Report on Nutrient Synoptic Surveys in the Newport and Sinepuxent Bay Watershed, Worcester County, Maryland, March, 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

This work was supported by the 2003 319(h) grant from U.S. Environmental Protection Agency # C9-00-3497-02-0.

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 Newport Bay by Niles Primrose

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Executive Summary

A nutrient synoptic survey was conducted during March, 2003 in the Newport/Sinepuxent Bay watershed as part of the Newport/Sinepuxent Bay WRAS. Samples were analyzed from 36 sites throughout the watershed. Sampling was focused in the Newport/Sinepuxent Bay watersheds, with additional samples collected at the outlets of other major tributaries. Biological samples were collected at five of the nutrient sites. Nitrate/nitrite concentrations were found to be excessive in one subwatershed, high in ten, moderately elevated in seven others, and baseline in the remaining eighteen subwatersheds. Nitrate/nitrite yields were found to be excessive in ten subwatersheds, high in one, moderately elevated in two, and baseline in the remaining twenty-three. Excessive concentrations of orthophosphate were found in sixteen subwatersheds, high concentrations in eight, moderate concentrations in six, and the remaining six were below baseline. Orthophosphate yields were found to be excessive in two subwatersheds, high in one subwatershed, moderate in two, and baseline in the remainder. The majority of the elevated nitrate/nitrite concentrations and/or yields appear to be associated with row crop agriculture. Discharges from the Berlin STP and chicken processing plant also contribute. 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. The discharge from the chicken processing plant is also a significant factor for orthophosphate. No anomalies were found in the insitu measurements of dissolved oxygen, or temperature. Two subwatersheds had significantly elevated conductivity (>600mmhos/cm) associated with the discharge from the poultry plant in Berlin. Depressed pH values (<6) were found in three subwatersheds. Benthic macroinvertebrate community Index of Biotic Integrity ranged from poor to very poor at the five sites sampled. The degradation in the benthic community was attributed to degraded habitat associated with storm water flows and Fish communities at the four sites sampled are considered fair to poor due to stream channel alterations and community isolation due to salt water.

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Introduction

A nutrient synoptic survey was conducted during March, 2003 in the Newport/Sinepuxent Bay watershed as part of the Newport/Sinepuxent Bay 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 March, 2003 in the Newport/Sinepuxent Bay watershed as part of the Newport/Sinepuxent Bay WRAS. Samples were collected at 36 sites throughout the watershed. 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 one subwatershed, high in ten, moderately elevated in seven others, and baseline in the remaining eighteen subwatersheds (Figure 2). Nitrate/nitrite yields were found to be excessive in ten subwatersheds, high in one, moderately elevated in two, and baseline in the remaining twenty-three (Figure 3). Excessive concentrations of orthophosphate were found in sixteen subwatersheds, high concentrations in eight, moderate concentrations in six, and the remaining six were below baseline (Figure 4). Orthophosphate yields were found to be excessive in two subwatersheds, high in one subwatershed, moderate in two, and baseline in the remainder (Figure 5). No anomalies were found in the insitu measurements of dissolved oxygen, or temperature (Table 4). Two subwatersheds had significantly elevated conductivity (>600mmhos/cm) associated with the discharge from the poultry plant in Berlin. Depressed pH values (<6) were found in three subwatersheds. Benthic macroinvertebrate community Index of Biotic Integrity ranged from poor to very poor at the five sites sampled Table 5). The degradation in the benthic community was attributed to degraded habitat associated with storm water flows and stream channel alterations. Fish communities at the four sites sampled are considered fair to poor due to stream channel alterations and community isolation due to salt water (Table 6).

Discussion

The major sources of the nitrate/nitrite in the Newport/Sinepuxent Bay watershed contributing to the elevated concentrations and yields appear to be permitted discharges, row crop agriculture, and residential septic. The excessive yields at sites 14, 15, and 17 are most probably associated with the discharges from the Berlin Waste Water Treatment Plant (14), and the poultry processing facility in Berlin (15, 17). Both of these streams have a history of elevated nutrients (Primrose, pers. com.). Land use in the other watersheds exhibiting elevated yields is a mix of row crop agriculture, poultry houses, and residential There is no readily identifiable nitrate/nitrite source for the one subwatershed with an excessive concentration.

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 wetlands and ponds. The discharge from the chicken processing plant is also a significant factor

Table 2. Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003
Station Locations

Site Number	Station Location	Sample Type*	Lat		Long	
0	Icehouse Br at Langmaid Rd	N	38	13.556	75	16.083
1	UT** to Marshall Cr at Langmaid Rd	N	38	14.104	75	16.742
2	UT to Marshall Cr at Langmaid Rd	N	38	14.215	75	16.941
3	Massey Br at Rt 113 or Newark Rd	N	38	15.177	75	16.152
4	Porter Cr at Rt 113	N	38	15.512	75	15.499
5	Basset Cr at Rt 113	N,F	38	16.067	75	14.671
6	Catbird Cr at Rt 113	N	38	16.546	75	14.253
8	Poplartown Br at Rt 113	N	38	17.409	75	13.757
9	Newport Cr at Harrison Rd	N	38	18.124	75	12.69
10	UT to Newport Cr at Rt 113	N	38	18.312	75	13.261
12	Bottle Br at Rt 113	N	38	19.034	75	12.97
13	Hudson Br at Rt 376	N	38	19.327	75	12.291
14	Bottle Br at Harrison Rd	N,B	38	18.796	75	11.639
15	Kitts Br at Flower St	N,B,F	38	19.931	75	12.042
16	UT to Kitts Br at Flower St	N	38	20.09	75	11.807
17	Kitts Br at Rt 346	N	38	20.236	75	12.48
18	Kitts Br at rr tracks near Rt 50	N	38	20.52	75	13
20	UT to Ayers Cr at Lewis Rd	N	38	18.596	75	9.032
21	UT to Sinepuxent Bay at Eagles Nest Rd	N	38	18.201	75	7.835
23	UT to Ayers Cr at Lewis Rd	N	38	17.781	75	9.105
24	UT to Sinepuxent Bay at Frontiertown	N	38	17.408	75	8.67
25	UT to Holland Cr at Rt 611	N	38	15.462	75	9.9
26	UT to Sinepuxent Bay at Rt 611	N	38	15.082	75	9.47
28	Deals Br at Rt 376	N	38	18.235	75	10.594
29	UT to Trappe Cr at Rt 376	N	38	18.643	75	11.176
30	UT to Kitts Br at Seahawk Rd	N	38	19.174	75	11.368
31	Ayers Cr at Sinepuxent Rd	N	38	18.772	75	9.426
33	Waterworks Cr at Basket Switch Rd	N	38	12.631	75	17.68
34	Robins Cr at Cedartown Rd	N	38	11.605	75	17.626
35	UT to Robins Cr at Taylor Rd	N	38	11.402	75	18.04
36	Pawpaw Cr at Pawpaw Rd	N, B	38	9.122	75	19.038
37	Rowley Cr at Bayview Rd	N	38	5.425	75	21.839
38	Pikes Cr at Rt 12	N	38	4.405	75	24.198
39	Payne Ditch at Steel Pond Rd	N	38	1.968	75	27.17
40	Little Mill Rn at Steel Pond Rd	N,B, F	38	2.536	75	27.572
41	Poplartown Br at Beaverdam Cr Rd	N,B,F	38	16.945	75	13.339

* N= Nutrients, B= Benthic, F= Fish
** UT =Unnamed Tributary

Figure 1.
Newport/Sinepuxent BAy WRAS Nutrient Synoptic March, 2003
Sampling Sites

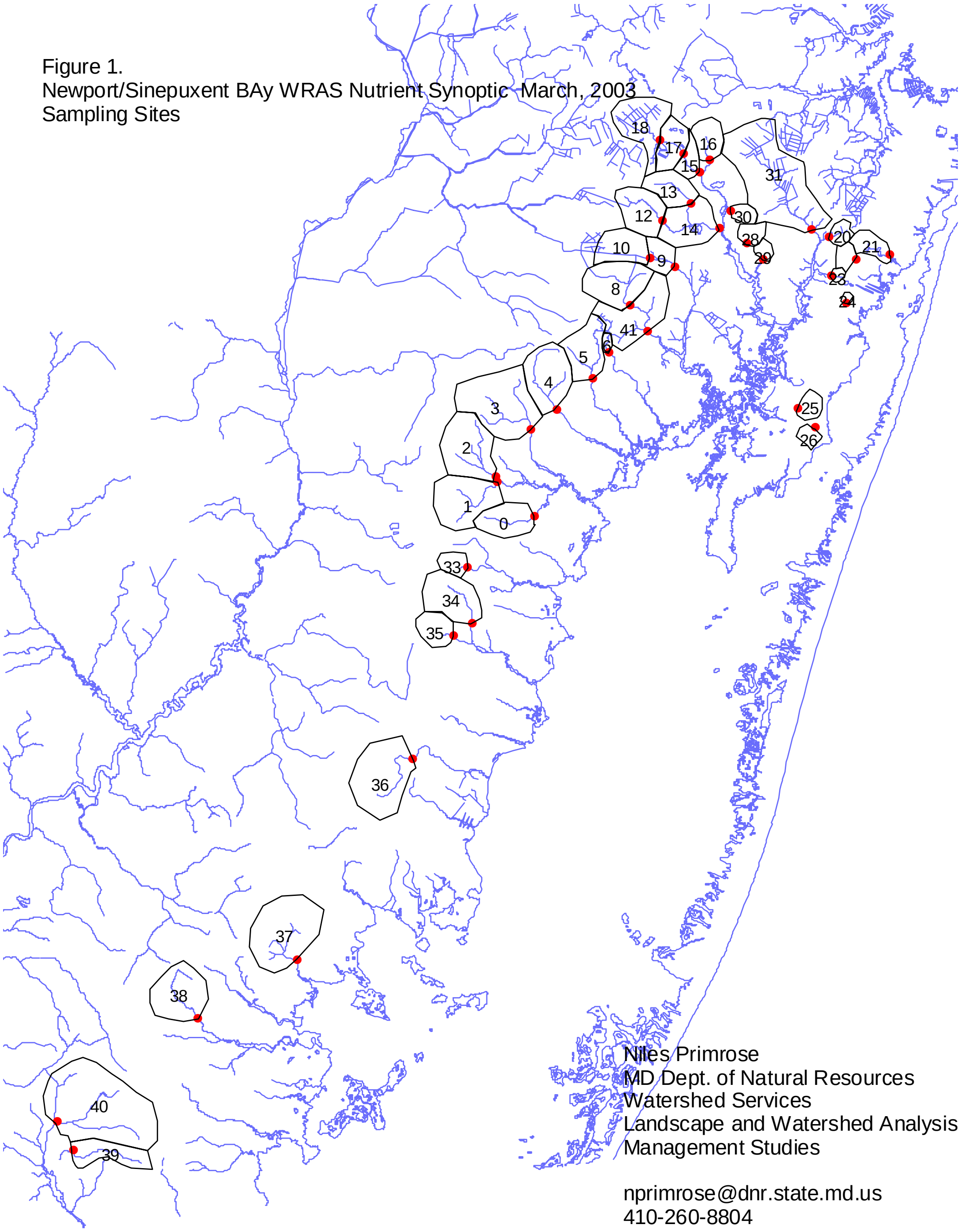

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Table 3. Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003

Nutrient Concentrations and Yields

Site Number	Date	Area Hectares	Discharge L/S	PO_4 mg/L	$NO_2 + NO_3$ mg/L	PO_4 kg/h/d	$NO_2 + NO_3$ kg/h/d
0	03/10/03	191	23.96	0.002	0.08	0.000022	0.000867
1	03/10/03	325	0.23	0.02	10.2	0.000001	0.000636
2	03/10/03	348	47.46	0.005	0.14	0.000059	0.001650
3	03/10/03	482	69.41	0.014	3.08	0.000174	0.038322
4	03/10/03	298	35.19	0.031	3.09	0.000316	0.031528
5	03/10/03	227	64.71	0.014	2.08	0.000345	0.051229
6	03/10/03	20	0.30	0.003	0.05	0.000004	0.000065
8	03/14/03	354	3.99	0.007	0.05	0.000007	0.000049
9	03/10/03	287	17.24	0.029	1.21	0.000150	0.006279
10	03/10/03	185	5.78	0.008	2.29	0.000022	0.006185
12	03/10/03	216	6.13	0.024	1.6	0.000059	0.003921
13	03/10/03	164	4.19	0.02	1.9	0.000044	0.004195
14	03/10/03	627	138.36	0.013	4.05	0.000248	0.077219
15	03/10/03	509	98.92	0.174	2.69	0.002922	0.045169
16	03/10/03	123	7.19	0.011	1.19	0.000056	0.006008
17	03/14/03	435	65.08	0.237	3.17	0.003064	0.040976
18	03/14/03	287	19.05	0.019	4.85	0.000109	0.027814
20	03/14/03	52	15.45	0.033	0.21	0.000847	0.005392
21	03/19/03	96	5.90	0.085	0.01	0.000451	0.000053
23	03/19/03	19	0.73	0.004	0.01	0.000013	0.000033
24	03/19/03	12	0.20	0.002	2.65	0.000003	0.003853
25	03/19/03	68	17.19	0.003	0.01	0.000066	0.000218
26	03/19/03	44	5.96	0.015	0.01	0.000176	0.000117
28	03/19/03	35	16.34	0.003	0.01	0.000121	0.000403
29	03/19/03	61	0.84	0.104	0.67	0.000123	0.000795
30	03/19/03	50	6.63	0.101	4.03	0.001156	0.046139
31	03/14/03	762	69.60	0.007	4.55	0.000055	0.035907
33	03/14/03	69	11.41	0.046	0.76	0.000657	0.010858
34	03/11/03	271	5.01	0.014	0.91	0.000022	0.001453
35	03/11/03	123	27.05	0.019	3.2	0.000360	0.060691
36	03/11/03	442	51.63	0.02	0.84	0.000202	0.008477
37	03/11/03	473	12.54	0.005	0.05	0.000011	0.000114
38	03/11/03	307	19.65	0.01	0.81	0.000055	0.004479
39	03/11/03	191	16.07	0.005	0.89	0.000036	0.006468
40	03/11/03	840	30.42	0.012	3.83	0.000038	0.011982
41	03/10/03	614	73.35	0.021	4.29	0.000217	0.044280

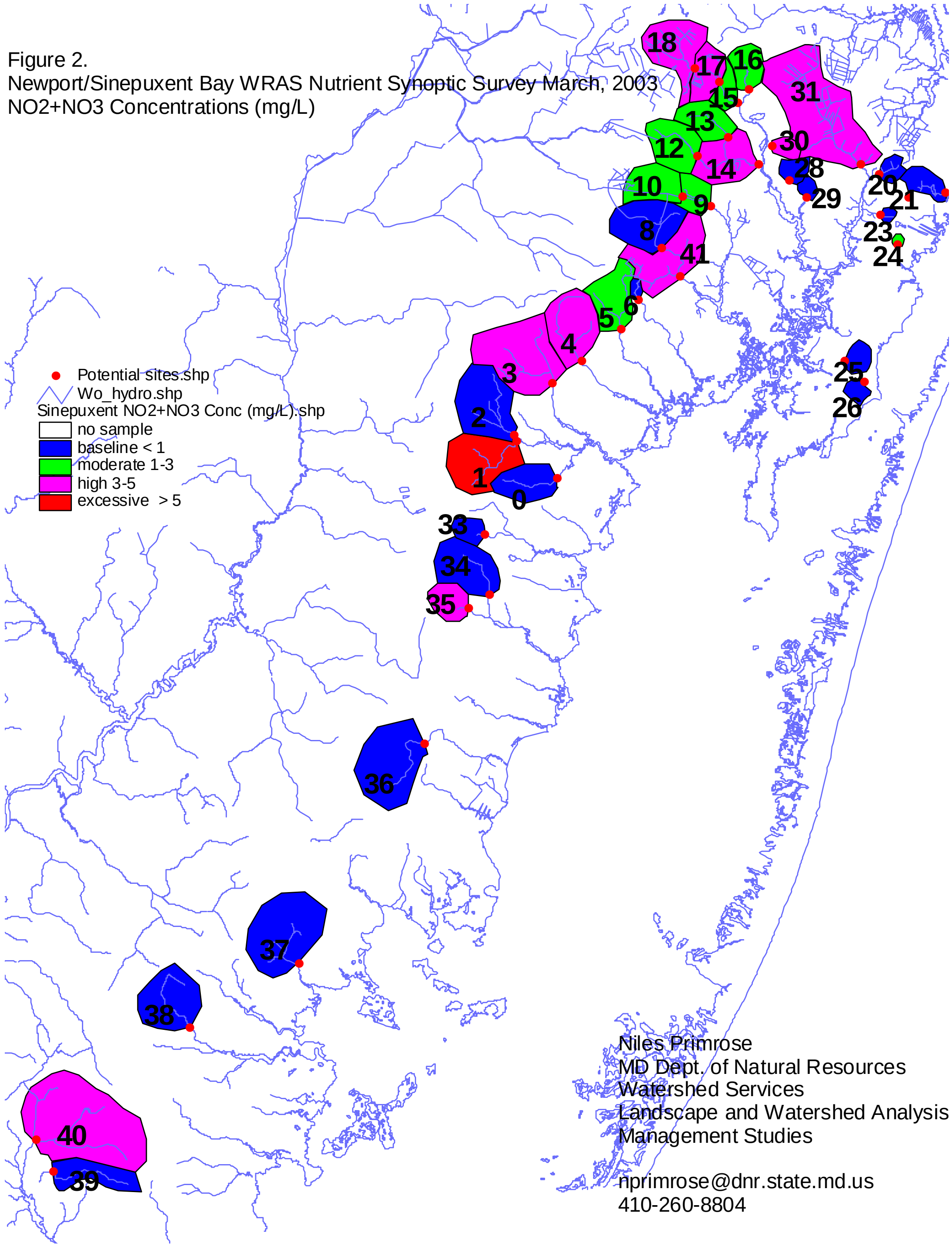
Figure 2.
Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003
NO2+NO3 Concentrations (mg/L)
Potential sites.shp
Wo_hydro.shp
Sinepuxent NO2+NO3 Conc (mg/L).shp
no sample
baseline < 1
moderate 1-3
high 3-5
excessive > 5
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Figure 3.
Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003
NO2+NO3 Yield (kg/h/day)

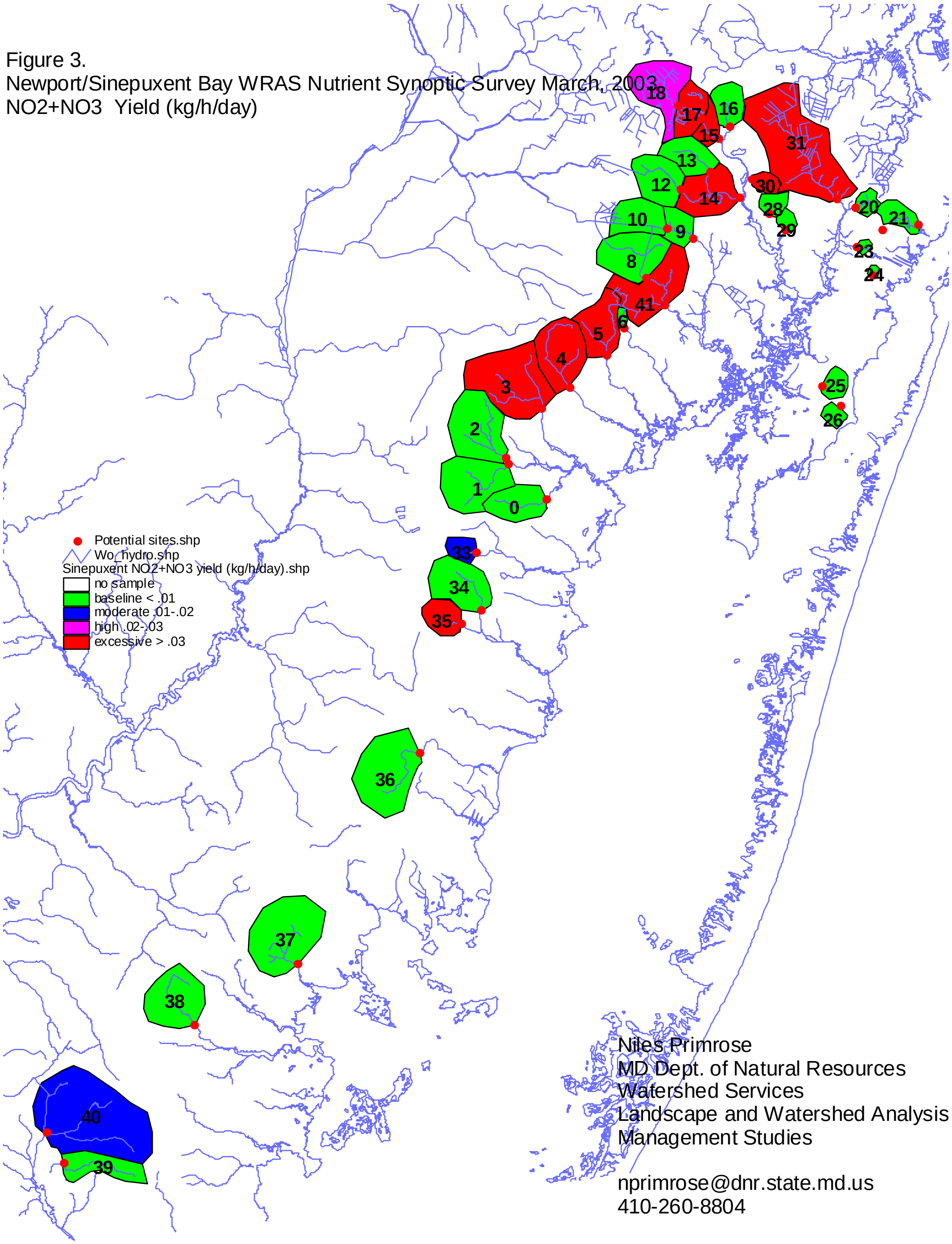

Figure 4.
Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003
PO4 Concentrations (mg/L)

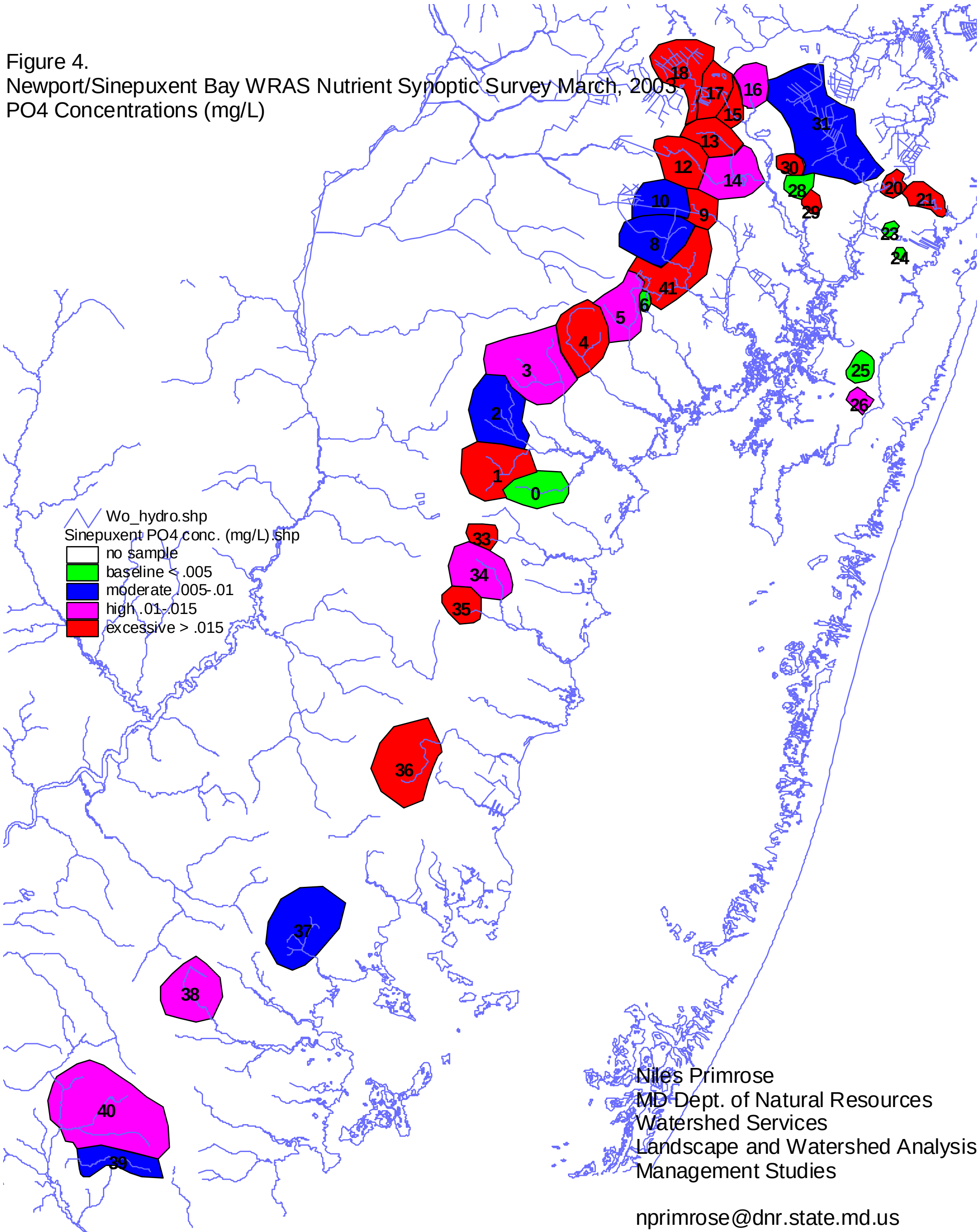

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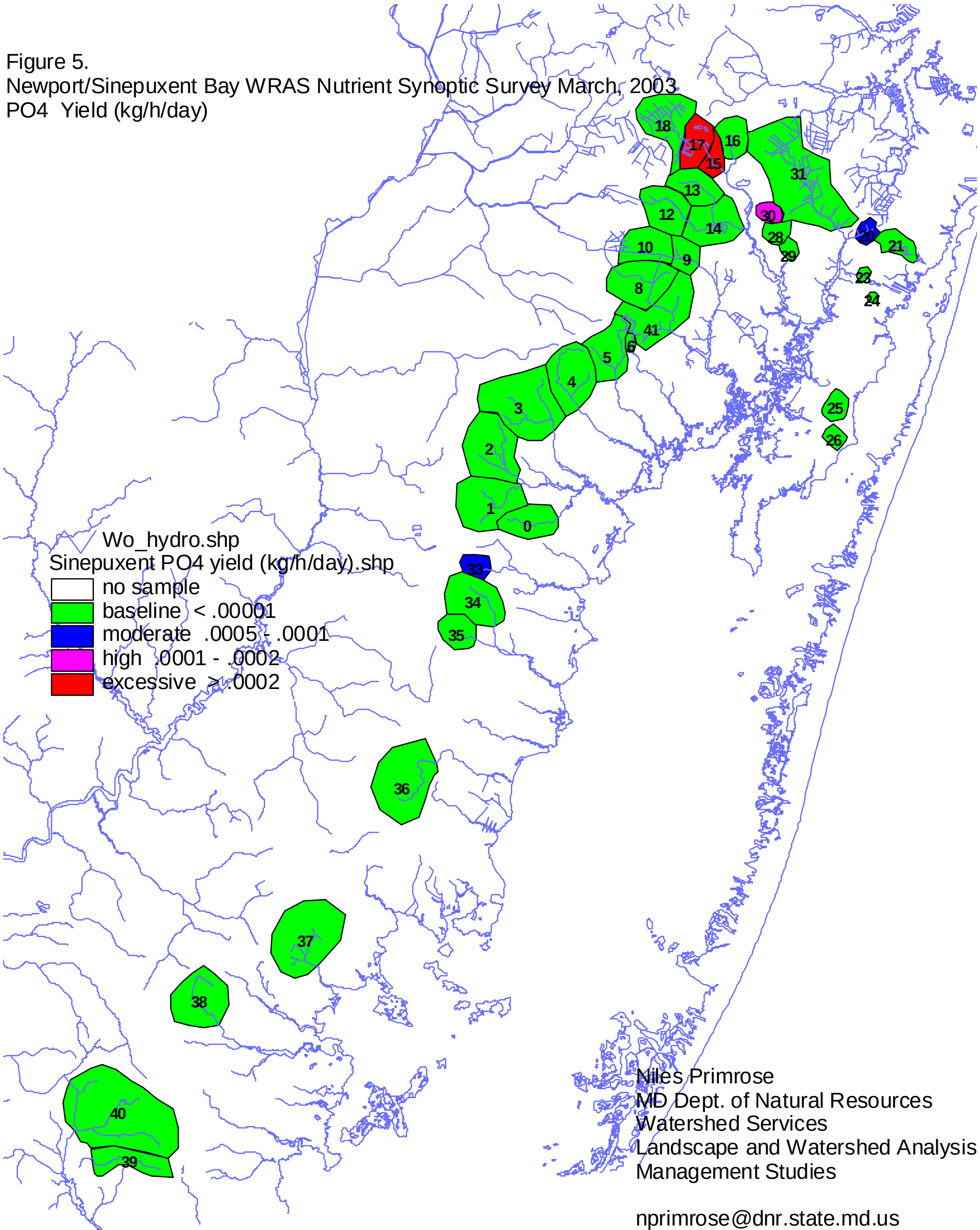
Figure 5.
Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003
PO4 Yield (kg/h/day)



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contributing to the orthophosphate. The average nitrate/nitrite concentration in the Newport/Sinepuxent Bay watershed streams was relatively low when compared to other watersheds across the state (Table 7). The removal of the one extremely high concentration would have brought the average more in line with sewered urban communities. The average orthophosphate concentration was more in line with rural watersheds, but would have been closer to the urban values without the contribution from the poultry processing facility.

The low pH values were clustered in the Marshall Creek watershed. The predominance of forest in these watersheds could be a significant source of tannic acid, especially with the above average rainfall flushing any wooded wetlands. Local geology could be a factor as well. There is a stream in the St. Martins watershed with a similar pH value that drains an old gravel pit as evidence that low pH strata are possible within the watershed. While pH values less than 5 are detrimental to the fresh water biotic community, saltwater in the bay would buffer any impacts to the saltwater biotic community.

As noted, the biological community was relatively poor when judged by coastal plain standard. Poor habitat due to ditching and storm flows was the major problem facing the biological community. Ditching and storm flows remove woody debris from channels and cover gravel riffles with sediment. In many cases, the sediment is very mobile, moving during base flow, thus eliminating almost all good quality habitat.

Conclusions

Several watersheds stand out as candidates for further investigation. Kitts Branch had both elevated nitrate/nitrite and orthophosphate as well as elevated specific conductivity readings. While the poultry processing plant discharging to this stream has been noted as the probable source of the elevated orthophosphate and specific conductivity, the source of elevated nitrate/nitrite is not as clear. The source of the elevated nitrate/nitrite in Bottle Branch is probably associated with the STP discharge to this stream. As noted, there was no immediately obvious source for the excessive nitrate/nitrite concentration found at station # 1. Although the majority of this watershed is wooded, stock piling or fresh application of chicken litter on the wet row crop land in the headwaters could be contributing. This same scenario could be contributing to the elevated nitrate/nitrite concentrations and yields found in a number of other subwatersheds. A small hog operation located adjacent to the stream upstream of site 41 is a possible nutrient source for this subwatershed. Many of these subwatersheds also have a fair number of residential septic drain fields that could also contribute significant nitrate/nitrite to the streams.

Table 4. Newport/Sinepuxent Bay WRAS Nutrient Synoptic Survey March, 2003

Insitu Water Quality Parameters

Site Number	Date	Time	Temp ^{o}C	pH	Cond ms/cm	DO mg/L
0	10-Mar-03	830	4.85	3.73	52	8.73
1	10-Mar-03	900	6.08	5.92	187	8.42
2	10-Mar-03	915	5.31	4.82	65	9.56
3	10-Mar-03	930				
4	10-Mar-03	950				
5	14-Mar-03	1355	8.68	6.22	167	11.8
6	10-Mar-03	1010				
8	14-Mar-03	1340	9.21	6.05	143	9.45
8	10-Mar-03	1020				
9	14-Mar-03	1406	9.07	6.22	183	11.3
10	10-Mar-03	1115				
12	10-Mar-03	1330				
13	14-Mar-03	1440	11.36	6.08	216	15.3
14	10-Mar-03	1230				
15	10-Mar-03	1340	11.08	6.44	665	13.4
16	14-Mar-03	1220	8.58	6.01	173	12.4
17	14-Mar-03	1250	10.83	6.79	796	12.74
18	14-Mar-03	1310	12.36	6.67	297	12.05
20	19-Mar-03	950				
21	19-Mar-03	1107				
23	19-Mar-03	1130				
24	19-Mar-03	1005				
25	19-Mar-03	1005				
26	19-Mar-03	1040				
28	19-Mar-03	1150				
29	19-Mar-03	1155				
30	14-Mar-03	1200	9.3	5.95	190	12.2
31	14-Mar-03	1130	10.6	5.96	179	10.86
33	11-Mar-03	1330				
34	11-Mar-03	1315				
35	11-Mar-03	1300				
36	11-Mar-03	1130				
37	11-Mar-03	1230				
38	11-Mar-03	1025				
39	11-Mar-03	1000				
40	11-Mar-03	930				
41	14-Mar-03	1400	10.8	6.27	168	11.28
42	10-Mar-03	1045				

Table 5. Newport Sinepuxent Bay WRAS Synoptic Survey, March 2003
Macroinvertebrate Index of Biotic Integrity

Station	# of Taxa	# of EPT	% Ephemoptera	% Tanytarsini of Chironomids	Becks Index	# of Scrapers	% Clingers	IBI Calc***	IBI Score
14	20/3	0/1	0/1	0/1	1/1	1/1	3/1	9/7	1.3
15	21/3	2/1	2/3	0/1	3/1	3/3	2/1	13/3	1.9
15 qa/qc	21/3	2/1	2/3	0/1	3/1	3/3	2/1	13/3	1.9
36	10/1	3/3	0/1	0/1	3/1	1/1	0/1	9/7	1.3
40	23/3	7/5	4/3	0/1	8/3	4/3	0/1	19/7	2.7
41	19/3	2/1	0/1	6/3	1/1	1/1	2/1	11/7	1.6

* value
** score
***Total score/# of metrics

Table 6. Newport/Sinepuxent Bay WRAS Biological Synoptic Survey Summer, 2003
Fish Species totals by site

Common name	Genus	species	CB#5	CB#15	CB#41	CB#40
Least brook lamprey	*Lampetra*	*aepyptera*	-	-	75	47
American eel	*Anguilla*	*rostrata*	37	17	59	58
Creek chubsucker	*Erimyzon*	*oblongus*	3	-	17	-
Banded killifish	*Fundulus*	*diaphanus*	-	61	-	-
Eastern mosquitofish	*Gambusia*	*holbrooki*	-	18	-	-
Chain pickerel	*Esox*	*niger*	13	-	-	-
Redfin pickerel	*Esox*	*americanus*	16	-	-	11
Eastern mudminnow	*Umbra*	*pygmaea*	104	129	52	84
Pirate perch	*Aphredoderus*	*sayanus*	13	-	76	5
Pumpkinseed	*Lepomis*	*gibbosus*	1	2	-	-
Bluegill	*Lepomis*	*macrochirus*	12	-	-	-
Tessellated darter	*Etheostoma*	*olmstedi*	-	-	-	26

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

Mg/L	Piney	German Br.	Pocomoke	**Newport Sinepuxent**	Western Branch	Upper Patuxent	Choptank	Liberty
NO2+NO3 Spring	3.742	3.832	3.734	**1.93**	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	**0.03**	0.005	0.012	0.023	0.004
PO4 Annual	1.177	0.067	0.022					

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