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2003 Bush River Shallow Water Monitoring Data Report

September 21, 2004

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2003 Bush River Shallow Water Monitoring Data Report

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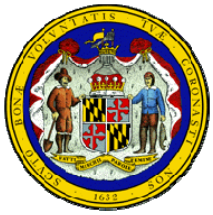

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Introduction

The Maryland Department of Natural Resources (DNR) was contracted by Harford County, Maryland to conduct temporally and spatially intensive water quality monitoring for the Bush River in 2003. Maryland DNR deployed and maintained 24 continuous monitoring sites in the Chesapeake and Coastal Bays in 10 tributaries during 2003. The project's aim was to monitor ambient water quality parameters (water temperature, salinity, pH, dissolved oxygen, chlorophyll, and turbidity) in order to characterize water quality and habitat conditions. Continuous monitoring data were collected at 15-minute intervals at sites in Lauderick Creek and Otter Point Creek, April through October. Water quality mapping cruises were conducted monthly throughout the Bush River, May through October. Nutrient and calibration data were collected weekly by DNR staff during instrument deployment. Harford County provided funding for continuous monitoring equipment, nutrient analysis and maintenance of the site located on Lauderick Creek. The site at Otter Point Creek was funded through a cooperative agreement with NOAA's National Estuarine Research Reserve System (NERRS) Program. Although Harford County funded the purchase of YSI real-time telemetry equipment for 2003, software and communication problems from the vendors prevented the implementation of this feature in 2003. These issues have been resolved and real-time data is available for the Lauderick Creek continuous monitoring site on Dnr's "Eyes on the Bay" web site. Data are uploaded on an hourly basis for the full suite of physical parameters. See Figure 1 for continuous monitoring site locations and a sample of a water quality mapping cruise track. For a timeline of continuous monitoring site visits, water quality mapping cruises, harmful algal bloom samples and other timely information, see Table 1.

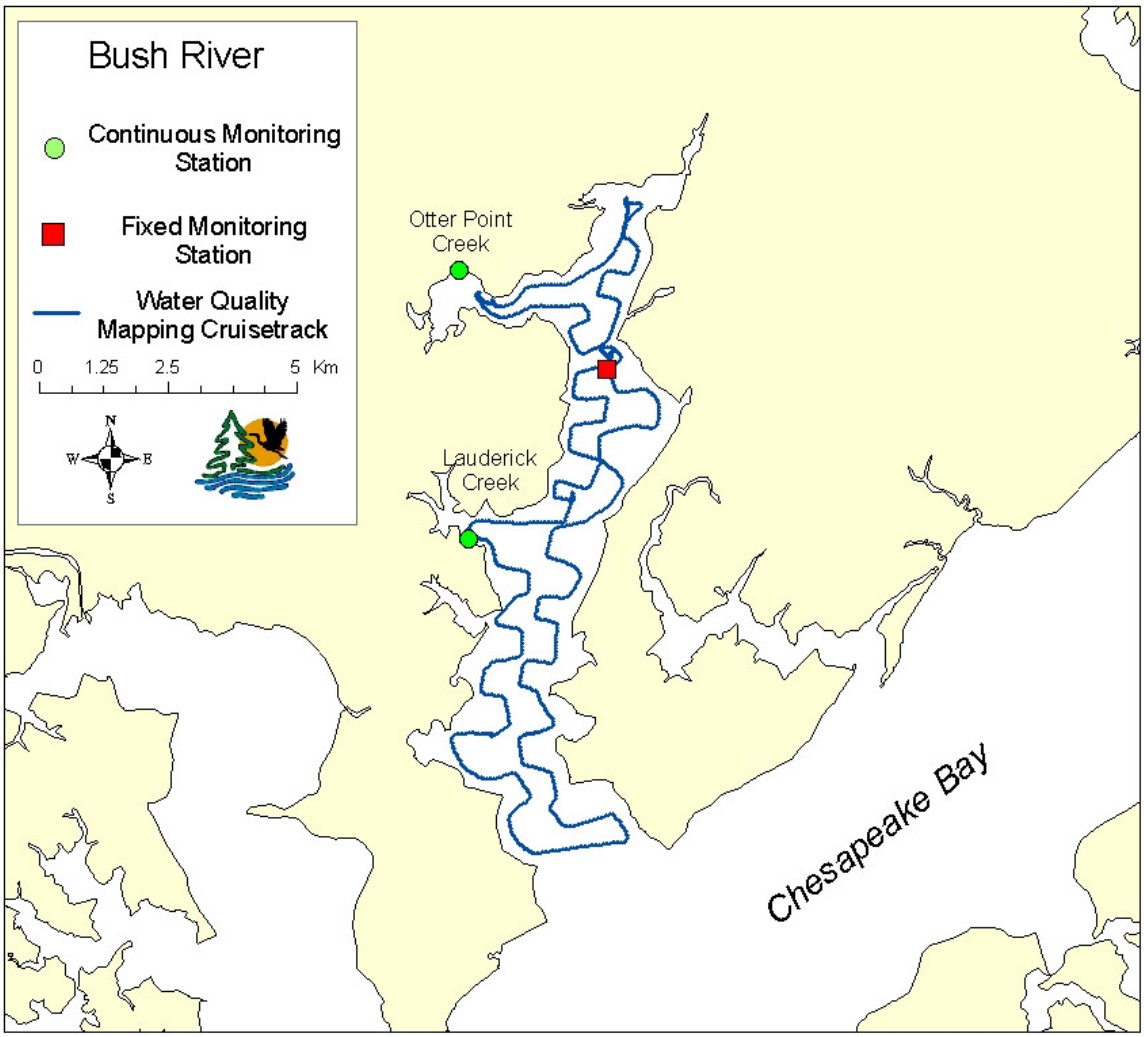

Figure 1. Site map and a sample water quality mapping cruisetrack for the Bush River monitoring project.

Dates	Lauderick Cr	Otter Pt. Cre	DataFlow Cr	Harmful Algal Sample	Other events and details
4/15/2003		X			
4/23/2003		X			
4/30/2003		X			
5/8/2003		X			
5/14/2003		X			
5/21/2003		X			
5/28/2003			X		
5/29/2003	X	X			
6/4/2003	X	X			
6/11/2003	X	X			
6/18/2003	X	X			
6/25/2003	X	X	X		
7/2/2003	X	X			
7/9/2003	X	X			
7/16/2003	X	X			
7/22/2003			X		
7/23/2003	X	X		X	Microcystis aeruginosa: 1.6 million (cells/ml) Anabaena sp. : 264,000 (cell/ml)
7/28/2003				X	Microcystis aeruginosa: 31.3 µg toxin/L (throughout the River)
7/30/2003	X	X			
8/6/2003	X	X			
8/13/2003	X	X		X	Microcystis: 24 µg toxin/L (upper reaches of the River)
8/20/2003	X	X			
8/26/2003			X		
8/27/2003	X	X			
9/2/2003		X			11:00 AM Continuous Monitoring ceased while deployment pier at Otter Creek Point was removed and rebuilt.
9/4/2003	X				
9/9/2003	X				
9/16/2003	X				
9/18/2003					Hurricane Isabel Landfall
9/22/2003					September 22-23, 2.4 inches of rain in 24 hrs
9/29/2003			X		
10/1/2003	X				
10/7/2003	X				
10/14/2003	X	X			9:00 AM Continuous monitoring resumes after completion of pier reconstruction.
10/20/2003			X		
10/21/2003	X	X			
10/26/2003					Oct 26-27, 3.19 inches of rain in 24 hrs
10/29/2003	X	X			

Table 1. Dates of 2003 water sample collection, DATAFLOW cruises, algal sample collection and other events and details.

2003 was one of the wettest years on record for Maryland and can be observed through precipitation records at BWI Airport (Table 2). This wet year was all the more unusual as it was preceded by an exceptional drought year in 2002. Comparison of water inflow for 2002 and 2003 to average flows highlights these disparities (Figure 2). In the Bush River, 2002 and 2003 water discharge records from the USGS Otter Point Creek Gauging station further illustrate the difference between these years (Figure 3). Further compounding 2003 high flows was a tidal surge and over three inches of rainfall from Hurricane Isabel on September 18, 2003 and a subsequent rain event several days later.

Station: Baltimore BWI		Total Rainfall For Month (inches):	Departure from Normal (inches)	Greatest in a 24Hr Period (inches)	ON Day(s) of Month
January	2003	2.59	-0.88	1.68	1-1
February	2003	6.7	3.68	2.55	21-22
March	2003	4.17	0.24	1.83	20-20
April	2003	2.4	-0.6	0.79	25-26
May	2003	6.81	2.92	1.96	16-16
June	2003	6.95	3.53	1.63	7-7
July	2003	5.56	1.71	1.84	2-3
August	2003	4.61	0.87	0.96	3-4
September	2003	7.47	3.49	2.4	22-23
October	2003	5.82	2.66	3.19	26-27
November	2003	4.86	1.74	1.5	19-19
December	2003	4.71	1.36	1.33	10-11

Table 2. Baltimore Washington International Airport Precipitation 2003.

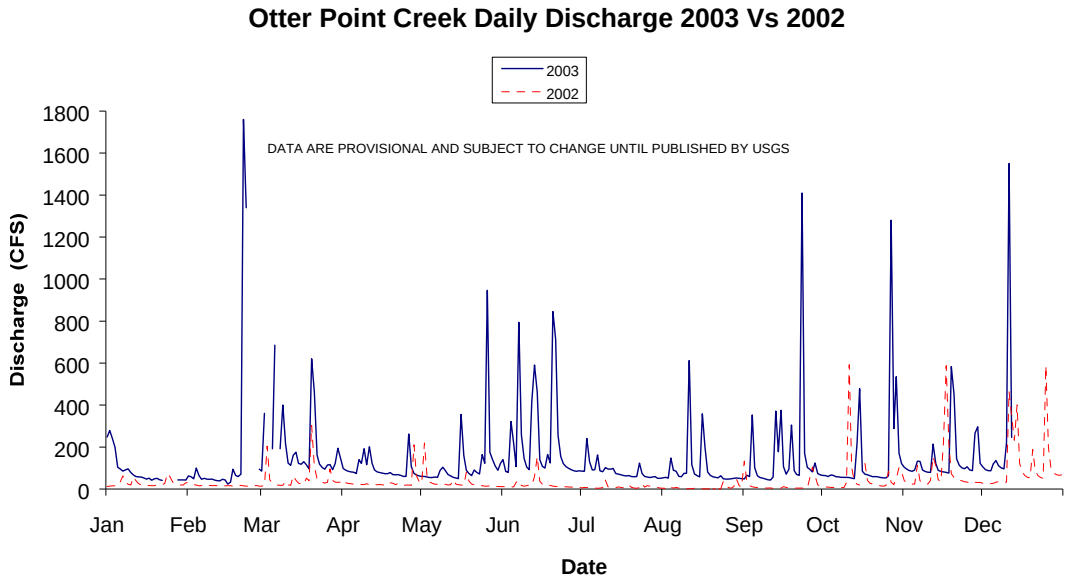

Figure 2. Comparison of Daily Discharge 2002 and 2003. USGS Gage 01581757 at Otter Point Creek Near Edgewood, Md. (Provisional data subject to revision).

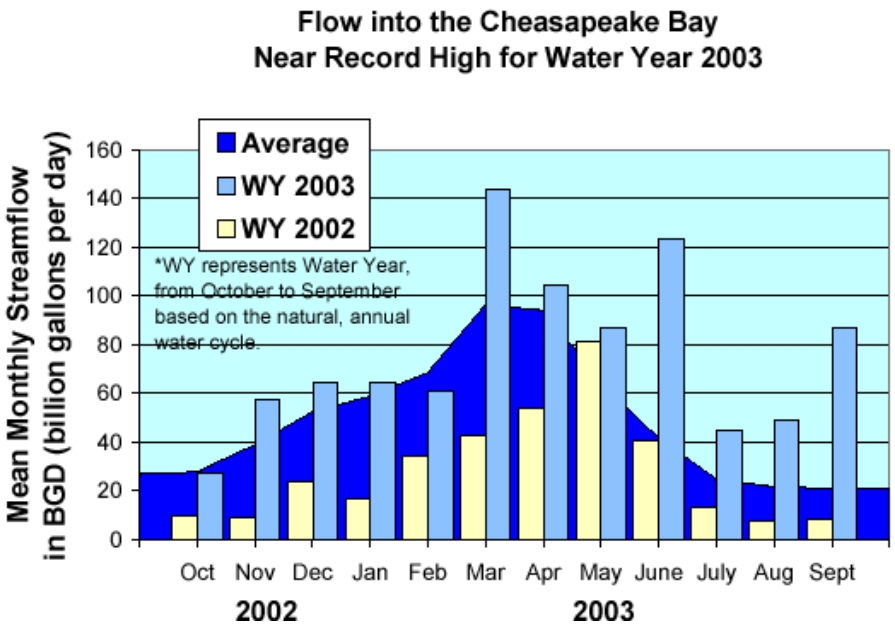

Figure 3. Mean Monthly Streamflow into Chesapeake Bay with monthly flow for water-years 2002 and 2003. (Data courtesy of Unites States Geological Survey).

Continuous Monitoring

In 2003, the Lauderick Creek continuous monitoring site was deployed from May 29, 2003 to November 12, 2003 at one-meter below the water's surface and the Otter Point Creek site was deployed April 15, 2003 to December 23, 2003 at 0.3 meters from the bottom. Otter Point Creek equipment was temporarily removed from service on September 2, 2003 to allow for pier reconstruction and was redeployed on October 14, 2003. Charts of annual continuous monitoring data illustrate many interesting observations. Figure 4 shows some ephemeral effects of Hurricane Isabel (September 18, 2003) at Lauderick Creek. Immediately following the hurricane, short-term rises in turbidity were observed, followed by brief chlorophyll blooms and resultant dissolved oxygen sags. Increases in salinity of roughly one part per thousand were observed as a result of Isabel's tidal surge (Figure 5). Other continuous monitoring stations in Maryland tributaries experienced salinity increases of over 6 parts per thousand from the tidal surge. Following the hurricane, nitrate values appear to rise from previous lower summer levels (Table 4). Overall, turbidity values were at their low during the end of July and beginning of August in relation to periods of lower flow which can be observed in higher salinity levels (Figure 5) and USGS flow data at Otter Point Creek (Figure 3). For Lauderick Creek dissolved oxygen data, 3.92% of the 152,551 measurements fell below 5 mg/l, the level at which many organisms begin to exhibit signs of stress.

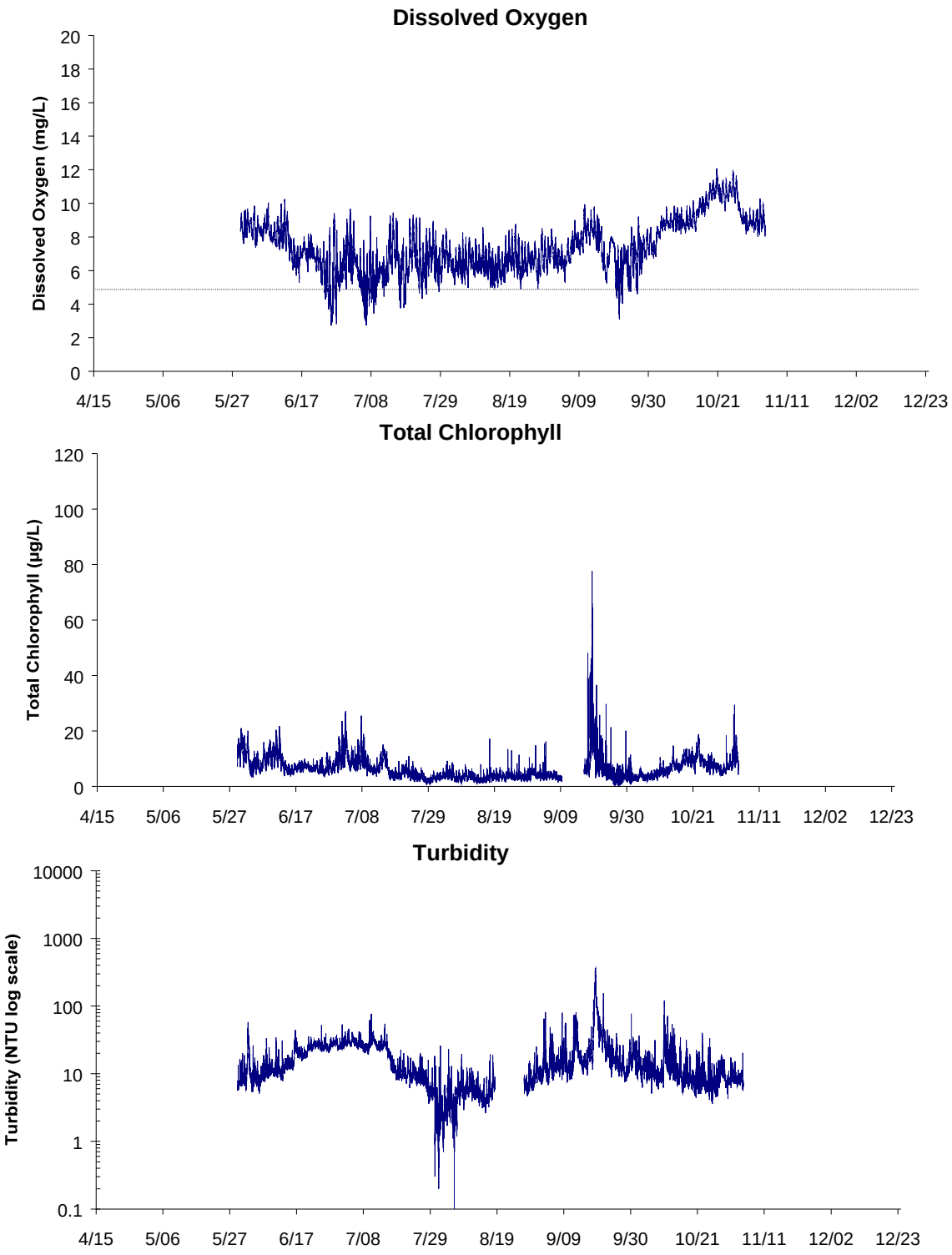

Figure 4. Lauderick Creek 2003 Dissolved Oxygen, Total Chlorophyll and Turbidity.

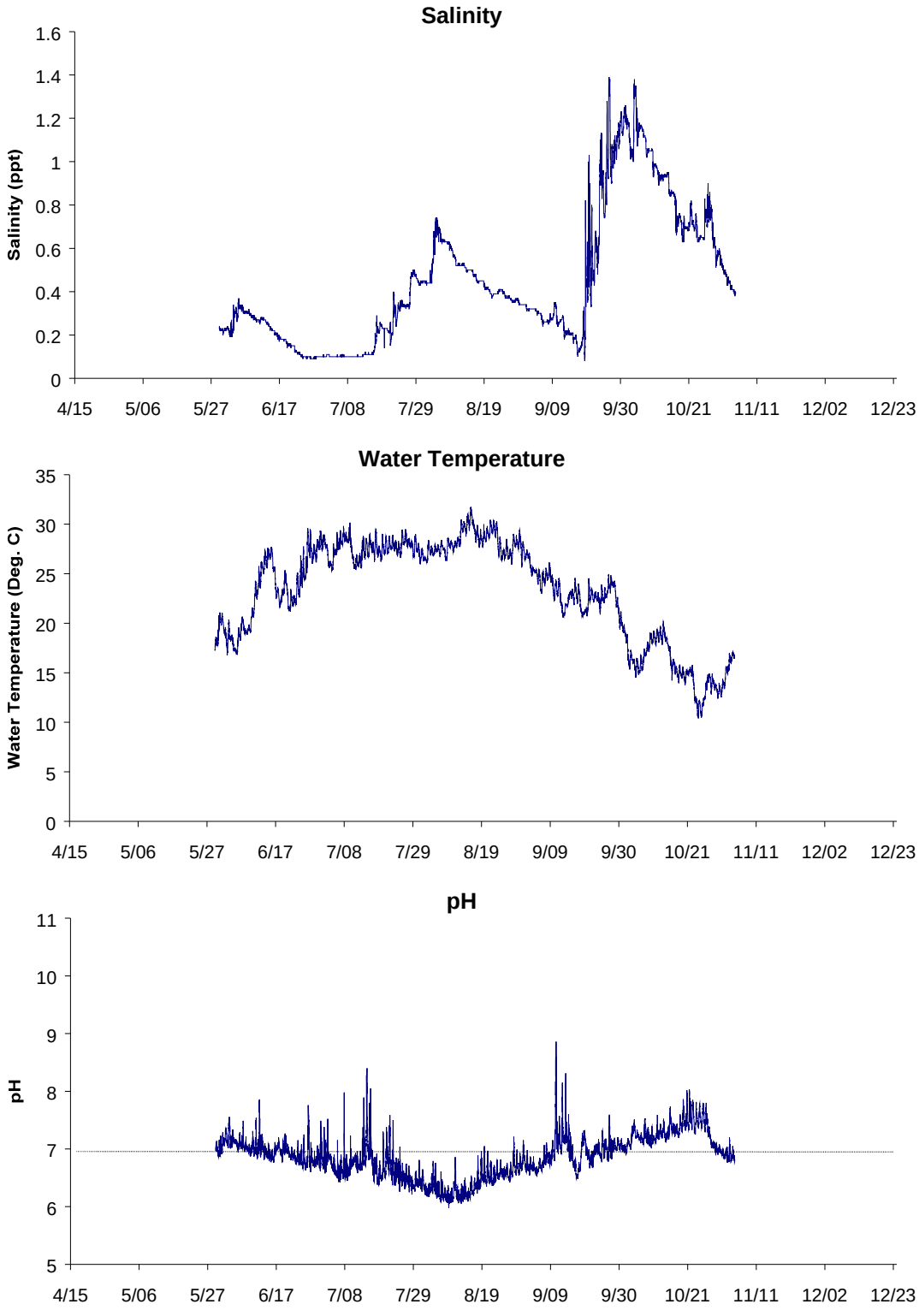

Figure 5. Lauderick Creek 2003 Salinity, Water Temperature and pH.

Due to its shallower depth, Otter Point Creek data (Figure 6) show that dissolved oxygen data exhibit greater daily fluctuations than Lauderick Creek. For the year, 2.25% of the 192,888 values were below 5 mg/l at the Otter Point Creek site. As anticipated, turbidity at the upriver site at Otter Point Creek (Figure 6) was an order of magnitude higher than the downriver Lauderick Creek (Figure 4) site. Chlorophyll levels for both creeks were lower than anticipated, mainly due to high turbidities that reduced light availability for algal growth. Unfortunately, the fluorometer on the YSI 6600 continuous monitors is unable to detect blue-green (Microcystis) algal concentrations which frequently occur in the Bush River. YSI, Inc. is currently working on the development of a fluorometry probe that better detects blue-green algae. Surrogate parameters, such as high pH values, could indicate the presence of a blue-green bloom. For instance, pH values of 9 to10 observed during July and August at Otter Point Creek (Figure 7), were concurrent with *Microcystis* blooms. Chlorophyll measurements from the weekly calibration data exceeded the SAV habitat requirements of 15 ug/l, 3.17% of 19,291 observations at Otter Point Creek and 3.36% out of 14,539 observations at Lauderick Creek.

2003 Bush River continuous monitoring data are archived on the Eyes on the Bay website at:
http://mddnr.chesapeakebay.net/newmontech/contmon/archived_results2.cfm?year=2003
and can be furthered queried to produce data charts and data tables at varying time scales. Complete results on weekly nutrient, pigment, TSS, VSS, and Secchi depths for both continuous monitoring sites are located in Tables 3-6. Limits of detection for these parameters are outlined in Table 7. Ambient water quality parameter data, collected concurrently with nutrient and pigments, are located in Tables 8 and 9.

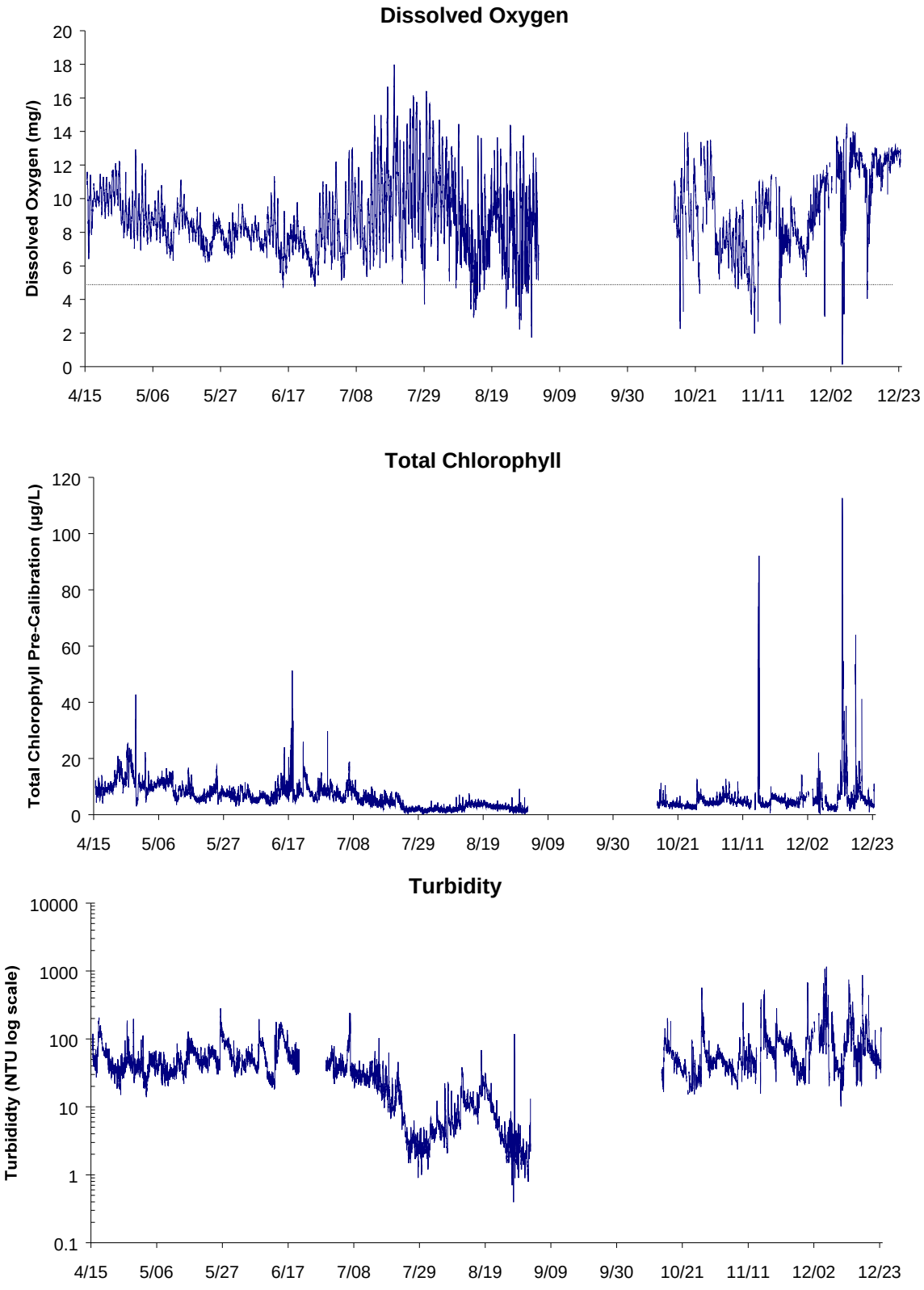

Figure 6. Otter Point Creek 2003 Dissolved Oxygen, Total Chlorophyll and Turbidity

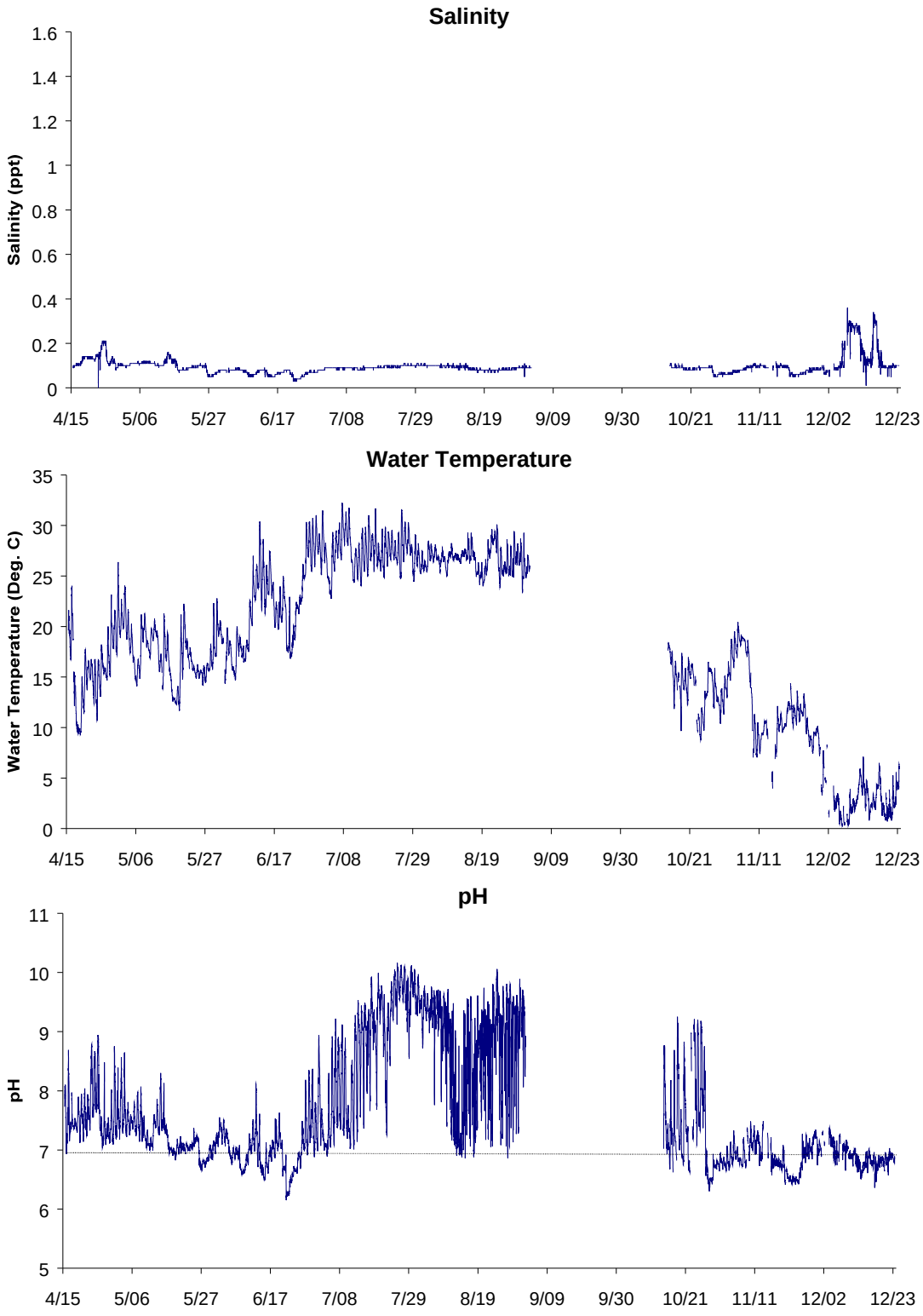

Figure 7. Otter Point Creek 2003 Salinity, Water Temperature and pH.

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
29-May-03	1.0	7.102	2.056	17.0	4.5	
05-Jun-03	1.0	6.878	1.495	6.4	2.0	0.9
11-Jun-03	1.0	11.460	1.445	9.3	4.7	0.5
19-Jun-03	1.0	6.479	2.592	13.3	4.0	0.4
25-Jun-03	1.0	13.950	3.489	14.0	5.3	0.4
02-Jul-03	1.0	23.920	5.034	17.3	4.0	0.3
09-Jul-03	1.0	6.542	16.350	65.0	11.3	0.4
16-Jul-03	1.0	5.981	7.626	13.3	6.7	0.6
23-Jul-03	0.8	4.859	3.514	6.5	2.0	0.7
30-Jul-03	1.0	4.486	1.794	20.0	7.6	1.2
06-Aug-03	1.0	4.785	2.542	5.2	2.4	0.9
13-Aug-03	1.0	11.960	2.273	5.2	4.0	0.9
20-Aug-03	0.7	6.355	1.757	4.0	5.0	0.8
27-Aug-03	0.8	5.233	1.308	8.5	3.5	0.7
04-Sep-03	1.0	4.486	2.056	4.5	3.5	1.0
09-Sep-03	1.0	5.482	1.844	6.7	5.3	0.6
16-Sep-03	1.0	9.719	2.318	21.0	8.0	0.4
01-Oct-03	1.0	4.984	1.645	13.3	6.0	0.6
07-Oct-03	0.8	4.486	0.748	10.0	4.0	0.7
14-Oct-03	1.0	7.476	1.944	16.0	4.0	0.8
21-Oct-03	1.0	7.476	1.159	8.0	3.0	1.0
29-Oct-03	1.0	4.984	1.296	6.7	2.7	0.7

Table 3. Lauderick Creek 2003 Weekly Pigment, Suspended Solids and Secchi Disk values.

Date	Depth (m)	NH_4 (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)	TDN (mg/l)	PN (mg/l)	PO_4 (mg/l)	PP (mg/l)	TDP (mg/l)	SiO_2 (mg/l)	PC (mg/l)
29-May-03	1.0	0.078	0.0092	0.5998	1.08	0.146	0.0086	0.0227	0.0322	2.76	1.34
05-Jun-03	1.0	0.072	0.0121	0.6019	1.12	0.175	0.0098	0.0212	0.0369	3.03	1.02
11-Jun-03	1.0	0.021	0.0077	0.4963	1.01	0.232	0.0036	0.0276	0.0255	3.23	1.30
19-Jun-03	1.0	0.066	0.0082	0.5758	1.19	0.206	0.0218	0.0269	0.0618	3.92	1.14
25-Jun-03	1.0	0.024	0.0114	0.5956	1.17	0.220	0.0161	0.0318	0.0514	2.85	1.56
02-Jul-03	1.0	0.068	0.0101	0.3219	0.88	0.240	0.0110	0.0344	0.0497	2.80	1.53
09-Jul-03	1.0	0.207	0.0095	0.2055	0.88	0.368	0.0385	0.0832	0.0811	1.83	3.19
16-Jul-03	1.0	0.220	0.0070	0.1210	0.78	0.143	0.0411	0.0218	0.0728	0.34	1.03
23-Jul-03	0.8	0.153	0.0035	0.0846	0.71	0.131	0.0288	0.0168	0.0527	0.51	0.92
30-Jul-03	1.0	0.114	0.0041	0.0290	0.59	0.110	0.0155	0.0149	0.0372	0.51	0.62
06-Aug-03	1.0	0.137	0.0019	0.0286	0.52	0.112	0.0168	0.0199	0.0463	0.64	0.67
13-Aug-03	1.0	0.014	0.0014	0.0112	0.53	0.195	0.0111	0.0225	0.0295	1.28	1.07
20-Aug-03	0.7	0.044	0.0017	0.0025	0.42	0.136	0.0068	0.0169	0.0324	1.77	0.71
27-Aug-03	0.8	0.144	0.0031	0.0195	0.56	0.133	0.0204	0.0183	0.0685	1.30	0.85
04-Sep-03	1.0	0.106	0.0024	0.0487	0.72	0.133	0.0343	0.0164	0.0387	0.58	0.78
09-Sep-03	1.0	0.073	0.0015	0.0065	0.70	0.145	0.0121	0.0176	0.0547	0.43	1.05
16-Sep-03	1.0	0.078	0.0031	0.0446	0.71	0.184	0.0049	0.0339	0.0275	0.63	1.44
01-Oct-03	1.0	0.036	0.0061	0.3549	0.74	0.138	0.0049	0.0230	0.0172	1.58	0.91
07-Oct-03	0.8	0.039	0.0050	0.3680	0.91	0.128	0.0047	0.0154	0.0176	1.41	0.84
14-Oct-03	1.0	0.015	0.0053	0.3287	0.72	0.206	0.0027	0.0272	0.0135	1.40	1.26
21-Oct-03	1.0	0.003	0.0071	0.3709	0.90	0.143	0.0020	0.0155	0.0233	1.77	0.81
29-Oct-03	1.0	0.117	0.0062	0.2828	0.75	0.136	0.0107	0.0166	0.0286	1.40	0.84

Table 4. Lauderick Creek 2003 Nutrient data: Ammonium (NH4), Nitrite (NO2), Nitrate (NO3), Total Dissolved Nitrogen (TDN), Particulate Nitrogen (PN), Phosphate (PO4), Particulate Phosphate (PP), Total Dissolved Nitrogen (TDP), Silicate (SiO4) and Particulate Carbon (PC).

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
15-Apr-03	0.1	5.327	1.477	186.3	20.0	
23-Apr-03	0.1	22.430	0.000	24.0	6.0	
30-Apr-03	0.4	23.360	7.383	82.5	8.7	
08-May-03	0.7	21.490	7.289	82.5	13.7	
14-May-03	0.4	14.950	3.364	55.0	10.0	
21-May-03	0.5	7.476	2.990	55.0	7.5	
29-May-03	0.7	7.476	1.682	45.0	10.0	
04-Jun-03	0.4	14.950	1.794	50.0	12.0	0.1
11-Jun-03	0.3	11.210	0.000	19.0	7.0	0.3
18-Jun-03	0.7	9.719	1.794	21.0	6.0	0.3
25-Jun-03	0.4	3.738	0.449	33.0	9.0	0.2
02-Jul-03	0.7	11.960	2.691	24.7	5.3	0.4
09-Jul-03	0.1	5.607	2.243	41.2	10.0	0.2
16-Jul-03	0.7	8.971	2.019	8.7	4.7	0.3
23-Jul-03	0.2	3.489	0.698	12.0	2.7	0.5
30-Jul-03	0.8	3.289	0.000	2.4	3.2	1.1
30-Jul-03	0.8	2.691	0.449	2.4	2.8	
06-Aug-03	0.2	4.859	1.159	12.5	3.5	0.5
13-Aug-03	0.5	8.473	1.296	9.3	4.0	0.4
20-Aug-03	0.2	4.486	0.050	8.0	6.0	0.5
27-Aug-03	0.5	2.990	1.196	2.4	3.0	0.8
27-Aug-03	0.5	1.495	0.860	2.4	3.0	
02-Sep-03	0.6	59.430	16.190	21.5	8.5	0.9
14-Oct-03	0.4	6.728	2.691	24.0	6.0	0.2
21-Oct-03	0.7	5.981	2.392	29.0	6.0	0.3
29-Oct-03	0.5			48.0	7.0	0.2
29-Oct-03	0.5	4.486	0.000			

Table 5. Otter Point 2003 Weekly Pigment, Suspended Solids and Secchi Disk values. N.B. On the dates 30-Jul-03 and 27-Aug-03 a second replicate sample was taken.

Date	Depth (m)	NH_4 (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)	TDN (mg/l)	PN (mg/l)	PO_4 (mg/l)	PP (mg/l)	TDP (mg/l)	SiO_2 (mg/l)	PC (mg/l)
15-Apr-03	0.1	0.024	0.0124	1.4076	1.83	1.270	0.0076	0.1838	0.0317	3.36	9.44
23-Apr-03	0.1	0.005	0.0107	1.0393	1.52	0.393	0.0028	0.0515	0.0176	3.16	2.76
30-Apr-03	0.4	0.018	0.0099	0.8901	1.23	0.565	0.0033	0.0981	0.0171	3.41	3.94
08-May-03	0.7	0.019	0.0139	0.8681	1.18	0.584	0.0033	0.1012	0.0151	3.65	4.12
14-May-03	0.4	0.031	0.0127	0.9033	1.36	0.420	0.0016	0.0883	0.0183	3.73	3.00
21-May-03	0.5	0.126	0.0177	1.0423	1.59	0.258	0.0036	0.0693	0.0248	4.60	2.33
29-May-03	0.7	0.123	0.0140	0.7910	1.38	0.269	0.0055	0.0673	0.0286	4.22	2.42
04-Jun-03	0.4	0.084	0.0211	1.1489	1.70	0.345	0.0051	0.0501	0.0194	5.03	2.54
11-Jun-03	0.3	0.044	0.0125	1.1175	1.61	0.207	0.0046	0.0307	0.0205	5.48	1.35
18-Jun-03	0.7	0.075	0.0158	1.1042	1.58	0.321	0.0045	0.0429	0.0277	5.10	1.72
25-Jun-03	0.4	0.100	0.0115	0.9885	1.53	0.141	0.0064	0.0406	0.0247	4.81	1.35
02-Jul-03	0.7	0.012	0.0175	1.2025	1.59	0.291	0.0076	0.0400	0.0238	5.14	1.81
09-Jul-03	0.1	0.065	0.0180	0.8260	1.23	0.587	0.0106	0.0602	0.0206	4.03	3.15
16-Jul-03	0.7	0.060	0.0204	1.0696	1.47	0.342	0.0108	0.0435	0.0216	4.26	1.84
23-Jul-03	0.2	0.030	0.0272	0.8178	1.18	0.119	0.0087	0.0191	0.0213	3.78	0.80
30-Jul-03	0.8	0.003	0.0159	0.5451	0.99	0.103	0.0098	0.0129	0.0155	2.79	0.54
30-Jul-03	0.8	0.006	0.0160	0.5310	0.97		0.0030		0.0221		
06-Aug-03	0.2	0.023	0.0213	0.6107	0.99	0.091	0.0046	0.0182	0.0201	4.97	0.96
13-Aug-03	0.5	0.057	0.0352	0.4748	0.93	0.104	0.0047	0.0137	0.0192	2.25	1.05
20-Aug-03	0.2	0.019	0.0112	0.2038	0.63	0.055	0.0037	0.0132	0.0169	0.90	0.51
27-Aug-03	0.5	0.023	0.0075	0.1705	0.86	0.080	0.0051	0.0085	0.0136	0.45	0.51
27-Aug-03	0.5	0.032	0.0082	0.1758	0.69		0.0027		0.0567		
02-Sep-03	0.6	0.035	0.0070	0.3060		0.690	0.0045	0.0536		0.50	4.54
14-Oct-03	0.4	0.016	0.0083	1.0717	1.33	0.153	0.0035	0.0287	0.0116	1.19	1.04
21-Oct-03	0.7	0.011	0.0066	0.9734	1.52	0.133	0.0027	0.0342	0.0189	1.32	1.25
29-Oct-03	0.5	0.046	0.0063	0.5417	1.06	0.125	0.0055	0.0267	0.0266	2.78	1.17

Table 6. Otter Point Creek 2003 Ammonium (NH4), Nitrite (NO2), Nitrate (NO3), Total Dissolved Nitrogen (TDN), Particulate Nitrogen (PN), Phosphate (PO4), Particulate Phosphate (PP), Total Dissolved Nitrogen (TDP), Silicate (SiO4) and Particulate Carbon (PC). N.B. On the dates 30-Jul-03 and 27-Aug-03 a second replicate sample was taken.

Table 7. Limits of detection, the lowest concentration of an analyte that the analytical procedure can reliably detect, have been established for all parameters routinely measured by Nutrient Analytical Services. The limit of detection is 3 times the standard deviation of a minimum of 7 replicates of a single low concentration sample.

Minimum limits of detection of CBL, October/November 1987, March 1994 a			
	MEAN CONC.	**STANDARD DEVIATION**	**DETECTION LIMIT**
NUTRIENT	**(mg/l)**	**(mg/l)**	**(mg/l)**
Ammonium	0.007	0.001	0.003
Nitrite	0.0002	0.00005	0.0002
Nitrite + Nitrate	0.0011	0.00023	0.0007
Phosphate	0.0027	0.00025	0.0007
Dissolved Organic Carbon	3.58	0.05	0.15
Total Suspended Solids	13.4	0.8	2.4
Particulate Phosphorus	0.0187	0.0008	0.0024
Particulate Inorganic Phosphorus	0.0027	0.0002	0.0006
Total Dissolved Nitrogen	0.39	0.0096	0.02
Total Dissolved Phosphorus	0.0057	0.0005	0.0015
Silicate	0.25	0.003	0.01
Particulate Nitrogen	0.317	0.0041	0.0123
Particulate Carbon	2.26	0.0253	0.0759
Particulate Biogenic Silica	0.163	0.003	0.009
Sediment C (10 mg)	0.02183	0.044	0.0013
Sediment N (10 mg)	0.00195	0.003	0.000084
Sediment P (34.8 mg)	0.000304	0.003	0.000087
FRESHWATER DETECTION LIMITS (1991)			
Total Volatile Solids	3.5	0.3	0.9
Hardness	41.8	2.1	6.3
Chloride	5.84	0.08	0.23
Sulfate	4.9	0.03	0.09
Carbonate Alkalinity	1.46	4.38	
Chlorophyll a	4	0.68	2.00 (µg/l)
a Results based on a minimum of seven replicates collected from one cubitainer and analyzed randomly on a typical day of analyses.			
http://www.cbl.umces.edu/nasl/			

Date	Depth (m)	specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
29-May-03	1.0	485	8.4	7.03	0.00	17.2
05-Jun-03	1.0	641	8.1	6.98	0.00	17.0
11-Jun-03	1.0	563	8.8	7.14	0.00	23.4
19-Jun-03	1.0	301	7.2	7.02	0.00	23.0
25-Jun-03	1.0	203	7.5	7.16	0.00	26.3
02-Jul-03	1.0	217	7.4	7.11	0.00	27.7
09-Jul-03	1.0	222	4.4	6.58	0.00	28.4
16-Jul-03	1.0	308	6.4	6.91	0.00	27.4
23-Jul-03	0.8	700	4.9	6.45	0.02	27.8
30-Jul-03	1.0	918	6.9	6.42	0.14	27.2
06-Aug-03	1.0	1287	5.4	6.16	0.34	27.1
13-Aug-03	1.0	1036	6.6	6.34	0.20	29.6
20-Aug-03	0.7	857	6.6	6.45	0.10	28.5
27-Aug-03	0.8	741	6.1	6.62	0.04	27.1
04-Sep-03	1.0	603	6.5	6.63	0.00	25.1
09-Sep-03	1.0	608	7.3	6.99	0.00	24.2
16-Sep-03	1.0	326	7.2	6.69	0.00	22.6
01-Oct-03	1.0	2421	7.2	7.07	0.96	19.5
07-Oct-03	0.8	2169	9.0	7.16	0.82	15.9
14-Oct-03	1.0	1856	8.9	7.16	0.65	18.2
21-Oct-03	1.0	1444	10.8	7.43	0.42	14.9
29-Oct-03	1.0	1063	8.9	7.09	0.22	13.6

Table 8. Lauderick Creek 2003 HydroLab values at time of pigment and nutrient samples. Depth (m), specific Conductance (µS/cm), Dissolved Oxygen (mg/l), pH, Salinity (psu) and Water Temperature (°C).

Date	Depth (m)	specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
15-Apr-03	0.1	215	11.1	7.73	0.00	19.6
23-Apr-03	0.1	319	11.5	8.07	0.00	14.4
30-Apr-03	0.4	217	8.9	7.39	0.00	18.9
08-May-03	0.7	254	9.5	7.47	0.00	19.8
14-May-03	0.4	317	9.1	7.46	0.00	15.6
21-May-03	0.5	189	7.1	7.05	0.00	18.3
29-May-03	0.7	137	7.0	6.87	0.00	16.3
04-Jun-03	0.4	170	8.1	7.09	0.00	16.0
11-Jun-03	0.3	153	7.8	7.02	0.00	22.8
18-Jun-03	0.7	147	8.4	7.3	0.00	22.4
25-Jun-03	0.4	134	6.0	6.83	0.00	22.9
02-Jul-03	0.7	185	8.6	7.54	0.00	27.7
09-Jul-03	0.1	189	8.3	7.92	0.00	29.3
16-Jul-03	0.7	191	7.6	7.95	0.00	27.0
23-Jul-03	0.2	203	9.1	9.12	0.00	27.0
30-Jul-03	0.8	216	10.7	9.65	0.00	26.5
30-Jul-03	0.8	216	10.7	9.65	0.00	26.5
06-Aug-03	0.2	203	8.7	9.29	0.00	25.6
13-Aug-03	0.5	183	6.9	8.14	0.00	27.5
20-Aug-03	0.2	164	9.7	9.25	0.00	25.3
27-Aug-03	0.5	185	5.2	8.29	0.00	25.4
27-Aug-03	0.5	185	5.2	8.29	0.00	25.4
02-Sep-03	0.6	196	6.8	8.77	0.00	26.0
14-Oct-03	0.4	215	8.7	7.02	0.00	17.6
21-Oct-03	0.7	175	9.5	7.26	0.00	15.0
29-Oct-03	0.5	128	7.2	6.72	0.00	12.7

Table 9. Otter Point Creek 2003 HydroLab values at time of pigment and nutrient samples. Depth (m), specific Conductance (µS/cm), Dissolved Oxygen (mg/l), pH, Salinity (psu) and Water Temperature (°C).

Water Quality Mapping

Bush River water quality mapping data were collected monthly, May through October 2003. Water quality mapping collects surface data every four seconds aboard a moving boat, creating thousands of data points in a daily cruise, and allows for the creation of highly detailed spatial maps of water quality. More information for this technology can be found at http://mddnr.chesapeakebay.net/sim/index.cfm. Data for dissolved oxygen, turbidity, chlorophyll, water temperature, and salinity were interpolated into spatially continuous surface maps (Figures 8-13) using the inverse distance weighted method. Data were quality assured and controlled but not standardized for time-of-day influences before interpolation. Approximately eight nutrient and calibration samples were collected during each cruise and analyzed at UMCES Chesapeake Biological Laboratory.

Overall results show that surface dissolved oxygen levels were mostly above 5 mg/l during collection, with areas of 5 – 7.5 mg/l occurring May through September. Temporal standardization of water quality mapping data with the continuous monitoring data could indicate that portions of these areas could deviate below 5 mg/l during early morning hours. Due to high water flows and runoff during 2003, turbidities were high throughout the river, May through September, with highest values observed upriver. High turbidities accounted for low light availability in the water column, restricting chlorophyll values to less than 20 ug/l throughout the tributary during the sampling period. Water quality mapping employs the same YSI 6600 fluorometer that is used in continuous monitoring and is therefore unable to detect blooms of blue-green algae. Maryland DNR is currently investigating new technologies to help us better monitor these blooms in the future. Water quality mapping data can be obtained through Eyes on the Bay at: http://mddnr.chesapeakebay.net/sim/dataflow_data.cfm. A more complete analysis of the data will be possible when compared with the second year of data from 2004.

Conclusion

Shallow water monitoring, consisting of temporally intensive continuous monitoring and spatially intensive water quality mapping, provides a critical function for assessing the health of Maryland's tidal waters in areas historically lacking in monitoring information. Not only will this information be used for characterizing the health of shallow water habitats, but its objectives are to: 1) assess the newly developed Chesapeake Bay water quality criteria for dissolved oxygen, water clarity and chlorophyll in shallow and open water habitats, 2) determine attainment or non-attainment of shallow water and open water habitats for their designated uses, 3) provide spatially and temporally intensive data in shallow water habitats to improve water quality mapping interpolations, 4) assess SAV habitats and identify potential SAV restoration sites, 5) provide information to better understand ecosystem processes and the impact of extreme events (e.g. hurricanes, high flows) in shallow water and open water environments, and 6) provide information for calibrating the Bay Eutrophication and Watershed Model.

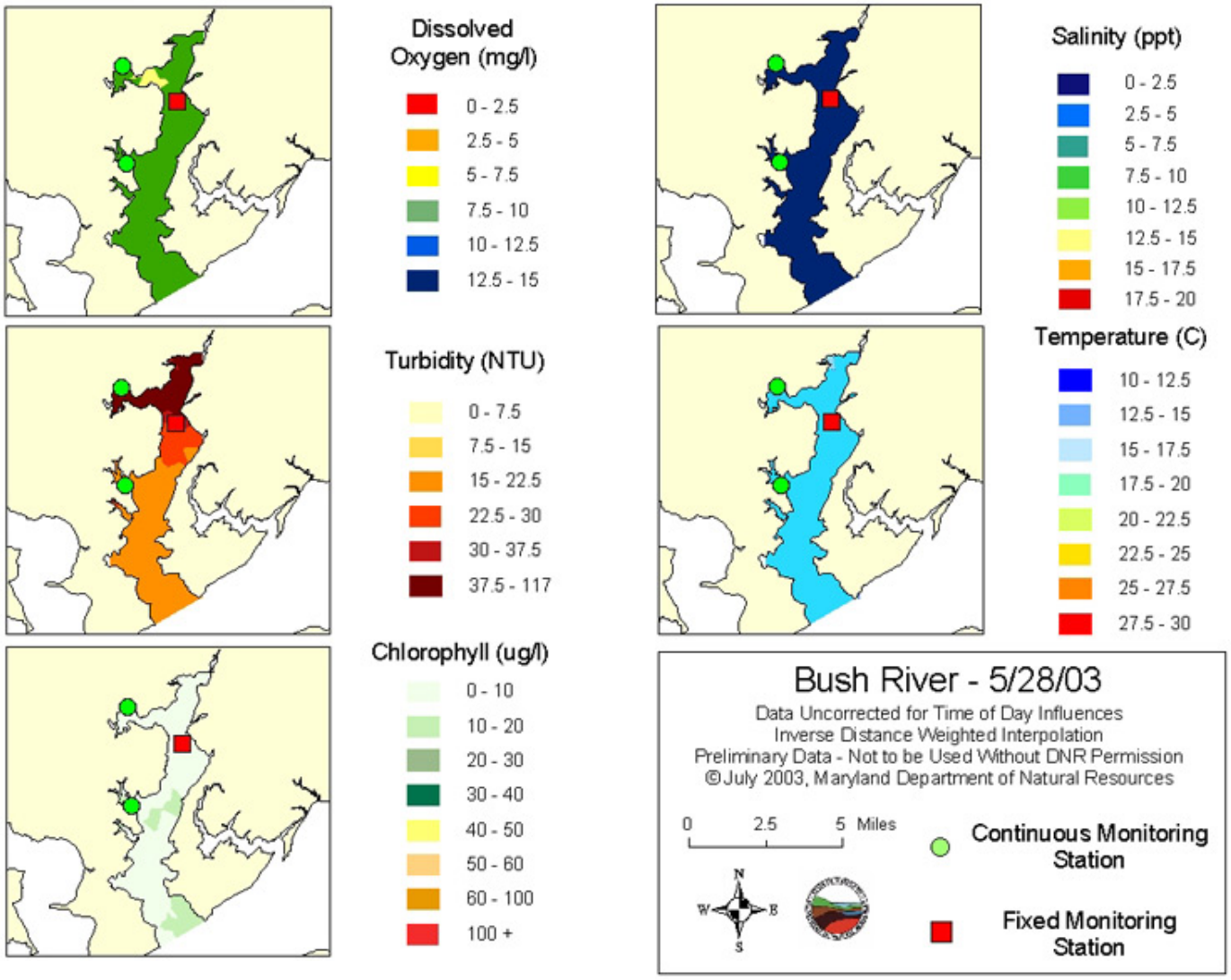

Figure 8. Bush River Water Quality Mapping from May 28, 2004.

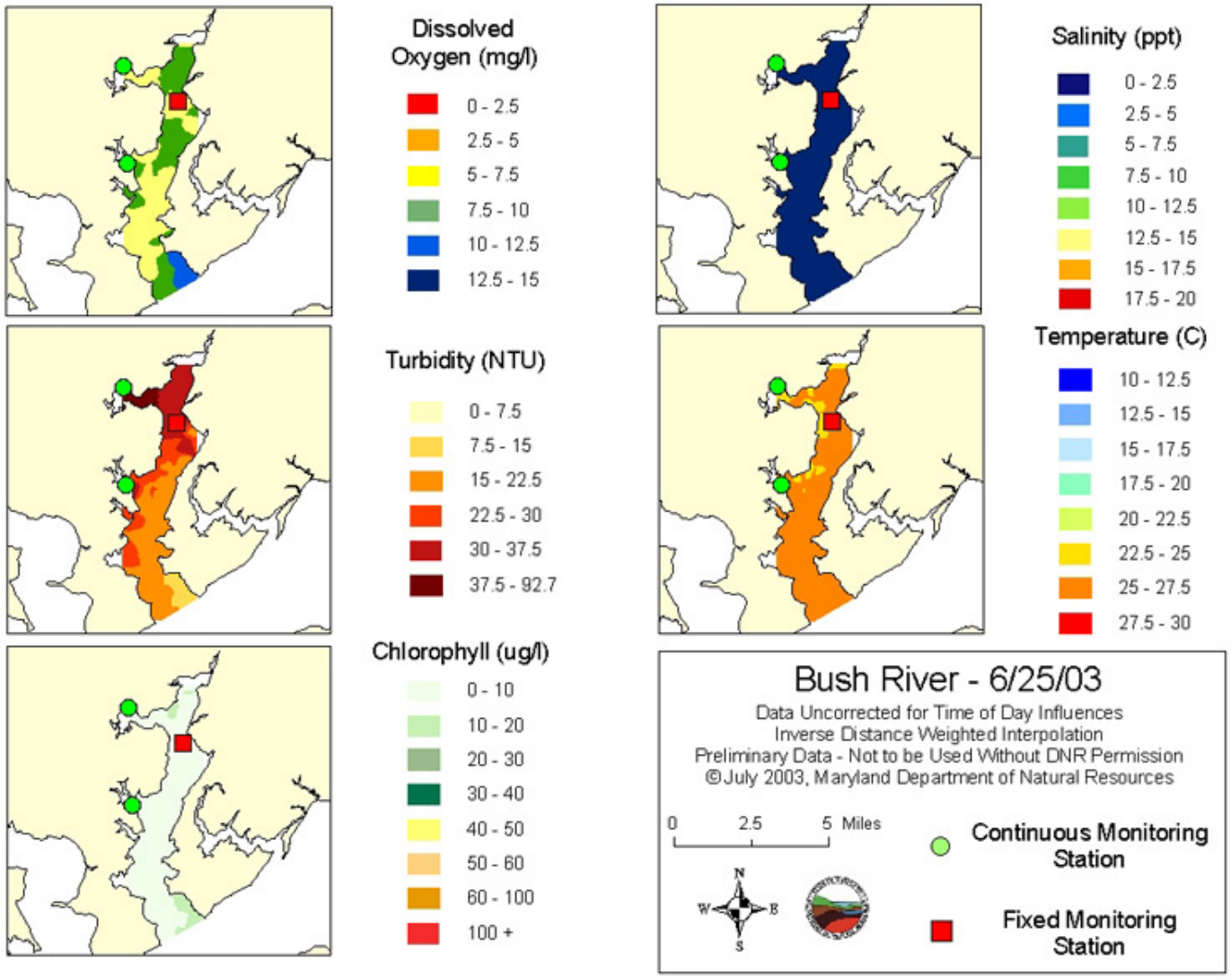

Figure 9. Bush River Water Quality Mapping from June 25, 2004.

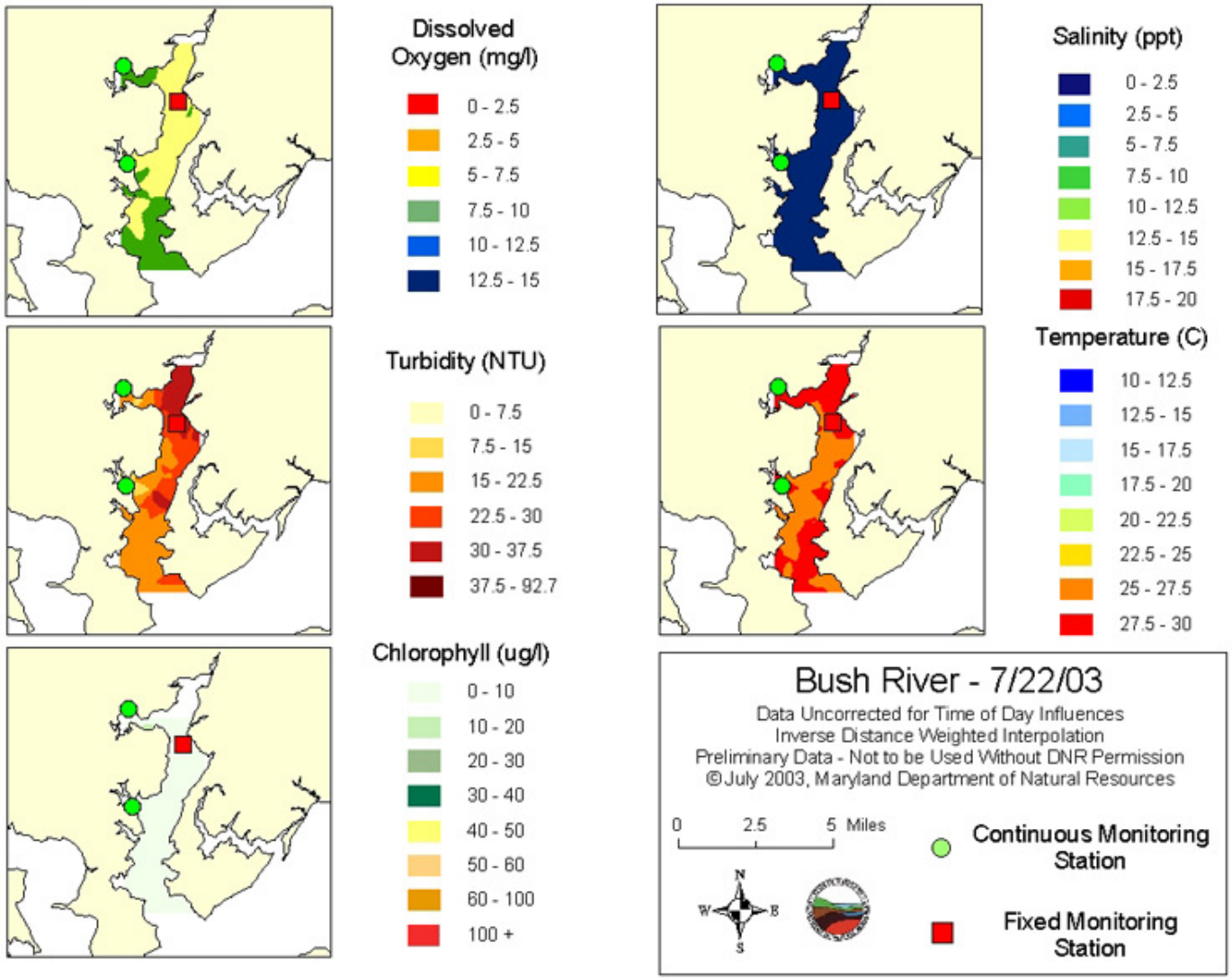

Figure 10. Bush River Water Quality Mapping from July 22, 2004.

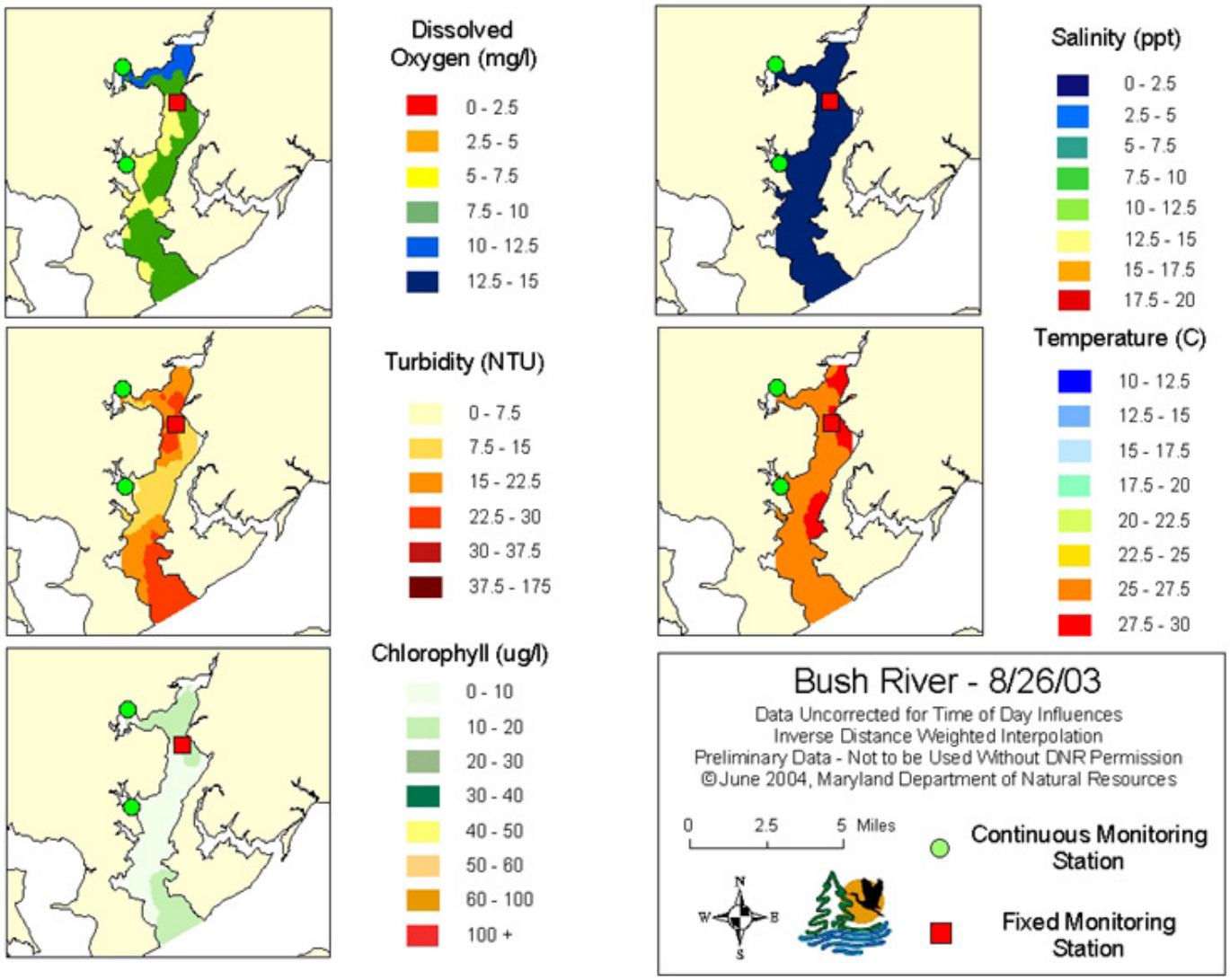

Figure 11. Bush River Water Quality Mapping from August 26, 2004.

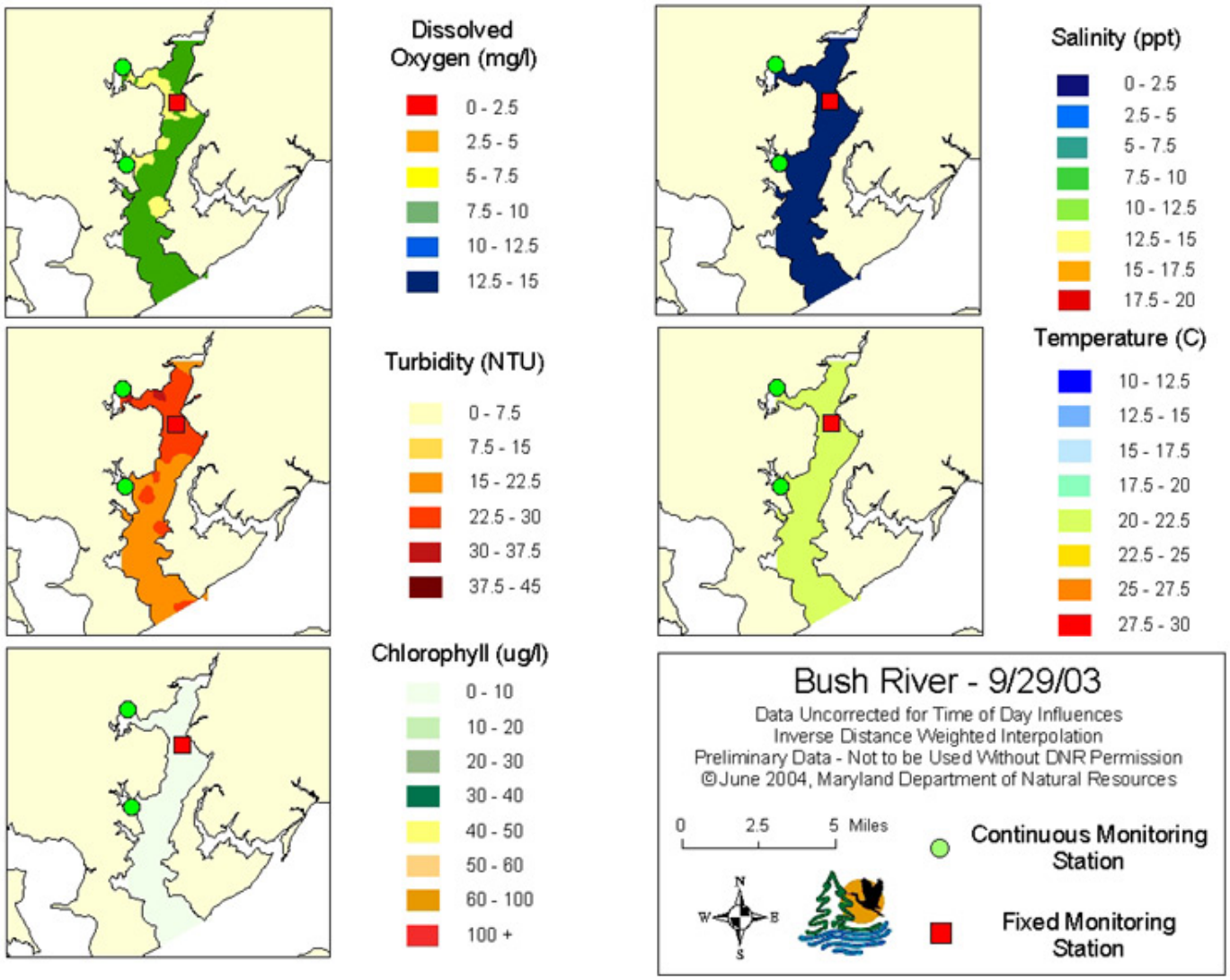

Figure 12. Bush River Water Quality Mapping from September 29, 2004.

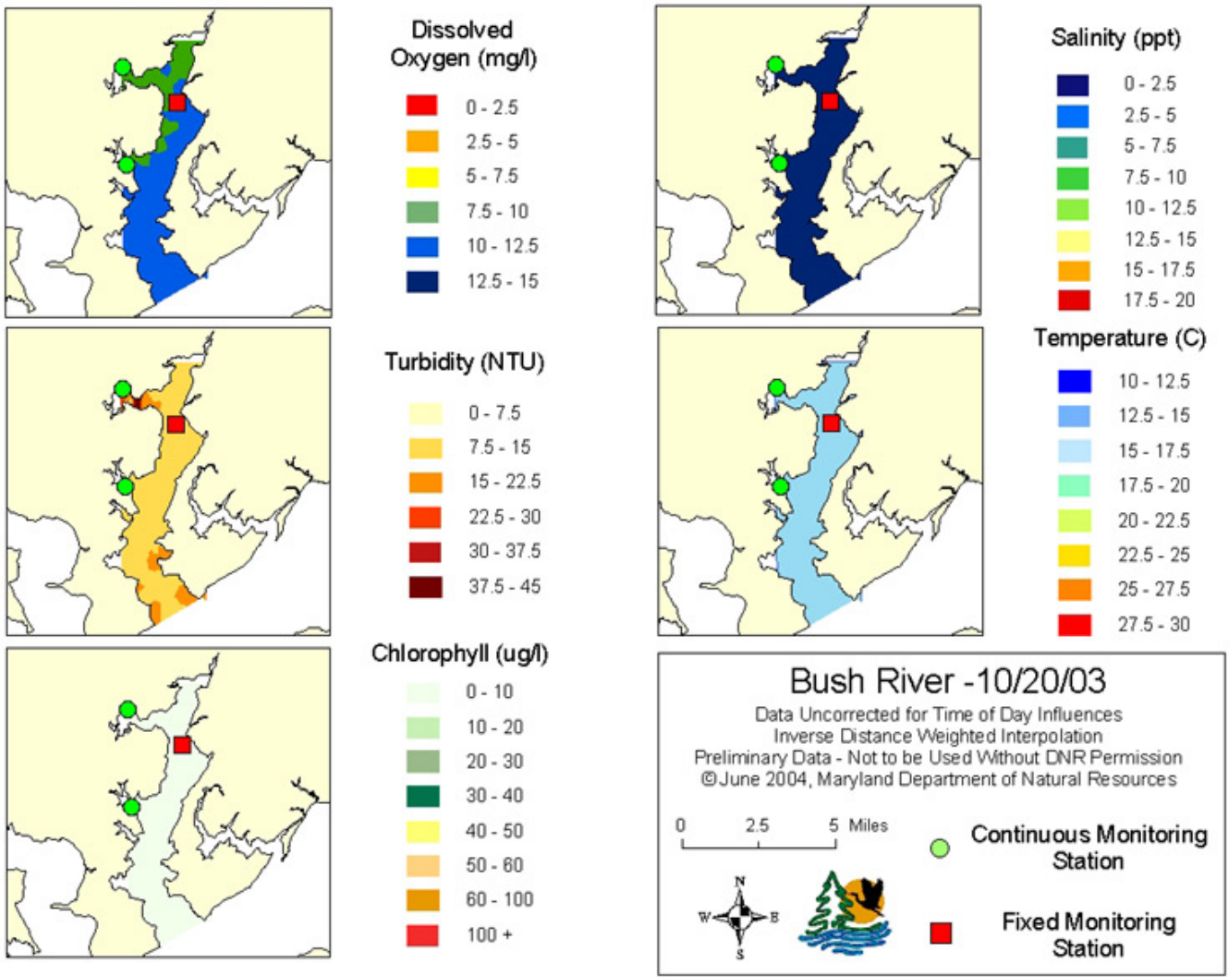

Figure 13. Bush River Water Quality Mapping from October 20, 2004.