle Chester Spring 2001 Nutrient Synoptic Survey. NO23 Yield (KG/hectare/yr)

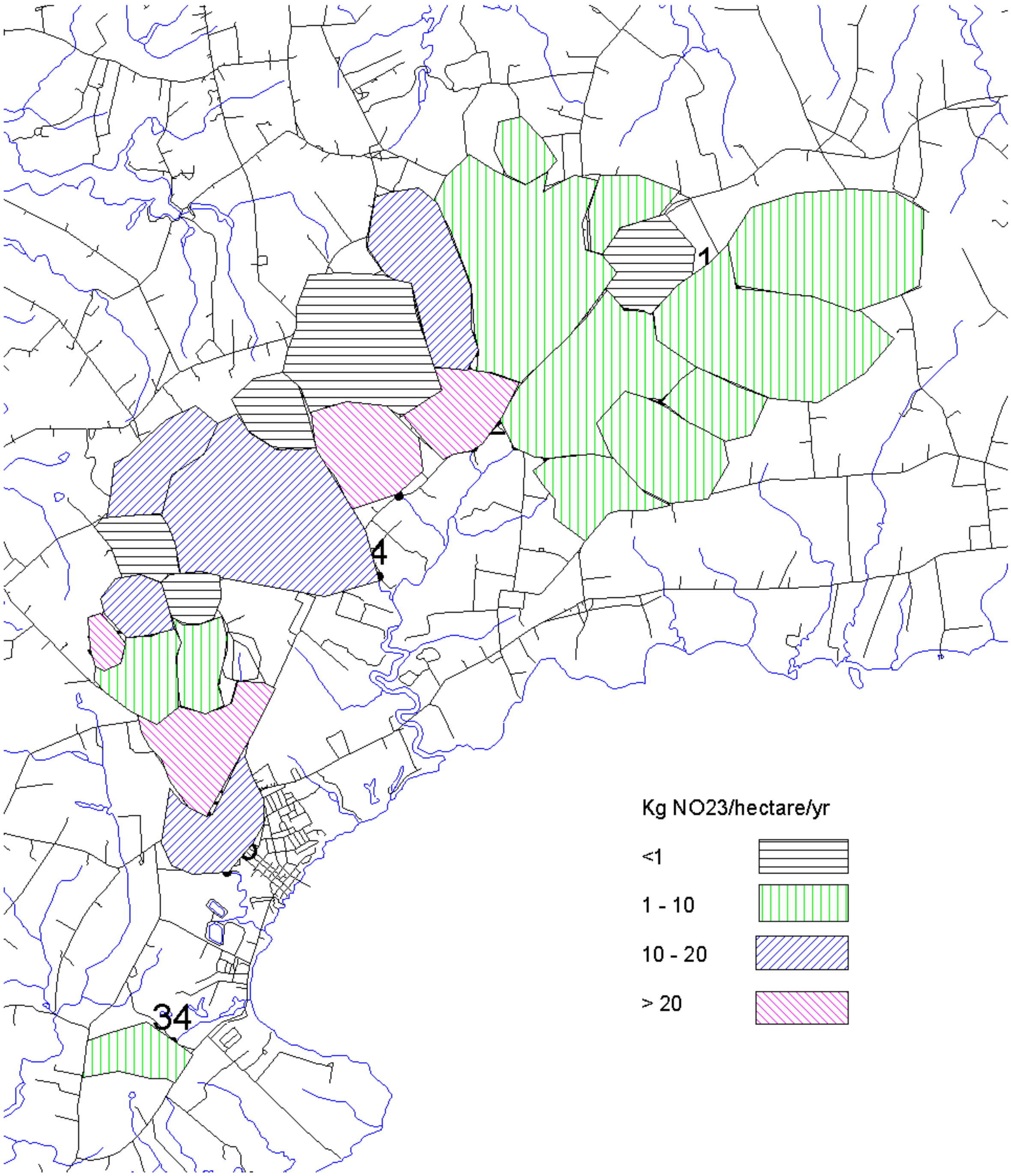


Figure 4. Middle Chester Spring 2001 Nutrient Synoptic Survey. PO4 Concentrations (mg/L).

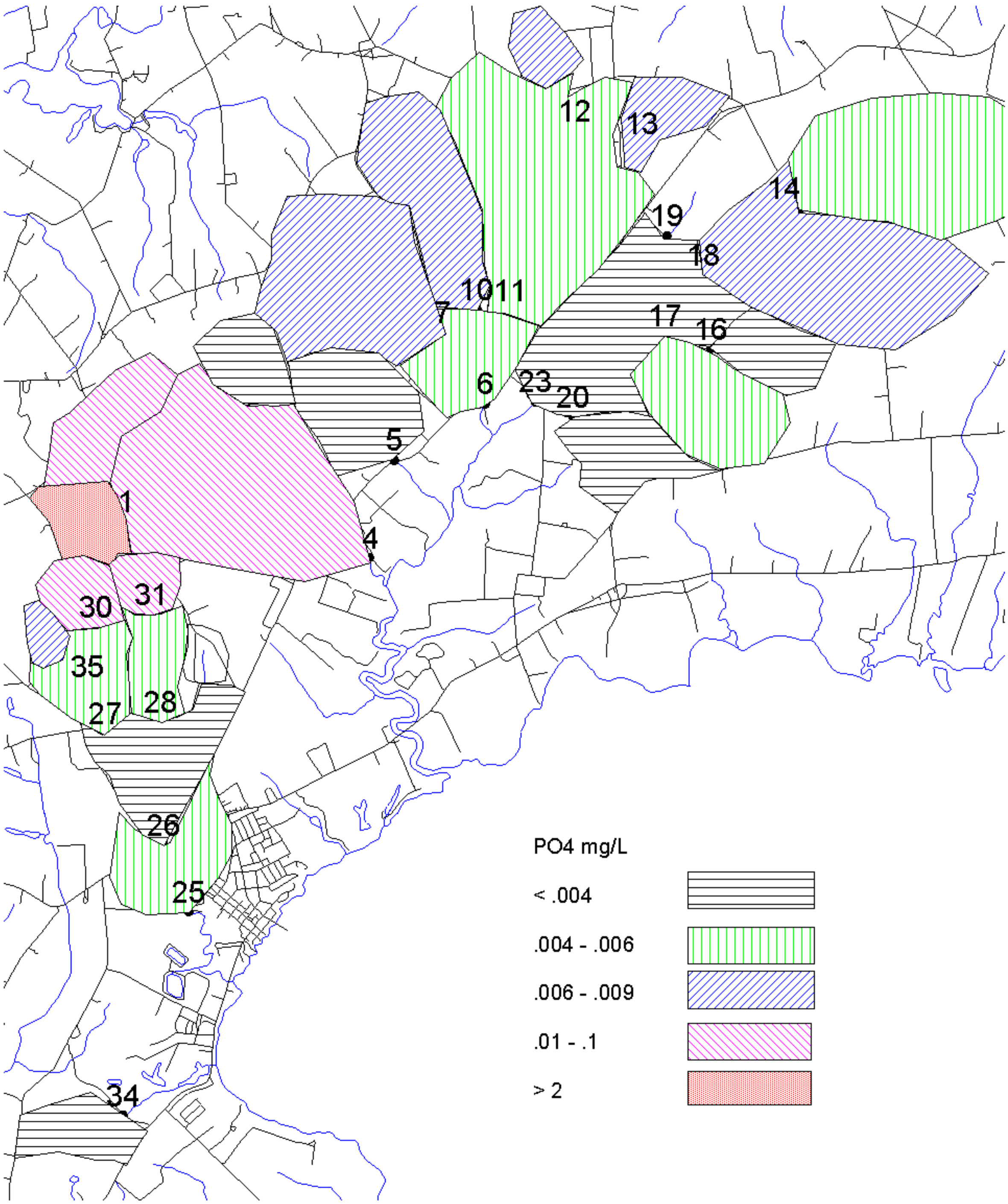


Figure 5. Middle Chester Spring 2001 Nutrient Synoptic Survey. PO4 Yield (Kg/hectare/yr).

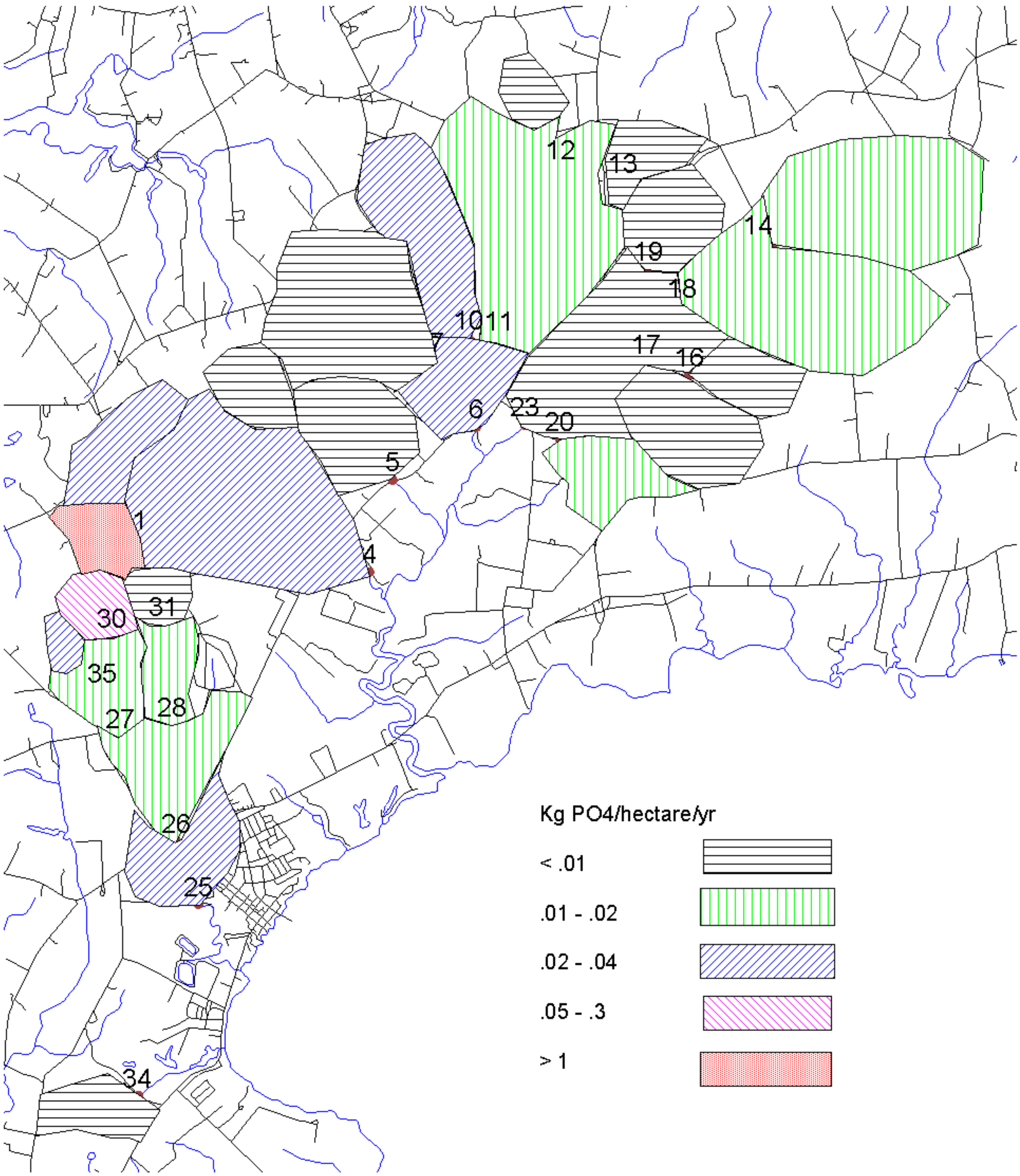


Table 4. Middle Chester Nutrient Synoptic Survey, Spring 2001, Insitu Water Quality.

DATE	SAMPLE SITE	Time	Water Temp C	Field pH	Dis O2 mg/L	Cond. mmohs/cm
02/28/01	MC 01	1125	13.02	7.82	6.23	0.234
03/01/01	MC 04	1150	5.25	7.30	10.68	0.234
03/01/01	MC 05	1135	5.25	7.04	10.47	0.199
03/01/01	MC 06	1100	6.71	7.44	11.08	0.176
02/28/01	MC 07	1150	8.15	7.60	9.71	0.177
02/28/01	MC 10	1200	7.13	7.18	10.49	0.150
02/28/01	MC 11	1215	8.33	7.49	11.11	0.207
02/28/01	MC 12	1250	7.11	6.70	12.40	0.341
02/28/01	MC 13	1230	10.01	7.89	11.87	0.241
02/28/01	MC 14	1300	5.87	7.12	10.31	0.160
02/28/01	MC 16	1410	9.41	7.04	11.42	0.142
02/28/01	MC 17	1400	7.69	7.12	9.79	0.165
02/28/01	MC 18	1335	9.20	7.28	10.88	0.183
02/28/01	MC 19	1330	12.35	7.39	16.30	0.235
03/01/01	MC 20	1035	4.37	6.82	9.17	0.125
03/01/01	MC 23	1000	3.47	7.18	10.55	0.158
02/28/01	MC 25	820	4.71	7.18	9.50	0.196
02/28/01	MC 26	920	5.34	7.00	9.72	0.174
02/28/01	MC 27	930	5.77	7.01	10.35	0.171
02/28/01	MC 28	1000	5.31	7.15	10.03	0.167
02/28/01	MC 30	1030	6.42	6.44	12.27	0.226
02/28/01	MC 31	1040	7.06	6.39	9.26	0.327
02/28/01	MC 34	855	3.61	6.90	11.21	0.484
02/28/01	MC 35	1020	7.19	6.11	9.18	0.155

Table 5. Annual & Spring Nutrient Concentration Averages from Other Nutrient Synoptic Surveys

	Piney	German Br.	Pocomoke	Bush	Breton Bay	Patuxent	Choptank	Liberty
NO23 Spring	3.742	3.832	3.734	1.944	0.223	0.439	2.892	3.410
NO23 Annual	4.823	4.704	2.384					
PO4 Spring	0.800	0.043	0.028	0.006	0.004	0.012	0.023	0.004
PO4 Annual	1.177	0.067	0.022					

Figure 6. Comparison of Various Eastern Shore Nutrient Synoptic Results:

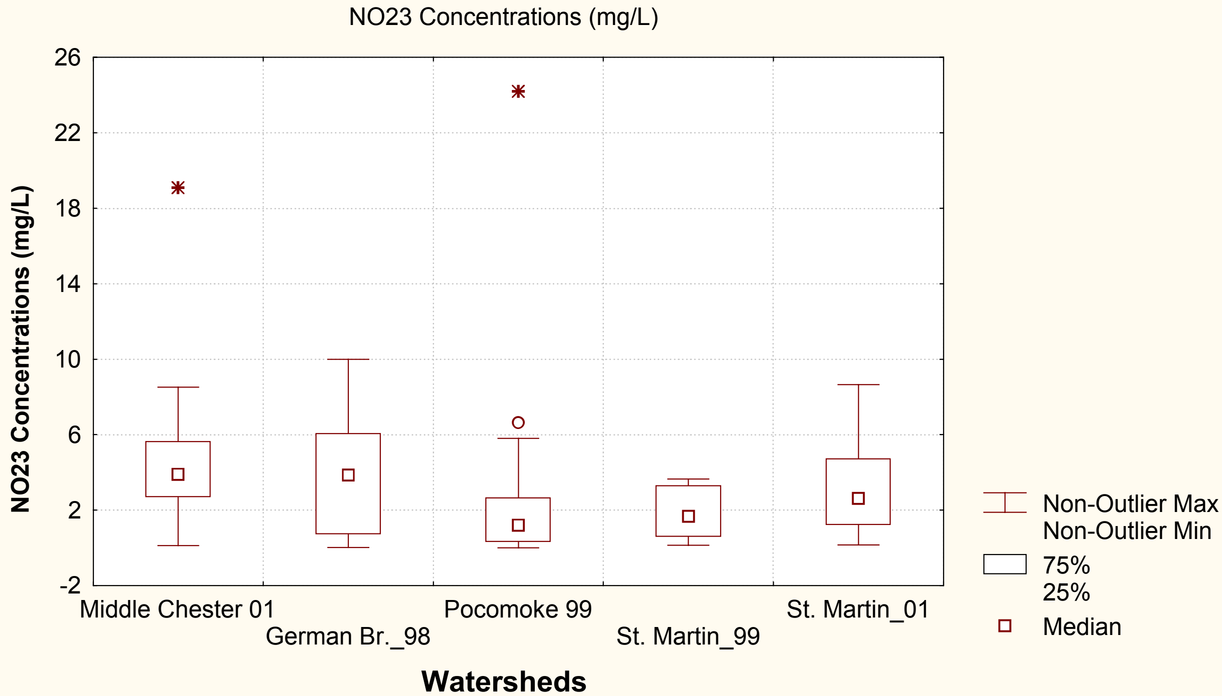
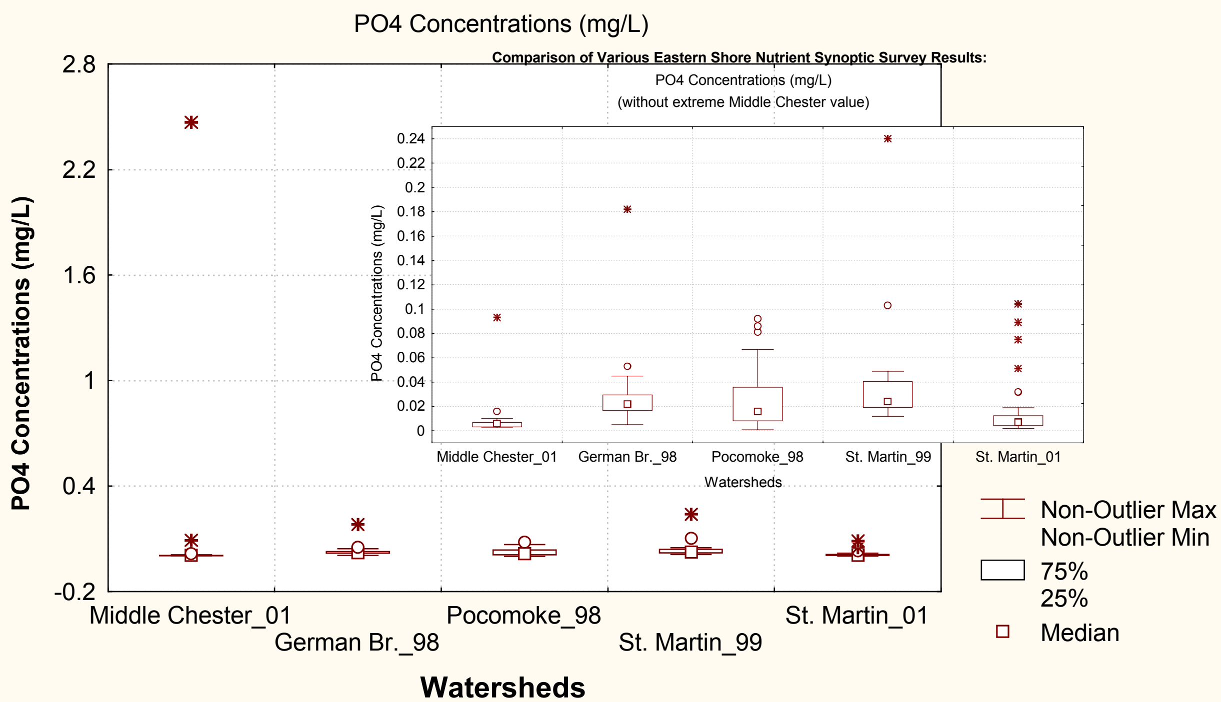


Figure 7. Comparison of Various Eastern Shore Nutrient Synoptic Results:



Literature Cited

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