Report on Nutrient Synoptic Surveys in the Anacostia River Watershed, Prince George's County, Maryland, April, 2004 as part of a Watershed Restoration Action Strategy.

Maryland Department of Natural Resources
Watershed Services
Landscape and Watershed Analysis
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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.

Cover photo: Site WRD 70 by Niles Primrose

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Executive Summary

A nutrient synoptic survey was conducted during April, 2004 in the Anacostia watershed as part of the Anacostia WRAS. Samples were analyzed from 37 sites throughout the watershed. Nitrate/nitrite concentrations were found to be high in one subwatershed, moderately elevated in six others, and baseline in the remaining thirty subwatersheds. Instantaneous nitrate/nitrite yields were found to be high in one, moderate in four, and baseline in the remaining thirty-one, with one tidal site not calculated. Orthophosphate concentrations and yields were found to be below baseline at all sites. No significant anomalies were found in the insitu measurements of pH, or temperature. Insitu specific conductivity values were generally high in the Beaverdam portion of the watershed, with 8 subwatersheds having values greater than 500 mmohs/cm. Eight additional sites were over 300 mmohs/cm, and the remaining 21 where less than 300 mmohs/cm. The high specific conductivities appear to be associated with road salts from concentrated road and highway systems in these subwatersheds. Dissolved oxygen levels were marginal (<5 mg/L) in 9 subwatersheds and supersaturated (>12 mg/L) in 3 others. Poor habitat scores tended to be associated with these subwatersheds with anomalous dissolved oxygen.

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Introduction

A nutrient synoptic survey was conducted during April, 2004 in the Prince George's portion of the Anacostia watershed as part of the Anacostia 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.

RESULTS

A nutrient synoptic survey was conducted during April, 2004 in the Anacostia watershed as part of the Anacostia WRAS. Samples were analyzed from 37 sites throughout the watershed. Sampling site locations are noted in Table 2 and mapped with subwatersheds in Figure 1. Dissolved nutrient concentrations and yields from all sites are noted in Table 3. Nitrate/nitrite concentrations were found to be high in one subwatershed, moderately elevated in six others, and baseline in the remaining thirty subwatersheds (Figure 2.). Instantaneous nitrate/nitrite yields were found to be high in one, moderate in four, and baseline in the remaining thirty-one, with one tidal site not calculated Figure 3.). Orthophosphate concentrations and yields were found to be below baseline at all sites (Figures 4 & 5 respectively). No significant anomalies were found in the insitu measurements of pH, or temperature (Table 4). Insitu specific conductivity values were generally high in the Beaverdam portion of the watershed, with 8 subwatersheds having values greater than 500 mmohs/cm. Eight additional sites were over 300 mmohs/cm, and the remaining 21 where less than 300 mmohs/cm (Figure 6.). Dissolved oxygen levels were marginal (<5 mg/L) in 9 subwatersheds and supersaturated (>12 mg/L) in 3 others (Figure 7.). Poor habitat scores tended to be associated with these subwatersheds with low dissolved oxygen (Figure 8.).

Table 2. Anacostia WRAS Nutrient Synoptic Survey, April 2004. Sampling Site Locations.

SITE ID	LONGITUDE	LATITUDE	ADC__MAP	USGS_QUAD_
WRD-16	-76.90519033	39.04856282	03J13	Beltsville
WRD-35	-76.91951523	38.98630818	07G11	Washington East
WRD-56	-76.88359271	38.93866351	13C07	Washington East
WRD-58	-76.86471882	38.95291328	13E04	Lanham
WRD-72	-76.91422217	38.91502189	12H11	Washington East
WRD-01	-76.89364758	39.06438196	04A10	Beltsville
WRD-02	-76.89392849	39.04591386	04A13	Beltsville
WRD-03	-76.89652785	39.06687730	04A09	Beltsville
WRD-04	-76.91161315	39.06674794	03H09	Beltsville
WRD-05	-76.90267850	39.00775607	07K07	Beltsville
WRD-06	-76.91022976	39.08349441	03J06	Beltsville
WRD-19	-76.90068063	39.04494661	03K13	Beltsville
WRD-24	-76.89607603	39.04651220	04A13	Beltsville
WRD-29	-76.89867622	39.01479787	07K06	Beltsville
WRD-30	-76.91846420	38.99497643	07G10	Washington East
WRD-38	-76.90534053	38.91176650	12J12	Washington East
WRD-39	-76.90031953	38.86935629	18K07	Anacostia
WRD-40	-76.89322580	38.88185484	19A04	Washington East
WRD-41	-76.87198975	38.94460499	13D06	Lanham
WRD-42	-76.86798955	38.95053395	13E05	Lanham
WRD-43	-76.86173008	38.92831575	13F09	Lanham
WRD-59	-76.89913426	38.92481417	12K10	Washington East
WRD-69	-76.92371504	38.91467414	12G11	Washington East
WRD-78	-76.94668835	38.92837060	12C09	Washington East
WRD-87	-76.93863996	38.92669164	12D09	Washington East
WRD-07	-76.90988825	39.03910538	07J02	Beltsville
WRD-09	-76.88798437	39.05658157	04B11	Beltsville
WRD-10	-76.91263096	39.06465302	03H10	Beltsville
WRD-11	-76.90905526	39.05773186	03J11	Beltsville
WRD-12	-76.88828802	39.07260810	04B08	Beltsville
WRD-20	-76.90259400	39.04705837	03K13	Beltsville
WRD-25	-76.89967719	39.04289550	07K01	Beltsville
WRD-32	-76.91033096	39.00754591	07J07	Beltsville
WRD-46	-76.89292819	38.88830388	19A03	Washington East
WRD-47	-76.89876845	38.90269582	18K01	Washington East
WRD-49	-76.89264534	38.90844269	13A13	Washington East
WRD-60	-76.88327667	38.92175970	13C10	Washington East
WRD-70	-76.91475954	38.91447645	12H11	Washington East
WRD-79	-76.95117656	38.93318133	12B08	Washington East
WRD-88	-76.93933074	38.93473107	12D08	Washington East

Figure 1.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Station Locations and Subwatersheds

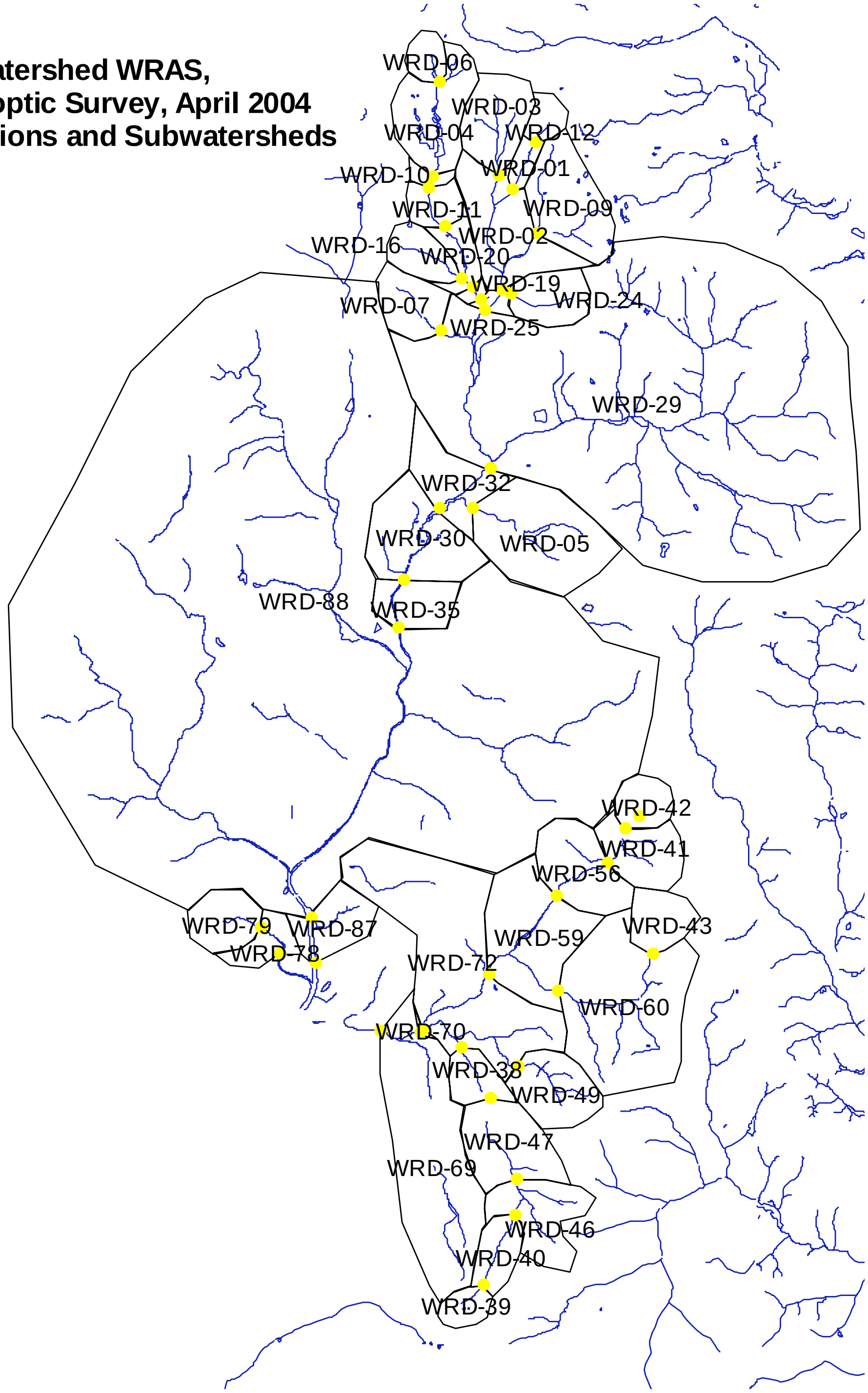


Table 3. Anacostia River Watershed WRAS Nutrient Synoptic April, 2004 Nutrient Concentrations and Yields

SITE	DATE	TIME	AREA Hectares	DISCHARGE L/sec	PO4 conc. (mg/L)	NO2+NO3 conc. (mg/L)	PO4 yield Kg/h/day	NO2+NO3 yield Kg/h/day
WRD-01	04/08/04	935	101	1	0.001	0.110	0.000001	0.000066
WRD-02	04/08/04	1310	923	14	0.004	0.310	0.000005	0.000412
WRD-03	04/08/04	945	210	23	0.001	0.440	0.000009	0.004158
WRD-04	04/09/04	920	334	25	0.001	0.130	0.000007	0.000856
WRD-05	04/09/04	1120	448	37	0.001	0.850	0.000007	0.006123
WRD-06	04/09/04	845	66	3	0.001	0.490	0.000004	0.001941
WRD-07	04/08/04	1455	152	14	0.001	0.910	0.000008	0.007464
WRD-09	04/08/04	1215	290	29	0.001	3.020	0.000009	0.025820
WRD-10	04/09/04	900	359	31	0.002	0.630	0.000015	0.004685
WRD-11	04/08/04	1015	445	0	0.001	0.290	0.000000	0.000001
WRD-12	04/08/04	900	59	43	0.001	0.280	0.000063	0.017779
WRD-16	04/08/04	1120	114	8	0.006	0.060	0.000037	0.000372
WRD-19	04/08/04	1345	660	61	0.001	0.360	0.000008	0.002868
WRD-20	04/08/04	1105	644	13	0.003	2.720	0.000005	0.004805
WRD-24	04/08/04	1245	148	19	0.001	0.470	0.000011	0.005126
WRD-25	04/09/04	1015	1757	105	0.001	0.810	0.000005	0.004168
WRD-29	04/09/04	1045	6110	486	0.001	1.080	0.000007	0.007424
WRD-30	04/09/04	1150	7089	584	0.001	0.110	0.000007	0.000783
WRD-32	04/15/04	1330	6763	1349	0.004	0.910	0.000069	0.015681
WRD-35	04/09/04	1215	7232	571	0.001	1.000	0.000007	0.006817
WRD-38	04/09/04	1400	766	55	0.001	0.100	0.000006	0.000620
WRD-39	04/07/04	1050	66	4	0.001	0.610	0.000006	0.003529
WRD-40	04/07/04	940	177	24	0.002	0.180	0.000023	0.002089
WRD-41	04/07/04	1300	286	22	0.003	0.840	0.000020	0.005561
WRD-43	04/15/04	1200	131	15	0.002	1.930	0.000019	0.018750
WRD-46	04/07/04	955	402	42	0.001	0.140	0.000009	0.001268
WRD-47	04/09/04	1430	665	1	0.001	0.400	0.000000	0.000041
WRD-49	04/07/04	1140	209	6	0.001	0.500	0.000003	0.001266
WRD-56	04/07/04	1230	530	13	0.001	0.910	0.000002	0.001925
WRD-59	04/07/04	1545	1764	98	0.002	0.650	0.000010	0.003107
WRD-60	04/07/04	1200	825	54	0.001	0.720	0.000006	0.004080
WRD-69	04/15/04	1230	2595	390	0.004	0.790	0.000052	0.010262
WRD-70	04/09/04	1315	2744	192	0.001	0.380	0.000006	0.002300
WRD-72	04/09/04	1330	2739	65	0.001	0.270	0.000002	0.000556
WRD-78	04/07/04	1440	237	13	0.001	0.900	0.000005	0.004225
WRD-79	04/07/04	1420	146	9	0.001	1.380	0.000005	0.007362
WRD-88	04/07/04	1500	17069		0.002	1.180		

Figure 2.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Nitrate/nitrite (NO2+NO3)
Concentration (mg/L)

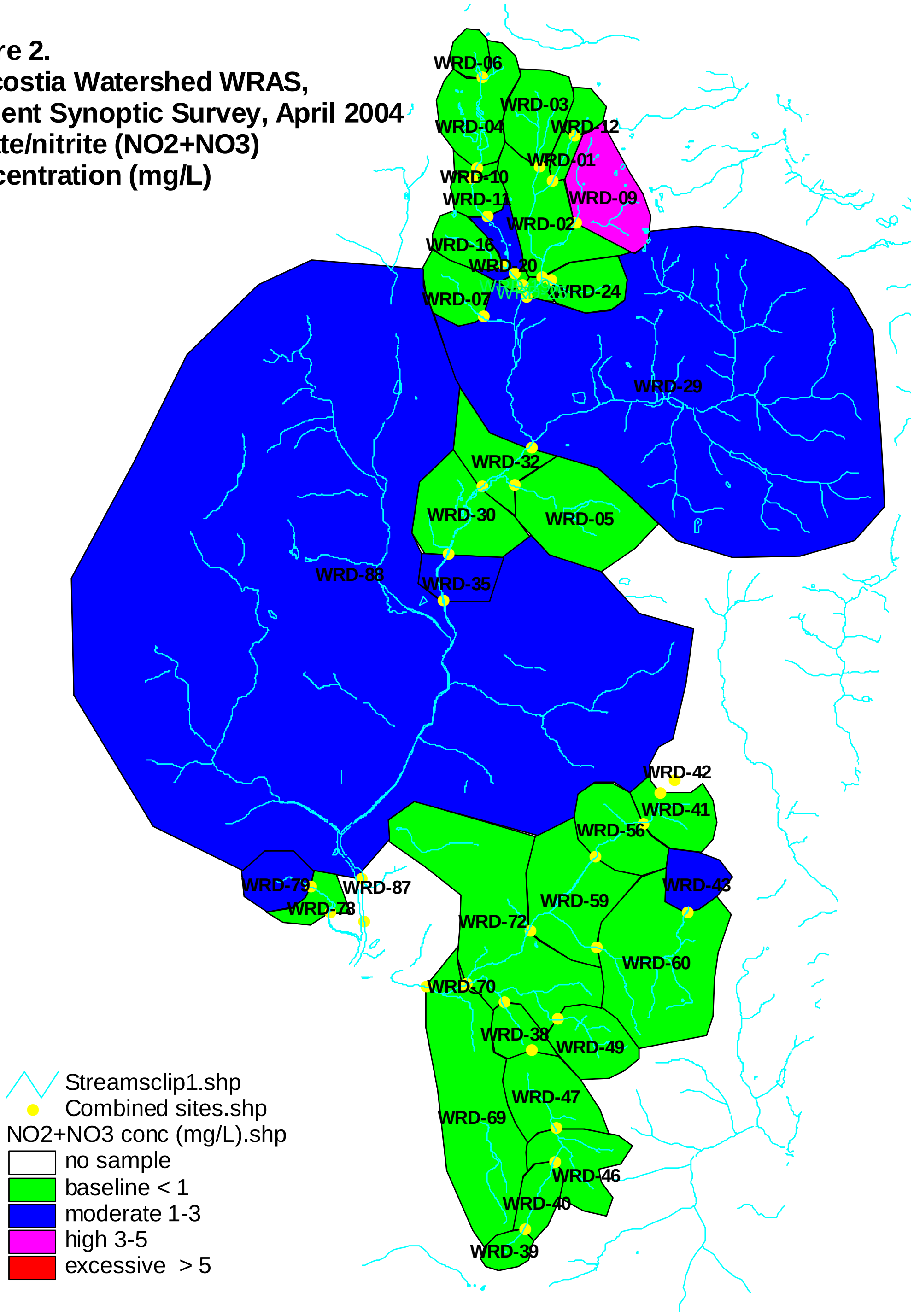


Figure 3.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Nitrate/nitrite (NO2+NO3)
Yield (Kg/H/d)

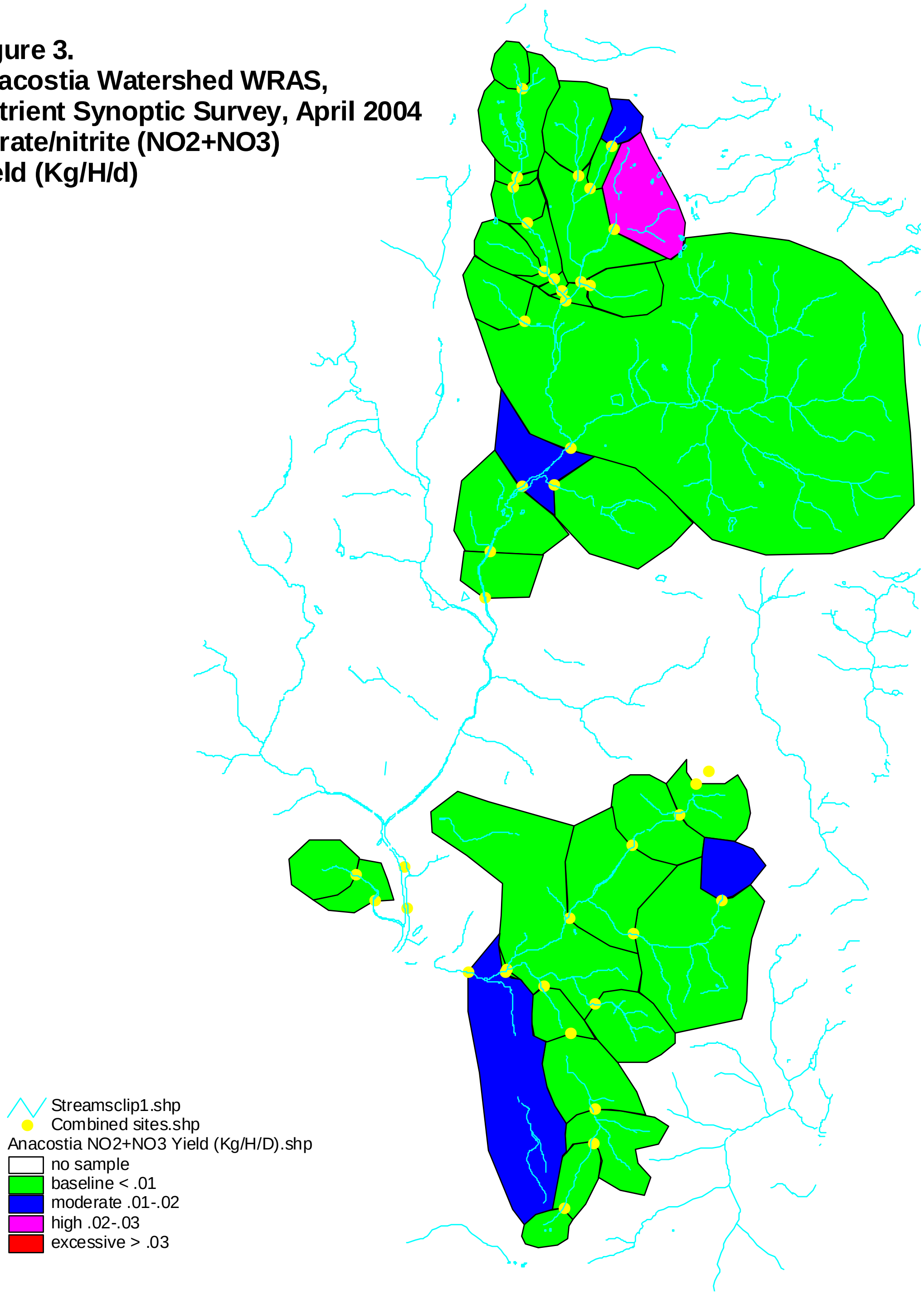


Figure 4.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Orthophosphate (PO4)
Concentration (mg/L)

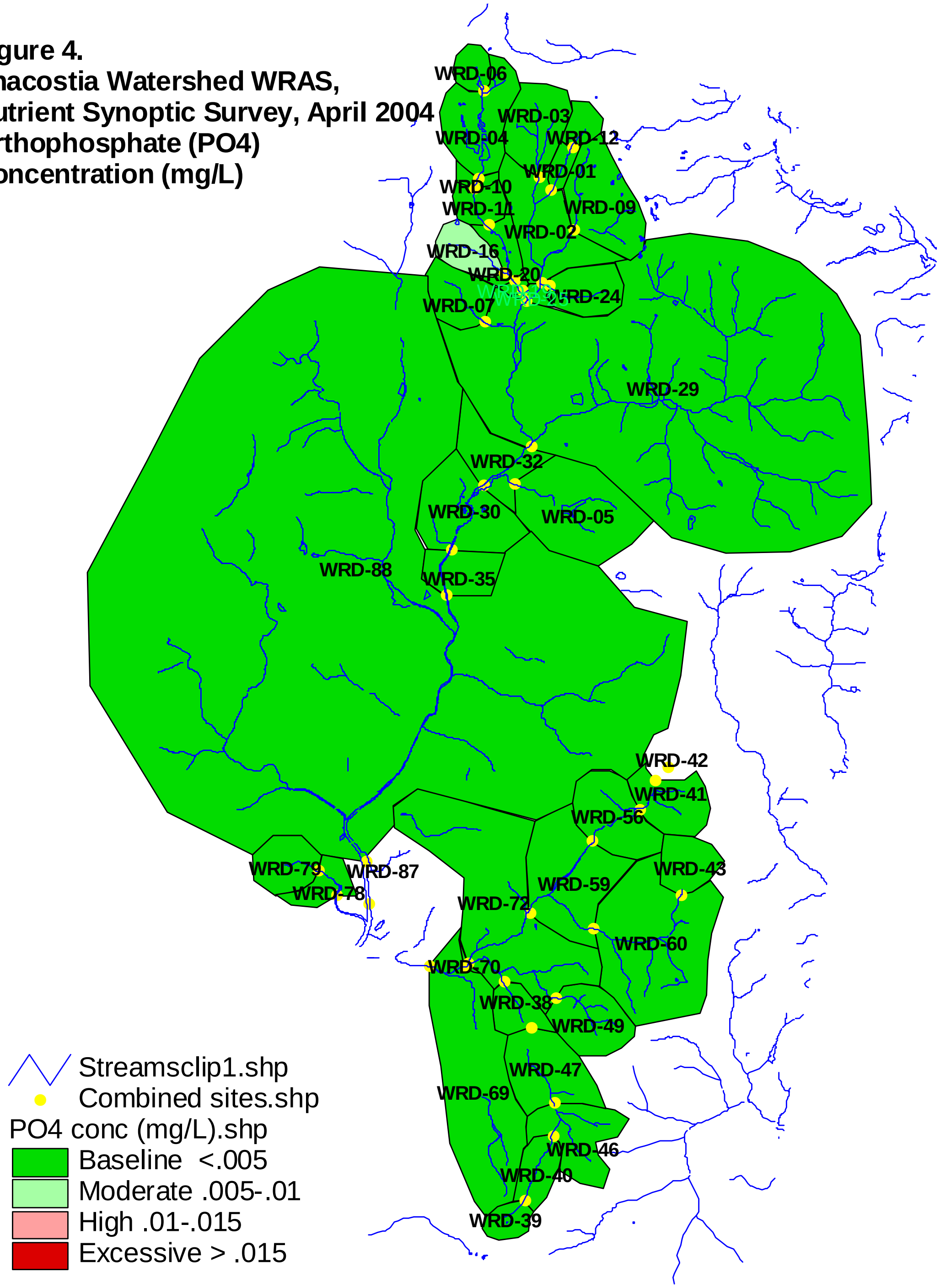


Figure 5.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Orthophosphate (PO4)
Yield Kg/Hect/day

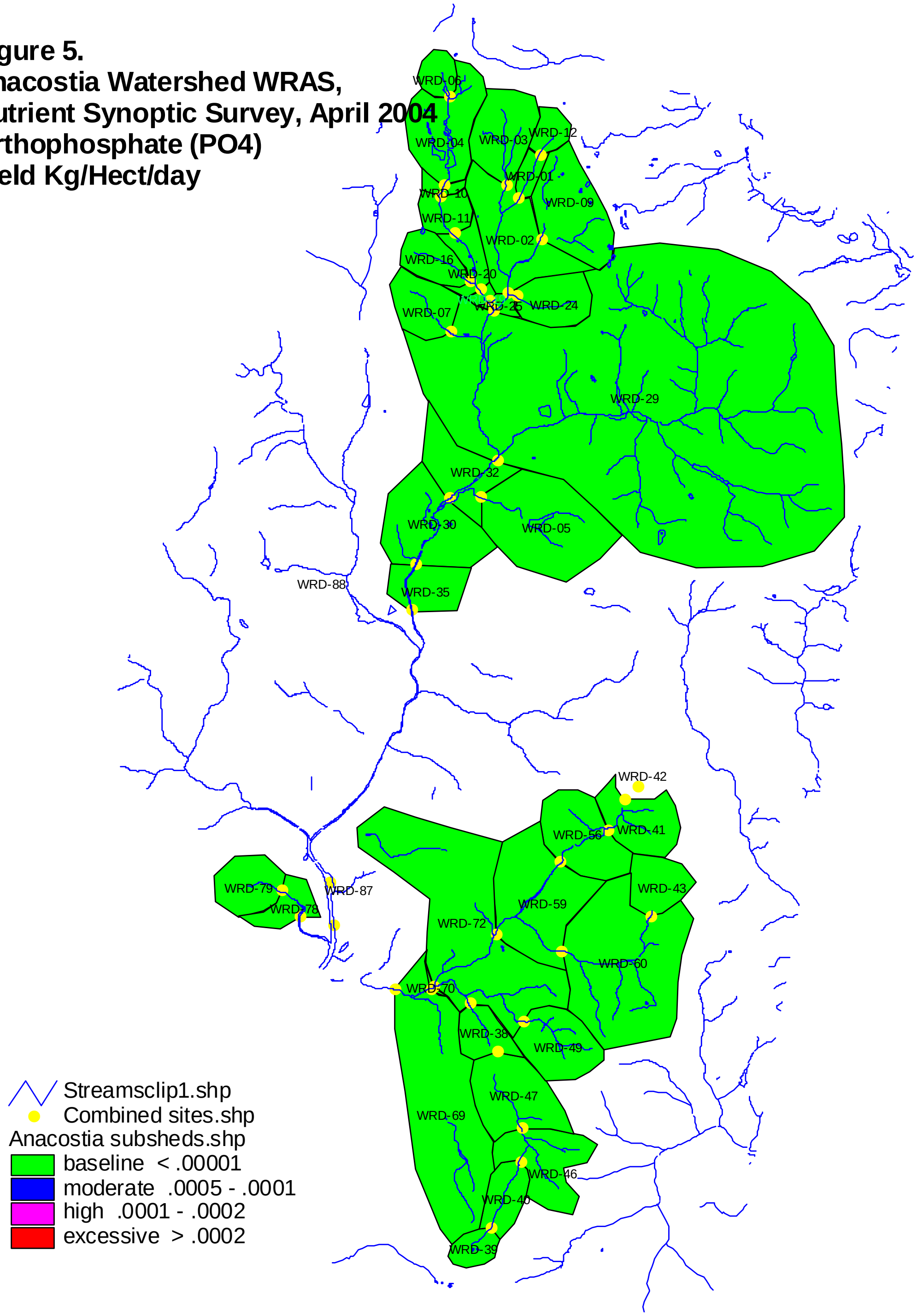
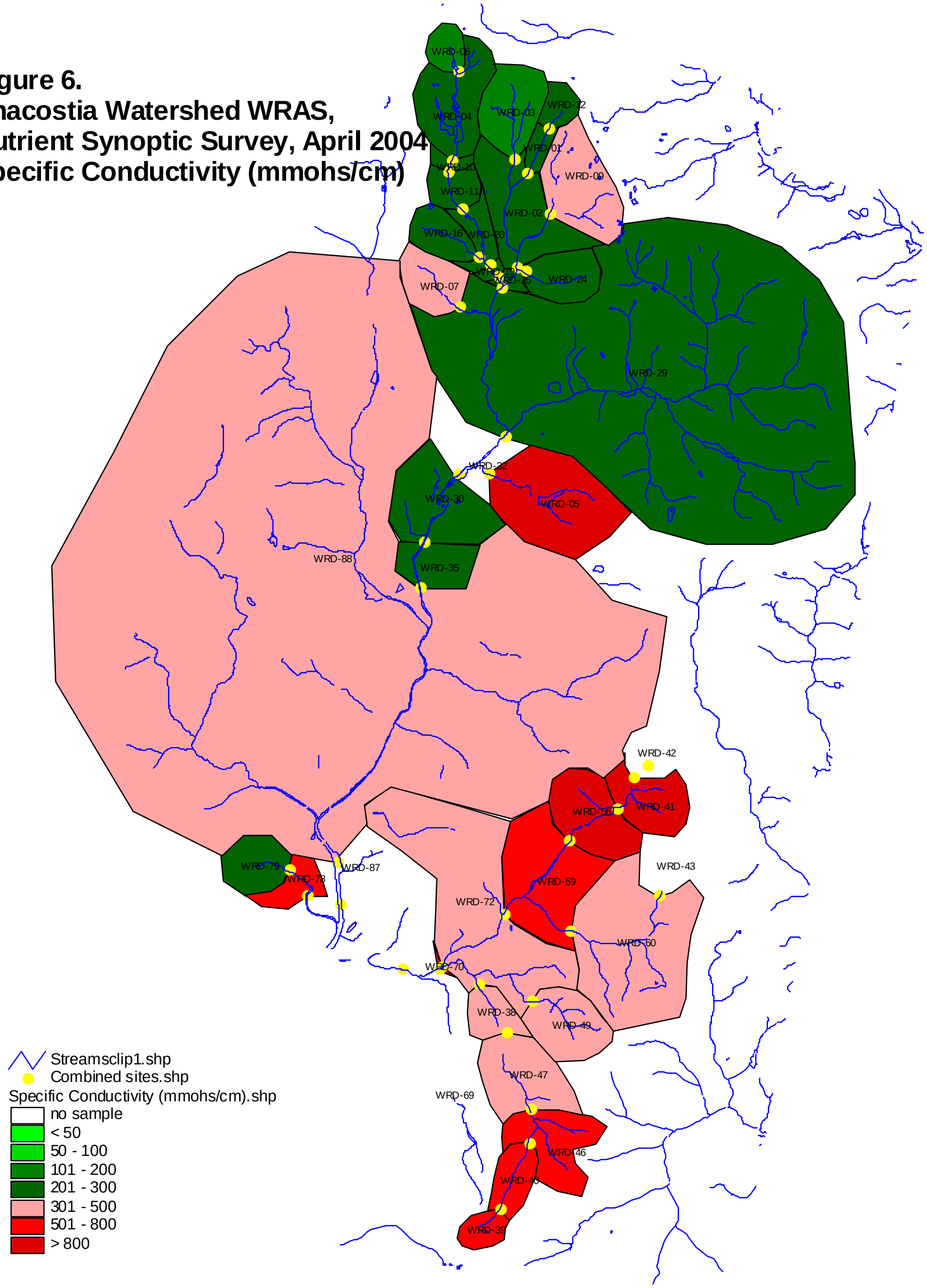


Table 4. Anacostia River Watershed WRAS April, 2004 Insitu Water Quality Parameters

Site	Date	Time	Temp ©	pH	Conductivity (mmohs/cm)	D.O. (mg/L)
WRD 01	8-Apr-04	925	8.75	6.56	207	3.71
WRD 02	8-Apr-04	1310	9.6	6.96	234	5.41
WRD 03	8-Apr-04	950	9.77	6.56	189	3.93
WRD 04	9-Apr-04	920	10.06	6.86	299	8.02
WRD 05	9-Apr-04	1120	11.22	7.07	897	9.48
WRD 06	9-Apr-04	845	9.68	6.82	168	9.15
WRD 07	8-Apr-04	1455	10.03	6.57	334	4.95
WRD 09	8-Apr-04	1215	9.58	6.75	373	4.86
WRD 10	9-Apr-04	900	10.05	6.9	274	9.66
WRD 11	8-Apr-04	1015	9.09	6.86	272	4.42
WRD 12	8-Apr-04	900	8.25	6.18	211	3.78
WRD 16	8-Apr-04	1120	9.39	6.81	275	4.4
WRD 19	8-Apr-04	1345	10.21	6.96	243	5.17
WRD 20	8-Apr-04	1105	9.12	6.91	258	4.7
WRD 24	8-Apr-04	1245	11.58	6.98	265	4.48
WRD 25	9-Apr-04	1015	10.28	6.97	270	10.12
WRD 29	9-Apr-04	1045	10.03	6.8	212	10.24
WRD 30	9-Apr-04	1150	11.27	7.03	275	11.04
WRD 32	15-Apr-04	1345				
WRD 35	9-Apr-04	1215	13.04	7.3	277	10.82
WRD 38	9-Apr-04	1400	14.27	8.49	493	11.98
WRD 39	7-Apr-04	1030	12.1	7.37	679	9.1
WRD 40	7-Apr-04	940	8.68	7.75	523	11.31
WRD 41	7-Apr-04	1300	12.44	6.93	912	8.3
WRD 43	15-Apr-04	1200				
WRD 46	7-Apr-04	955	8.98	8.01	501	12.15
WRD 47	9-Apr-04	1430	13.98	7.11	460	9.64
WRD 49	7-Apr-04	1150	10.2	7.46	327	11
WRD 56	7-Apr-04	1230	11.35	7.29	844	9.31
WRD 59	7-Apr-04	1545	16.1	8.11	545	11.7
WRD 60	7-Apr-04	1200	11.27	7.19	447	10.81
WRD 69	15-Apr-04	1245				
WRD 70	9-Apr-04	1315	13.65	8.09	533	11.43
WRD 72	9-Apr-04	1330	13.27	8.51	477	13.35
WRD 78	7-Apr-04	1440	17.91	7.38	666	11.6
WRD 79	7-Apr-04	1420	16.41	8.43	239	12.54
WRD 88	7-Apr-04	1515	13.85	7.87	316	11.32

Figure 6.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Specific Conductivity (mmohs/cm)



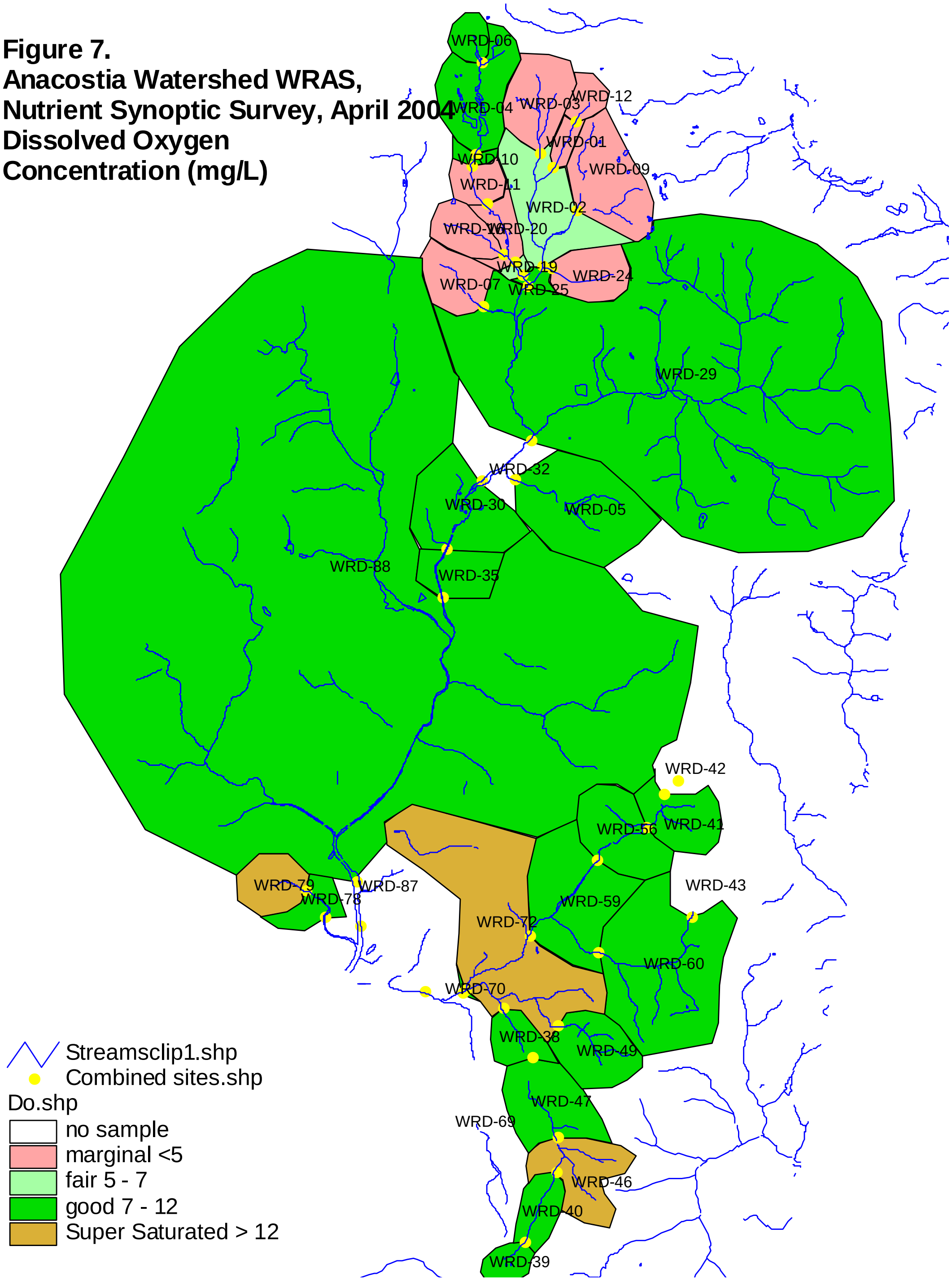
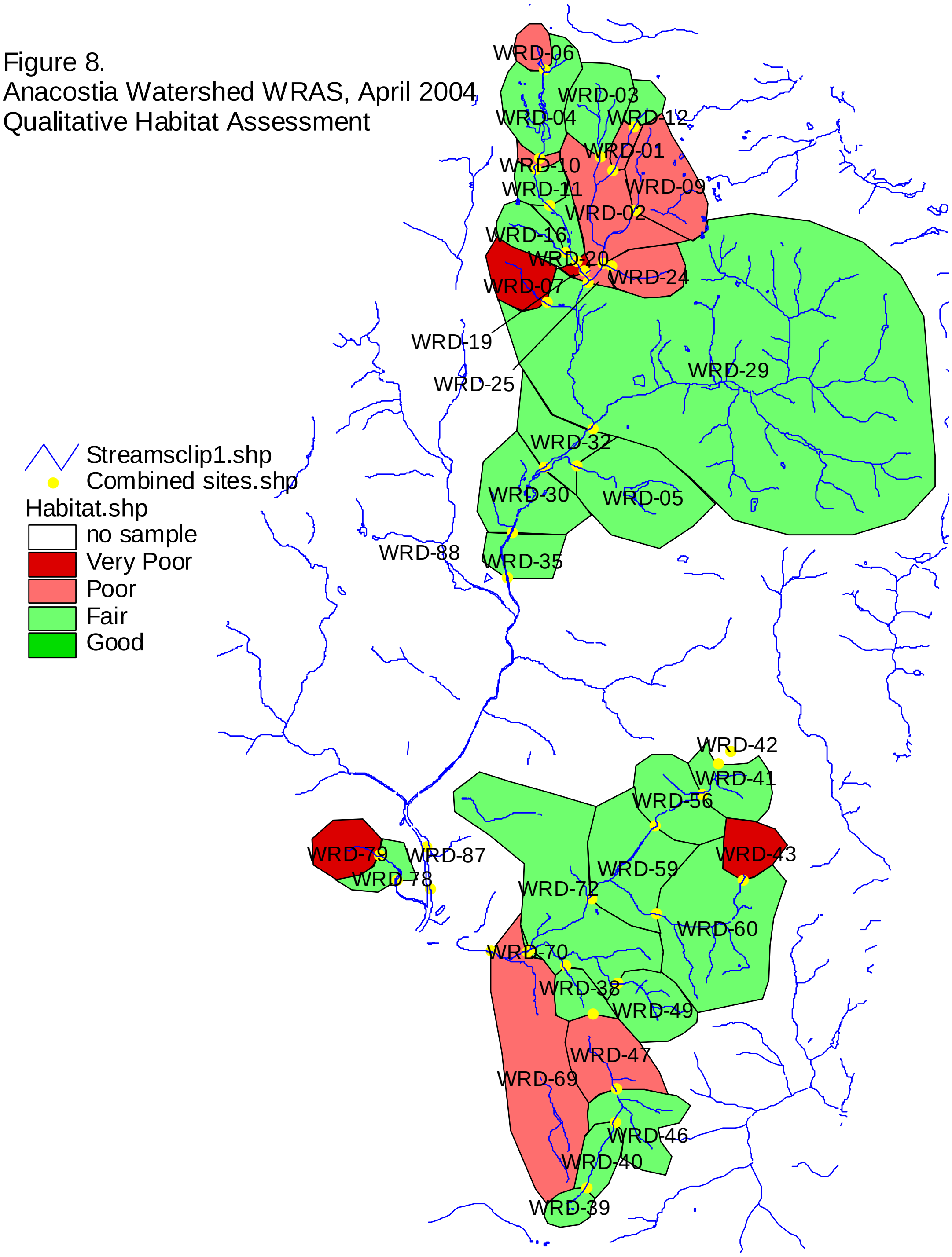


Figure 7.
Anacostia Watershed WRAS,
Nutrient Synoptic Survey, April 2004
Dissolved Oxygen
Concentration (mg/L)

Figure 8.
Anacostia Watershed WRAS, April 2004
Qualitative Habitat Assessment



Discussion

Nutrients concentrations in watersheds dominated by urban and suburban land use are generally relatively low as illustrated in the nutrient synoptic averages from around the state shown in Table 5. Exceptions to this rule are streams that are receiving waters for permitted discharges that have high nutrient limits. This latter exception may be the cause for the elevated nitrate/nitrite concentrations within subwatershed WRD 09. The one high nitrate/nitrite yield was also found in WRD 09 due to possible enhancement of flow from the discharge.

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

Mg/L	Anacostia	German Br.	Pocomoke	Upper Patapsco	Western Branch	Upper Patuxent	Upper Monocacy	Liberty
NO2+NO3 Spring	**.726**	3.832	3.734	1.25	0.214	0.439	1.731	3.410
NO2+NO3 Annual		4.704	2.384					
PO4 Spring	**0.0016**	0.043	0.028	0.004	0.005	0.012	0.019	0.004
PO4 Annual		0.067	0.022					

As noted previously, orthophosphate generally travels bound to sediment. The lack of significant sediment sources in urban areas during low flow would account for the absence of elevated orthophosphorus concentrations and yields within the watershed.

While no significant anomalies where noted for pH, there were a number of sites with values greater than 8. These subwatersheds also exhibited high dissolved oxygen indicating heavy algal production. Water temperature during April is generally not a problem. This may not be the case later in the summer in streams that run through concrete channels. The significantly elevated specific conductivity in many of the subwatersheds appears to be the result of road salts moving into the surface aquifer. All of these subwatersheds have heavy road networks. There did appear to be some correlation between low and super saturated dissolved oxygen and poor habitat scores as shown in Table 6.

Conclusion

Nutrients do not appear to be a significant problem in the Anacostia watershed at this time. Road salt does appear to be causing a water quality impact in a major portion of the Anacostia watershed. Salt spills in or near streams have been implicated in fish kills, but little data is available on the significance of impacts to freshwater stream biota from groundwater contaminated with chronic low level salt concentrations. Impacts to roadside vegetation from excessive salt are well documented. The low dissolved oxygen concentrations, less than 5 mg/L, may be problematic as these are a violation of state water quality standards. The association of low oxygen and poor habitat may indicate that some type of stream/habitat restoration in the effected subwatersheds could address the problem.

Table 6. Anacostia Watershed Qualitative Habitat and Dissolved Oxygen.

Parameter Station	Instream Cover	Epifaunal Substrate	Pool Substrate	Pool Variability	Channel Alteration	Sediment Deposition	Channel Sinuosity	Flow Status	Bank Condition	Bank Protection	Disruptive Pressure	Riparian Buffer	Total	Dissolved Oxygen (mg/L)
WRD 43	2	2	0	0	0	1	1	12	12	0	0	2	32	
WRD 07	2	0	0	0	0	0	2	18	19	0	0	0	41	4.95
WRD 19	0	0	0	0	0	0	5	18	20	0	0	0	43	5.17
WRD 79	0	0	0	0	0	20	0	6	19	0	0	1	46	12.54
WRD 01	4	4	4	11	19	5	12	6	2	2	2	2	73	3.71
WRD 47	8	8	7	7	6	6	6	6	4	4	8	6	76	9.64
WRD 09	9	7	3	11	5	6	6	9	6	6	10	8	86	4.86
WRD 25	7	7	5	3	4	10	6	13	12	8	12	13	100	10.12
WRD 69	8	10	5	12	11	10	6	10	7	6	10	6	101	
WRD 24	10	11	8	11	7	10	6	9	7	7	15	5	106	4.48
WRD 02	12	11	13	11	3	14	3	14	14	13	6	2	116	5.41
WRD 06	3	6	6	2	20	4	9	10	3	13	20	20	116	9.15
WRD 10	14	15	9	11	8	12	14	12	3	3	14	3	118	9.66
WRD 12	6	3	3	11	19	10	18	2	7	6	17	19	121	3.78
WRD 46	6	16	5	11	18	8	5	7	12	11	9	14	122	12.15
WRD 03	11	16	11	12	17	14	10	11	6	5	8	3	124	3.93
WRD 78	5	1	5	11	11	15	2	19	14	16	15	10	124	11.6
WRD 39	4	11	2	1	16	13	6	12	18	15	13	16	127	9.1
WRD 05	11	10	9	12	12	7	8	16	10	9	15	10	129	9.48
WRD 11	9	8	10	8	19	8	8	12	6	7	16	19	130	4.42
WRD 60	15	14	14	15	9	15	2	15	8	11	6	6	130	10.81
WRD 38	13	11	12	8	14	10	10	10	6	7	13	16	130	11.98
WRD 56	11	0	3	11	11	19	1	19	15	16	18	8	132	9.31
WRD 59	9	10	8	15	11	14	6	15	12	10	13	9	132	11.7
WRD 30	15	13	11	13	6	11	3	12	13	13	12	11	133	11.04
WRD 40	13	12	11	14	16	12	13	11	10	14	6	4	136	11.31
WRD 49	18	8	6	15	15	15	10	18	9	6	9	9	138	11
WRD 35	15	15	12	13	6	11	6	14	12	13	12	10	139	10.82
WRD 72	10	13	10	13	13	10	9	14	13	12	13	11	141	13.35
WRD 41	16	4	9	15	13	17	1	15	14	19	15	6	144	8.3
WRD 32	13	14	7	11	17	12	8	9	13	5	17	18	144	
WRD 04	12	13	8	11	18	9	17	12	7	5	16	19	147	8.02
WRD 16	11	12	16	12	17	14	8	15	11	6	13	18	153	4.4
WRD 70	15	13	15	14	17	13	10	8	8	11	14	16	154	11.43
WRD 20	12	16	14	11	18	7	11	13	7	8	19	20	156	4.7
WRD 29	15	12	15	15	14	14	13	14	11	14	15	18	170	10.24

Literature Cited

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