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2005 Bush River Shallow Water Monitoring Data Report

December 14, 2006

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2005 Bush River Shallow Water Monitoring Data Report

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TABLE OF CONTENTS

FIGURES

TABLES

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 2005.

Temporally Intensive Monitoring - Maryland DNR deployed and maintained thirty-six Continuous Monitoring sites located on twelve Chesapeake Bay tributary/water bodies during 2005. Three additional Coastal Bay sites were also monitored. The project's aim was to monitor ambient water quality parameters (dissolved oxygen, chlorophyll, turbidity, water temperature, salinity and pH) in order to assess the new Chesapeake Bay water quality criteria and to characterize water quality and habitat conditions.

Continuous Monitoring data were collected at 15-minute intervals at two Harford County sites: Lauderick Creek, (March through November) and Otter Point Creek, (January through December).

Spatially Intensive Monitoring - Water Quality Mapping cruises were conducted, throughout the Bush River, monthly April through October using DATAFLOW, a compact, self-contained surface water quality mapping system deployed in a small boat operating at planing speeds of 46 km/hr (25 kts) or less. Measurements were made approximately every four seconds or 30 meters (100 feet). Six water quality parameters were measured (dissolved oxygen, chlorophyll, turbidity, water temperature, salinity and pH). Water depth was also measured. The DATAFLOW system sampled water at approximately 0.5-m depths below the surface.

Nutrient and Calibration Samples - When Continuous Monitoring sondes were deployed, and during mapping cruises, nutrient and calibration data were collected by DNR staff. Samples were collected to measure the following parameters: chlorophyll *a*, phaeophytin, total suspended solids, volatile suspended solids, ammonium, nitrite, nitrate, total dissolved nitrogen, particulate nitrogen, phosphate, particulate phosphate, total dissolved nitrogen, silicate and particulate carbon. Secchi disk depth was also measured.

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 the National Oceanic and Atmospheric Administration's National Estuarine Research Reserve System (NERRS) Program.

Real-time 2005 data from the Lauderick Creek continuous monitoring site were made available through DNR's "Eyes on the Bay" web site. Data were uploaded on an hourly basis for the full suite of physical parameters. See Figure 1 (page 6) for Continuous Monitoring site locations and a sample 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 (page 7).

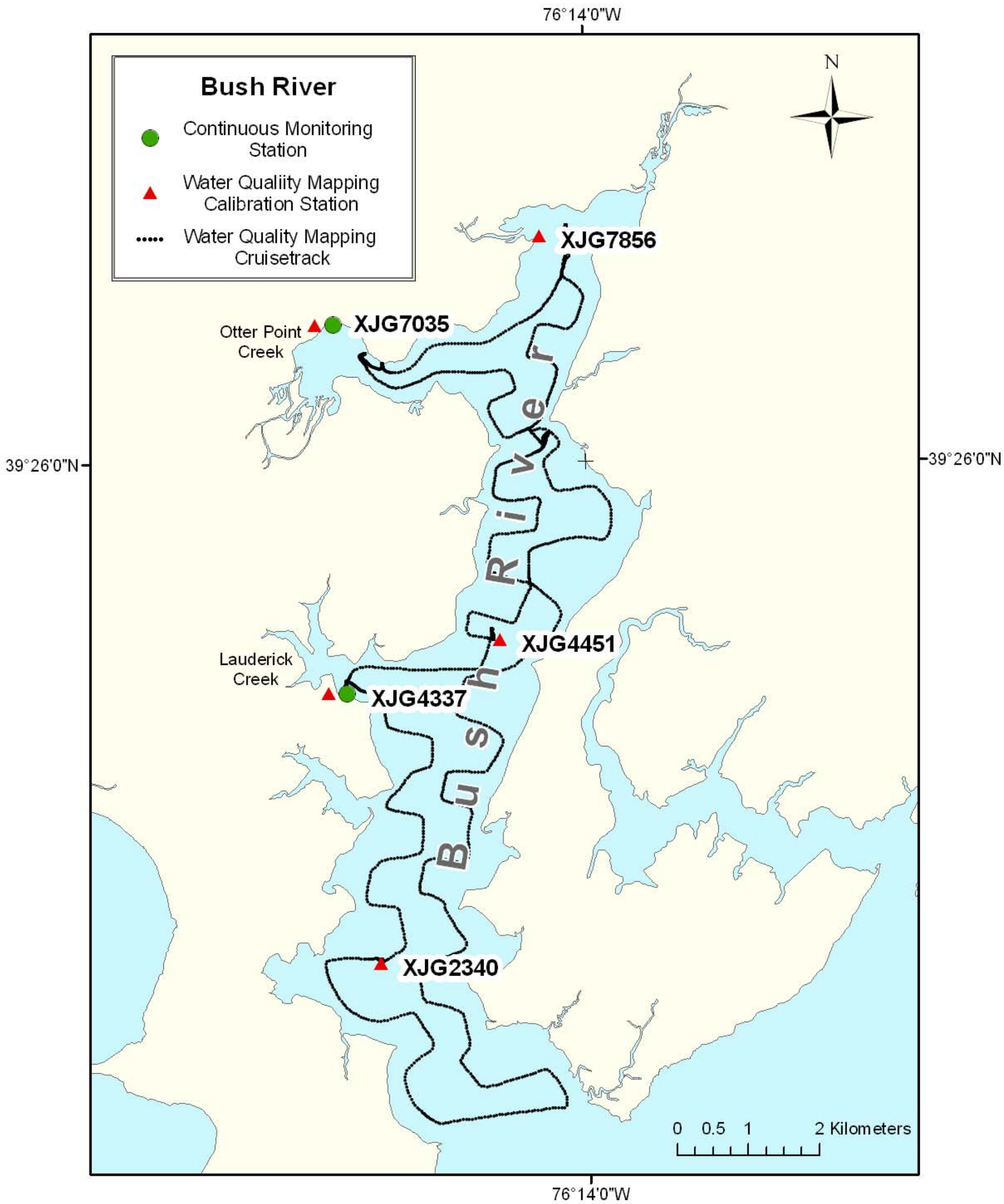

Figure 1 Site map with example water quality mapping cruise track for the Bush River monitoring project.

Year	Dates	Lauderick Creek	Otter Pt. Creek	DataFlow Cruise Dates	Harmful Algal Sample	Other Events and Details
2003	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)
	8/13/2003	X	X		X	(Microcystis): 24 µg toxin/L (upper reaches of the River)
	9/2/2003		X			11:00 AM Continuous Monitoring ceased while deployment pier at Otter Creek Point was removed and rebuilt.
	9/18/2003					Hurricane Isabel Landfall
	9/22/2003					September 22-23, 2.4 inches of rain in 24 hrs
	10/14/2003	X	X			9:00 AM Continuous monitoring resumes after completion of pier reconstruction.
	10/26/2003					Oct 26-27, 3.19 inches of rain in 24 hrs
2004	5/11/2004				X	Lauderick Creek on the Bush River measured 23,250cells/ml of the (bluegreen algae) *Microcystis aeruginosa* .
	5/26/04					MDE collected Bush R. sample of *Microcystis aeruginosa* - 500,000 cells per milliliter .
	5/27/2004			X	X	MD DNR collected Bush R. sample - *Microcystis aeruginosa* 1,400,00 cells per milliliter. Water described as having the appearance of green paint spilled on the surface. Water - Swimming/Drinking Contact Health advisory published.
	6/1/2004				X	Sample collected at Flying Point Marina - *Microcystis aeruginosa* 2,970,000 cells per milliliter.
	6/9/2004				X	OtterPoint Park - *Microcystis aeruginosa* 2,100,000 cells/ml and 13,992 cells/ml *Anabaena sp.*
	6/14/2004 through 6/16/2004				X	LauderickCreek - *Microcystis aeruginosa* 12,731 cells/ml and 13,992 cells/ml *Anabaena sp.*
	7/27/2004					4.45 inches of rain measured at BWI Airport
	9/18/2004					Tropical Depression Ivan
	9/28/2004					Tropical Depression Jeanne
2005	01/04/05		X			Continuous monitoring begins
	1/19/2005 through 2/24/2005	X				Sonde removed due to ice concerns
	03/24/05	X				Continuous monitoring begins
	4/11/2005			X		
	5/3/2005			X		
	6/6/2005			X		
	7/7/2005			X		
	7/12/2005				X	Otter Point algal sample, a mixture of: *Anabaena planktonica* at 63,665 cells/ml, *Aphanizomenon sp* . at 47,833 cells/ml and (bluegreen algae) *Microcystis aeruginosa* at 3,604 cells/ml.
	8/1/2005			X		
	9/1/2005			X		
	9/4/2005					Sewage Overflow, Perryman, pipe failure, 6,075 gallons
	10/4/2005			X		
	11/2/2005	X				Lauderick Station continuous monitoring ends
	12/6/2005		X			Otter Point Creek Station 2004 continuous monitoring ends

N.B. 2003 and 2004 events are partial listings

Table 1 Dates of 2003, 2004 and 2005 water sample collections, DataFlow cruises, algal sample collections, and other events and details

Table 2 shows that based on precipitation measured at Baltimore Washington International Thurgood Marshal Airport, September 2005 was much dryer than normal. The October 2005 monthly rainfall total of 9.23 inches made this month the wettest October on record at the airport.

Station: Baltimore BWI		Total Rainfall For Month (inches):	Departure from Normal (inches)	Greatest in a 24Hr Period (inches)	ON Day(s) of Month
January	2005	3.75	0.28	2.15	13 - 14
February	2005	1.66	-1.36	0.64	13 - 14
March	2005	5.13	1.20	2.56	23 - 23
April	2005	3.81	0.81	1.78	2 - 3
May	2005	2.64	-1.25	2.04	19 - 20
June	2005	3.74	0.31	1.43	6 - 6
July	2005	8.77	4.92	2.79	16 - 16
August	2005	3.71	-0.03	1.29	8 - 9
September	2005	0.67	-3.31	0.50	14 - 15
October	2005	9.23	6.07	5.97	7 - 8
November	2005	1.12	-1.00	0.89	21 - 22
December	2005	3.90	0.55	1.47	15 - 16

Table 2 2005 Precipitation measured at Baltimore Washington International Thurgood Marshal Airport.

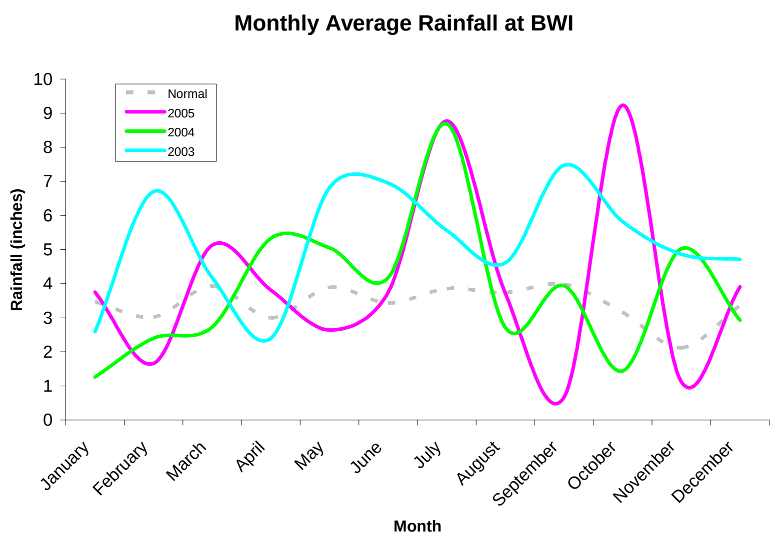

Figure 2 Comparison of 2003, 2004, 2005 and normal monthly rainfall (inches) at Baltimore Washington Thurgood Marshal International Airport.

The dry September and wet October conditions in 2005 listed in Table 2 can be seen in Figure 2.

Figure 3 shows daily discharge at the USGS Otter Creek Gage Station. The October high rainfall event recorded at the airport is not seen in the discharge data because data are not available from October 6 through October 10, 2006.

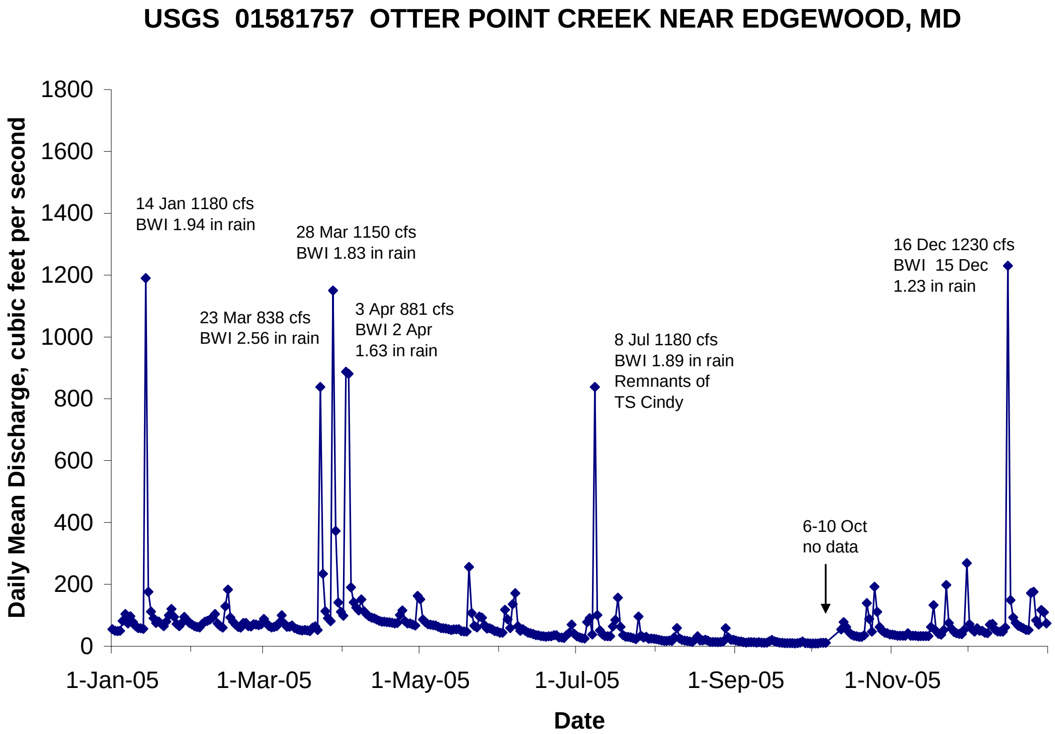

Figure 3 Daily Discharge measured at Otter Creek Gage Station in 2005 (cfs)

Precipitation in 2003 was considerably greater than in both 2004 and 2005.

Three plots of discharge data, from USGS Gaging Station 01581757 Otter Point Creek near Edgewood, MD, on the following page, depict inter-annual differences between the years 2003, 2004 and 2005.

Computation results, based on USGS provisional data, for annual mean flow in cubic feet per second (cfs) at the Otter Point Creek gage were: Calendar Year 2003: 147.76 cfs, Calendar Year 2004: 91.94 cfs and Calendar Year 2005: 80.6 cfs. The year 2003 was a very wet year that followed a drought.

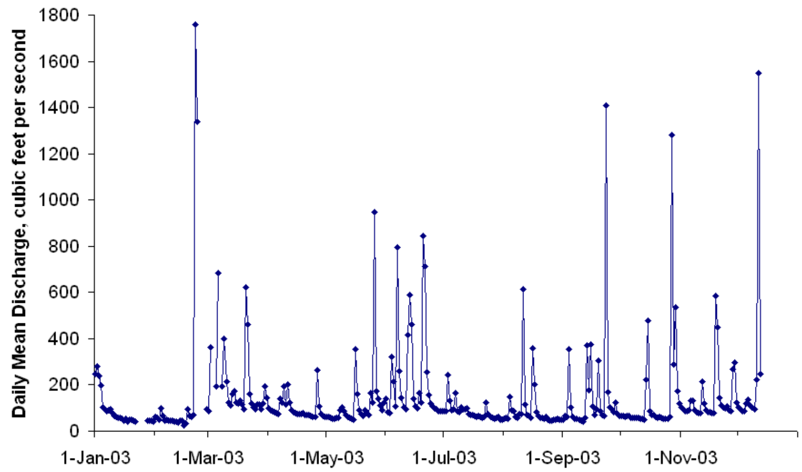

Figure 4 Daily Discharge measured at Otter Creek Gage Station in 2003 (cfs)

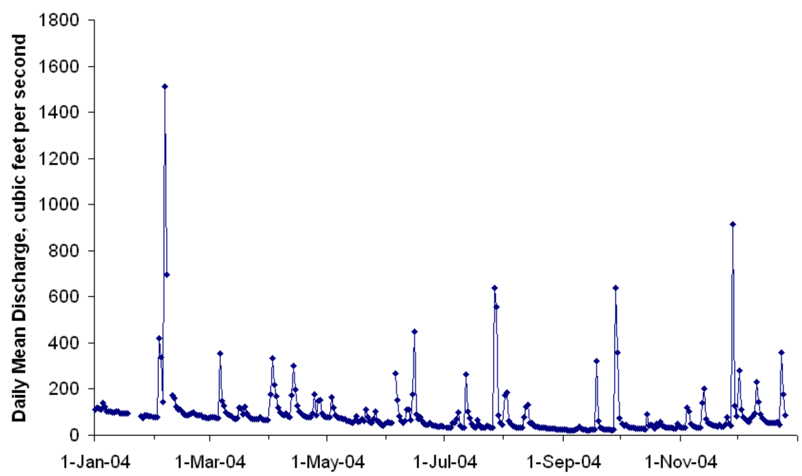

Figure 5 Daily Discharge measured at Otter Creek Gage Station in 2004 (cfs)

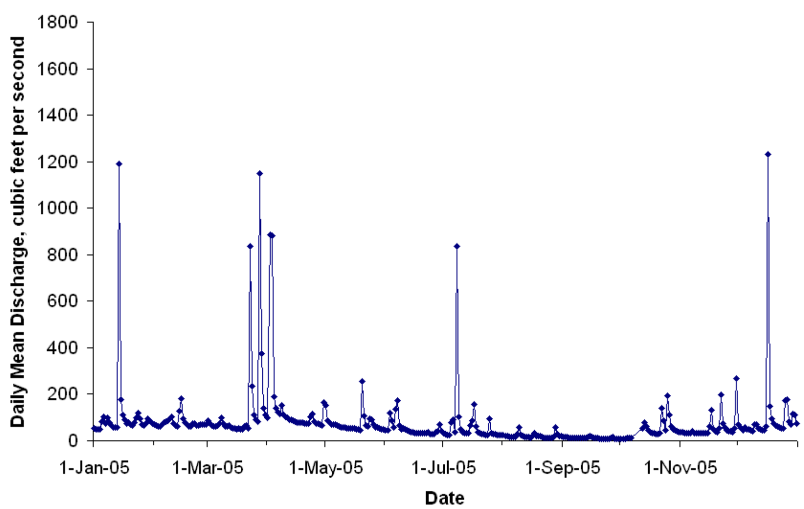

Figure 6 Daily Discharge measured at Otter Creek Gage Station in 2005 (cfs)

Continuous Monitoring

The Lauderick Creek continuous monitoring site was deployed at a depth of one-meter below the water's surface. The sonde at the Otter Point Creek site was deployed 0.3 meters from the bottom. The mean low water depths of the Lauderick Creek and Otter Point Creek locations were 1.3m and 0.5m, respectively.

Sonde Data Discontinuities

The reader will observe gaps in the sonde data archived at the two Bush River continuous monitoring sites during the past three years. A brief summary of these gaps follows.

The Otter Point Creek sonde was temporarily removed from service on September 2, 2003 to allow for pier reconstruction and was redeployed on October 14, 2003. Unless noted otherwise, the data gaps were usually short-term problems such as probe, power, membrane, and wiper failures. On several occasions, the sonde at the Otter Point Creek site was not submerged due to very low water levels and data were deleted. This site will potentially be relocated in 2007. In June of 2004, the Lauderick Creek sonde dissolved oxygen probe failed, resulting in missing data from the 10^{th} through the 14^{th}. The Otter Creek sonde was removed January 19th, 2005 due to ice concerns. The sonde was redeployed 24 February, 2005. During 2005, May 17^{th} through May 31^{st} and July 12^{th} through July 26^{th} Lauderick Creek and May 17^{th} through 31^{st} Otter Point Creek dissolved oxygen data (Figure 8) were removed from the published data because the oxygen sensor post-calibration readings were out of range. A power supply problem resulted in no data being collected at the Otter Point Creek site from July 26th through August 9^{th}.

Salinity

Bush River waters usually had very low salinity values, often less than one ppt (Figure 7). The location of the Otter Point Creek site is further upstream, closer to the Bush River's tidal headwaters. Salinity values there are lower than those at the Lauderick site.

The effects of the Hurricane Isabel tidal surge can be seen September 18^{th} 2003 when the salinity at Lauderick Creek rose approximately one psu. Similarly, although less distinctly, a feature caused by the surge from Hurricane Ivan (September 18^{th}) can be seen in 2004. Storm induced increases in Salinity measurements were not observed at the Otter Point Creek site.

The 2005 salinity measurements rose to unusually high levels due to abnormally low rainfall conditions in September (see Table 2 and Figure 2). The low flow conditions allowed higher salinity Chesapeake Bay waters to intrude further up river than usual. Salinity measurements rose to 5.11 ppt at Lauderick Creek on September 26^{th} and 2.54 ppt at Otter Point Creek on October 6^{th}.

Dissolved Oxygen

When viewing Bush River dissolved oxygen data (Figure 8), it is clear that the range of the values at the Otter Point site is considerably greater than the range at the Lauderick site. Lauderick Creek dissolved oxygen conditions were generally good during the three years data were collected. In contrast, low dissolved oxygen conditions were measured at Otter Point Creek for extended periods (July through October each year).

Lauderick Creek dissolved oxygen values dipped briefly below five mg/l a few times in July and once, after Hurricane Isabel, in September of 2003. At the Otter Point site in 2003 the minimum and maximum oxygen measurements were greater and numerous low values were recorded between mid-June and mid-October.

Dissolved oxygen concentrations at Lauderick Creek remained at healthy levels in 2004 with two minor exceptions. Values dipped below five mg/l for sixteen hours May 16th and again for less than an hour on June 31st. Periods of high dissolved oxygen measurements in March, June and October of 2004 contrasted with the period in July-September when many low values were recorded. Shortly after the strong spring phytoplankton bloom (May 17th - 22nd 2004), very high dissolved oxygen measurements were observed at Otter Point Creek

July 2005 dissolved oxygen concentrations at Lauderick Creek were an improvement over values measured in 2003 and 2004. No dissolved oxygen values below five mg/l were observed until August 2005.

Dissolved oxygen conditions at Otter Point Creek in July 2005 were somewhat better than those measured in the preceding two years. Ranges of the measurements at Otter Point were considerably greater than ranges at Lauderick Creek. The shallower depth of the Otter Point site was believed to be the primary cause of this phenomenon.

In general, the Otter Point Creek site had greater daily fluctuations in dissolved oxygen values than those observed at the Lauderick site. Of 26,208 dissolved oxygen measurements at Otter Point Creek in 2005, 2,184, or 8.33%, were below five mg/L. With the exception of a brief excursion to 1.81mg/l on January 4th, low dissolved oxygen values were measured between June 6th and October 13th. The dissolved oxygen dip in January correlates with a phytoplankton bloom (see Figure 8). The number of records logged in July-September 2005 at Otter Point Creek was 7,394, of which 1,713, or 23.17%, had dissolved oxygen concentrations below five mg/l.

Unfortunately, due to probe failures and records deleted because of bad post-calibration results on two occasions, only 21,075 dissolved oxygen records were collected at Lauderick Creek during 2005. The first 2005 date Lauderick dissolved oxygen values below five mg/l were measured was the 2nd of August and the last date was the 26th of September. A total of 7,240 dissolved oxygen records were logged in the July – September period at Lauderick Creek (records between July 12th and 26th were removed because of bad post-calibrations). Of the 7,240 records, dissolved oxygen below five mg/l was measured in only 240, or 3.31%, of the records.

Dissolved oxygen (DO) is an important measure of water quality. DO concentrations below five mg/l can stress aquatic organisms. An instantaneous water quality criteria value of 3.2mg/l is listed by the EPA (U.S. Environmental Protection Agency. 2003. Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll *a* for the Chesapeake Bay and Its Tidal Tributaries, EPA 903-R-03-002, Region III Chesapeake Bay Program Office, Annapolis, Maryland). DO levels of around one mg/l can result in fish kills. Dissolved oxygen values below five mg/l fail water quality criteria standards for dissolved oxygen.

The table below summarizes dissolved oxygen criteria failure at both Bush River sites.

Continuous Monitoring Site	Period	2003	2004	2005
Otter Point Creek				
Dissolved Oxygen less than 5 (mg/l)	July - Sept.	4%	32%	23%
Dissolved Oxygen less than 3.2 (mg/l)	July - Sept.	0%	10%	5%
Lauderick Creek				
Dissolved Oxygen less than 5 (mg/l)	July - Sept.	5%	0%	3%
Dissolved Oxygen less than 3.2 (mg/l)	July - Sept.	0%	0%	0%

Table 3 - 2003, 2004 and 2005 Dissolved Oxygen criteria failure at Otter Point Creek and Lauderick Creek

pH

Currently, the fluorometers used to measure chlorophyll on YSI 6600 Continuous Monitoring sondes are unable to accurately detect and measure blue-green (*Microcystis*) algal concentrations which frequently occur in the Bush River. However, elevated pH values in low salinity waters often indicate that a blue-green algal bloom may be occurring. For instance, pH values of 9 to 10 observed during July and August 2003 at Otter Point Creek (Figure 9) were concurrent with *Microcystis* blooms (Table 1). The sonde manufacturer is working to develop fluorometry probes that will better detect blue-green algae.

The range of Otter Point pH measurements was generally greater than Lauderick Creek range. The waters of the Otter Point Creek site are consistently more alkaline, having higher pH values, than those at the Lauderick site.

In 2003 and 2004 at Lauderick Creek, pH values were normal in June, dipped lower in the July–September period and rose in October. In contrast, during 2005, pH levels at the Lauderick site in the same three-month period were elevated. The highest pH measurements recorded each of the three years at the Otter Point Creek site occurred during the months of June – September.

Turbidity

Lauderick Creek 2003 turbidity values (Figure 10) were lowest at the end of July and beginning of August, a low flow period (Figure 4). Similar low values were observed at Otter Point at the end of July and in the beginning of September 2003.

A correspondence can be seen between phytoplankton blooms (Table 1) and four Lauderick Creek turbidity peaks in April 2004. A correlation between blooms of the blue green algae *Microsystis aeruginosa* and two Otter Point turbidity peaks can be seen in May 2004. Otter Point Creek turbidity also spiked after the heavy rainfall July 27th and after Tropical Storm Jean (September 28, 2004; Table 1).

Elevated turbidity values that may be related to phytoplankton blooms in February – April of 2005 can be seen in the 2005 Otter Point Creek turbidity plots (Figure 10). High turbidity levels were also measured at the Lauderick site in the March – April period. High turbidity may also be related to rain events with sediment runoff.

In 2004 especially, and in 2005, the differences in the range of turbidity values observed at the two sites were impressive. Values at the Otter Point Creek site were considerably greater. This is likely due to the shallow depth of the water in which the sonde is deployed.

Chlorophyll

The most striking feature in the 2003 Lauderick Creek chlorophyll plot (Figure 11) was the phytoplankton bloom that occurred in September shortly after Hurricane Isabel. Moderate blooms occurred in April and June at the Otter Point Creek site and a severe bloom formed in December.

The sonde at the Lauderick Creek site measured severe phytoplankton blooms in late March and April of 2004. The largest 2004 bloom at the Otter Point site occurred a month later in May.

The magnitude and structure of the strong April 2005 phytoplankton bloom at the Lauderick Creek was quite similar to the blooms that occurred there in the same time period in 2004.

Chlorophyll concentration is one means of quantifying the amount of algae in water. High levels of chlorophyll indicate eutrophic conditions that can have detrimental effects on the health of living resources. There is an ongoing debate about optimal chlorophyll concentrations and thresholds above which ecosystem health is impacted.

Chlorophyll concentrations of above 50 µg/L represent a significant algal bloom and concentrations above 100 µg/L are evidence of a severe bloom. Some research suggests that harmful effects can occur at chlorophyll concentrations as low as15 µg/L.

In 2005, the counts of chlorophyll records measured at Otter Point Creek and Lauderick Creek respectively were 25,360 and 20,432. Of the 7,994 records collected between March and May 2005 at Otter Point, 2,077, or 25.98% had chlorophyll values that exceeded 15 µg/L. The count of Lauderick Creek records collected during the same period was 6,582. Of those, nearly all (6,370 or 96.78%) had chlorophyll values that exceeded 15 µg/L.

Continuous Monitoring Site	Period	2003	2004	2005
Otter Point Creek				
Total Chlorophyll greater than 15 (µg/L)	Mar. - May	7%	27%	26%
Lauderick Creek				
Total Chlorophyll greater than 15 (µg/L)	Mar. - May	*	58%	97%
		* insufficient data		

Table 4 - 2003, 2004 and 2005 Chlorophyll exceedances at Otter Point Creek and Lauderick Creek

Water Temperature

Examination and comparison of the structures of Lauderick Creek and Otter Point Creek sonde water temperature data (Figure 12) for the past three years revealed that while maximum temperatures were reached in July-August during 2003 and 2005. Interestingly, the maximum 2004 water temperature readings were measured earlier in the year (May 13th through 17th).

Data Access

Bush River continuous monitoring data are archived on the "Eyes on the Bay" website at the location listed below. The interface allows users to query the datasets and produce data charts and data tables at varying time scales. It is also possible to download data.

http://mddnr.chesapeakebay.net/newmontech/contmon/archived_results2.cfm?year=2003

http://mddnr.chesapeakebay.net/newmontech/contmon/archived_results2.cfm?year=2004

http://mddnr.chesapeakebay.net/newmontech/contmon/archived_results2.cfm?year=2005

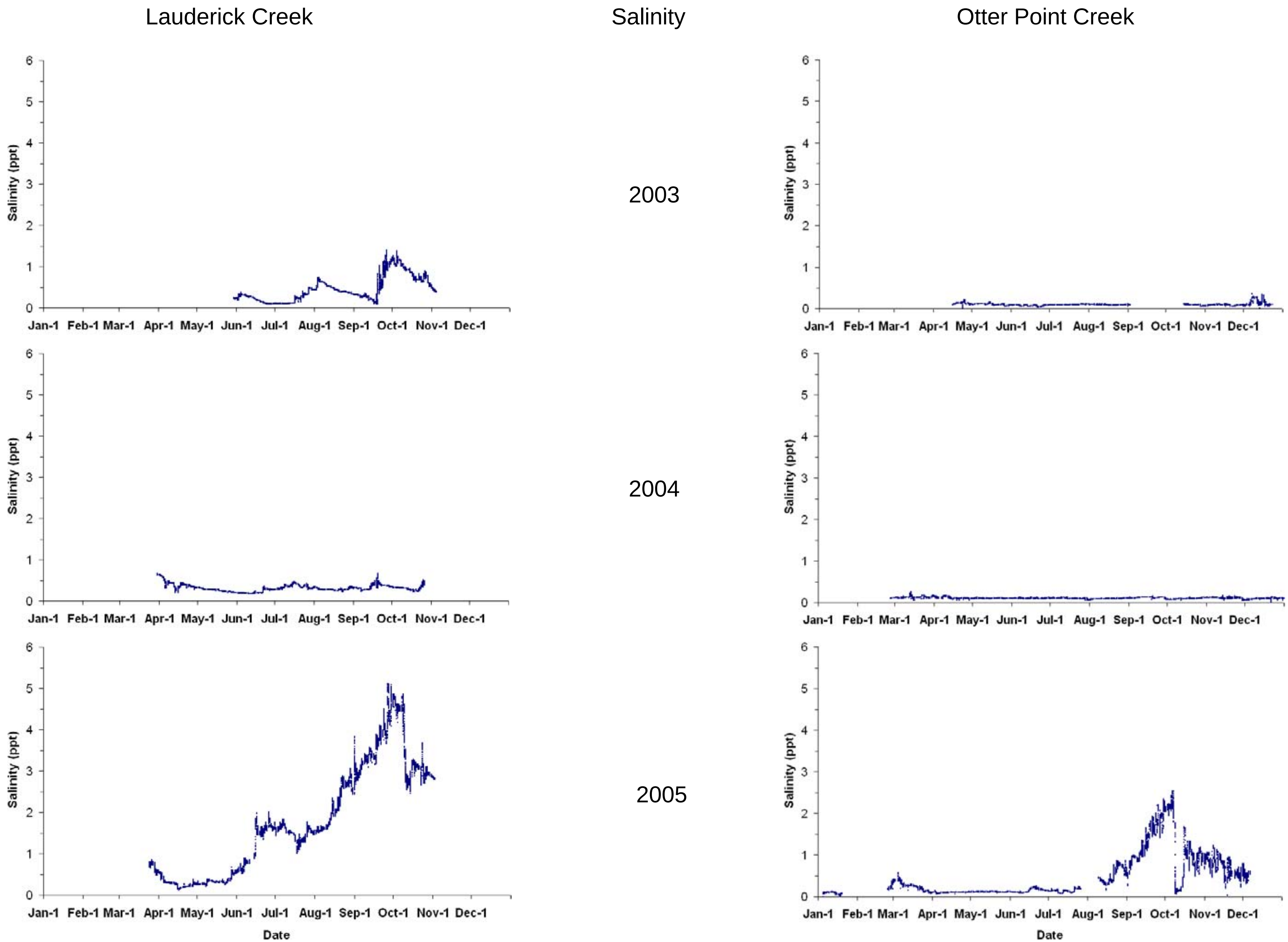

Figure 7 Salinity 2003, 2004, 2005, Continuous Monitoring sonde readings, Lauderick Creek and Otter Point Creek

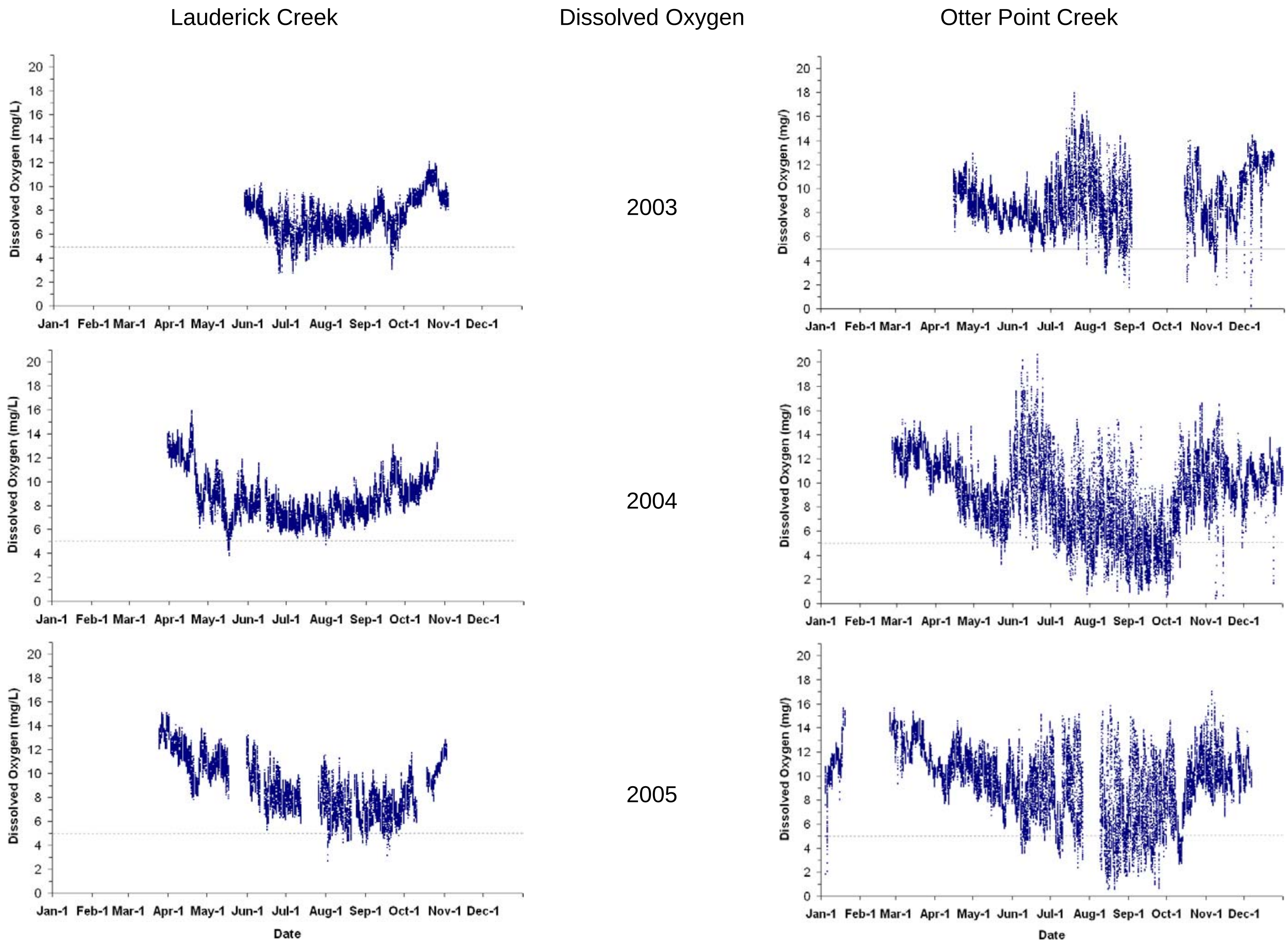

Figure 8 Dissolved Oxygen 2003, 2004 and 2005, Continuous Monitoring sonde readings, Lauderick Creek and Otter Point Creek

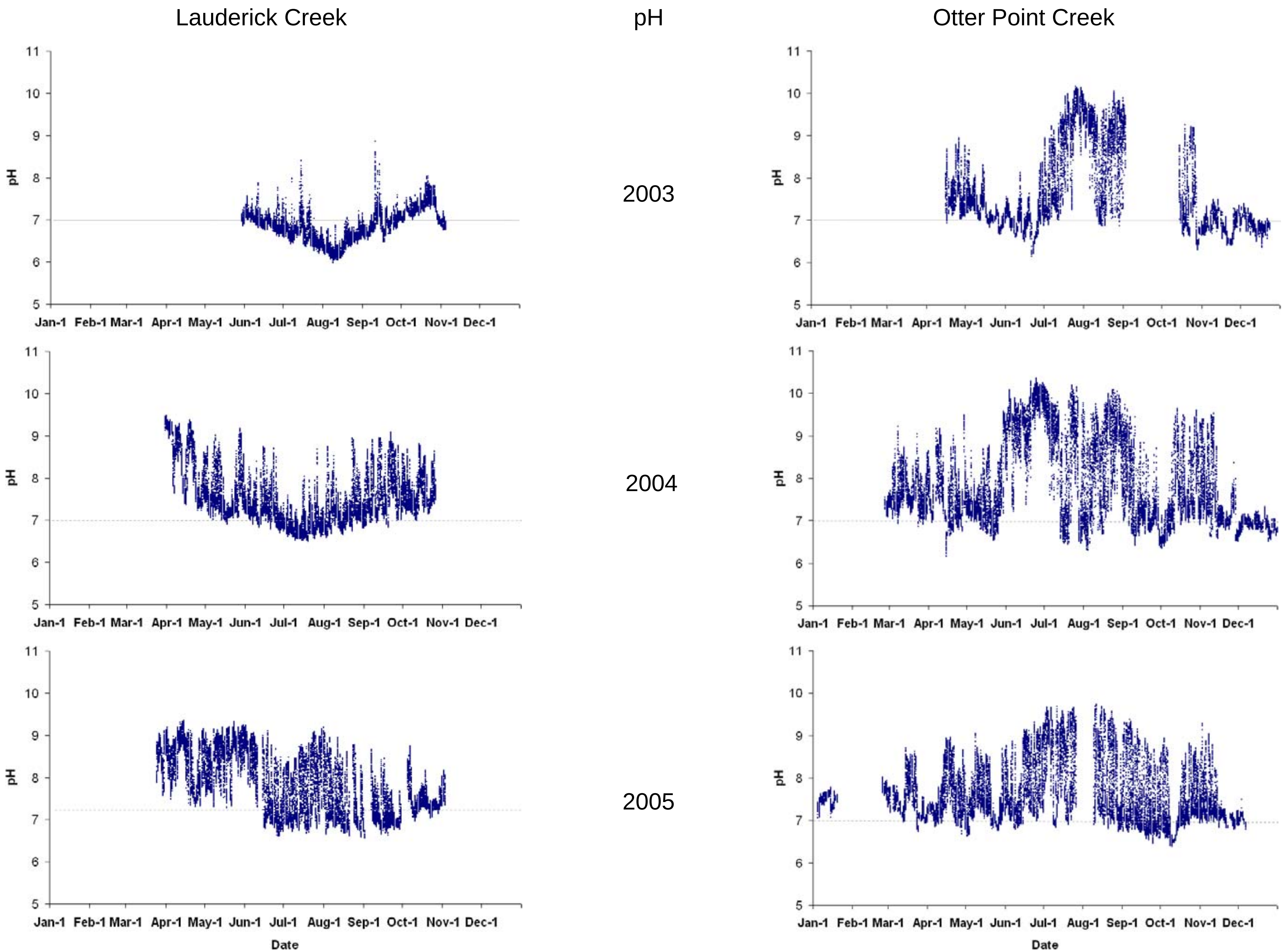

Figure 9 pH 2003, 2004 and 2005, Continuous Monitoring sonde readings. Lauderick Creek and Otter Point Creek

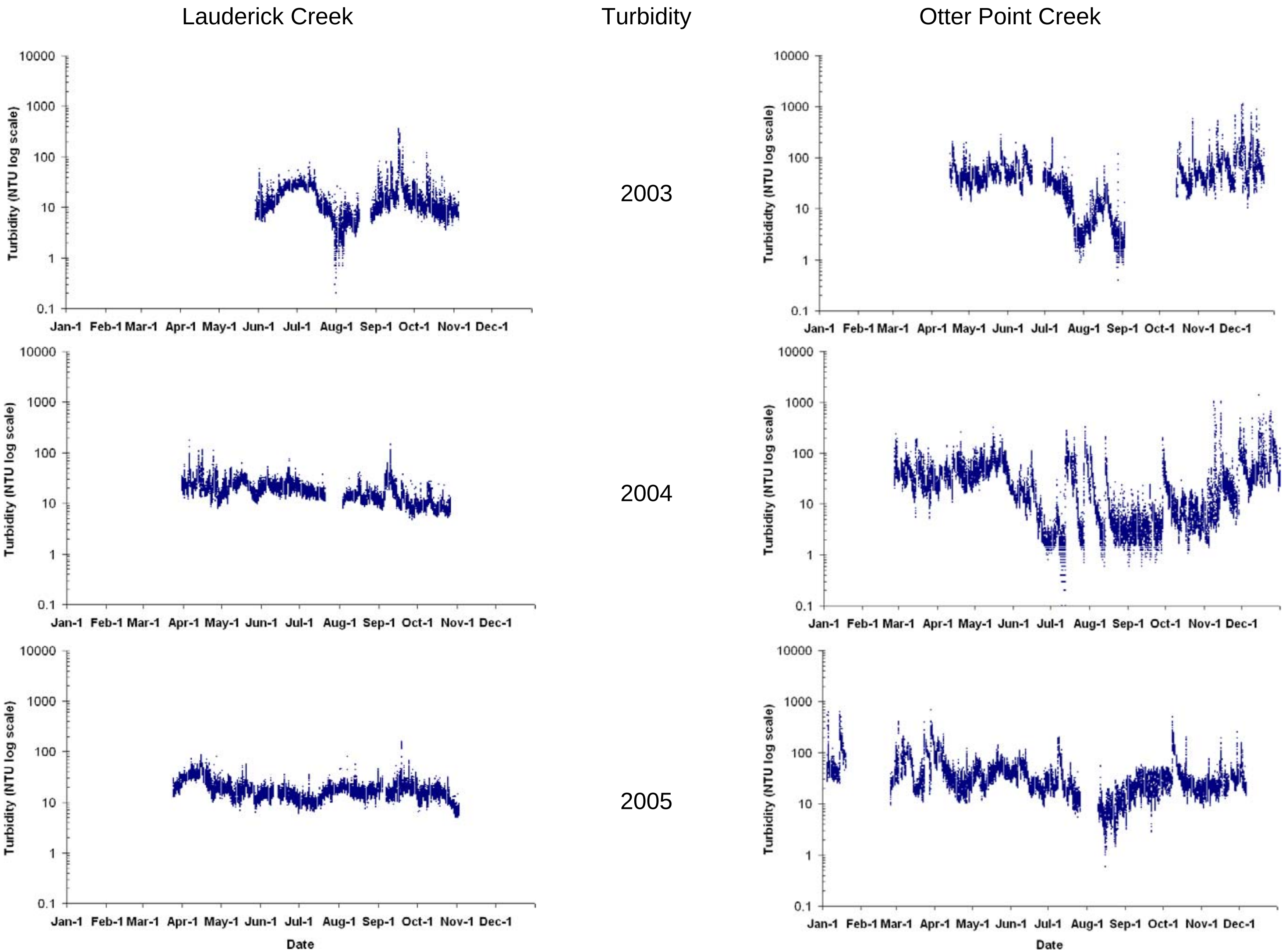

Figure 10 Turbidity 2003, 2004 and 2005, Continuous Monitoring sonde readings, Lauderick Creek and Otter Point Creek

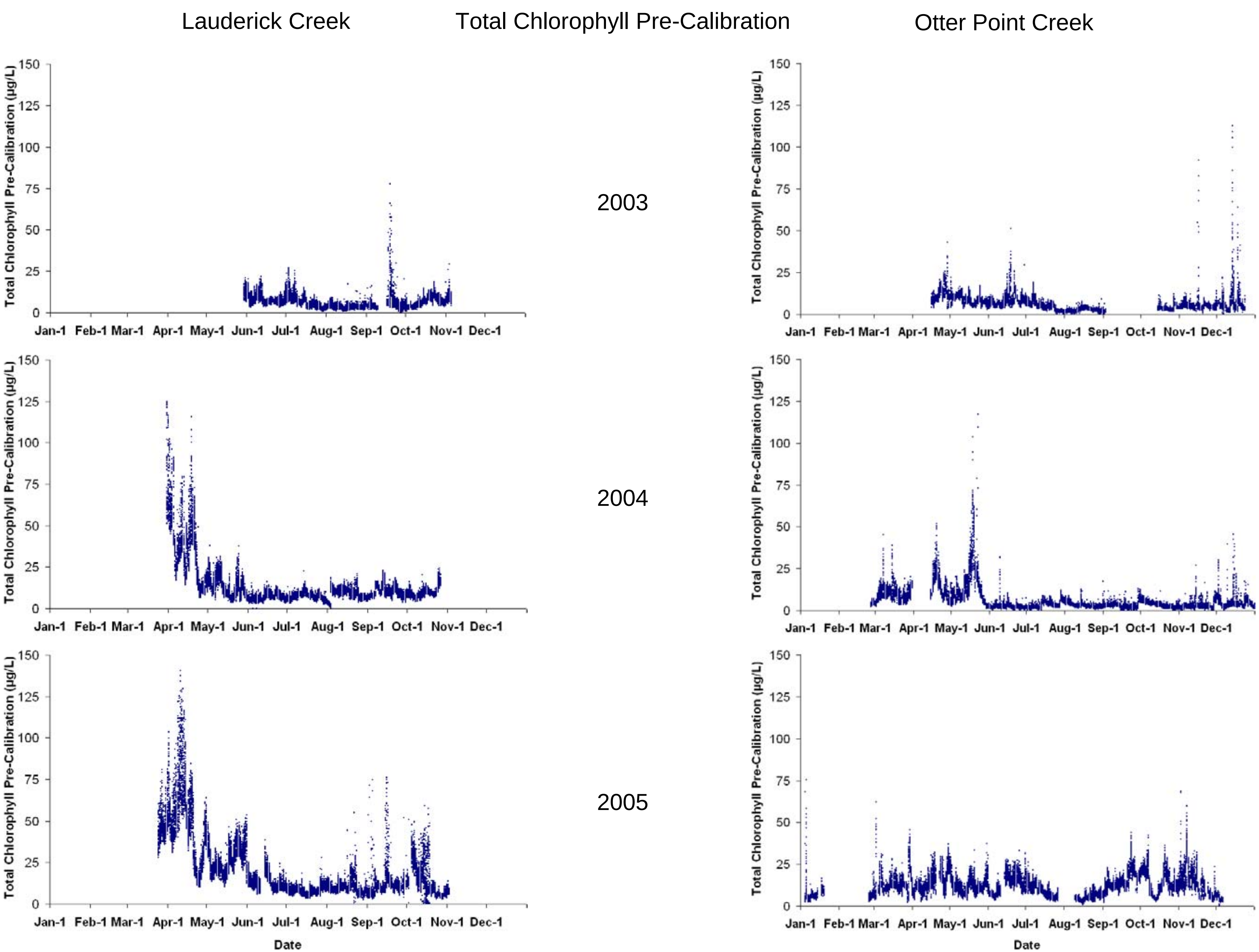

Figure 11 Total Chlorophyll Pre-Calibration 2003, 2004 and 2005, Continuous Monitoring sonde readings, Lauderick Creek and Otter Point Creek

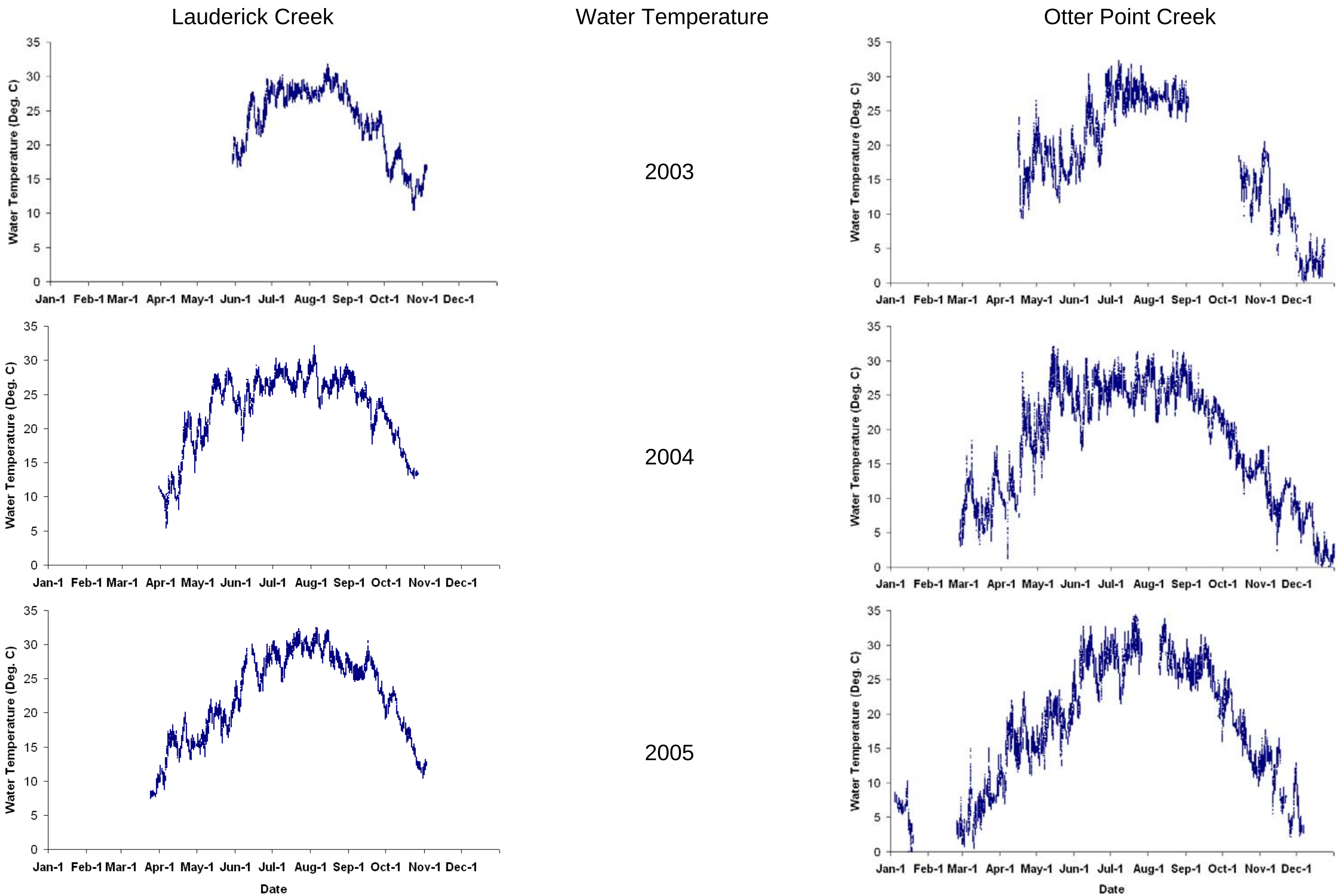

Figure 12 Water Temperature 2003, 2004 and 2005, Continuous Monitoring sonde readings, Lauderick Creek and Otter Point Creek

Calibration Data

Pigments, Suspended Solids and Secchi

Tables 5-9 present pigment (chlorophyll *a*, phaeophytin), total suspended solids, volatile suspended solids and Secchi data for the two Continuous Monitoring sites (Lauderick Creek and Otter Point Creek) and the three DataFlow calibration sites (XJG 2430, XJG4451 and XJG7858).

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
11-Apr-05	0.5	19.440	2.193	14.0	4.7	0.2
3-May-05	0.5	14.450	4.386			0.2
6-Jun-05	0.5	41.870	2.093	16.7	12.7	0.3
7-Jul-05	0.5	36.880	4.286	17.3	10.7	0.3
1-Aug-05	0.5	48.840	0.349	24.7	17.3	0.3
1-Sep-05	0.5	56.820	11.210	42.0	14.7	0.2
4-Oct-05	0.5	72.770	13.760	41.3	16.0	0.2

Table 5 DataFlow Calibration Station XJG2340 - 2005 Pigment, Suspended Solids and Secchi Disk values

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
24-Mar-05	1.0	36.630	6.280	29.0	10.0	0.2
5-Apr-05	1.0	43.920	12.330	33.8	10.0	0.2
11-Apr-05	0.5	112.100	16.070	38.0	12.0	0.1
19-Apr-05	1.0	57.810	17.540	38.7	10.7	0.3
3-May-05	0.5	23.920	12.710	16.0	7.3	0.3
3-May-05	1.0	29.900	17.720	35.0	9.0	0.2
17-May-05	1.0	32.400	8.423	34.7	9.3	0.3
31-May-05	1.0	29.900	6.380	21.3	9.3	0.3
6-Jun-05	0.5	35.510	3.215	13.5	8.5	0.5
14-Jun-05	1.0	36.380	7.227	16.0	7.3	
28-Jun-05	1.0	21.930	5.981	15.3	5.3	0.5
7-Jul-05	0.5	18.940	4.087	13.3	6.0	0.5
12-Jul-05	1.0	22.930	4.984	13.3	5.3	0.6
26-Jul-05	1.0	41.870	3.663	15.0	13.0	0.3
1-Aug-05	0.5	36.880	2.891	21.3	12.0	0.3
9-Aug-05	1.0	50.840	5.333	20.0	8.0	0.4
23-Aug-05	1.0	32.400	5.632	24.0	7.3	0.4
1-Sep-05	0.5	18.940	6.878	14.0	6.7	0.4
6-Sep-05	1.0	35.140	8.822	26.0	9.0	0.4
20-Sep-05	1.0	38.880	1.420	25.0	7.0	0.3
4-Oct-05	0.5	34.390	6.080	35.3	12.7	0.4
4-Oct-05	1.0	55.320	2.592	20.0	10.7	0.2
18-Oct-05	1.0	17.440	2.791	30.7	6.0	0.5
2-Nov-05	1.0	21.430	0.897	12.7	6.7	0.6

Table 6 Lauderick Creek (XJG4337) - 2005 Pigment, Suspended Solids and Secchi Disk values

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
4-Jan-05	0.1	6.728	3.738	69.0	10.0	0.2
19-Jan-05	0.3			34.0	14.0	
19-Jan-05	0.3			34.0	12.0	
24-Feb-05	0.3	5.981	0.822	27.0	8.0	0.3
24-Feb-05	0.3	4.486	0.000	21.0	7.0	
8-Mar-05	0.2	13.460	3.289	62.0	12.0	0.1
24-Mar-05	0.4	5.981	0.000	100.0	16.0	0.1
24-Mar-05	0.4			88.0	16.0	
5-Apr-05	0.2			52.0	12.0	0.1
11-Apr-05	0.5	13.460	2.243	18.7	4.7	0.3
19-Apr-05	0.3	16.450	4.486	39.3	8.0	0.4
19-Apr-05	0.3	16.450	9.719	144.0	18.0	
3-May-05	0.1	13.080	1.962	38.7	8.7	0.2
3-May-05	0.5	3.987	1.944	16.0	4.7	0.3
17-May-05	0.1	14.450	4.386	34.0	8.0	0.2
31-May-05	0.3	17.940	5.084	40.0	10.0	0.2
31-May-05	0.3	17.190	4.261	31.0	7.0	
6-Jun-05	0.5	15.950	2.193	18.7	7.3	0.3
14-Jun-05	0.1	21.680	5.009	26.0	7.0	
28-Jun-05	0.1	20.930	4.710	24.0	8.0	0.2
28-Jun-05	0.1	19.440	3.588	21.0	8.0	
7-Jul-05	0.5	54.330	6.728	29.3	10.7	0.2
12-Jul-05	0.5	39.620	2.766	33.0	9.0	0.3
26-Jul-05	0.1	30.280	7.401	9.0	7.0	0.4
1-Aug-05	0.5	11.960	1.906	8.0	7.0	0.6
9-Aug-05	0.6	52.330	1.047	12.0	9.0	0.3
23-Aug-05	0.3	53.080	1.869	24.0	13.0	0.3
23-Aug-05	0.3	45.600	2.542	25.0	14.0	
1-Sep-05	0.5	54.820	9.021	44.7	12.0	0.1
6-Sep-05	0.5	67.280	9.121	49.0	19.0	0.1
20-Sep-05	0.6	87.470	4.112	30.0	16.0	0.4
20-Sep-05	0.6	93.450	1.271	29.3	16.0	
4-Oct-05	0.1	83.730	9.420	32.0	17.0	0.1
4-Oct-05	0.5	79.250	17.570	46.0	18.0	0.2
18-Oct-05	0.2	38.880	0.199	22.0	9.3	0.4
18-Oct-05	0.2	34.890	0.000	21.3	9.3	
2-Nov-05	0.2	60.310	0.000	18.7	11.3	0.3
1-Dec-05	0.1	6.728	1.121	27.0	8.0	0.2
1-Dec-05	0.1	5.233	1.047	29.0	9.0	
6-Dec-05	0.3	3.987	2.293	12.0	4.0	0.4
6-Dec-05	0.3	4.236	1.869	14.0	5.0	

Table 7 Otter Point Creek (XJG4451) - 2005 Pigment, Suspended Solids and Secchi Disk values

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
11-Apr-05	0.5	66.290	16.400	32.7	8.7	0.2
3-May-05	0.5	36.880	11.960	20.7	8.0	0.3
6-Jun-05	0.5	32.890	3.215	10.0	9.0	0.6
7-Jul-05	0.5	20.430	8.523	18.7	6.7	0.4
1-Aug-05	0.5	68.280	3.240	16.7	13.3	0.3
1-Sep-05	0.5	31.400	10.120	20.0	8.0	0.3
4-Oct-05	0.5	27.410	7.476	12.0	6.7	0.3

Table 8 DataFlow Calibration Station XJG4451 - 2005 Pigment, Suspended Solids and Secchi Disk values.

Date	Sample Depth (m)	Chlorophyll a (µg/l)	Pheophytin (µg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg)	Secchi Disk Depth (m)
11-Apr-05	0.5	19.440	2.193	14.0	4.7	0.2
3-May-05	0.5	14.450	4.386			0.2
6-Jun-05	0.5	41.870	2.093	16.7	12.7	0.3
7-Jul-05	0.5	36.880	4.286	17.3	10.7	0.3
1-Aug-05	0.5	48.840	0.349	24.7	17.3	0.3
1-Sep-05	0.5	56.820	11.210	42.0	14.7	0.2
4-Oct-05	0.5	72.770	13.760	41.3	16.0	0.2

Table 9 DataFlow Calibration Station XJG7856 - 2005 Pigment, Suspended Solids and Secchi Disk values.

Pigment, Nutrient and Suspended Solid samples were collected by DNR at the Continuous Monitoring sites when YSI meters were exchanged. DNR Secchi Disk depth was measured at the same time.

Pigment samples were analyzed at the Maryland Department of Health and Mental Hygiene (DHMH) Environmental Chemistry Division. Suspended Solid and Nutrient samples were analyzed at the University of Maryland's Chesapeake Biological Laboratory (CBL) Nutrient Analytical Services Laboratory (NASL).

For details of how the labs performed the analyses, refer to procedures in the Quality Assurance Project Plan for the Maryland Department of Natural Resources Chesapeake Bay Shallow Water Quality Monitoring Program for the period July 1, 2005 - June 30, 2006 http://mddnr.chesapeakebay.net/eyesonthebay/swm_qapp_2005.pdf

There are several possible reasons for missing parameter values in tables in this report. The measurement was not made. It was not possible to derive a value because a value needed in the calculation was missing. Some values were determined to be "bad" when quality-control/quality-assurance procedures were conducted. All "bad" data values are retained in Maryland DNR data archives but not published in reports.

Nutrient Data

Nutrient data are presented in tables 10-14.

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)
3-May-05	0.5	0.007	0.0050	0.5450	0.88	0.314	0.0020	0.0230	0.0120	0.86	1.97
6-Jun-05	0.5	0.006	0.0007	0.5093	0.89	0.235	0.0030	0.0140	0.0130	0.71	1.33
7-Jul-05	0.5	0.093	0.0050	0.3210	0.77	0.168	0.0060	0.0190	0.0170	0.95	0.86
1-Aug-05	0.5	0.032	0.0020	0.0460	0.48	0.325	0.0030	0.0290	0.0150	2.21	2.02
1-Sep-05	0.5	0.099	0.0490	0.1160	0.71	0.271	0.0030	0.0230	0.0150	3.01	1.51
4-Oct-05	0.5	0.021	0.0850	0.2000	0.64	0.325	0.0050	0.0370	0.0160	2.77	1.63

Table 10 DataFlow Calibration Station XJG2340 - 2005 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	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)
24-Mar-05	1.0	0.028	0.0130	0.7350	1.34				0.0140	2.19	3.85
5-Apr-05	1.0	0.003	0.0140	0.7480	1.23				0.0190	2.56	4.00
11-Apr-05	0.5	0.006	0.0090	0.3960	0.90	0.843	0.0030	0.0820	0.0150	1.06	5.34
19-Apr-05	1.0	0.004	0.0090	0.3190	0.78				0.0270	0.94	5.16
3-May-05	0.5	0.015	0.0050	0.2090	0.63	0.514	0.0030	0.0450	0.0180	0.37	3.16
3-May-05	1.0	0.059	0.0070	0.1920	0.73				0.0170	0.42	4.01
17-May-05	1.0	0.009	0.0002	0.0038	0.39				0.0160	0.37	3.74
31-May-05	1.0	0.014	0.0002	0.0088	0.37				0.0130	0.23	3.77
6-Jun-05	0.5	0.031	0.0008	0.0212	0.48	0.661	0.0060	0.0440	0.0150	0.25	3.78
14-Jun-05	1.0	0.016	0.0110	0.0380	0.62				0.0190	0.09	3.48
28-Jun-05	1.0	0.015	0.0005	0.0235	0.56				0.0190	0.89	2.31
7-Jul-05	0.5	0.004	0.0002	0.0058	0.50	0.392	0.0020	0.0380	0.0140	0.66	2.49
12-Jul-05	1.0	0.010	0.0009	0.0121	0.38				0.0130	0.56	2.93
26-Jul-05	1.0	0.008	0.0002	0.0038	0.79				0.0220	2.06	3.89
1-Aug-05	0.5	0.003	0.0002	0.0038	0.47	0.744	0.0030	0.0830	0.0170	2.98	4.49
9-Aug-05	1.0	0.023	0.0008	0.0072	0.46				0.0390	3.42	3.40
23-Aug-05	1.0	0.005	0.0002	0.0028	0.38				0.0240	3.69	3.42
1-Sep-05	0.5	0.161	0.0130	0.0410	0.60	0.398	0.0020	0.0270	0.0140	3.38	2.31
6-Sep-05	1.0	0.016	0.0020	0.0090	0.48				0.0320	4.02	3.46
20-Sep-05	1.0	0.069	0.0030	0.0110	0.55				0.0240	3.62	3.28
4-Oct-05	0.5	0.047	0.0250	0.0870	0.59	0.657	0.0040	0.0570	0.0170	3.18	3.21
4-Oct-05	1.0	0.008	0.0220	0.1340	0.54				0.0270	3.33	4.19
18-Oct-05	1.0	0.085	0.0280	0.4020	0.88				0.0130	2.63	2.62
2-Nov-05	1.0	0.010	0.0160	0.5200	0.95				0.0150	2.43	2.47

Table 11 Lauderick Creek (XJG4337) - 2005 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	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)
11-Apr-05	0.5	0.007	0.0090	0.7430	1.10	0.598	0.0030	0.0580	0.0150	1.98	3.97
3-May-05	0.5	0.003	0.0060	0.5460	0.98	0.534	0.0030	0.0600	0.0190	0.63	3.13
6-Jun-05	0.5	0.022	0.0030	0.0520	0.47	0.606	0.0040	0.0310	0.0140	0.24	3.40
7-Jul-05	0.5	0.008	0.0004	0.0046	0.33	0.426	0.0030	0.0510	0.0120	0.54	2.64
1-Aug-05	0.5	0.012	0.0002	0.0028	0.48	1.010	0.0040	0.0890	0.0140	2.77	5.73
1-Sep-05	0.5	0.125	0.0080	0.0390	0.58	0.533	0.0020	0.0440	0.0140	3.90	2.86
4-Oct-05	0.5	0.016	0.0380	0.1180	0.54	0.543	0.0030	0.0480	0.0140	3.24	2.73

Table 12 DataFlow Calibration Station XJG4451 - 2005 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	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)
11-Apr-05	0.5	0.029	0.0150	1.1150	1.51	0.288	0.0040	0.0270	0.0190	4.90	1.95
3-May-05	0.5	0.050	0.0140	1.0160	1.50	0.381	0.0030	0.0400	0.0170	4.09	2.47
6-Jun-05	0.5	0.018	0.0100	0.2790	1.04	1.020	0.0040	0.0590	0.0170	1.16	5.68
7-Jul-05	0.5	0.005	0.0070	0.2770	0.75	0.624	0.0020	0.0530	0.0170	1.74	3.65
1-Aug-05	0.5	0.005	0.0020	0.0560	0.62	1.100	0.0030	0.0570	0.0150	3.48	6.95
1-Sep-05	0.5	0.037	0.0040	0.0690	0.66	0.987	0.0020	0.0920	0.0180	4.27	5.76
4-Oct-05	0.5	0.072	0.0140	0.0470	0.54	1.210	0.0110	0.1080	0.0110	4.63	6.88

Table 13 DataFlow Calibration Station XJG7856 - 2005 Nutrient data: Ammonium (NH4), Nitrite (NO2), Nitrate (NO3), Total Dissolved Nitrogen (TDN), Particulate Nitrogen (PN), Phosphate (PO4), Particulate Phosphate), Total Dissolved Nitrogen (TDP), Silicate (SiO4) and Particulate Carbon (PC).

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)
4-Jan-05	0.1	0.495	0.0330	2.0170	3.04				0.0930		
19-Jan-05	0.3	0.131	0.0140	1.4460	2.25				0.1010		
19-Jan-05	0.3	0.131	0.0130	1.4570	2.30				0.1030		
24-Feb-05	0.3	0.061	0.0120		2.59				0.0100		
24-Feb-05	0.3	0.054	0.0110		2.55				0.0080		
8-Mar-05	0.2	0.140	0.0150	2.1850	2.92				0.0670		
24-Mar-05	0.4	0.171	0.0100	1.0100	1.94				0.1060		
24-Mar-05	0.4	0.213	0.0250	0.9750	1.93				0.1000		
5-Apr-05	0.2	0.073	0.0090	0.7830	1.32				0.0310	3.07	2.44
11-Apr-05	0.5	0.006	0.0130	1.7370	2.26	0.266	0.0040	0.0280	0.0150	5.23	2.02
19-Apr-05	0.3	0.008	0.0140	1.7160	2.23				0.0130	4.72	4.41
19-Apr-05	0.3	0.004	0.0140	1.6560	2.92				0.1790		
3-May-05	0.1	0.064	0.0170	1.3830	1.87				0.0150	3.83	2.94
3-May-05	0.5	0.062	0.0120	1.5580	1.99	0.169	0.0010	0.0200	0.0130	4.88	1.24
17-May-05	0.1	0.022	0.0200	0.9140	1.37				0.0180	2.94	2.92
31-May-05	0.3	0.069	0.0210	0.9630	1.42				0.0140	3.16	3.08
31-May-05	0.3	0.057	0.0210	0.9790							
6-Jun-05	0.5	0.029	0.0260	1.2040	1.63	0.394	0.0030	0.0380	0.0170	4.47	2.20
14-Jun-05	0.1	0.336	0.0530	0.6930	1.58				0.0220	4.55	2.52
28-Jun-05	0.1	0.117	0.0280	0.3930	1.29				0.0290	1.33	2.51
28-Jun-05	0.1	0.117	0.0290	0.4110	1.32				0.0760		
7-Jul-05	0.5	0.016	0.0110	0.3440	0.74	0.745	0.0050	0.0690	0.0170	2.32	4.26
12-Jul-05	0.5	0.052	0.0210	0.3360	0.93				0.0220	1.92	4.00
26-Jul-05	0.1	0.029	0.0020	0.0100	0.71				0.0170	2.35	3.03
1-Aug-05	0.5	0.045	0.0060	0.0280	0.57	0.409	0.0040	0.0330	0.0140	1.78	2.23
9-Aug-05	0.6	0.087	0.0040	0.0280	0.68				0.0190	3.04	3.84
23-Aug-05	0.3	0.008	0.0030	0.0150	0.57				0.0180	3.49	5.93
23-Aug-05	0.3	0.003	0.0005	0.0035							
1-Sep-05	0.5	0.055	0.0120	0.2730	0.83	0.888	0.0030	0.0690	0.0150	3.48	4.74
6-Sep-05	0.5	0.008	0.0003	0.0097	0.46				0.0260	3.63	9.21
20-Sep-05	0.6	0.012	0.0007	0.0163	0.50				0.0140	4.50	7.75
20-Sep-05	0.6	0.008	0.0004	0.0096	0.51				0.0230		
4-Oct-05	0.1	0.062	0.0110	0.0990	0.56				0.0230	4.28	6.62
4-Oct-05	0.5	0.136	0.0080	0.1010	0.70	1.340	0.0020	0.1050	0.0140	4.36	7.69
18-Oct-05	0.2	0.062	0.0540	0.8160	1.54				0.0180	3.96	3.62
18-Oct-05	0.2	0.060	0.0470	0.8250							
2-Nov-05	0.2	0.006	0.0120	0.6100	1.17				0.0170	3.87	4.48
1-Dec-05	0.1	0.130	0.0120	0.9580	1.71				0.0830		
1-Dec-05	0.1	0.130	0.0120	0.9880	1.72				0.0820		
6-Dec-05	0.3	0.154	0.0120	0.9360	1.54				0.0380		
6-Dec-05	0.3	0.153	0.0120	0.9530	1.57				0.0370		

Table 14 Otter Point Creek (XJG7035) - 2005 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).

Limits of Detection

Table 15 lists the limits of detection for nutrient and suspended solids (sediments).

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/			

Table 15 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 Chesapeake Biological Laboratory 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.

Water Column

Ambient water quality parameter data, collected concurrently with nutrient and pigments, are located in Tables 16 - 20.

Date	Depth (m)	Specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
3-May-05	0.5	966	9.6	8.00	0.16	14.6
3-May-05	1.0	974	9.6	8.00	0.17	14.5
3-May-05	1.2	974	9.6	8.00	0.17	14.5
6-Jun-05	0.5	3480	9.2	7.30	1.56	23.3
6-Jun-05	1.0	3510	9.5	7.20	1.57	23.2
6-Jun-05	1.5	3590	9.4	7.30	1.62	23.0
6-Jun-05	2.0	3690	8.8	7.20	1.68	22.3
6-Jun-05	2.4	3640	8.2	7.10	1.65	21.7
7-Jul-05	0.5	5260	6.8	6.70	2.57	27.0
7-Jul-05	1.0	5260	6.7	6.70	2.57	27.0
7-Jul-05	1.5	5300	6.6	6.70	2.60	27.0
7-Jul-05	2.0	5520	6.6	6.70	2.72	26.9
7-Jul-05	2.5	5520	6.6	6.70	2.72	26.9
1-Aug-05	0.5	3970	9.0	7.40	1.83	29.0
1-Aug-05	1.0	3780	8.1	8.20	1.73	28.4
1-Aug-05	1.5	3820	8.3	7.30	1.75	28.2
1-Aug-05	2.0	3860	7.7	6.90	1.77	28.0
1-Sep-05	0.5	6810	6.2	7.20	3.48	26.3
1-Sep-05	1.0	6820	6.1	7.20	3.48	26.3
1-Sep-05	1.5	6980	5.9	7.20	3.58	26.2
1-Sep-05	1.7	7040	5.8	7.20	3.61	26.2
4-Oct-05	0.5	10340	8.3	7.50	5.60	21.3
4-Oct-05	1.0	10340	8.4	7.50	5.60	21.3
4-Oct-05	1.5	10400	8.2	7.50	5.63	21.3
4-Oct-05	2.0	10713	8.1	7.40	5.82	21.3
4-Oct-05	2.4	11530	7.5	7.30	6.33	21.4

Table 16 DataFlow Calibration Station XJG2340 - 2005 YSI 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)
24-Mar-05	0.5	1460	11.3	7.81	0.43	7.3
24-Mar-05	1.0	1496	12.1	7.88	0.45	7.4
24-Mar-05	1.0	1460	11.3	7.81	0.43	7.3
24-Mar-05	1.5	1490	11.2	7.81	0.45	7.3
24-Mar-05	1.8	1490	11.2	7.31	0.45	7.3
5-Apr-05	0.5	679	12.3	8.20	0.01	10.5
5-Apr-05	1.0	672	12.0	7.84	0.00	10.3
5-Apr-05	1.0	682	11.9	8.08	0.01	10.1
5-Apr-05	1.8	679	11.6	8.00	0.01	10.0
11-Apr-05	0.5	580	10.9	9.00	0.00	15.9
11-Apr-05	1.0	580	10.9	9.00	0.00	15.9
11-Apr-05	1.5	581	10.6	9.00	0.00	15.8
11-Apr-05	1.7	584	10.6	8.90	0.00	15.8
19-Apr-05	0.5	384	11.6	9.10	0.00	17.6
19-Apr-05	1.0	388	11.0	8.97	0.00	17.2
19-Apr-05	1.0	370	11.6	8.98	0.00	17.2
19-Apr-05	1.5	388	10.3	8.79	0.00	17.0
3-May-05	0.5	569	9.7	8.60	0.00	14.3
3-May-05	1.0	542	10.2	7.90	0.00	14.5
3-May-05	1.0	543	9.9	8.18	0.00	14.3
3-May-05	1.0	569	9.7	8.60	0.00	14.3
17-May-05	0.5	678	10.6	8.95	0.01	20.8
17-May-05	1.0	672	10.3	8.53	0.00	20.3
17-May-05	1.0	681	9.6	8.68	0.01	20.1
17-May-05	1.7	684	9.0	8.32	0.01	19.7
31-May-05	0.5	1121	10.0	8.67	0.25	20.7
31-May-05	1.0	1133	10.0	8.64	0.25	20.7
31-May-05	1.0	1132	10.5	8.51	0.25	20.7
31-May-05	1.7	1143	9.9	8.62	0.26	20.6
6-Jun-05	0.5	1530	10.5	9.10	0.47	24.3
6-Jun-05	1.0	1650	10.4	9.00	0.54	23.6
6-Jun-05	1.5	1720	9.7	8.60	0.58	23.3
6-Jun-05	1.7	1720	9.6	8.50	0.58	23.3
14-Jun-05	0.5	1750	6.7	7.45	0.59	28.4
14-Jun-05	1.0	1770	6.3	7.33	0.60	28.2
14-Jun-05	1.0	1789	7.0	7.45	0.61	28.5
28-Jun-05	0.5	3120	8.0	7.39	1.35	28.0
28-Jun-05	1.0	3134	7.5	7.11	1.36	27.0
28-Jun-05	1.0	3090	7.0	7.16	1.34	26.9
28-Jun-05	1.5	3090	6.4	7.06	1.34	26.8
7-Jul-05	0.5	3320	7.2	7.10	1.47	27.3
7-Jul-05	1.0	3320	7.2	7.00	1.47	27.3
7-Jul-05	1.5	3320	7.2	7.00	1.47	27.3

Table 17 Lauderick Creek (XJG4337) - 2005 YSI 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). (Continued on next page).

Table 17 Lauderick Creek, continued

Date	Depth (m)	Specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
12-Jul-05	0.5	2870	8.8	7.80	1.21	27.4
12-Jul-05	1.0	2940	9.1	7.94	1.25	27.3
12-Jul-05	1.0	2880	8.4	7.89	1.22	27.1
12-Jul-05	1.5	2890	7.7	7.63	1.23	27.0
12-Jul-05	1.9	2890	7.2	7.78	1.23	26.9
26-Jul-05	0.5	2880	8.8	8.60	1.22	29.1
26-Jul-05	1.0	3010	7.8	7.80	1.29	29.0
26-Jul-05	1.0	2970	6.7	7.40	1.27	28.9
26-Jul-05	1.7	3240	3.3	6.70	1.42	28.4
1-Aug-05	0.5	2980	10.2	9.10	1.28	29.6
1-Aug-05	1.0	2990	8.3	8.40	1.28	28.3
1-Aug-05	1.3	2990	7.6	8.20	1.28	28.2
9-Aug-05	0.5	2990	6.2	7.19	1.28	28.3
9-Aug-05	1.0	2990	6.1	7.19	1.28	28.3
9-Aug-05	1.0	3155	6.4	7.08	1.37	28.4
9-Aug-05	1.5	3000	6.1	7.17	1.29	28.3
9-Aug-05	2.0	3000	6.0	7.17	1.29	28.3
23-Aug-05	0.5	5150	8.6	8.23	2.51	28.0
23-Aug-05	1.0	5160	8.4	8.07	2.52	27.8
23-Aug-05	1.0	5284	8.6	8.24	2.59	27.9
23-Aug-05	1.7	5170	7.3	7.70	2.52	27.5
1-Sep-05	0.5	5630	5.2	7.10	2.79	25.9
1-Sep-05	1.0	5640	5.2	7.30	2.79	25.9
6-Sep-05	0.5	5860	7.2	7.26	2.92	25.2
6-Sep-05	1.0	5870	7.0	7.35	2.93	25.2
6-Sep-05	1.0	6060	7.6	7.28	3.04	25.2
6-Sep-05	1.5	5820	6.4	7.06	2.90	25.0
6-Sep-05	2.2	5810	6.1	7.05	2.89	24.9
20-Sep-05	0.5	7040	7.5	7.36	3.61	27.2
20-Sep-05	1.0	7350	6.1	6.99	3.80	26.8
20-Sep-05	1.0	7270	5.8	7.04	3.75	26.6
20-Sep-05	1.5	7430	4.4	6.87	3.84	26.3
20-Sep-05	1.9	7440	4.6	6.89	3.85	26.3
4-Oct-05	0.5	8250	9.5	8.10	4.33	22.1
4-Oct-05	0.5	8326	8.2	7.40	4.38	21.7
4-Oct-05	1.0	8338	8.6	7.50	4.39	21.6
4-Oct-05	1.0	8276	10.0	8.05	4.35	21.8
4-Oct-05	1.0	8260	9.5	8.10	4.34	22.0
4-Oct-05	1.6	8525	7.1	7.20	4.50	21.7
4-Oct-05	1.6	8300	9.0	7.90	4.36	21.8
18-Oct-05	0.5	5950	9.6	7.75	2.97	17.4
18-Oct-05	1.0	5940	9.5	7.67	2.97	17.1
18-Oct-05	1.0	5828	9.5	7.71	2.90	17.3
18-Oct-05	1.5	5960	9.4	7.56	2.98	17.0
2-Nov-05	0.5	5380	10.8	7.95	2.64	12.5
2-Nov-05	1.0	5193	12.1	7.74	2.53	12.8
2-Nov-05	1.0	5380	10.7	7.93	2.64	12.5
2-Nov-05	1.3	5380	10.7	7.94	2.64	12.5

Date	Depth (m)	Specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
11-Apr-05	0.5	506	11.1	8.70	0.00	14.9
11-Apr-05	1.0	526	11.0	8.70	0.00	14.9
11-Apr-05	1.5	525	10.9	8.70	0.00	14.8
11-Apr-05	2.0	528	10.8	8.70	0.00	14.8
11-Apr-05	2.5	532	10.8	8.60	0.00	14.8
3-May-05	0.5	338	10.1	9.00	0.00	14.4
3-May-05	1.0	349	9.8	8.80	0.00	14.3
3-May-05	1.5	355	9.8	8.80	0.00	14.3
6-Jun-05	0.5	1570	10.9	9.10	0.49	23.6
6-Jun-05	1.0	1670	11.0	9.10	0.55	23.3
6-Jun-05	1.5	1780	10.6	8.90	0.61	22.8
6-Jun-05	2.0	2050	10.1	8.60	0.76	22.8
6-Jun-05	2.5	2230	9.7	8.20	0.86	22.6
7-Jul-05	0.5	3490	7.8	7.60	1.56	27.3
7-Jul-05	1.0	3490	7.8	7.60	1.56	27.3
7-Jul-05	1.5	3490	7.8	7.50	1.56	27.3
7-Jul-05	2.0	3490	7.7	7.50	1.56	27.3
7-Jul-05	2.5	3490	7.7	7.50	1.56	27.3
1-Aug-05	0.5	2510	11.1	9.30	1.01	28.9
1-Aug-05	1.0	2320	10.6	9.30	0.91	28.3
1-Aug-05	1.5	2400	9.4	9.00	0.95	28.1
1-Aug-05	2.1	2550	8.9	8.80	1.04	27.9
1-Sep-05	0.5	5210	6.1	7.20	2.54	26.1
1-Sep-05	1.0	5210	6.1	7.20	2.54	26.1
1-Sep-05	1.5	5210	5.9	7.20	2.54	26.1
1-Sep-05	2.0	5200	5.8	7.30	2.54	26.1
4-Oct-05	0.5	8549	8.9	7.80	4.51	21.1
4-Oct-05	1.0	8570	9.0	7.80	4.52	21.1
4-Oct-05	1.5	8855	8.3	7.70	4.70	21.0
4-Oct-05	2.0	10232	7.0	7.20	5.53	21.1
4-Oct-05	2.3	10245	7.0	7.20	5.54	21.1

Table 18 DataFlow Calibration Station XJG4451 - 2005 YSI 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)
4-Jan-05	0.1	229	8.4	6.80	0.00	6.9
4-Jan-05	0.1	201	8.8	6.81	0.00	7.2
19-Jan-05	0.3	152	15.4	7.56	0.00	1.2
19-Jan-05	0.3	156	14.2	7.00	0.00	1.3
19-Jan-05	0.3	152	15.4	7.56	0.00	1.2
24-Feb-05	0.3	368	14.0	7.75	0.00	4.4
24-Feb-05	0.3	383	12.9	7.41	0.00	4.3
24-Feb-05	0.3	368	14.0	7.75	0.00	4.4
8-Mar-05	0.2	507	11.3	7.24	0.00	8.6
8-Mar-05	0.2	526	10.6	7.30	0.00	8.6
24-Mar-05	0.4	332	11.2	6.92	0.00	6.1
24-Mar-05	0.4	358	11.5	7.40	0.00	6.5
24-Mar-05	0.4	358	11.5	7.40	0.00	6.5
5-Apr-05	0.2	159	10.4	7.29	0.00	13.6
5-Apr-05	0.2	169	9.9	7.02	0.00	13.4
11-Apr-05	0.5	185	9.5	7.50	0.00	16.6
11-Apr-05	1.0	185	9.5	7.40	0.00	16.7
19-Apr-05	0.3	217	11.1	8.42	0.00	17.1
19-Apr-05	0.3	205	12.1	7.84	0.00	17.2
19-Apr-05	0.3	217	11.1	8.42	0.00	17.1
3-May-05	0.1	237	9.4	7.40	0.00	13.8
3-May-05	0.1	232	9.9	7.42	0.00	13.8
3-May-05	0.5	224	8.8	8.00	0.00	12.2
17-May-05	0.1	260	8.8	7.68	0.00	20.4
17-May-05	0.1	250	9.5	7.50	0.00	20.2
31-May-05	0.3	252	8.3	7.33	0.00	20.0
31-May-05	0.3	244	7.7	7.43	0.00	20.0
31-May-05	0.3	244	7.7	7.43	0.00	20.0
6-Jun-05	0.5	211	8.2	7.60	0.00	24.4
6-Jun-05	0.7	211	7.7	7.40	0.00	23.9
14-Jun-05	0.1	228	5.4	7.25	0.00	28.5
14-Jun-05	0.1	234	6.1	7.29	0.00	28.6
28-Jun-05	0.1	343	6.5	7.69	0.00	26.9
28-Jun-05	0.1	340	6.6	7.65	0.00	26.5
28-Jun-05	0.1	340	6.6	7.65	0.00	26.5
7-Jul-05	0.5	380	8.8	8.90	0.00	26.7
12-Jul-05	0.5	200	11.2	8.70	0.00	28.0
12-Jul-05	0.5	263	11.6	9.06	0.00	29.3
26-Jul-05	0.1	376	3.8	7.60	0.00	28.5
26-Jul-05	0.1	134	4.5	7.70	0.00	28.6
1-Aug-05	0.5	412	7.3	8.60	0.00	27.3
9-Aug-05	0.6	872	9.3	9.44	0.11	27.8
9-Aug-05	0.6	888	3.1	7.04	0.12	26.8

Table 19 Otter Point Creek (XJG7035) - 2005 YSI 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). (Continued next page).

Table 19 Otter Point Creek, continued from previous page

Date	Depth (m)	Specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
23-Aug-05	0.3	1530	10.5	9.16	0.47	28.7
23-Aug-05	0.3	1324	6.2	7.81	0.36	26.3
23-Aug-05	0.3	1324	6.2	7.81	0.36	26.3
1-Sep-05	0.5	1290	6.8	7.60	0.34	25.6
6-Sep-05	0.5	2830	10.2	8.21	1.19	27.0
6-Sep-05	0.5	1900	8.3	8.62	0.68	25.4
20-Sep-05	0.6	2840	10.3	8.30	1.20	27.0
20-Sep-05	0.6	2830	10.2	8.21	1.19	27.0
20-Sep-05	0.6	2840	10.3	8.30	1.20	27.0
4-Oct-05	0.1	4068	11.0	7.90	1.89	22.8
4-Oct-05	0.1	4100	10.9	8.20	1.91	20.9
4-Oct-05	0.5	4115	7.8	7.10	1.92	21.2
18-Oct-05	0.2	2030	10.0	7.73	0.75	18.6
18-Oct-05	0.2	1897	10.6	7.49	0.67	10.5
18-Oct-05	0.2	1897	10.6	7.49	0.67	10.5
2-Nov-05	0.2	2120	10.8	7.62	0.80	12.3
1-Dec-05	0.1	1039	9.7	6.95	0.20	8.5
1-Dec-05	0.1	1075	9.1	7.01	0.22	8.5
1-Dec-05	0.1	1039	9.7	6.95	0.20	8.5
6-Dec-05	0.3	1300	8.3	7.12	0.35	3.5
6-Dec-05	0.3	1210	10.4	6.93	0.30	3.1
6-Dec-05	0.3	1210	10.4	6.93	0.30	3.1

Date	Depth (m)	Specific Conductance (µS/cm)	D.O. (mg/l)	pH	Salinity (psu)	Water Temperature (°C)
11-Apr-05	0.5	187	8.9	7.40	0.00	16.5
11-Apr-05	1.0	187	8.9	7.40	0.00	16.2
11-Apr-05	1.2	187	8.9	7.30	0.00	16.0
3-May-05	0.5	255	8.9	8.20	0.00	13.5
6-Jun-05	0.5	300	11.1	9.30	0.00	25.8
6-Jun-05	1.0	280	9.8	8.70	0.00	23.7
7-Jul-05	0.5	1030	8.4	8.30	0.20	26.4
7-Jul-05	1.0	1280	7.3	7.80	0.33	26.5
1-Aug-05	0.5	650	12.4	9.50	0.00	30.9
1-Sep-05	0.5	2370	7.5	7.80	0.94	26.1
4-Oct-05	0.5	5186	9.2	7.50	2.53	21.4
4-Oct-05	0.8	4920	8.1	7.20	2.38	21.3

Table 20 DataFlow Calibration Station XJG7856 - 2005 YSI 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

Overview of 2005 data collection

Bush River water quality mapping data were collected monthly. Water quality mapping crews collected surface data every four seconds aboard a moving boat, creating thousands of data points in a daily cruise. This allowed for the creation of highly detailed spatial maps of water quality. More information about 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 13-19) 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. Nutrient samples (Table 10-14) were analyzed at the University of Maryland Chesapeake Biological Laboratory.

Overall results show that surface dissolved oxygen levels were above five mg/L during collection, with areas of 5-10 mg/L occurring from May through October. Temporal standardization of water quality mapping data with continuous monitoring data indicates that portions of these areas deviated below five mg/L during early morning hours. Turbidities were high throughout the river from May through October with higher values observed upriver. High turbidities resulted in low light availability in the water column. Ninety-five percent of chlorophyll values measured during water quality mapping throughout the Bush River were less than 20 µg/L. Only four tenths of one percent (0.37%) of the observations were greater than the State narrative criteria of 50 µg/L chlorophyll. Water quality mapping employed the same YSI 6600™ fluorometer that was used for continuous monitoring and was therefore unable to detect blooms of blue-green algae. Maryland DNR is currently investigating new technologies to better monitor blue-green blooms. Water quality maps can be obtained through the Eyes on the Bay website at: http://mddnr.chesapeakebay.net/sim/dataflow_data.cfm.

Water quality mapping cruises, conducted during a single day over large spatial areas, provide an intensive view of water quality conditions throughout a water body. However, this strength is complimented by the inability of the system to detect changes over short time periods. This is especially problematic when dealing with dissolved oxygen, which can vary widely during the course of a single day. In addition, these mapping cruises only collect surface data while most anoxic and hypoxic conditions tend to occur in deeper water. Therefore, analyzing data from all three monitoring programs (water quality mapping and continuous monitoring, as well as fixed station sampling, which is not covered in this report) are essential for a full evaluation of the Bush River.

Three-year comparisons

Dissolved oxygen

Surface dissolved oxygen values were rarely below the five mg/L living resources threshold in 2003, 2004, or 2005. The general trend within all years was for was for dissolved oxygen ranges between 7.5 and 10 mg/L, or even higher, from April through June, followed by expected summer drops, but not below the five mg/L level (Figures 13-32). Dissolved oxygen levels generally rose in the fall (September and October) back to at least the 7.5 to 10 mg/L level.

April dissolved oxygen was generally higher throughout the lower portions of the Bush River in both 2004 and 2005 (Figures 13 and 14). In May of all three years, as the temperature warmed, dissolved oxygen concentrations decreased, but not below critical levels (Figures 15-17). A sizable area at the mouth of Otter Point Creek had slightly lower dissolved oxygen than the rest of the river during May of 2003, perhaps dropping to around five mg/L (Figure 15). Likewise, dissolved oxygen was below 7.5 mg/L over much of the river's surface waters in June and July 2003 (Figures 18 and 21) and July 2004 and 2005 (Figures 22 and 23). Dissolved oxygen below 7.5 mg/L dominated the mouth of the Bush River in August and September of 2004 and 2005 (Figures 25, 26, 28, and 29). Relatively high dissolved oxygen water (greater than 7.5 mg/L) dominated most of the river area in October of all three years (Figures 30-32).

Turbidity

The Bush River is a turbid system, with turbidity values above seven NTU over most of the water quality mapping cruises. Turbidity values of less than 5.5 NTU allow adequate light for Submerged Aquatic Vegetation (SAV) growth at one meter depth. General trends in turbidity over the three-year period were seasonal in nature. The system was more turbid during April (Figures 13 and 14), and then appeared to become clearer during May (Figures 15-17). Greater turbidity recurred in June, especially in Otter Point and Lauderick Creeks (Figures 18-20), and continued through September (Figures 21-29). The water was generally clearer in October (Figures 30-32). Turbidity is usually caused by sediment inflow following rain events or by algal blooms, both of which fluctuate seasonally. Variations on the general trends above were likely caused by variations in rainfall between years (for a discussion of the contribution of algal blooms, see the chlorophyll section below).

April turbidity was about half as severe in 2004 as 2005, with heavy turbidity around the mouth of the Bush River in 2005 (Figures 13 and 14). In May of 2003, heavy turbidity was found in the upper tributaries, including Otter Point Creek (Figure 15), while fairly even, but slightly high (greater than seven NTU), turbidities dominated in May of the following two years (Figures 16 and 17). Similar patterns across years were observed during the remainder of the months (Figures 18-29), except for October, where 2003 turbidities were lower than in previous months (Figure 30). These observations are consistent with high precipitation levels recorded in 2003.

Chlorophyll

The Bush River had moderate chlorophyll levels with occurrences of higher levels in certain areas throughout the three-year period. Overall, algal activity (as indicated by chlorophyll levels) tended to begin in the early spring throughout the mid-section of the Bush River around Lauderick Creek (Figures 14-17). Here, small blooms at or around the 15 µg/L chlorophyll threshold occurred during all three years. Algal activity tended to clear during the early summer (Figures 18-23) and resume during August and into September (Figures 24-29). With the exception of 2005, chlorophyll values were below the 15 µg/L during October.

During April 2005, the only year that chlorophyll data were collected during April, an algal bloom of between 20 and 30 µg/L was indicated, covering most of the central reach of the Bush River. An even larger bloom was in evidence in the mouth of Lauderick Creek (Figure 14). Slightly high chlorophyll values dominated a similar area during May 2004 and 2005 (Figures 16 and 17), while patchy high chlorophyll values were present in the mid-Bush River and in the mouth in May of 2003. Such a pattern may indicate an earlier bloom washing out of the river (Figure 15). Chlorophyll values were below 10 µg/L during June of all three years (Figures 18-20), and the only July exceedance was in 2004 (Figures 21-23). This low-grade bloom (chlorophyll values between 10 and 20 µg/L) occurred in the northern reaches of the river, outside of Otter Point Creek (Figure 22). Similar low-grade blooms were present in the northern and southern reaches in August 2003 (Figure 24), in the northern reaches in August 2004 (Figure 25), but not during August 2005 (Figure 26). September and October were intermittent in bloom occurrence, with low-grade blooms occurring mid-river in September 2004 (Figure 28), in the upper reaches during September 2005 (Figure 29), and more extensively throughout the river in October 2005 (Figure 32).

As mentioned previously, algal blooms can be a cause of high turbidity. For example, the high turbidity water dominating the upper portion of the Bush River in October 2005 is associated with chlorophyll values hovering around or exceeding the 15 µg/L threshold during the same cruise (Figure 32). However, high chlorophyll levels do not always explain high turbidity. In September 2003, turbidity exceeded seven NTU throughout most of the river, but chlorophyll levels were relatively low, mostly below ten µg/L. These observations could be explained in two ways. First, the turbidity was caused by sediment washing into the system. Secondly, as mentioned in the last section, the fluorescent sensor on the DataFlow unit does not detect fluorescence in the blue-green range. Thus, a bloom of blue-green algae could have caused the high turbidity in September 2003. Ancillary information from this time period points to the latter, since a storm passed through just prior to the cruise and probably caused increased sediment loading (Table 1). These results indicate some strengths and weaknesses of concurrently measuring several parameters, in this case turbidity and chlorophyll fluorescence, over a wide spatial area.

Salinity

Salinity remained stable at between 0 and 2.5 throughout the three-year period and between months. This is characteristic of tidal tributaries in the northern Chesapeake Bay. In September and October 2005 (Figures 29 and 32), saltier water inundated the lower portion of the river, most likely indicating drought conditions.

Temperature

Temperature tended to fluctuate on a seasonal and annual basis. The seasonal fluctuations are intuitively explained by regular variation in air temperature. On an annual basis, temperature readings were similar in 2003 and 2005 (Figures 15 and 17, for example). However, May 2004 temperatures were as much as ten degrees warmer than temperatures in May 2003 and 2004 (see Figure 16 in comparison to Figures 15 and 17). This could be explained by high early spring temperatures observed at a nearby weather station (http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KMDEDGEW). During March 2004, temperatures averaged 44.2 degrees Fahrenheit, while in March 2005 the average was 39.4 degrees Fahrenheit. This produced a lagging effect of high water temperatures throughout the spring and early summer of 2004. Unfortunately, no data was available for 2003 at this weather station to further bolster this argument, but data from other sources indicates that 2003 March temperatures were closer to those in 2005 than in 2004.

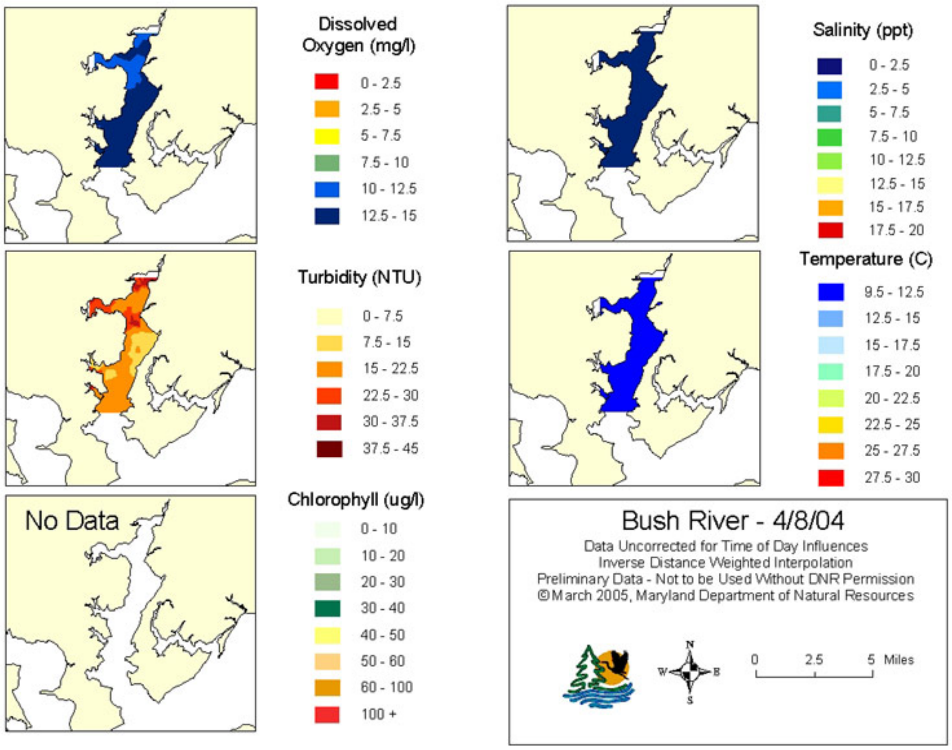

Figure 13 Bush River Water Quality Mapping from April 4, 2004

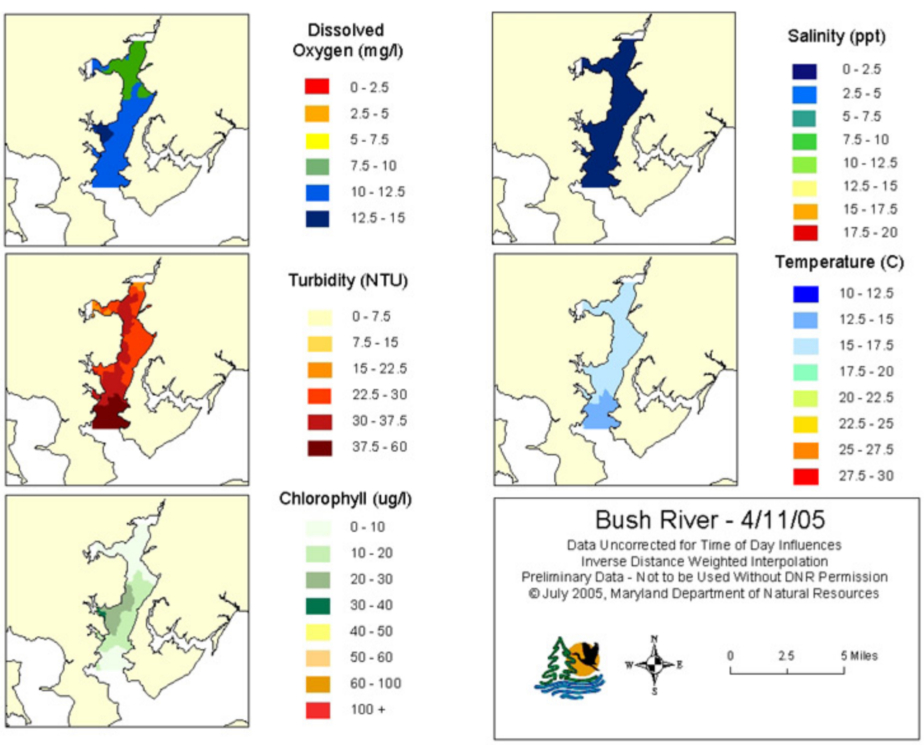

Figure 14 Bush River Water Quality Mapping from April 11, 2005

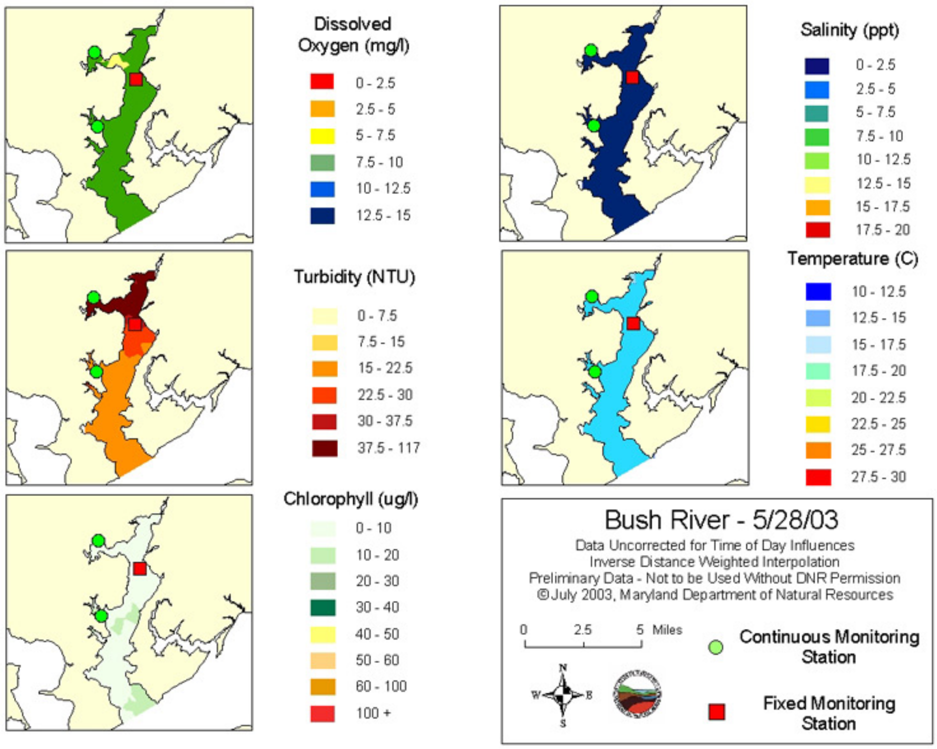

Figure 15 Bush River Water Quality Mapping from May 28, 2003

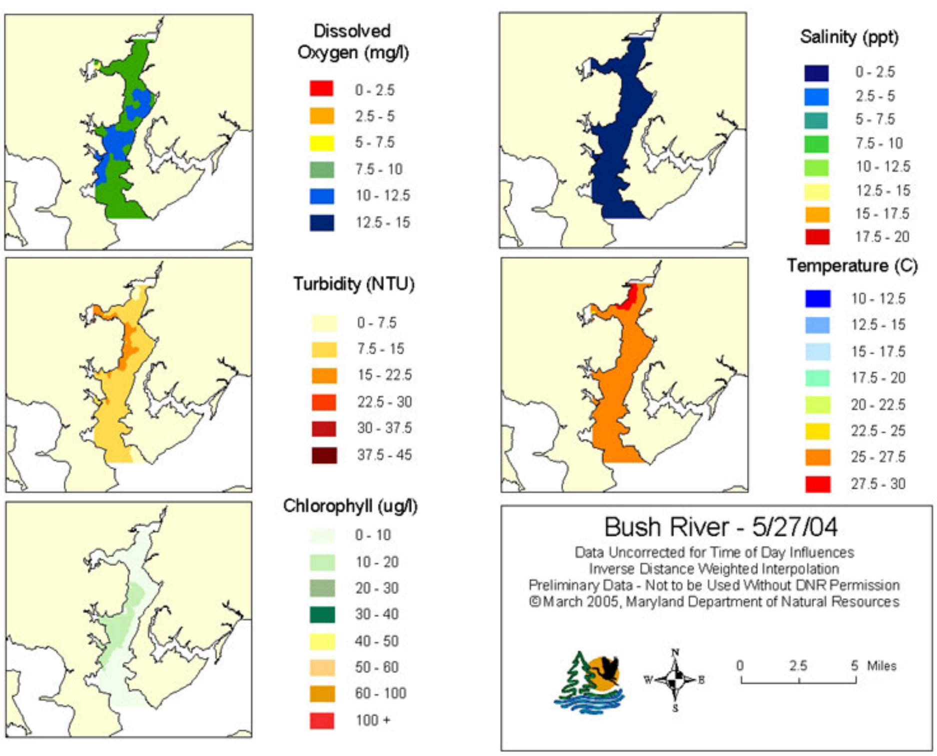

Figure 16 Bush River Water Quality Mapping from May 27, 2004

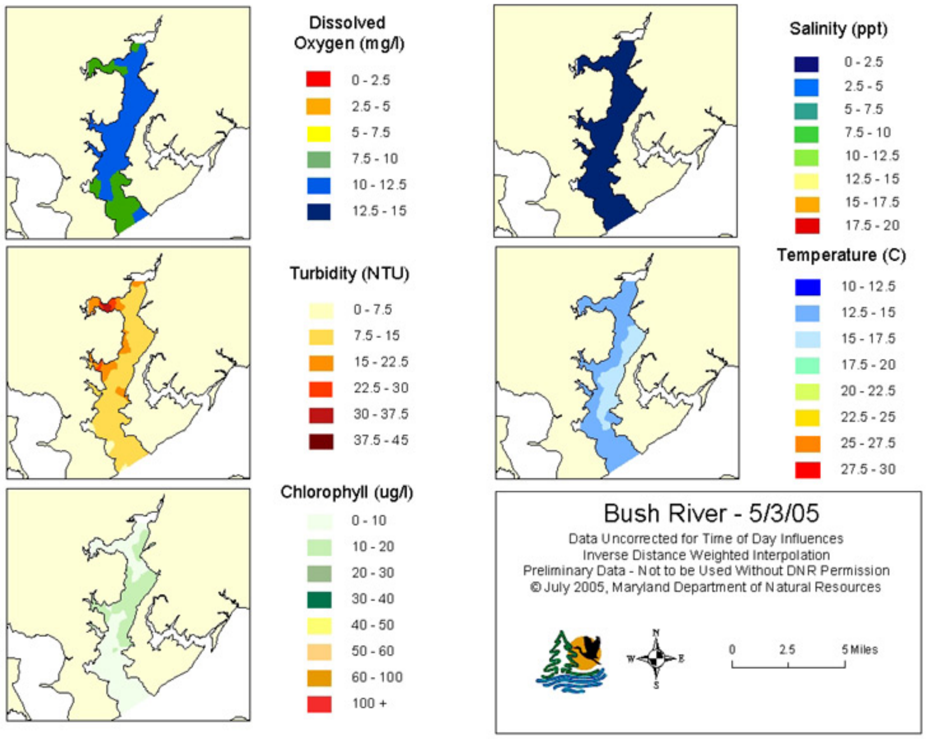

Figure 17 Bush River Water Quality Mapping from May 3, 2005

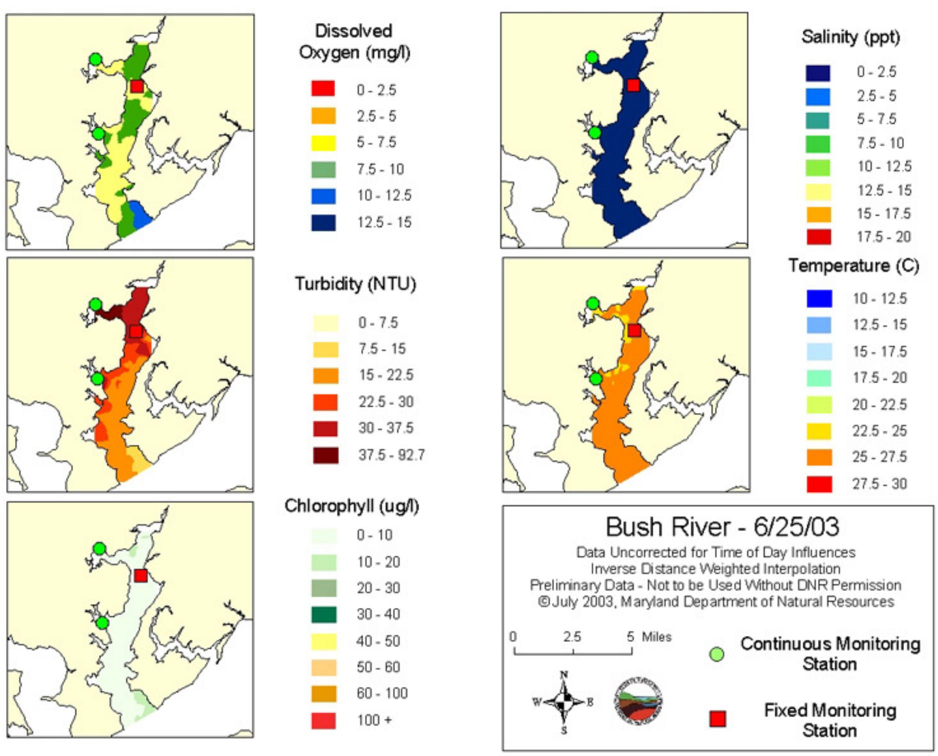

Figure 18 Bush River Water Quality Mapping from June 25, 2003

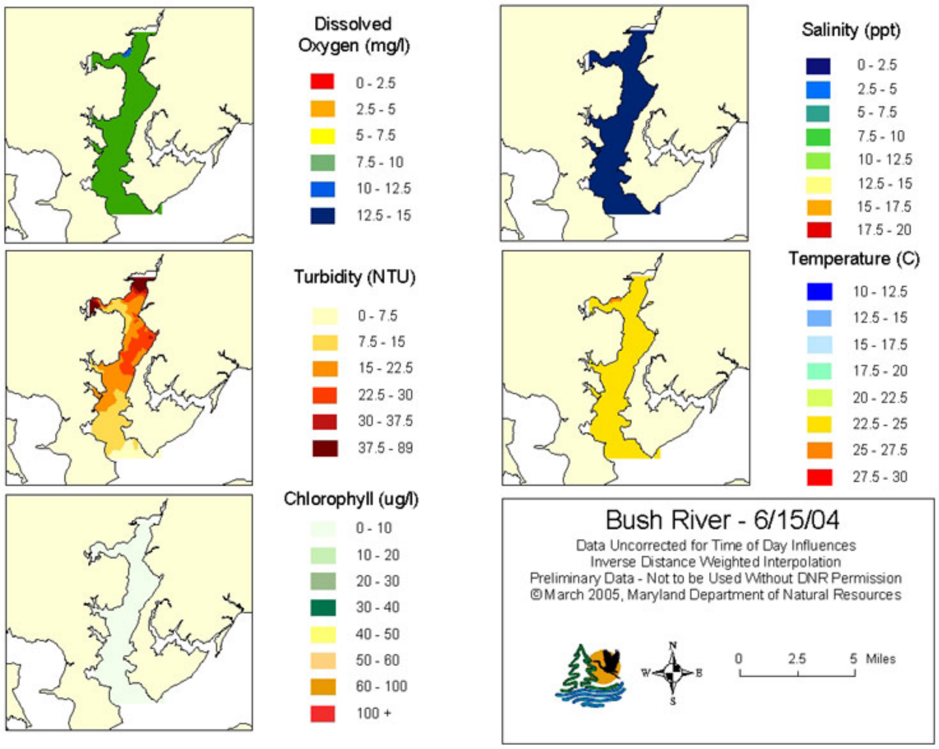

Figure 19 Bush River Water Quality Mapping from June 15, 2004

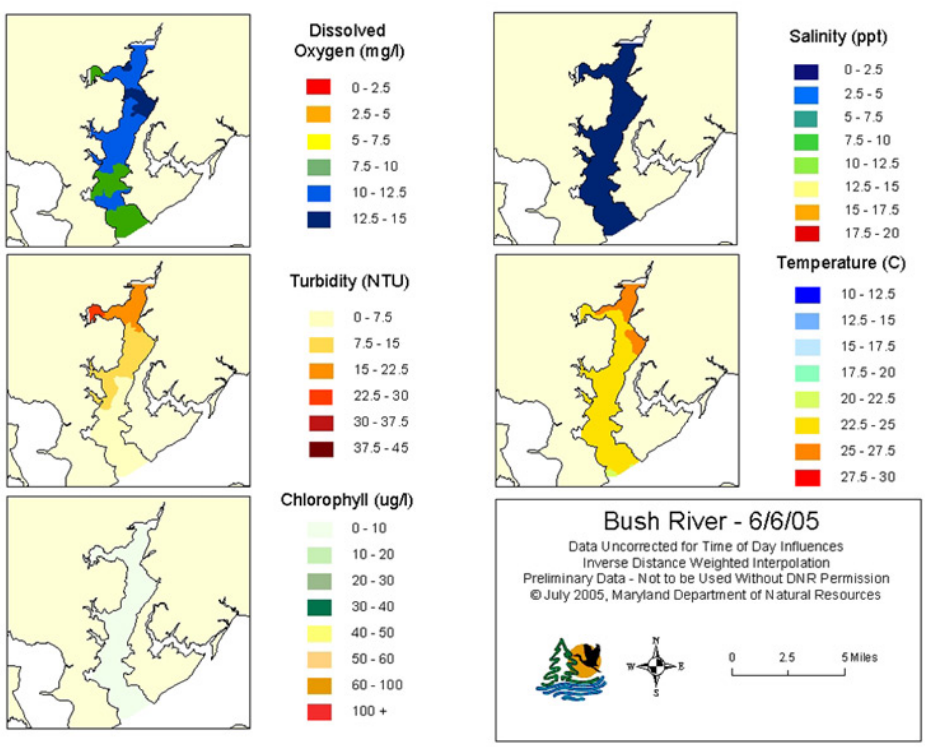

Figure 20 Bush River Water Quality Mapping from June 6, 2005

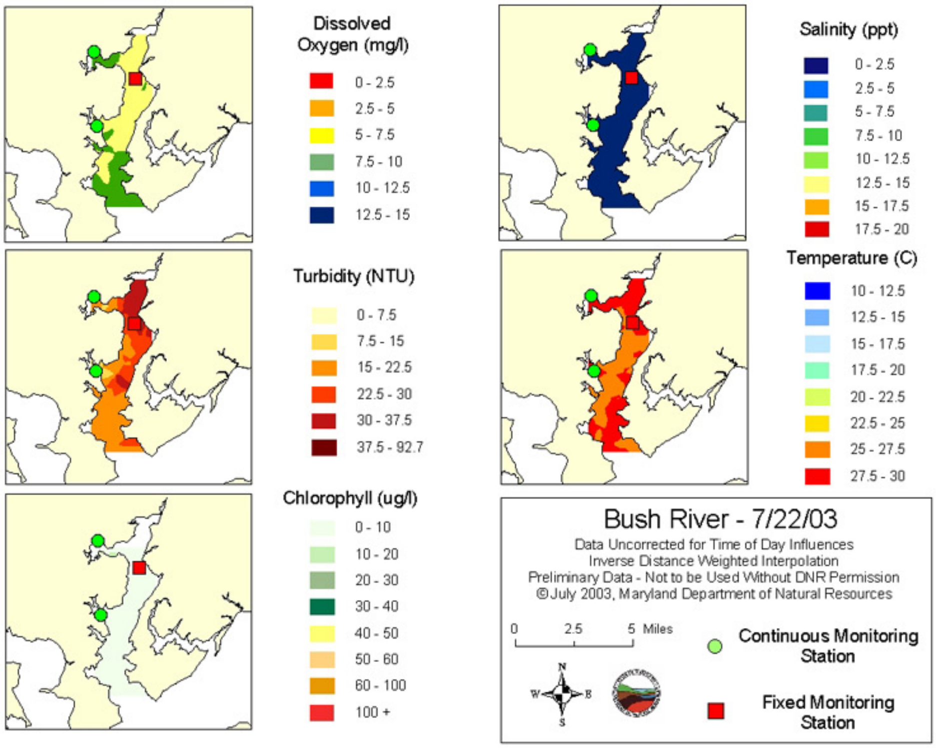

Figure 21 Bush River Water Quality Mapping from July 22, 2003

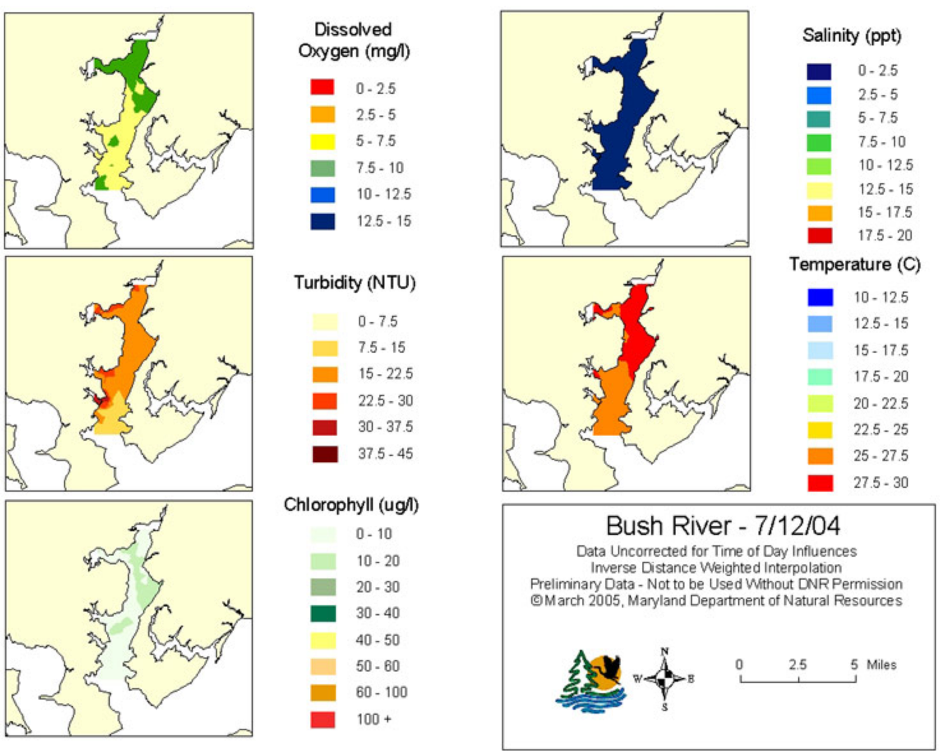

Figure 22 Bush River Water Quality Mapping from July 12, 2004

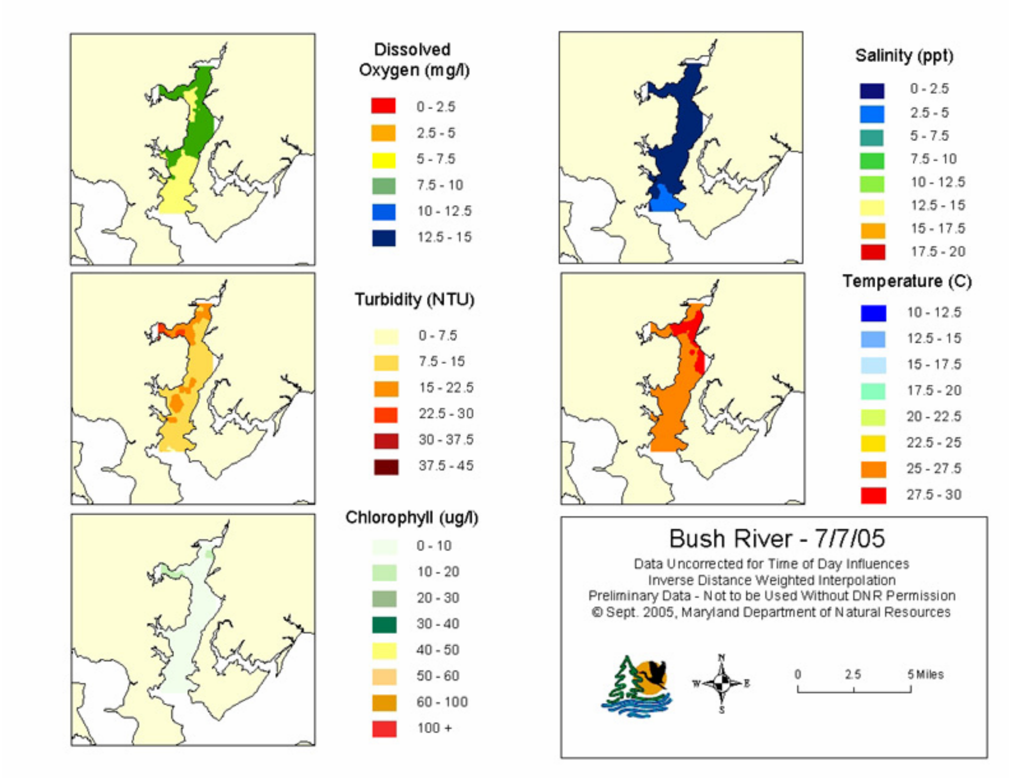

Figure 23 Bush River Water Quality Mapping from July 7, 2005

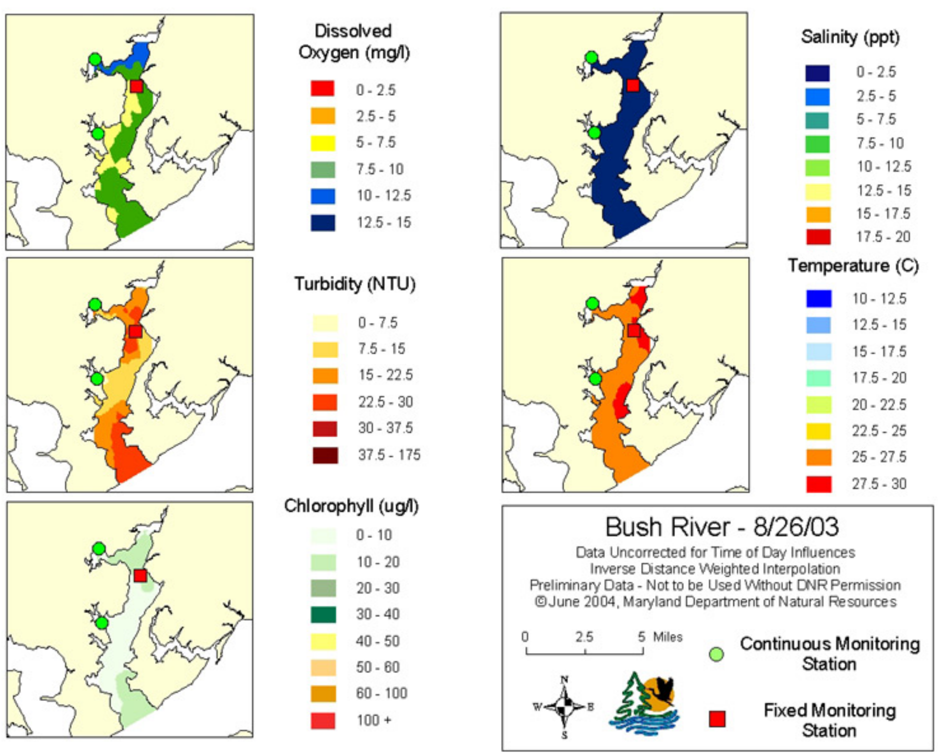

Figure 24 Bush River Water Quality Mapping from August 26, 2003

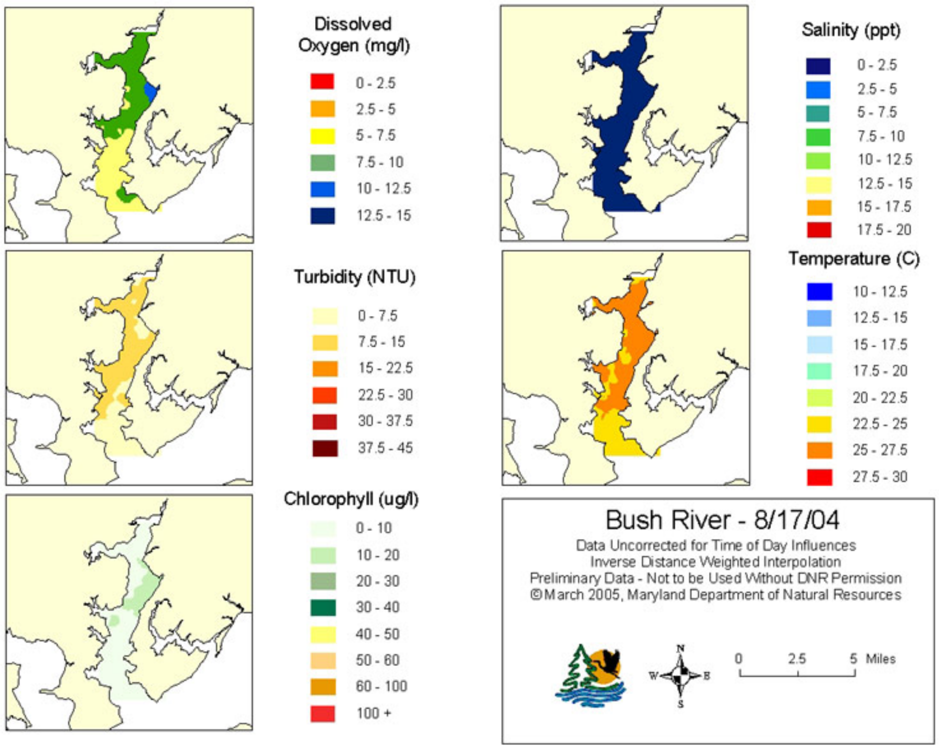

Figure 25 Bush River Water Quality Mapping from August 17, 2004

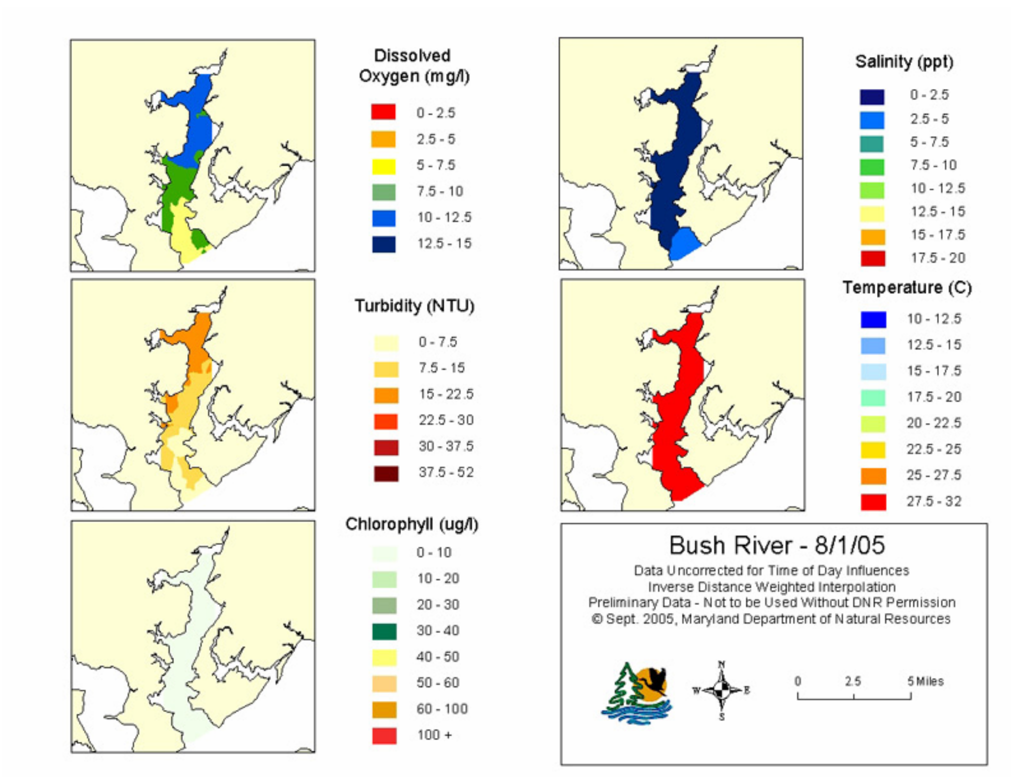

Figure 26 Bush River Water Quality Mapping from August 1, 2005

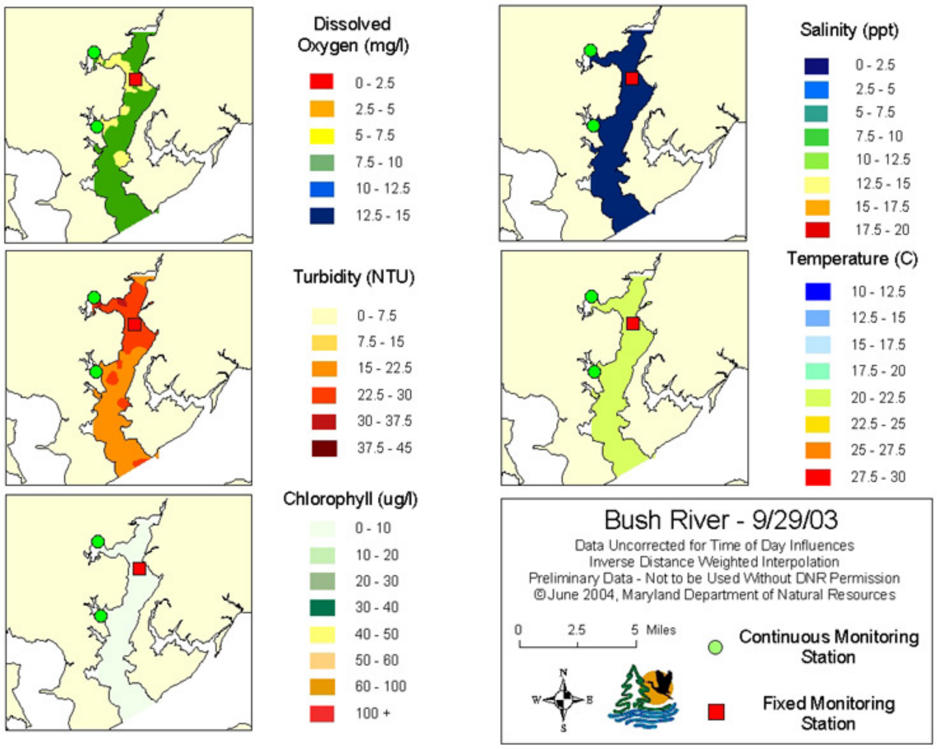

Figure 27 Bush River Water Quality Mapping from September 29, 2003

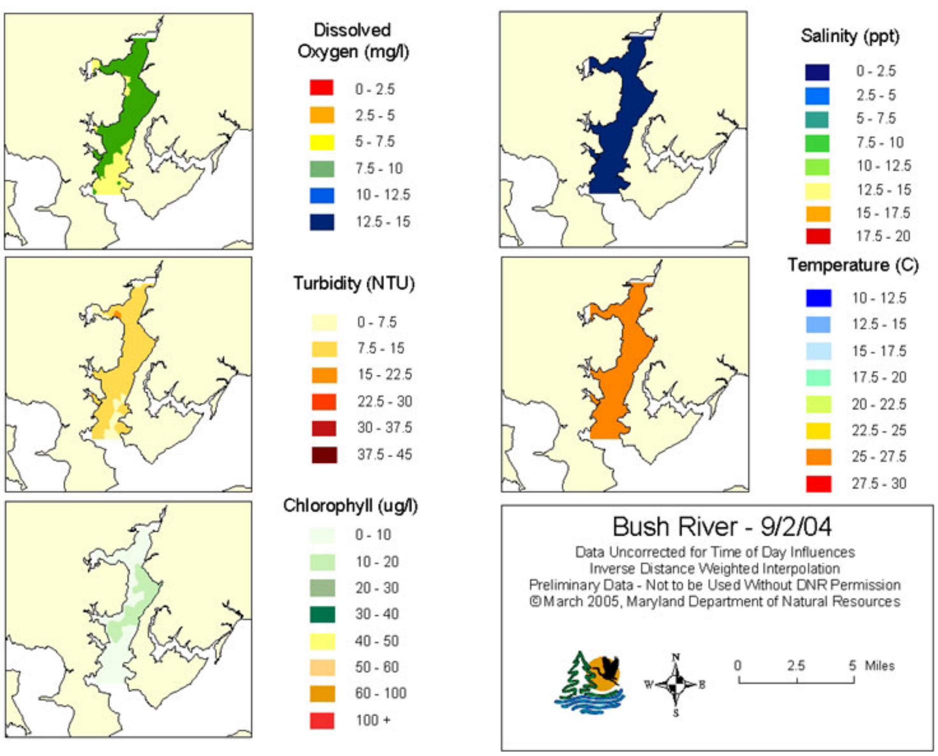

Figure 28 Bush River Water Quality Mapping from September 2, 2004

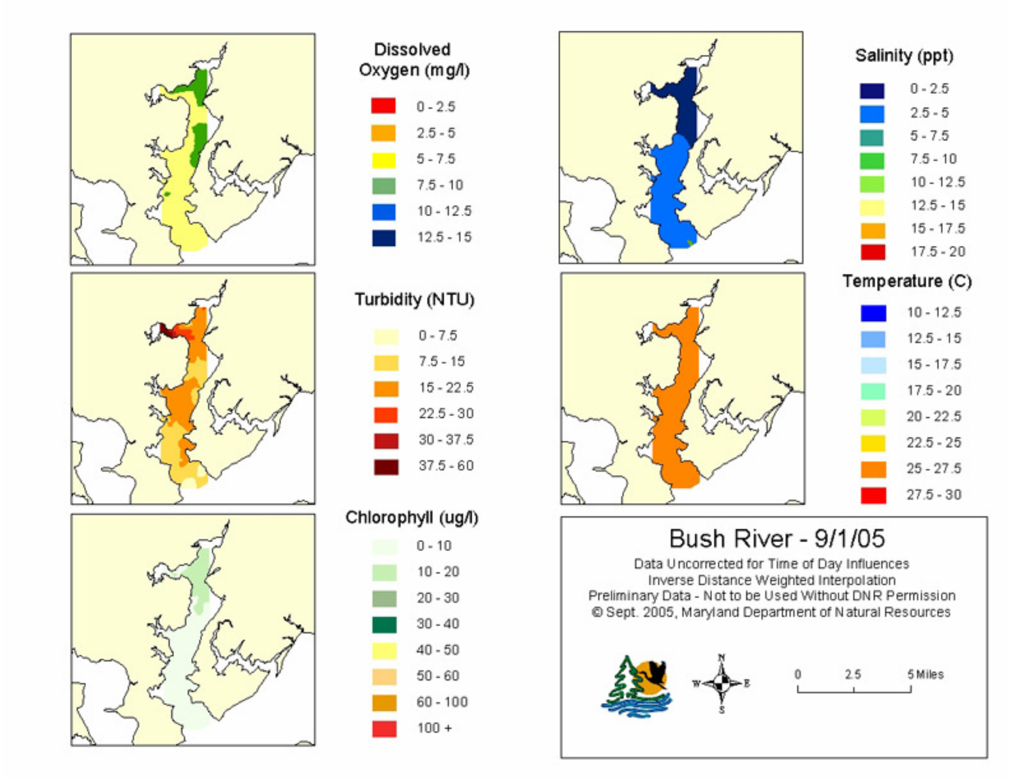

Figure 29 Bush River Water Quality Mapping from September 1, 2005

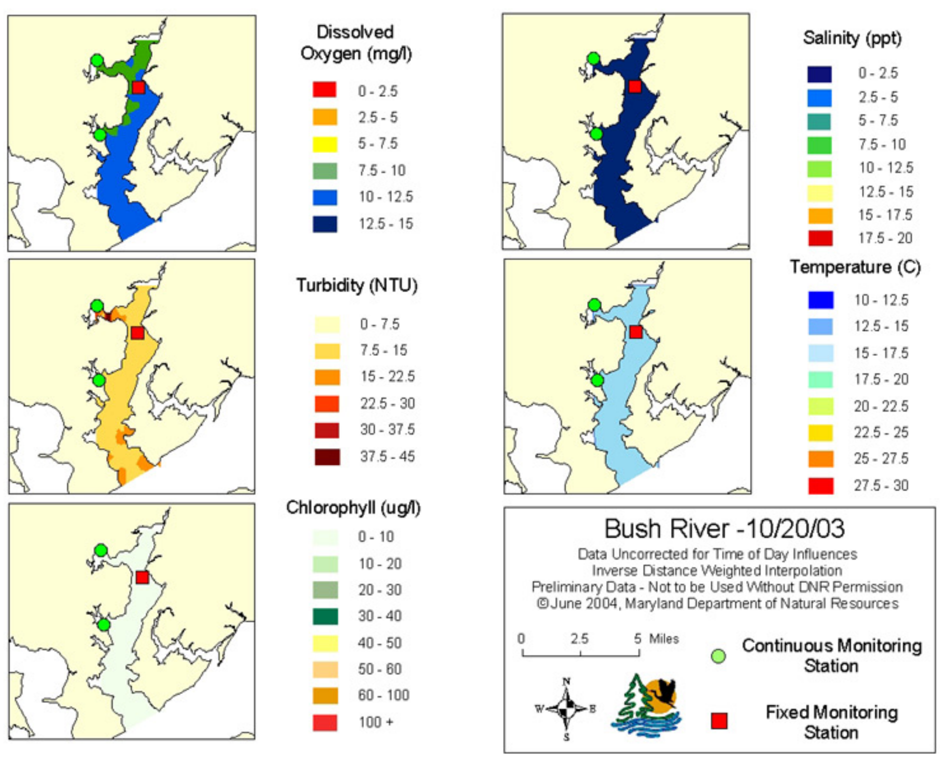

Figure 30 Bush River Water Quality Mapping from October 20, 2003

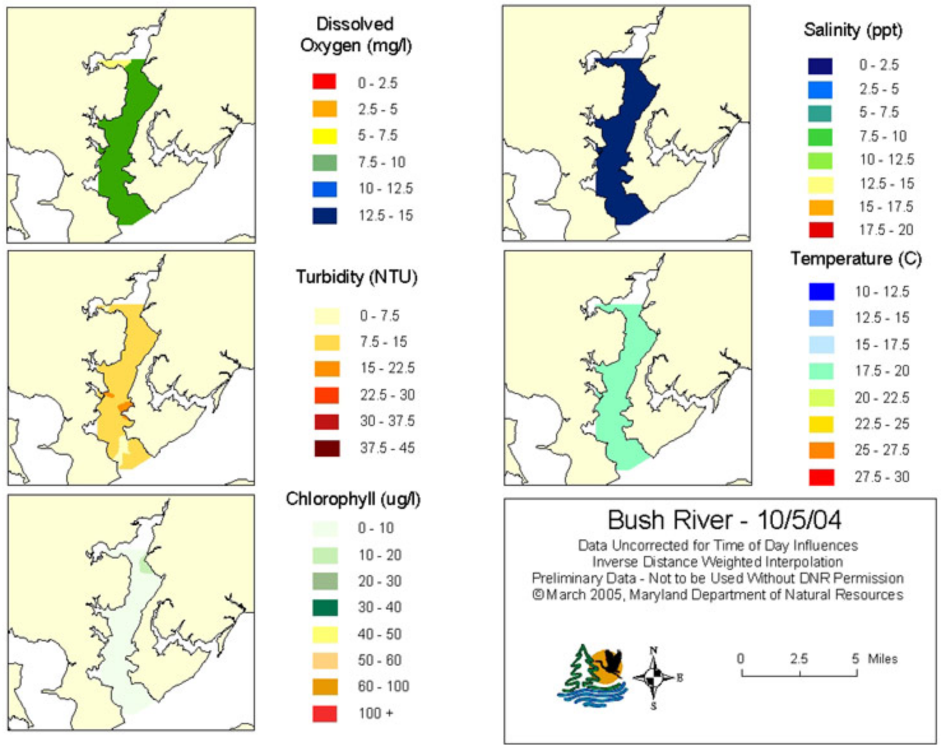

Figure 31 Bush River Water Quality Mapping from October 5, 2004

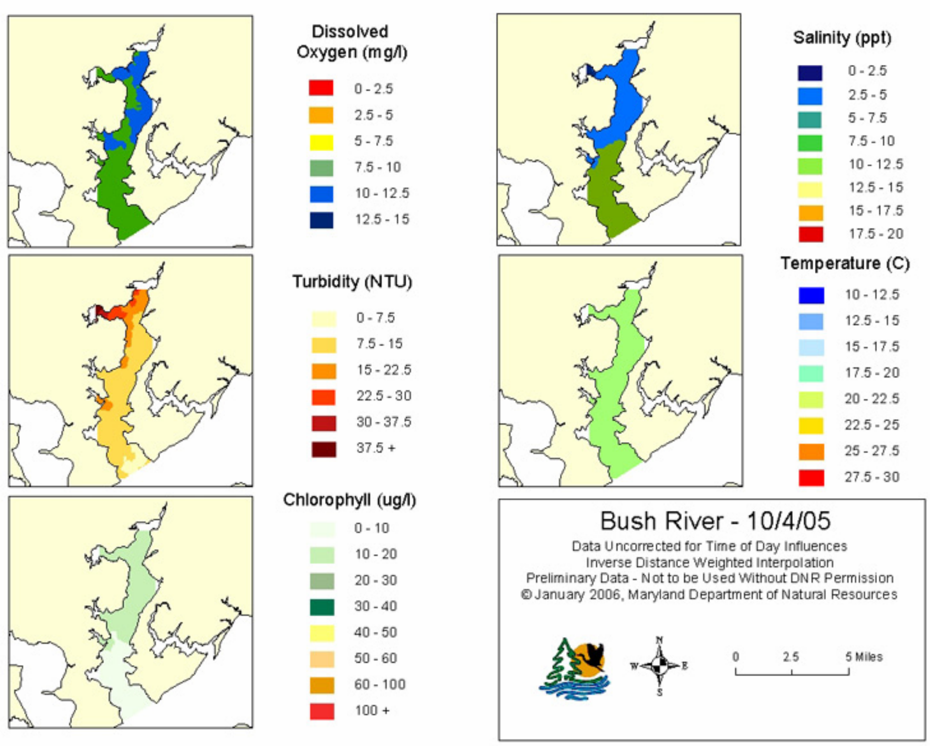

Figure 32 Bush River Water Quality Mapping from October 4, 2005

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 also to: 1) assess 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.