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# 2004 Bush River Shallow Water Monitoring Data Report

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**2004 Bush River Shallow Water Monitoring Data Report**

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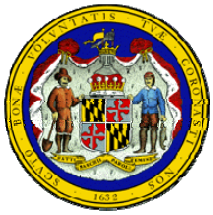

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## Introduction

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 2004. Maryland DNR deployed and maintained 34 continuous monitoring sites located in ten Chesapeake Bay tributaries and two Coastal Bays during 2004. 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, March through October, and Otter Point Creek, February through December. Water quality mapping cruises were conducted monthly throughout the Bush River, April 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 the National Oceanic and Atmospheric Administration's National Estuarine Research Reserve System (NERRS) Program. After resolving early problems with telemetry equipment in 2003, real-time 2004 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 4) 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 (page 5).

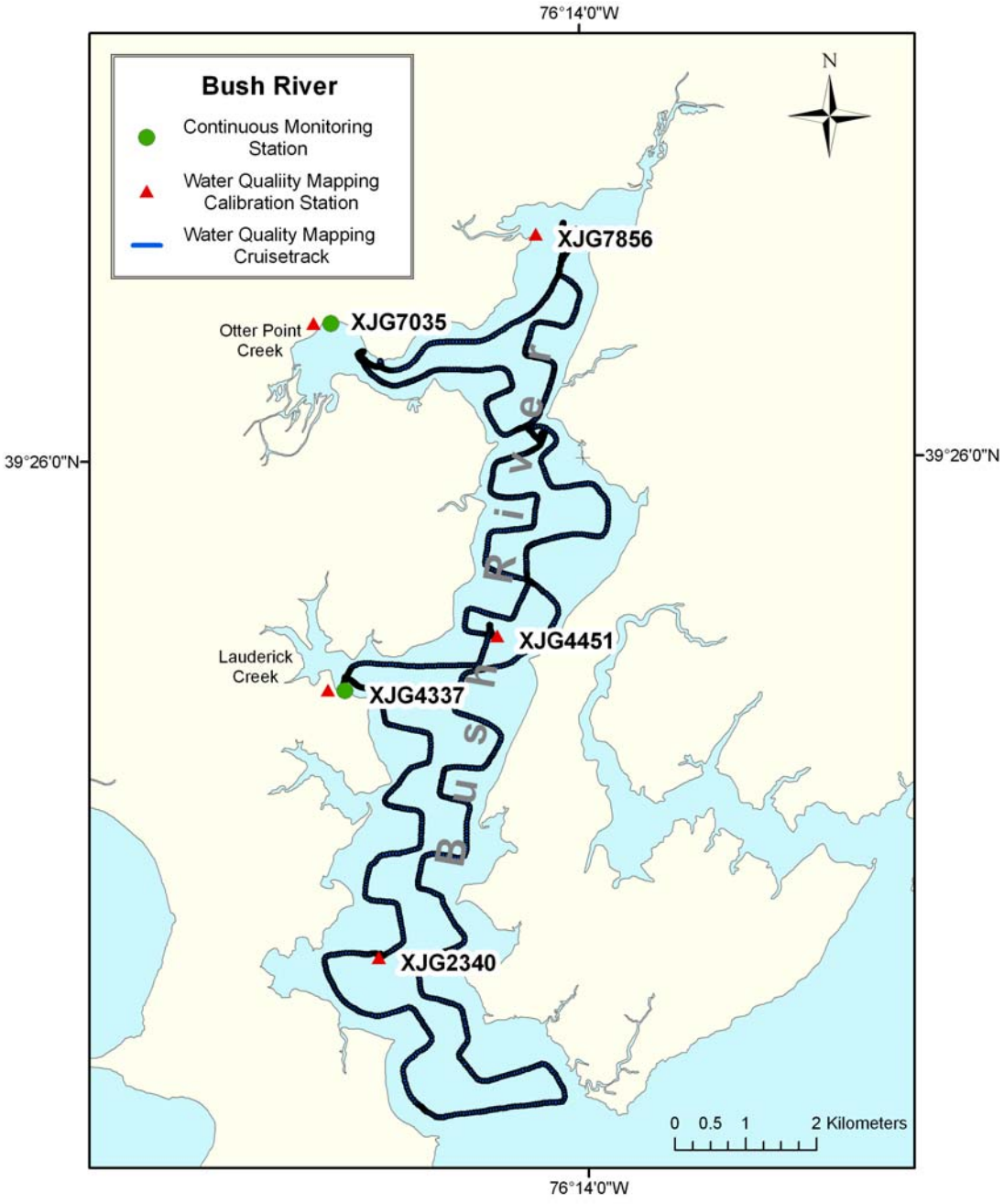


**Figure 1 Site map and a sample water quality mapping cruise track for the Bush River monitoring project.**

| Dates | Lauderick Creek | Otter Pt. Creek | DataFlow Cruise Dates | Harmful Algal Sample | Other events and details |
|---|---|---|---|---|---|
| 2/26/2004 | | X | | | Continuous monitoring begins |
| 3/30/2004 | X | | | | Continuous monitoring begins |
| 04/0804 | | | X | | |
| 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.* |
| 6/15/2004 | | | X | | |
| 6/14/2004 through 6/16/2004 | | | | X | LauderickCreek - *Microcystis aeruginosa* 12,731 cells/ml and 13,992 cells/ml *Anabaena sp.* |
| 7/12/2004 | | | X | | |
| 7/27/2004 | | | | | 4.45 inches of rain measured at BWI Airport |
| 8/17/2002 | | | X | | |
| 9/18/2004 | | | | | Tropical Depression Ivan |
| 9/20/2004 | | | X | | |
| 9/28/2004 | | | | | Tropical Depression Jeanne |
| 10/26/2004 | X | | | | Lauderick Station continuous monitoring ends |
| 10/26/2004 | | | X | | |
| 12/31/2004 | | X | | | Otter Point Creek Station 2004 continuous monitoring ends |

**Table 1 Dates of 2004 water sample collection, DATAFLOW cruises, algal sample collection and other events and details.**

Table 2 shows that, based on precipitation measured at Baltimore Washington International Thurgood Marshal Airport, the first three months of 2004 were dryer than normal. The next four months were wetter. A slow moving frontal system that moved through the area on July 27th dropped a notable 4.45 inches of rain. August and October 2004 were dryer than normal and November was wetter.

| Station: Baltimore BWI | | Total Rainfall For Month (inches): | Departure from Normal (inches) | Greatest in a 24Hr Period (inches) | ON Day(s) of Month |
|---|---|---|---|---|---|
| January | 2004 | 1.26 | -2.21 | 0.41 | 25-26 |
| February | 2004 | 2.4 | -0.62 | 1.64 | 5-6 |
| March | 2004 | 2.73 | -1.2 | 1.31 | 6 |
| April | 2004 | 5.33 | 2.33 | 1.4 | 31-1 |
| May | 2004 | 5.05 | 1.16 | 1.26 | 2-3 |
| June | 2004 | 4.17 | 0.74 | 1.73 | 4-5 |
| July | 2004 | 8.69 | 4.84 | **4.45** | 27 |
| August | 2004 | 2.71 | -1.03 | 0.64 | 1 |
| September | 2004 | 3.94 | -0.04 | 1.39 | 28 |
| October | 2004 | 1.44 | -1.72 | 0.55 | 13-14 |
| November | 2004 | 5.02 | 1.9 | 1.82 | 3-4 |
| December | 2004 | 2.93 | -0.42 | 1.03 | 23 |

**Table 2 2004 Precipitation measured at Baltimore Washington International**

The Bush River area felt the effects of two tropical weather systems during 2004 (Figure 2). The remnants of Hurricane Ivan passed within 70 kilometers (43.5 mi.) of the Continuous Monitoring sites.

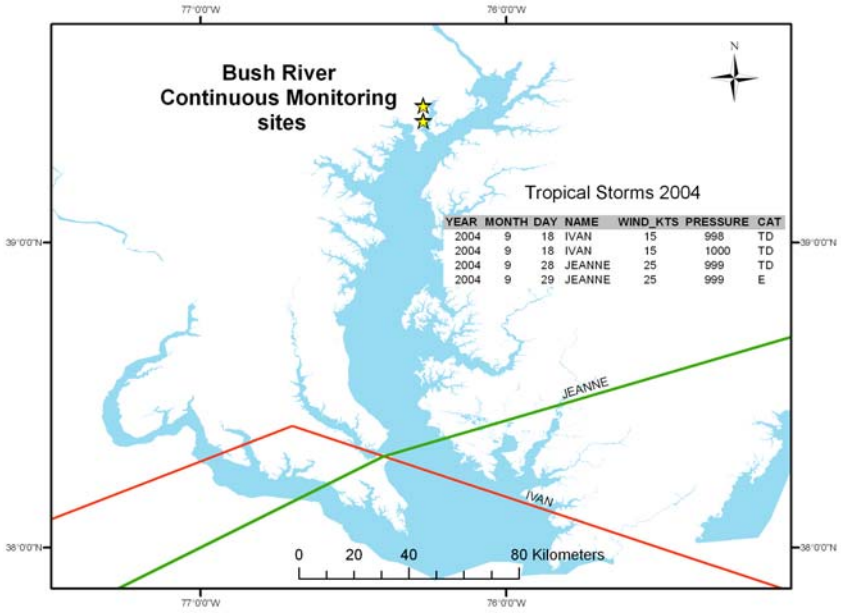


Figure 2 Paths of tropical weather in 2004

The total amount of precipitation in 2004 was less than 2003 and greater than 2002. 2002 was a drought year and 2003 was a very wet year. Three plots of data from USGS Otter Point Creek Gauging station water discharge records illustrate differences between years.

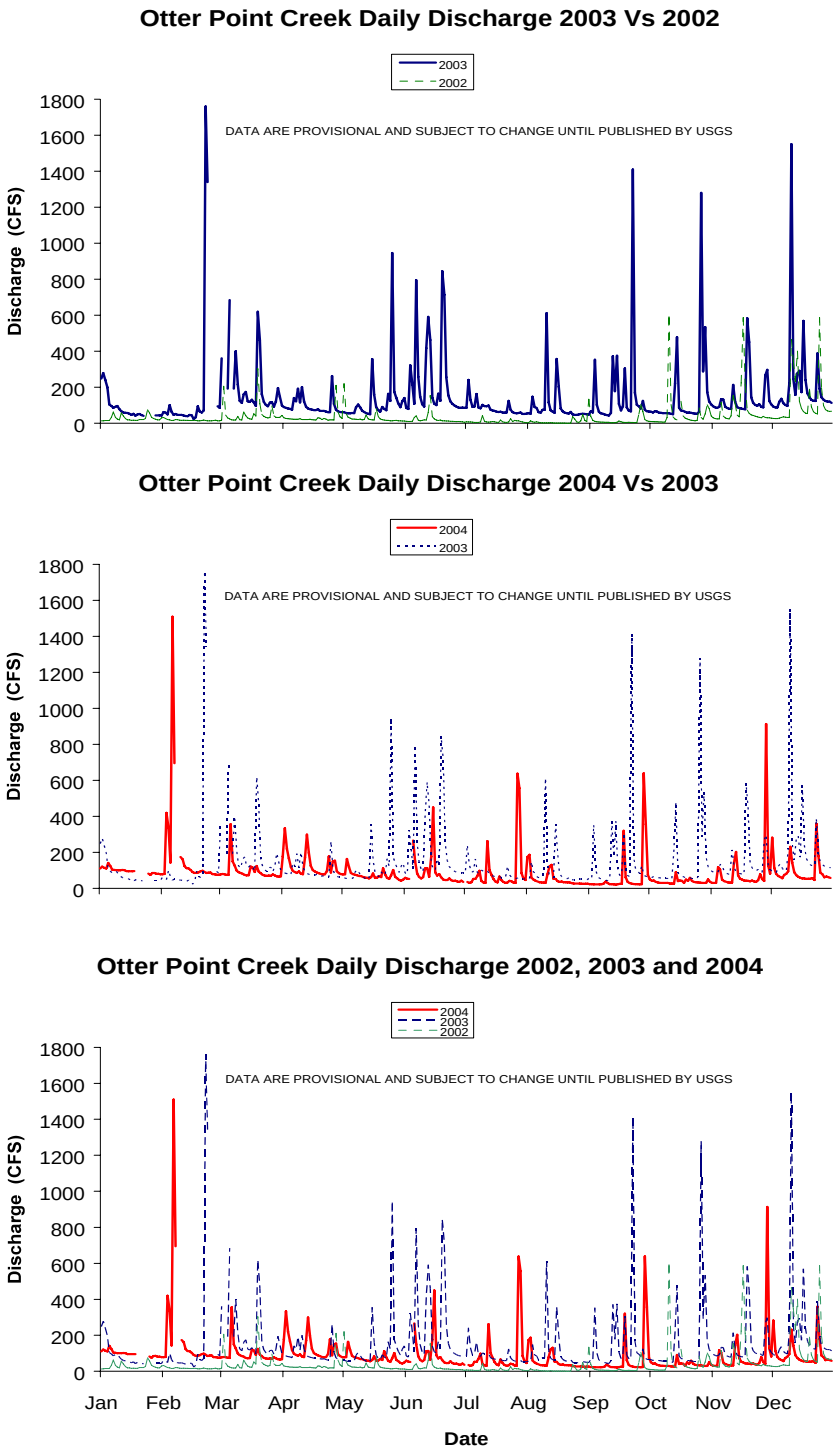


Figure 3 a, b and c 2002, 2003, and 2004 Daily Discharge At Otter Point Creek.

## Continuous Monitoring

In 2004, the water quality sonde at the Lauderick Creek continuous monitoring site was deployed from March 30, 2004 to October 26, 2004 at a depth of one-meter below the water's surface. The sonde at the Otter Point Creek site was deployed from February 26, 2004 through December 31, 2004 at 0.3 meters from the bottom. Charts of annual continuous monitoring data illustrate many interesting observations (Figure 4).

Dissolved Oxygen concentrations at Lauderick Creek remained at healthy levels throughout the year but dipped slightly below 5 mg/L for sixteen hours on May 16th and again for a less than one hour on July 31st. The gap in Dissolved Oxygen data between June 10$^{th}$ and June 14$^{th}$ was due to a probe failure.

The plot of Total Chlorophyll shows the magnitude of the spring phytoplankton bloom in the first three weeks of April. The fluorometer probe on the YSI 6600 continuous monitors is unable to detect blue-green (Microcystis) algal concentrations which frequently occur in the Bush River (Table 1). Surrogate parameters, such as high pH values, could indicate the presence of a blue-green bloom. The elevated pH values in May were concurrent with observed *Microcystis* blooms. The average pH value at Lauderick Creek in 2003 was 6.86. In 2004 the average pH value increased to 7.54.

Lauderick Creek Turbidity was plotted on a log scale so measurements could be compared to those acquired at the Otter Point site. Unfortunately, since the range in values at Otter Point was so much greater, features of the Lauderick graph are less pronounced. Nevertheless the correspondence between the series of four Turbidity peaks in April and spring phytoplankton blooms can be seen. The Turbidity peak on the 9$^{th}$ of September may have been caused by rains and winds associated with a thunderstorm on that date.

The Salinity graph (Figure 5) shows that the Salinity measurements at the site are generally low. The peak at September 18$^{th}$ resulted from Hurricane Ivan storm surge. A rapid drop in Temperature values caused by the same tropical system can also be seen.

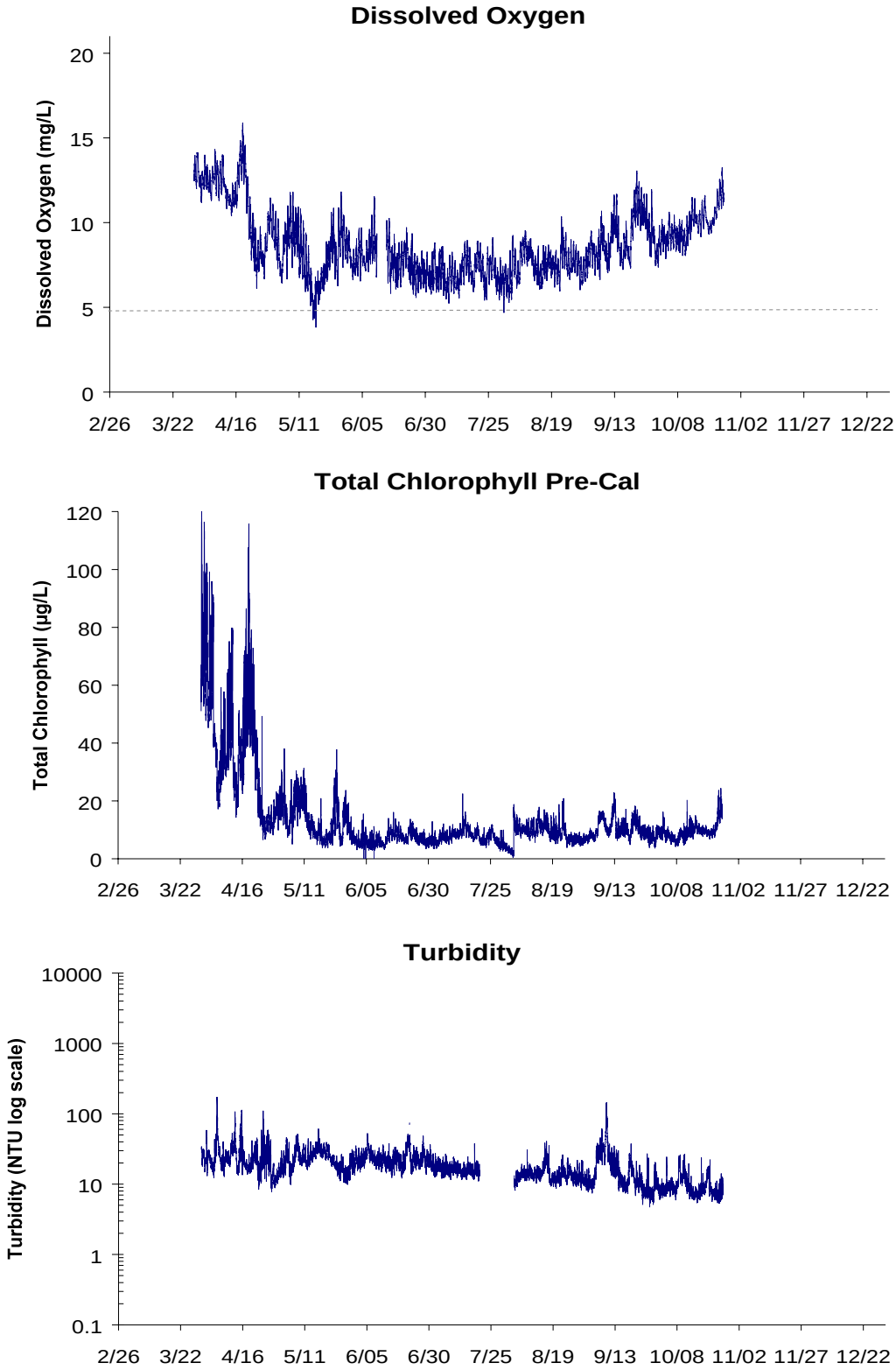


**Figure 4 Dissolved Oxygen, Total Chlorophyll and Turbidity at Lauderick Creek 2004**

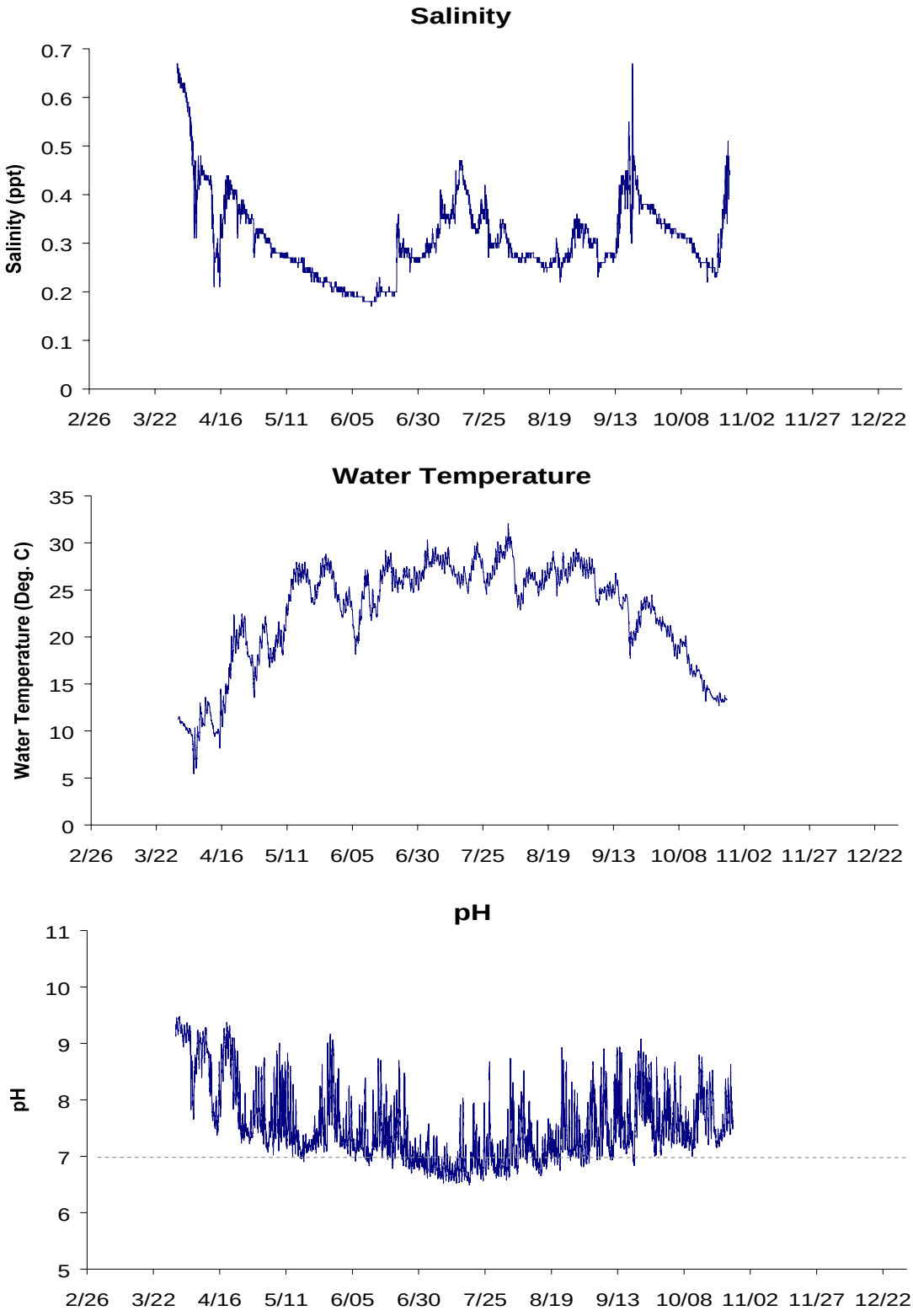


**Figure 5 Lauderick Creek 2004 Salinity, Water Temperature and pH.**

The Otter Point Creek site had greater daily fluctuations in dissolved oxygen (Figure 6) than were observed at the Lauderick site. Of 28,323 dissolved oxygen measurements at Otter Point Creek in 2004, 3,259, or 11.5%, were below 5 mg/L. The majority of the low dissolved oxygen values were measured between July 6th and October 11th. In the July through September period, Table 3, 32% of dissolved oxygen values were below 5 mg/l.

| Continuous Monitoring Site | Period | 2003 | 2004 |
|---|---|---|---|
| **Otter Point Creek** | | | |
| Dissolved Oxygen less than 5 (mg/l) | July - Sept. | 4% | 32% |
| Total Chlorophyll greater than 15 (µg/l) | Mar. - May | 7% | 27% |
| **Lauderick Creek** | | | |
| Dissolved Oxygen less than 5 (mg/l) | July - Sept. | 5% | 0% |
| Total Chlorophyll greater than 15 (µg/l) | Mar. - May | * | 58% |
| | | | * insufficient data |

**Table 3 2003 and 2004 oxygen and chlorophyll exceedances at the two sites**

Very high dissolved oxygen measurements were observed at Otter Point Creek shortly after the strong spring phytoplankton bloom, May 17 – May 22, 2004.

Chlorophyll data from the period between March 30th and April 14th are not reported because the probe was out of range when post-calibrated.

Turbidity, a measurement of the cloudiness in water, is caused by sediments which are stirred up in the water. A correlation of the blue green algae *Microsystis aeruginosa* blooms on turbidity can be seen in two peaks in May. Turbidity also spiked after the heavy rainfall July 27th and Tropical Storm Jean September 28th (Table 1). The Effect of the heavy rainfall from the two events can also be seen in salinity drops on those dates. The structure of the graph of 2004 pH data is quite similar to what was observed at the site in 2003.

2004 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=2004 and can be furthered queried to produce data charts and data tables at varying time scales.

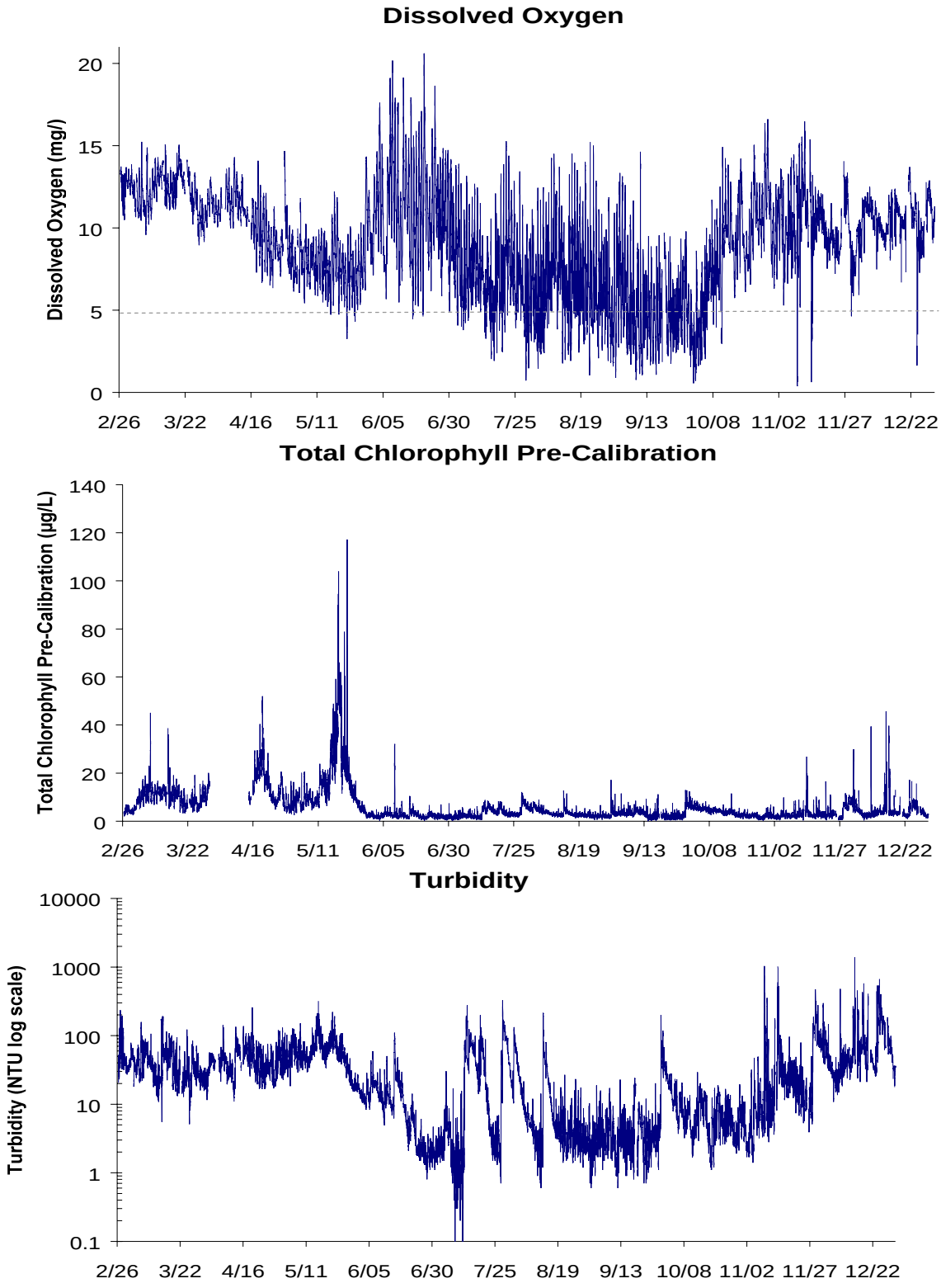


**Figure 6 - Dissolved Oxygen, Total Chlorophyll and Turbidity at Otter Point Creek**

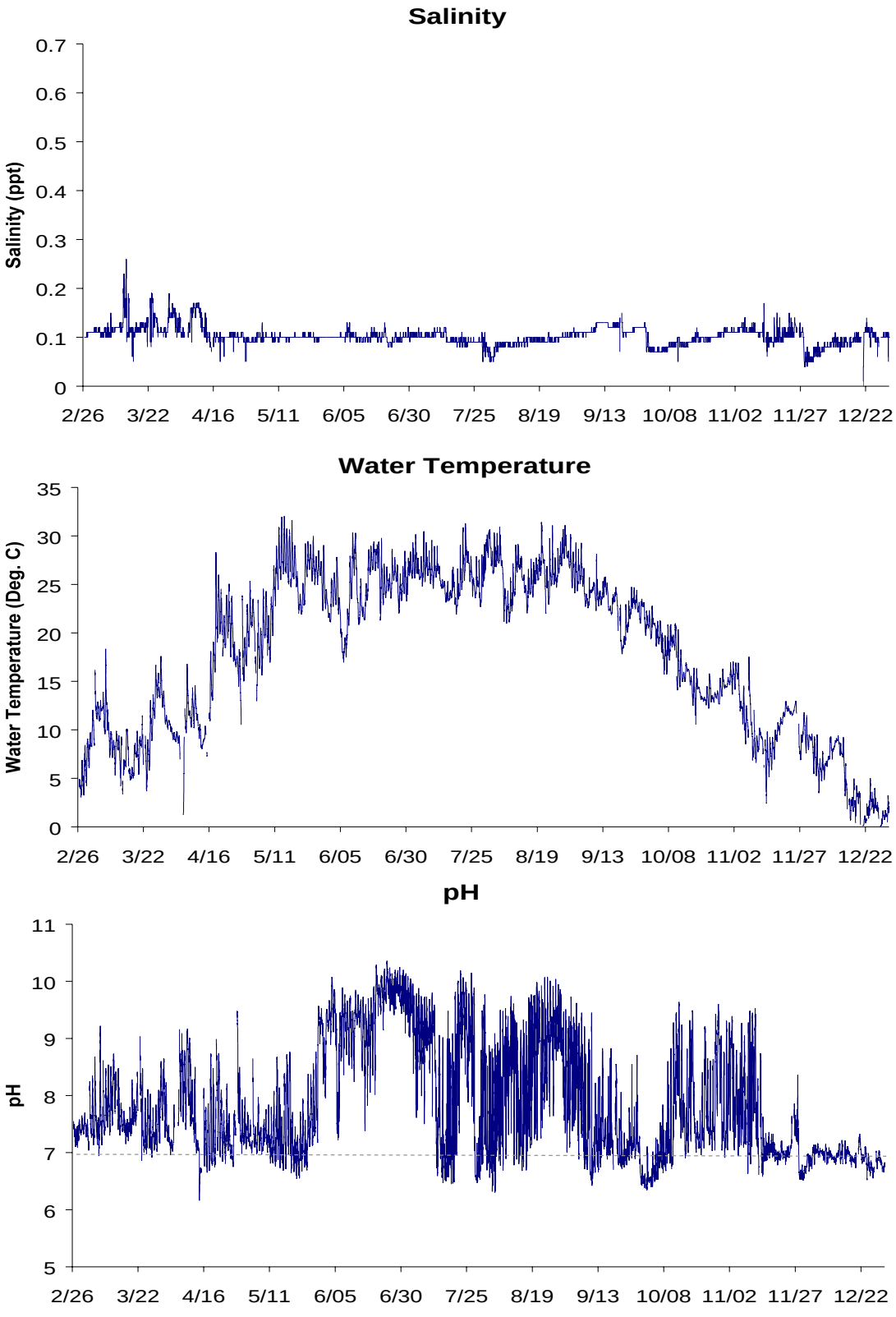


**Figure 7 Salinity, Water Temperature and pH at Otter Point Creek 2004**

Pigment, Total Suspended Solids, Volatile Suspended Solids, and Secchi depth data for two Continuous Monitoring sites (Lauderick Creek and Otter Point Creek) and three DataFlow calibration sites (XJG 2430, XJG4451 and XJG7858) are presented in Tables 4-8.

| Date | Sample Depth (m) | Chlorophyll a ( µg/l) | Pheophytin (µg/l) | Total Suspended Solids (mg/l) | Volatile Suspended Solids (mg) | Secchi Disk Depth (m) |
|---|---|---|---|---|---|---|
| 27-May-04 | 0.5 | 21.307 | 4.859 | 14.0 | | 0.6 |
| 15-Jun-04 | 0.5 | 15.700 | 2.093 | 12.5 | | 0.5 |
| 12-Jul-04 | 0.5 | 9.345 | 3.215 | 9.0 | 3.0 | 0.7 |
| 17-Aug-04 | 0.5 | 2.392 | 0.120 | 3.3 | 4.0 | 1.6 |
| 02-Sep-04 | 0.5 | 5.981 | 0.927 | 8.4 | | 0.8 |
| 05-Oct-04 | 0.5 | 9.345 | 4.261 | 15.0 | 4.0 | 0.6 |

**Table 4 DataFlow Calibration Station XJG2340 - 2004 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) |
|---|---|---|---|---|---|---|
| 30-Mar-04 | 1.0 | 97.936 | 15.102 | 44.0 | 14.0 | 0.3 |
| 08-Apr-04 | 0.5 | 42.862 | 13.307 | 44.7 | | 0.3 |
| 14-Apr-04 | 1.0 | 35.137 | 13.008 | 20.0 | 8.0 | 0.3 |
| 27-Apr-04 | 1.0 | 9.470 | 4.486 | 10.7 | 5.3 | 0.5 |
| 11-May-04 | 1.0 | 18.441 | 8.772 | 34.7 | 8.7 | 0.4 |
| 25-May-04 | 1.0 | 9.968 | 6.778 | 14.0 | 5.3 | 0.7 |
| 27-May-04 | 0.5 | 28.035 | 5.196 | 15.5 | | 0.5 |
| 08-Jun-04 | 1.0 | 13.457 | 3.289 | 19.3 | 6.0 | 0.3 |
| 15-Jun-04 | 0.5 | 23.923 | 4.336 | 12.0 | | 0.5 |
| 22-Jun-04 | 1.0 | 33.642 | 7.177 | 33.0 | 7.0 | 0.4 |
| 07-Jul-04 | 1.0 | 14.204 | 4.635 | 27.0 | 7.0 | 0.4 |
| 12-Jul-04 | 0.5 | 13.457 | 5.906 | 17.5 | 5.5 | 0.4 |
| 03-Aug-04 | 1.0 | 21.307 | 6.953 | 20.5 | 8.0 | 0.3 |
| 17-Aug-04 | 0.5 | 12.460 | 3.937 | 11.3 | 4.7 | 0.5 |
| 17-Aug-04 | 1.0 | 11.962 | 4.785 | 11.3 | 8.0 | 0.5 |
| 31-Aug-04 | 1.0 | 11.463 | 3.190 | 11.3 | 6.7 | 0.6 |
| 02-Sep-04 | 0.5 | 11.962 | 3.738 | 19.3 | | 0.4 |
| 14-Sep-04 | 1.0 | 19.064 | 7.364 | 15.5 | 5.5 | 0.4 |
| 05-Oct-04 | 0.5 | 12.709 | 4.560 | 10.5 | 4.5 | 0.6 |
| 13-Oct-04 | 1.0 | 17.569 | 4.149 | 10.5 | 5.0 | 0.7 |
| 26-Oct-04 | 1.0 | 20.933 | 2.442 | 7.3 | 5.3 | 0.6 |

**Table 5 Lauderick Creek (XJG4337) - 2004 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) |
|---|---|---|---|---|---|---|
| 08-Apr-04 | 0.5 | 47.846 | 12.510 | 20.7 | | 0.4 |
| 27-May-04 | 0.5 | 31.399 | 6.018 | 16.0 | | 0.5 |
| 15-Jun-04 | 0.5 | 41.367 | 7.127 | 21.3 | | 0.4 |
| 12-Jul-04 | 0.5 | 18.690 | 5.121 | 17.0 | 6.0 | 0.4 |
| 17-Aug-04 | 0.5 | 26.914 | 4.137 | 13.3 | 6.0 | 0.5 |
| 02-Sep-04 | 0.5 | 19.438 | 4.897 | 13.3 | | 0.5 |
| 05-Oct-04 | 0.5 | 20.933 | 6.018 | 2.4 | 2.5 | 0.6 |

**Table 6 DataFlow Calibration Station XJG4451 - 2004 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) |
|---|---|---|---|---|---|---|
| 10-Mar-04 | 0.5 | 27.661 | 1.645 | 31.0 | 11.0 | 0.2 |
| 30-Mar-04 | 0.4 | 20.185 | 4.934 | 32.0 | 11.0 | 0.3 |
| 08-Apr-04 | 0.5 | 25.917 | 4.436 | 32.7 | | 0.2 |
| 14-Apr-04 | 0.5 | 6.541 | 0.654 | 42.5 | 11.3 | 0.2 |
| 27-Apr-04 | 0.1 | 13.083 | 3.925 | 37.5 | 10.0 | 0.2 |
| 11-May-04 | 0.1 | 7.476 | 2.990 | 37.0 | 8.0 | 0.2 |
| 25-May-04 | 0.5 | 14.952 | 7.027 | 131.3 | 16.3 | 0.1 |
| 27-May-04 | 0.5 | 4.486 | 2.056 | 13.5 | | 0.5 |
| 08-Jun-04 | 0.1 | 3.987 | 0.548 | 14.7 | 3.3 | 0.1 |
| 22-Jun-04 | 0.8 | 5.607 | 1.458 | 8.0 | 3.0 | |
| 07-Jul-04 | 0.3 | 6.978 | 1.396 | 8.0 | 4.7 | |
| 12-Jul-04 | 0.5 | 29.007 | 3.439 | 11.2 | 6.4 | 0.6 |
| 20-Jul-04 | 0.7 | 11.463 | 4.585 | 18.0 | 5.3 | 0.5 |
| 03-Aug-04 | 0.4 | 4.486 | 1.794 | 15.0 | 7.0 | 0.3 |
| 17-Aug-04 | 0.5 | 4.984 | 0.000 | 5.3 | 6.0 | 0.6 |
| 17-Aug-04 | 0.7 | 3.489 | 1.396 | 6.0 | 5.3 | 0.7 |
| 31-Aug-04 | 0.5 | 7.476 | 4.299 | 9.0 | 5.5 | |
| 02-Sep-04 | 0.5 | 2.990 | 0.987 | 4.4 | | 0.8 |
| 14-Sep-04 | 0.5 | 20.185 | 9.644 | 25.5 | 11.0 | |
| 29-Sep-04 | 0.2 | 35.885 | 13.307 | 66.0 | 18.0 | 0.1 |
| 13-Oct-04 | 0.7 | 7.476 | 2.642 | 16.0 | 6.0 | 0.9 |
| 26-Oct-04 | 0.8 | 7.476 | 2.205 | 21.0 | 4.0 | 0.9 |
| 18-Nov-04 | 0.6 | 4.859 | 2.205 | 19.0 | 4.5 | 0.5 |
| 30-Nov-04 | 0.4 | 5.981 | 0.299 | 44.0 | 14.0 | 0.1 |
| 16-Dec-04 | 0.3 | 1.495 | 2.691 | 30.0 | 14.0 | 0.1 |

**Table 7 Otter Point Creek (XJG4451) - 2004 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) |
|---|---|---|---|---|---|---|
| 08-Apr-04 | 0.5 | 18.939 | 3.738 | 22.0 | | 0.3 |
| 27-May-04 | 0.5 | 12.709 | 3.514 | 8.0 | | 0.8 |
| 15-Jun-04 | 0.5 | 35.885 | 5.283 | 47.3 | | 0.2 |
| 12-Jul-04 | 0.5 | 38.501 | 5.457 | 25.5 | 9.5 | 0.3 |
| 17-Aug-04 | 0.5 | 20.434 | 1.545 | 8.7 | 8.7 | 0.6 |
| 02-Sep-04 | 0.5 | 6.579 | 1.166 | 3.6 | | 0.8 |

**Table 8 DataFlow Calibration Station XJG7856 - 2004 Pigment, Suspended Solids and Secchi Disk values.**

Nutrient data are presented in tables 9-13.

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27-May-04 | 0.5 | 0.020 | 0.0085 | 0.2815 | 0.63 | 0.354 | 0.0051 | 0.0391 | 0.0160 | 0.25 | 1.95 |
| 15-Jun-04 | 0.5 | 0.040 | 0.0061 | 0.3949 | 0.96 | 0.328 | 0.0114 | 0.0295 | 0.0278 | 1.02 | 1.76 |
| 12-Jul-04 | 0.5 | 0.018 | 0.0064 | 0.4856 | 0.81 | 0.220 | 0.0113 | 0.0228 | 0.0204 | 0.88 | 1.24 |
| 17-Aug-04 | 0.5 | 0.093 | 0.0073 | 0.5497 | 0.97 | 0.066 | 0.0398 | 0.0066 | 0.0452 | 2.12 | 0.37 |
| 02-Sep-04 | 0.5 | 0.072 | 0.0074 | 0.6456 | 1.00 | 0.117 | 0.0355 | 0.0120 | 0.0422 | 1.66 | 0.79 |
| 05-Oct-04 | 0.5 | 0.004 | 0.0064 | 0.3706 | 0.74 | 0.226 | 0.0075 | 0.0245 | 0.0172 | 1.99 | 1.52 |

**Table 9 DataFlow Calibration Station XJG2340 - 2004 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30-Mar-04 | 1.0 | 0.016 | 0.0263 | 0.6427 | 1.20 | 1.020 | 0.0055 | 0.1049 | 0.0213 | 1.07 | 6.06 |
| 08-Apr-04 | 0.5 | 0.010 | 0.0184 | 0.7286 | 1.20 | 0.839 | 0.0027 | 0.0862 | 0.0141 | 1.39 | 4.79 |
| 14-Apr-04 | 1.0 | 0.013 | 0.0133 | 0.9217 | 1.24 | 0.453 | 0.0058 | 0.0527 | 0.0123 | 1.86 | 2.73 |
| 27-Apr-04 | 1.0 | 0.157 | 0.0117 | 0.4923 | 1.07 | 0.291 | 0.0039 | 0.0414 | 0.0270 | 1.19 | 1.65 |
| 11-May-04 | 1.0 | 0.297 | 0.0100 | 0.2930 | 1.28 | 0.644 | 0.0060 | 0.0854 | 0.0301 | 0.25 | 3.89 |
| 25-May-04 | 1.0 | 0.204 | 0.0173 | 0.3017 | 0.96 | 0.729 | 0.0085 | 0.0427 | 0.0354 | 0.64 | 3.76 |
| 27-May-04 | 0.5 | 0.039 | 0.0122 | 0.2048 | 0.62 | 0.440 | 0.0026 | 0.0500 | 0.0202 | 0.44 | 2.51 |
| 08-Jun-04 | 1.0 | 0.105 | 0.0073 | 0.2077 | 0.79 | 0.354 | 0.0120 | 0.0378 | 0.0436 | 0.76 | 1.95 |
| 15-Jun-04 | 0.5 | 0.015 | 0.0037 | 0.1023 | 0.59 | 0.385 | 0.0030 | 0.0275 | 0.0196 | 0.80 | 2.13 |
| 22-Jun-04 | 1.0 | 0.027 | 0.0034 | 0.0207 | 0.38 | 0.508 | 0.0111 | 0.0576 | 0.0265 | 0.67 | 3.00 |
| 07-Jul-04 | 1.0 | 0.011 | 0.0009 | 0.0059 | 0.81 | 0.399 | 0.0082 | 0.0474 | 0.0358 | 0.45 | 2.56 |
| 12-Jul-04 | 0.5 | 0.003 | 0.0025 | 0.0047 | 0.43 | 0.341 | 0.0042 | 0.0369 | 0.0233 | 0.59 | 2.04 |
| 03-Aug-04 | 1.0 | 0.012 | 0.0011 | 0.0070 | 0.43 | 0.394 | 0.0059 | 0.0494 | 0.0287 | 1.29 | 2.36 |
| 17-Aug-04 | 0.5 | 0.004 | 0.0009 | 0.0036 | 0.48 | 0.301 | 0.0034 | 0.0287 | 0.0196 | 1.27 | 1.93 |
| 17-Aug-04 | 1.0 | 0.039 | 0.0031 | 0.0005 | 0.87 | 0.303 | 0.0052 | 0.0303 | 0.0394 | 1.35 | 2.15 |
| 31-Aug-04 | 1.0 | 0.052 | 0.0015 | 0.0052 |  | 0.292 | 0.0060 | 0.0240 |  | 1.55 | 1.75 |
| 02-Sep-04 | 0.5 | 0.011 | 0.0009 | 0.0031 | 0.40 | 0.361 | 0.0067 | 0.0390 | 0.0208 | 1.59 | 2.43 |
| 14-Sep-04 | 1.0 | 0.039 | 0.0084 | 0.0052 | 0.48 | 0.399 | 0.0056 | 0.0431 | 0.0223 | 1.30 | 2.27 |
| 05-Oct-04 | 0.5 | 0.007 | 0.0040 | 0.0345 | 0.53 | 0.285 | 0.0019 | 0.0326 | 0.0130 | 1.31 | 1.72 |
| 13-Oct-04 | 1.0 | 0.005 | 0.0015 | 0.0021 | 0.53 | 0.343 | 0.0043 | 0.0342 | 0.0165 | 1.41 | 1.87 |
| 26-Oct-04 | 1.0 | 0.012 | 0.0063 | 0.2847 | 0.93 | 0.388 | 0.0100 | 0.0289 | 0.0174 | 1.47 | 2.33 |

**Table 10 Lauderick Creek (XJG4337) - 2004 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 08-Apr-04 | 0.5 | 0.007 | 0.0155 | 0.7205 | 1.13 | 0.578 | 0.0032 | 0.0581 | 0.0102 | 1.05 | 3.27 |
| 27-May-04 | 0.5 | 0.021 | 0.0121 | 0.4139 | 0.83 | 0.442 | 0.0027 | 0.0555 | 0.0155 | 0.37 | 2.38 |
| 15-Jun-04 | 0.5 | 0.045 | 0.0079 | 0.2911 | 0.81 | 0.718 | 0.0092 | 0.0528 | 0.0283 | 1.57 | 3.74 |
| 12-Jul-04 | 0.5 | 0.003 | 0.0018 | 0.0103 | 0.38 | 0.333 | 0.0085 | 0.0440 | 0.0225 | 0.42 | 1.99 |
| 17-Aug-04 | 0.5 | 0.017 | 0.0019 | 0.0158 | 0.56 | 0.406 | 0.0059 | 0.0461 | 0.0216 | 1.84 | 2.21 |
| 02-Sep-04 | 0.5 | 0.017 | 0.0015 | 0.0060 | 0.40 | 0.438 | 0.0090 | 0.0383 | 0.0234 | 1.75 | 3.01 |
| 05-Oct-04 | 0.5 | 0.014 | 0.0125 | 0.2415 | 0.65 | 0.369 | 0.0029 | 0.0448 | 0.0110 | 1.52 | 2.00 |

**Table 11 DataFlow Calibration Station XJG4451 - 2004 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10-Mar-04 | 0.5 | 0.006 | 0.0132 | 1.4968 | 2.37 | | 0.0030 | | 0.0919 | | |
| 30-Mar-04 | 0.4 | 0.035 | 0.0181 | 1.7319 | 1.96 | 0.586 | 0.0122 | 0.0477 | 0.0140 | 3.85 | 3.79 |
| 08-Apr-04 | 0.5 | 0.018 | 0.0139 | 0.9861 | 1.49 | 0.448 | 0.0036 | 0.0589 | 0.0154 | 3.21 | 2.72 |
| 14-Apr-04 | 0.5 | 0.130 | 0.0134 | 1.1766 | 1.62 | 0.292 | 0.0078 | 0.0455 | 0.0204 | 3.25 | 2.50 |
| 27-Apr-04 | 0.1 | 0.167 | 0.0262 | 1.1638 | 1.77 | 0.668 | 0.0050 | 0.0584 | 0.0226 | | 3.44 |
| 11-May-04 | 0.1 | 0.188 | 0.0444 | 1.3956 | 2.55 | 0.452 | 0.0066 | 0.0525 | 0.0411 | 4.53 | 2.72 |
| 25-May-04 | 0.5 | 0.244 | 0.0567 | 1.1733 | 2.04 | 0.616 | 0.0052 | 0.1104 | 0.0285 | 4.59 | 4.84 |
| 27-May-04 | 0.5 | 0.059 | 0.0467 | 1.1033 | 1.41 | 0.147 | 0.0062 | 0.0214 | 0.0199 | 4.78 | 0.86 |
| 08-Jun-04 | 0.1 | 0.035 | 0.0141 | 0.5859 | 1.25 | 0.132 | 0.0051 | 0.0158 | 0.0338 | 2.13 | 1.01 |
| 22-Jun-04 | 0.8 | 0.092 | 0.0161 | 0.4329 | 1.18 | 0.097 | 0.0133 | 0.0106 | 0.0363 | 1.14 | 0.77 |
| 07-Jul-04 | 0.3 | 0.022 | 0.0019 | 0.0103 | 0.45 | 0.139 | 0.0091 | 0.0158 | 0.0209 | 1.00 | 0.92 |
| 12-Jul-04 | 0.5 | 0.003 | 0.0090 | 0.2940 | 0.71 | 0.471 | 0.0030 | 0.0384 | 0.0146 | 0.91 | 2.51 |
| 20-Jul-04 | 0.7 | 0.022 | 0.0107 | 0.0870 | 1.41 | 0.211 | 0.0489 | 0.0559 | 0.0550 | 1.79 | 1.58 |
| 03-Aug-04 | 0.4 | 0.041 | 0.0142 | 0.1698 | 0.69 | 0.160 | 0.0072 | 0.0206 | 0.0431 | 1.48 | 0.95 |
| 17-Aug-04 | 0.5 | 0.026 | 0.0063 | 0.8347 | 1.22 | 0.131 | 0.0016 | 0.0124 | 0.0086 | 1.11 | 0.77 |
| 17-Aug-04 | 0.7 | 0.032 | 0.0022 | 0.0317 | 0.59 | 0.124 | 0.0064 | 0.0132 | 0.0257 | 0.68 | 0.78 |
| 31-Aug-04 | 0.5 | 0.029 | 0.0034 | 0.0745 | 0.49 | 0.292 | 0.0085 | 0.0638 | 0.0150 | 1.63 | 2.10 |
| 02-Sep-04 | 0.5 | 0.018 | 0.0050 | 0.6560 | 1.02 | 0.096 | 0.0027 | 0.0096 | 0.0106 | 1.15 | 0.63 |
| 14-Sep-04 | 0.5 | 0.018 | 0.0011 | 0.0132 | 0.68 | 0.464 | 0.0079 | 0.0398 | 0.0294 | 0.66 | 3.52 |
| 29-Sep-04 | 0.2 | 0.042 | 0.0174 | 0.6806 | 1.14 | 0.644 | 0.0089 | 0.0642 | 0.0214 | 1.95 | 5.08 |
| 13-Oct-04 | 0.7 | 0.007 | 0.0018 | 0.1652 | 0.55 | 0.218 | 0.0039 | 0.0351 | 0.0129 | 0.41 | 1.83 |
| 26-Oct-04 | 0.8 | 0.005 | 0.0034 | 0.7796 | 1.12 | 0.262 | 0.0067 | 0.0280 | 0.0089 | 1.02 | 1.83 |
| 18-Nov-04 | 0.6 | 0.055 | 0.0082 | 0.6988 | 1.27 | | 0.0159 | | 0.0793 | | |
| 30-Nov-04 | 0.4 | 0.133 | 0.0136 | 0.6934 | 1.50 | | 0.0069 | | 0.0883 | | |
| 16-Dec-04 | 0.3 | 0.342 | 0.0197 | 1.2203 | 2.26 | | 0.0078 | | 0.0943 | | |

**Table 12 Otter Point Creek (XJG7035) - Weekly 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 08-Apr-04 | 0.5 | 0.011 | 0.0130 | 1.1070 | 1.53 | 0.344 | 0.0030 | 0.0506 | 0.0153 | 4.51 | 2.22 |
| 27-May-04 | 0.5 | 0.034 | 0.0230 | 0.5700 | 1.00 | 0.597 | 0.0040 | 0.0575 | 0.0172 | 1.74 | 2.85 |
| 15-Jun-04 | 0.5 | 0.016 | 0.0118 | 0.5112 | 0.95 | 0.901 | 0.0065 | 0.0653 | 0.0198 | 2.42 | 5.34 |
| 12-Jul-04 | 0.5 | 0.010 | 0.0034 | 0.0098 | 0.53 | 0.711 | 0.0128 | 0.0577 | 0.0221 | 2.68 | 4.07 |
| 17-Aug-04 | 0.5 | 0.013 | 0.0039 | 0.0552 | 1.00 | 0.430 | 0.0034 | 0.0231 | 1.0000 | 1.87 | 2.66 |
| 02-Sep-04 | 0.5 | 0.023 | 0.0059 | 0.1431 | 0.53 | 0.190 | 0.0028 | 0.0129 | 0.0148 | 1.08 | 1.20 |

**Table 13 DataFlow Calibration Station XJG7856 - 2004 Weekly 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).**

Table 14 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 | 0.1630 | 0.003 | 0.0090 |
| Sediment C (10 mg) | 2.1830% | 0.044 | 0.1300% |
| Sediment N (10 mg) | 0.1950% | 0.003 | 0.0084% |
| Sediment P (34.8 mg) | 0.0304% | 0.003 | 0.0087% |
| FRESHWATER DETECTION LIMITS (1991) | | | |
| Total Volatile Solids | 3.50 | 0.3 | 0.9 |
| Hardness | 41.8 | 2.1 | 6.3 |
| Chloride | 5.84 | 0.08 | 0.23 |
| Sulfate | 4.90 | 0.03 | 0.09 |
| Carbonate Alkalinity | 1.46 | 4.38 | |
| Chlorophyll a | 4.00 | 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/QAQC%20Proced.HTM#detect | | | |

**Table 14 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.**

**Ambient water quality parameter data, collected concurrently with nutrient and pigments, are located in Tables 15 - 19.**

| Date | Depth (m) | Specific Conductance (µS/cm) | D.O. (mg/l) | pH | Salinity (psu) | Water Temperature (°C) |
|---|---|---|---|---|---|---|
| 27-May-04 | 0.5 | 358 | 8.6 | 8.6 | 0.00 | 26.9 |
| 15-Jun-04 | 0.5 | 773 | 8.2 | 7.4 | 0.06 | 24.0 |
| 12-Jul-04 | 0.5 | 2150 | 7.5 | 7.1 | 0.81 | 27.2 |
| 17-Aug-04 | 0.5 | 1570 | 6.8 | 6.9 | 0.49 | 24.9 |
| 02-Sep-04 | 0.5 | 608 | 7.2 | 7.1 | 0.00 | 26.5 |
| 05-Oct-04 | 0.5 | 483 | 8.9 | 7.6 | 0.00 | 19.3 |

**Table 15 DataFlow Calibration Station XJG2340 - 2004 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) |
|---|---|---|---|---|---|---|
| 30-Mar-04 | 1.0 | 1317 | 12.4 | 9.12 | 0.36 | 11.3 |
| 08-Apr-04 | 0.5 | 940 | 11.3 | 8.7 | 0.15 | 11.2 |
| 14-Apr-04 | 1.0 | 589 | 11.0 | 7.65 | 0.00 | 9.6 |
| 27-Apr-04 | 1.0 | 715 | 7.7 | 7.23 | 0.03 | 17.0 |
| 11-May-04 | 1.0 | 568 | 8.3 | 7.51 | 0.00 | 23.0 |
| 25-May-04 | 1.0 | 472 | 7.5 | 7.43 | 0.00 | 27.0 |
| 27-May-04 | 0.5 | 488 | 8.4 | 8.6 | 0.00 | 26.9 |
| 08-Jun-04 | 1.0 | 397 | 8.7 | 7.41 | 0.00 | 22.0 |
| 15-Jun-04 | 0.5 | 503 | 7.9 | 7.4 | 0.00 | 23.9 |
| 22-Jun-04 | 1.0 | 712 | 7.8 | 7.47 | 0.03 | 24.8 |
| 07-Jul-04 | 1.0 | 655 | 6.8 | 6.94 | 0.00 | 28.2 |
| 12-Jul-04 | 0.5 | 732 | 6.5 | 6.8 | 0.04 | 27.6 |
| 03-Aug-04 | 1.0 | 603 | 7.3 | 7.27 | 0.00 | 29.1 |
| 17-Aug-04 | 0.5 | 538 | 7.4 | 7 | 0.00 | 25.2 |
| 17-Aug-04 | 1.0 | 530 | 7.7 | 7.32 | 0.00 | 25.5 |
| 31-Aug-04 | 1.0 | 702 | 6.3 | 7 | 0.02 | 27.2 |
| 02-Sep-04 | 0.5 | 688 | 7.7 | 7.2 | 0.01 | 26.2 |
| 14-Sep-04 | 1.0 | 744 | 8.6 | 7.59 | 0.04 | 25.6 |
| 05-Oct-04 | 0.5 | 655 | 8.3 | 7.5 | 0.00 | 19.6 |
| 13-Oct-04 | 1.0 | 573 | 10.2 | 8.02 | 0.00 | 16.0 |
| 26-Oct-04 | 1.0 | 902 | 11.4 | 7.71 | 0.13 | 13.3 |

**Table 16 Lauderick Creek (XJG4337) - 2004 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) |
|---|---|---|---|---|---|---|
| 08-Apr-04 | 0.5 | 957 | 12.1 | 8.8 | 0.16 | |
| 27-May-04 | 0.5 | 482 | 8.7 | 8.6 | 0.00 | 26.3 |
| 15-Jun-04 | 0.5 | 393 | 8.1 | 7.8 | 0.00 | 24.1 |
| 12-Jul-04 | 0.5 | 704 | 6.9 | 7.1 | 0.02 | 27.4 |
| 17-Aug-04 | 0.5 | 518 | 7.9 | 7.6 | 0.00 | 24.9 |
| 02-Sep-04 | 0.5 | 576 | 8.2 | 8.2 | 0.00 | 26.5 |
| 05-Oct-04 | 0.5 | 514 | 9.0 | 7.9 | 0.00 | 19.7 |

**Table 17 DataFlow Calibration Station XJG4451 - 2004 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) |
|---|---|---|---|---|---|---|
| 10-Mar-04 | 0.5 | 251 | 11.8 | 7.63 | 0.00 | 7.9 |
| 30-Mar-04 | 0.4 | 298 | 10.4 | 7.61 | 0.00 | 10.7 |
| 08-Apr-04 | 0.5 | 401 | 11.3 | 8.4 | 0.00 | 11.5 |
| 14-Apr-04 | 0.5 | 206 | 10.5 | 6.65 | 0.00 | 9.1 |
| 27-Apr-04 | 0.1 | 228 | 7.3 | 7.14 | 0.00 | 14.4 |
| 11-May-04 | 0.1 | 215 | 7.1 | 6.97 | 0.00 | 23.9 |
| 25-May-04 | 0.5 | 207 | 4.4 | 7.18 | 0.00 | 26.3 |
| 27-May-04 | 0.5 | 237 | 7.4 | 8.1 | 0.00 | 25.5 |
| 08-Jun-04 | 0.1 | 227 | 10.5 | 8.46 | 0.00 | 21.0 |
| 22-Jun-04 | 0.8 | 183 | 8.6 | 9.82 | 0.00 | 23.9 |
| 07-Jul-04 | 0.3 | 217 | 5.3 | 8.68 | 0.00 | 26.0 |
| 12-Jul-04 | 0.5 | 243 | 7.5 | 9 | 0.00 | 27.6 |
| 20-Jul-04 | 0.7 | 241 | 9.2 | 8.23 | 0.00 | 26.1 |
| 03-Aug-04 | 0.4 | 164 | 4.8 | 7.55 | 0.00 | 27.3 |
| 17-Aug-04 | 0.5 | 180 | 9.1 | 8.5 | 0.00 | 25.0 |
| 17-Aug-04 | 0.7 | 194 | 6.9 | 8.96 | 0.00 | 24.0 |
| 31-Aug-04 | 0.5 | 222 | 2.4 | 7.74 | 0.00 | 26.7 |
| 02-Sep-04 | 0.5 | 248 | 7.2 | 8.3 | 0.00 | 25.4 |
| 14-Sep-04 | 0.5 | 264 | 2.0 | 7.29 | 0.00 | 24.0 |
| 29-Sep-04 | 0.2 | 174 | 3.4 | 6.4 | 0.00 | 19.8 |
| 13-Oct-04 | 0.7 | 166 | 9.8 | 8.82 | 0.00 | 15.0 |
| 26-Oct-04 | 0.8 | 233 | 9.3 | 7.3 | 0.00 | 13.3 |
| 18-Nov-04 | 0.6 | 244 | 10.5 | 7.04 | 0.00 | 10.1 |
| 30-Nov-04 | 0.4 | 110 | 7.5 | 6.85 | 0.00 | 8.4 |
| 16-Dec-04 | 0.3 | 189 | 11.3 | 7.04 | 0.00 | 1.6 |

**Table 18 Otter Point Creek (XJG7035) - 2004 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) |
|---|---|---|---|---|---|---|
| 08-Apr-04 | 0.5 | 356 | 10.9 | 7.9 | 0.00 | 10.7 |
| 27-May-04 | 0.5 | 360 | 7.8 | 8 | 0.00 | 27.4 |
| 15-Jun-04 | 0.5 | 286 | 9.1 | 8.2 | 0.00 | 24.0 |
| 12-Jul-04 | 0.5 | 305 | 7.5 | 8.7 | 0.00 | 27.5 |
| 17-Aug-04 | 0.5 | 286 | 8.9 | 8.8 | 0.00 | 24.8 |
| 02-Sep-04 | 0.5 | 334 | 8.5 | 8.7 | 0.00 | 25.9 |

**Table 19 DataFlow Calibration Station XJG7856 - 2004 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, April through October 2004. 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 8-14, pages 23 - 30) 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. Calibration samples (tables 9-13) were 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 – 10 mg/l occurring May through October. 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. 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 µg/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 maps can be obtained through Eyes on the Bay at: http://mddnr.chesapeakebay.net/sim/dataflow_data.cfm.

## 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.

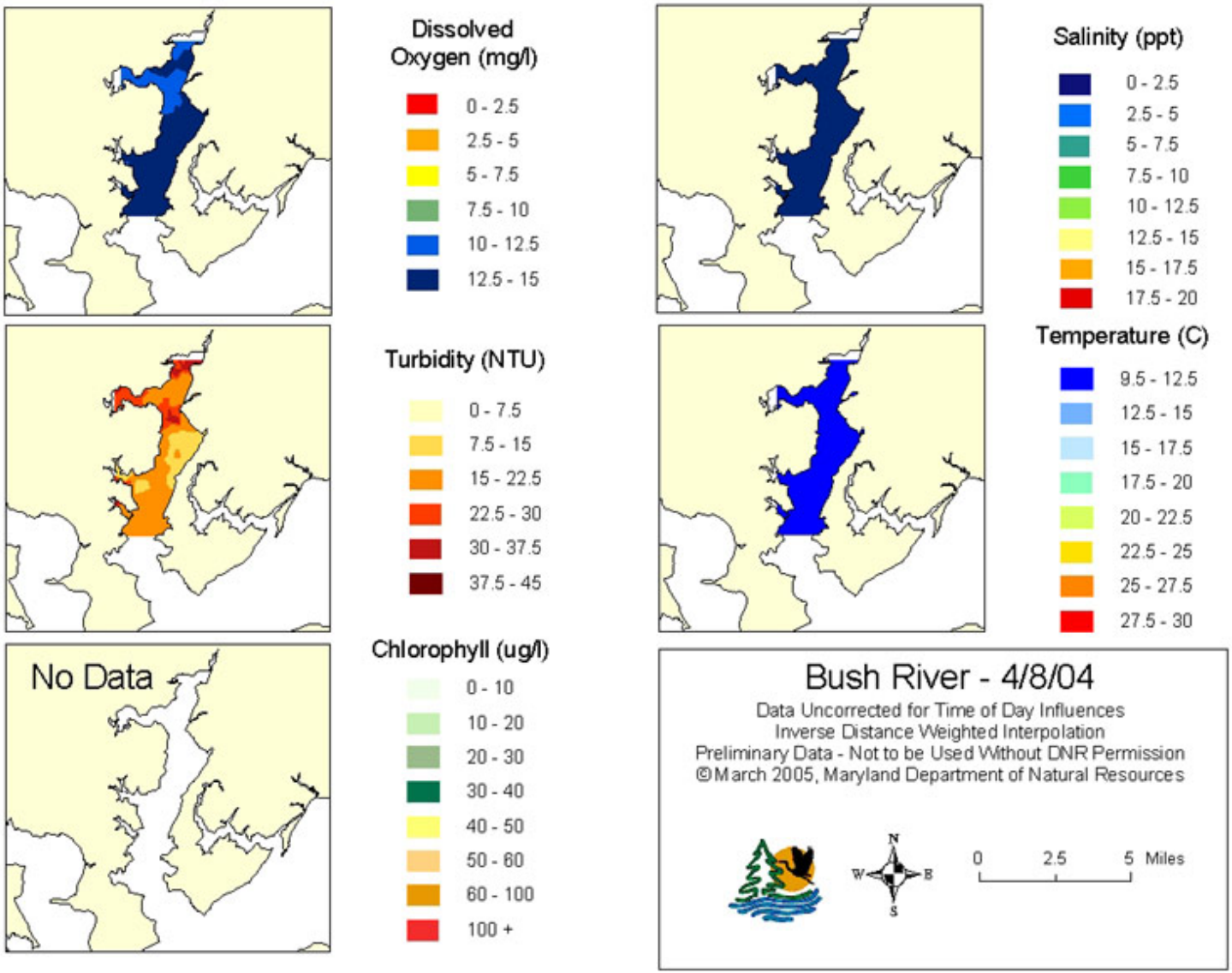


**Figure 8 Bush River Water Quality Mapping from April 8, 2004.**

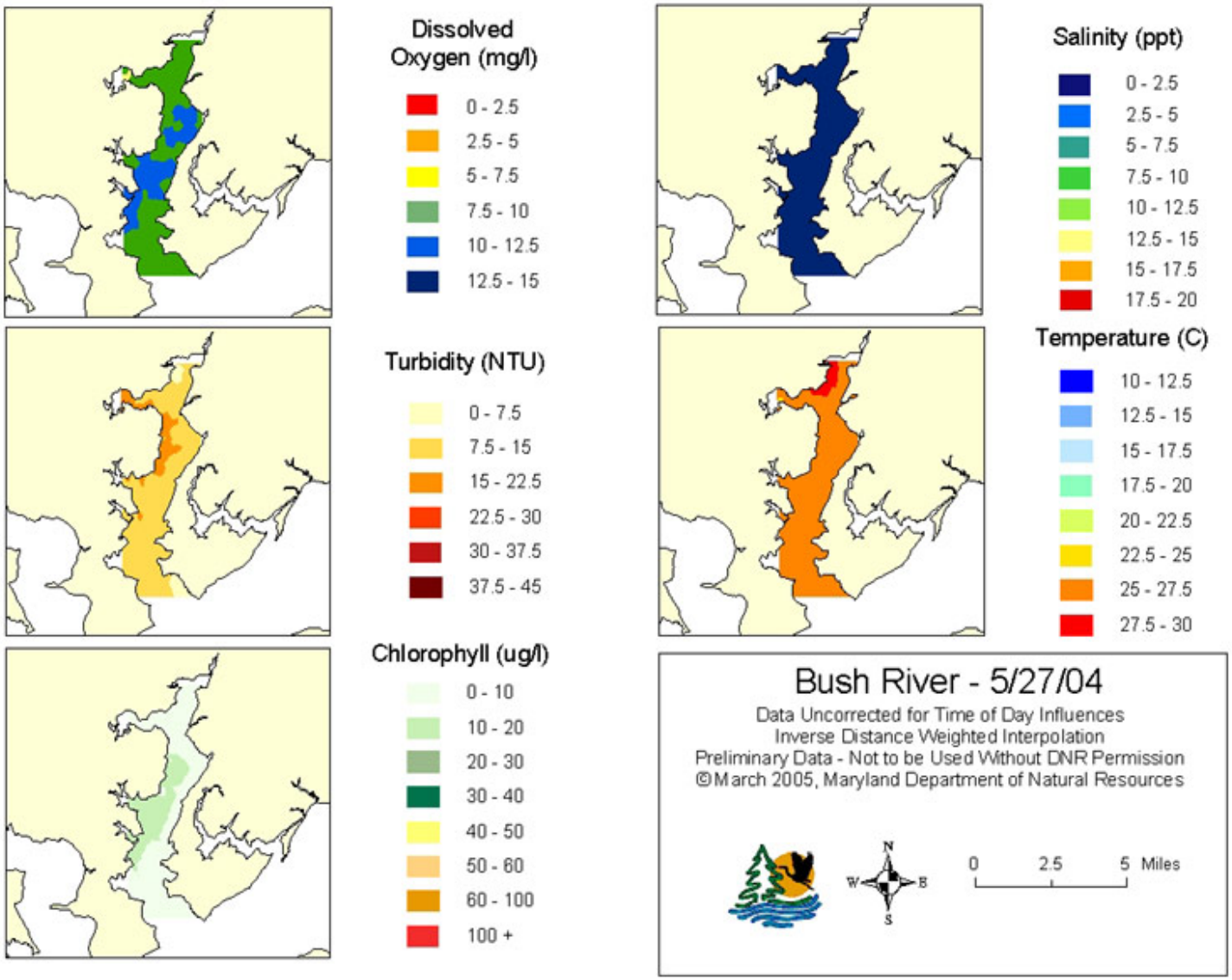


**Figure 9 Bush River Water Quality Mapping from May 27, 2004**

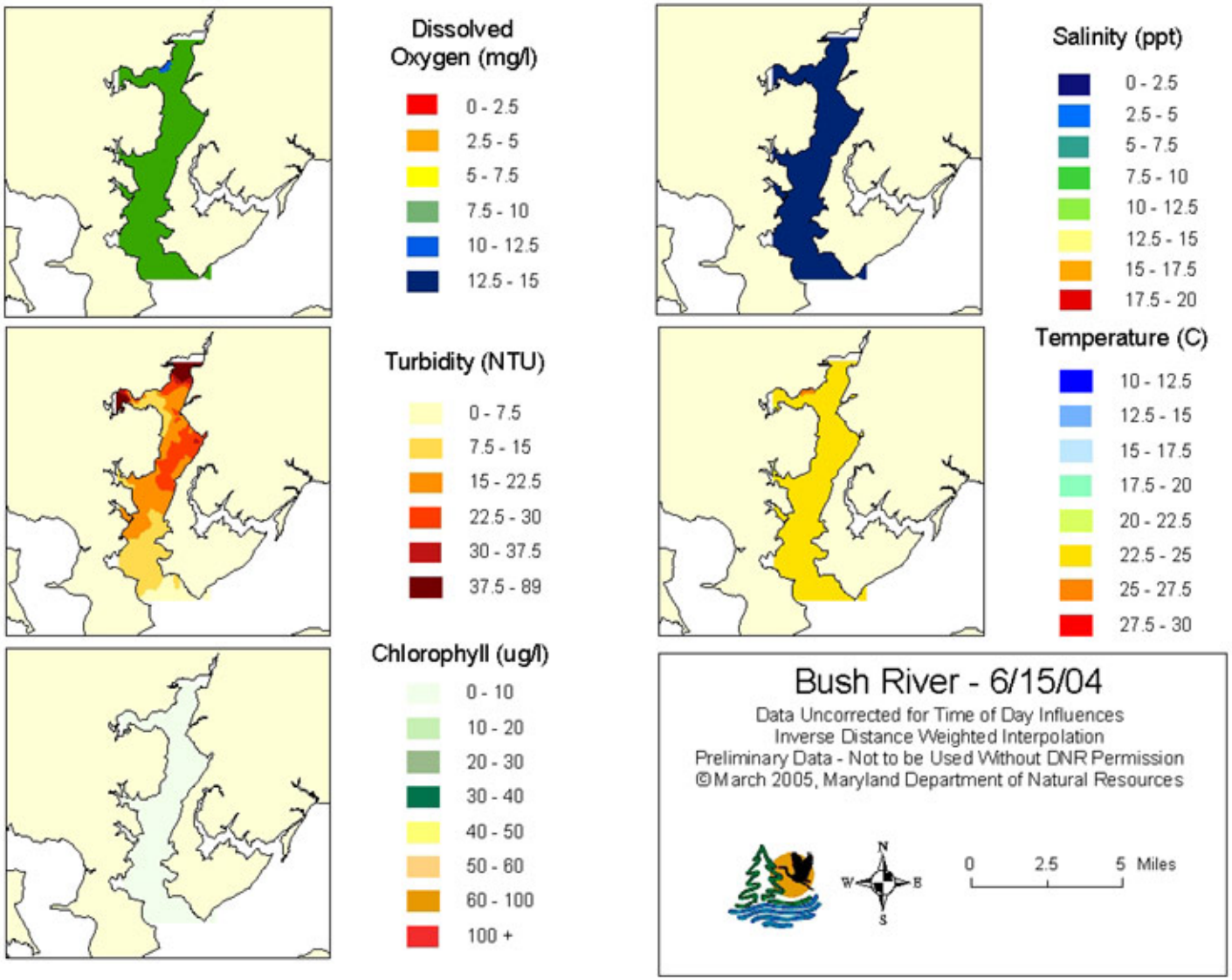


**Figure 10 Bush River Water Quality Mapping from June 16, 2004**

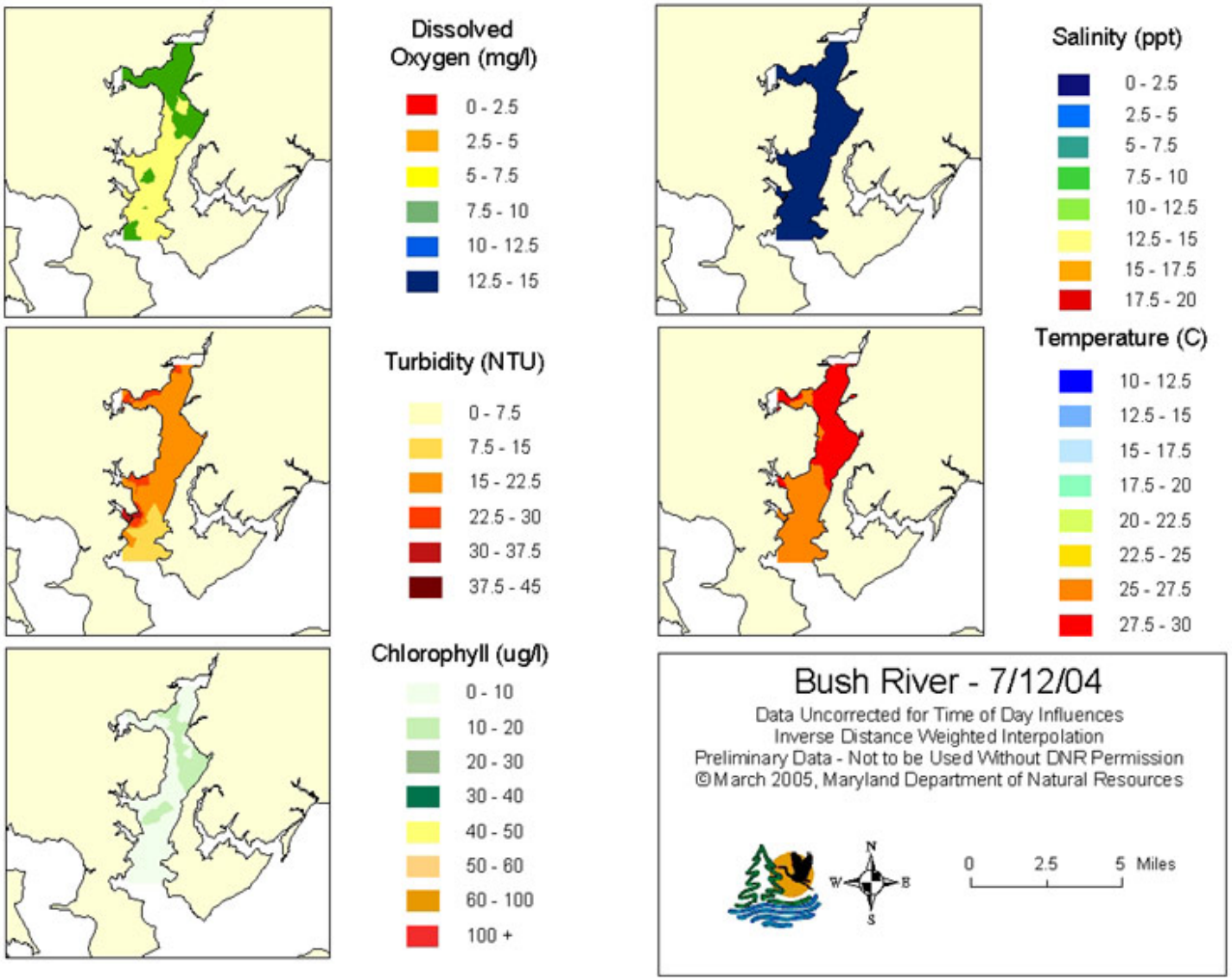


**Figure 11 Bush River Water Quality Mapping from July 12, 2004**

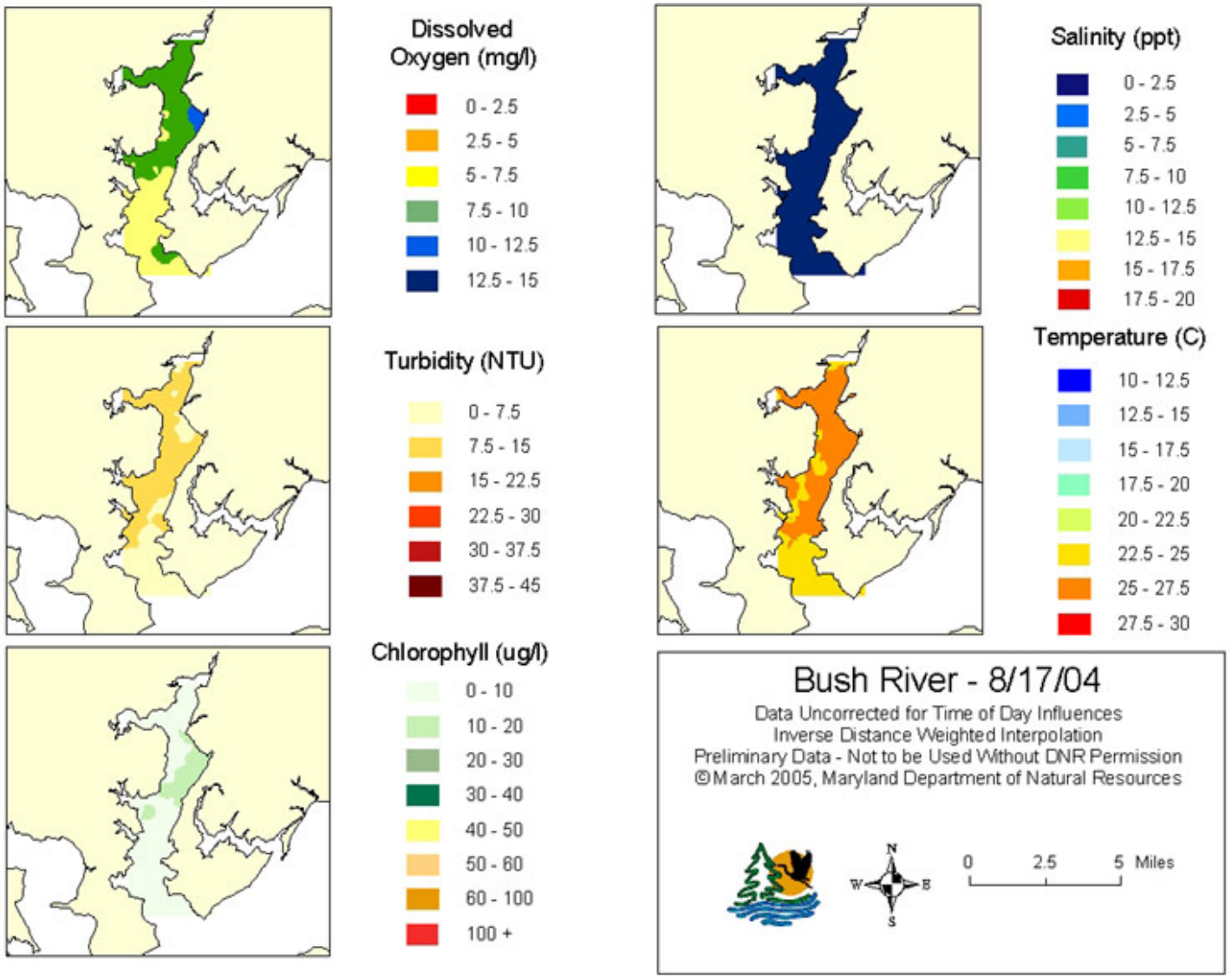


**Figure 12 Bush River Water Quality Mapping from August 17, 2004**

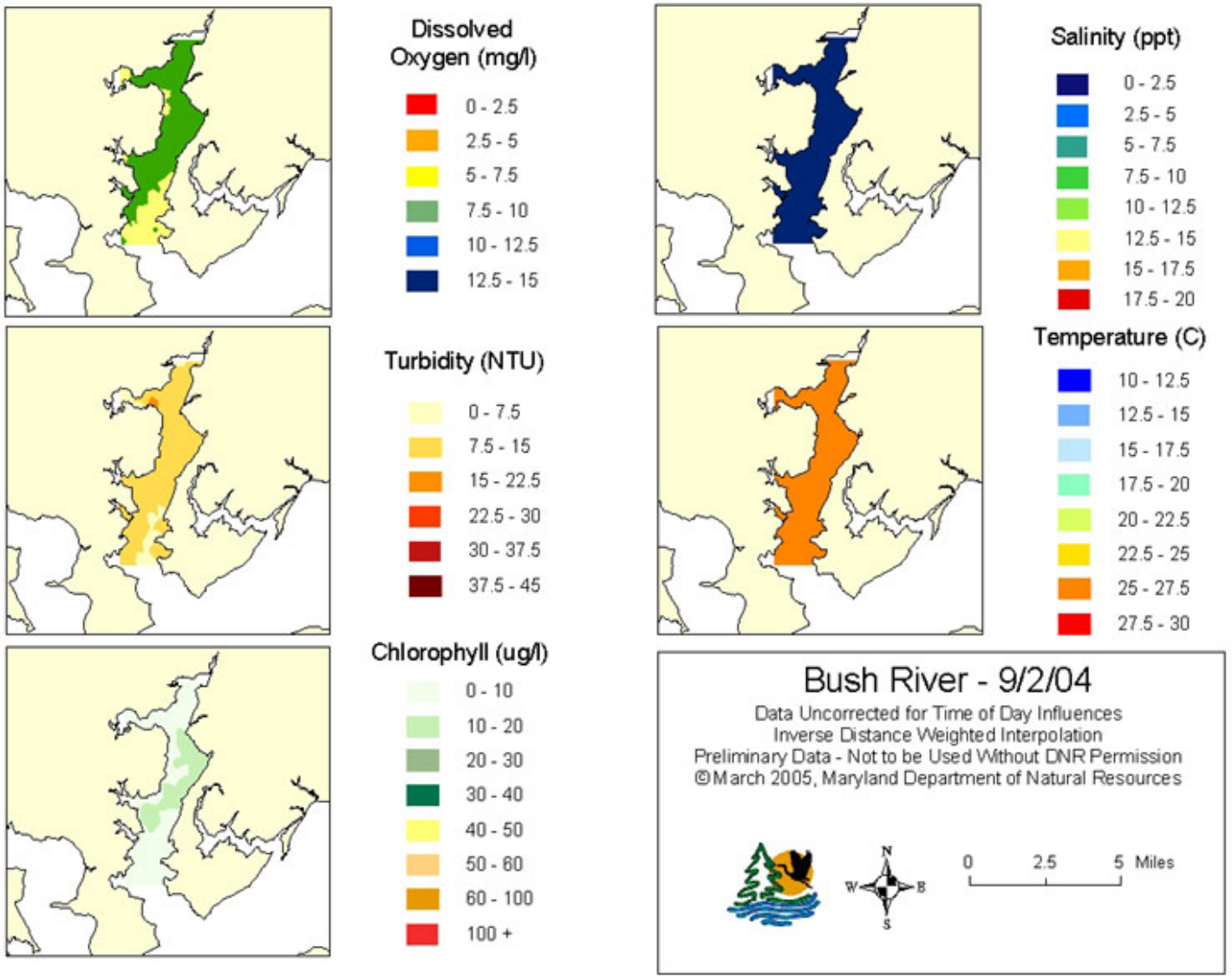


**Figure 13 Bush River Water Quality Mapping from September 2, 2004**

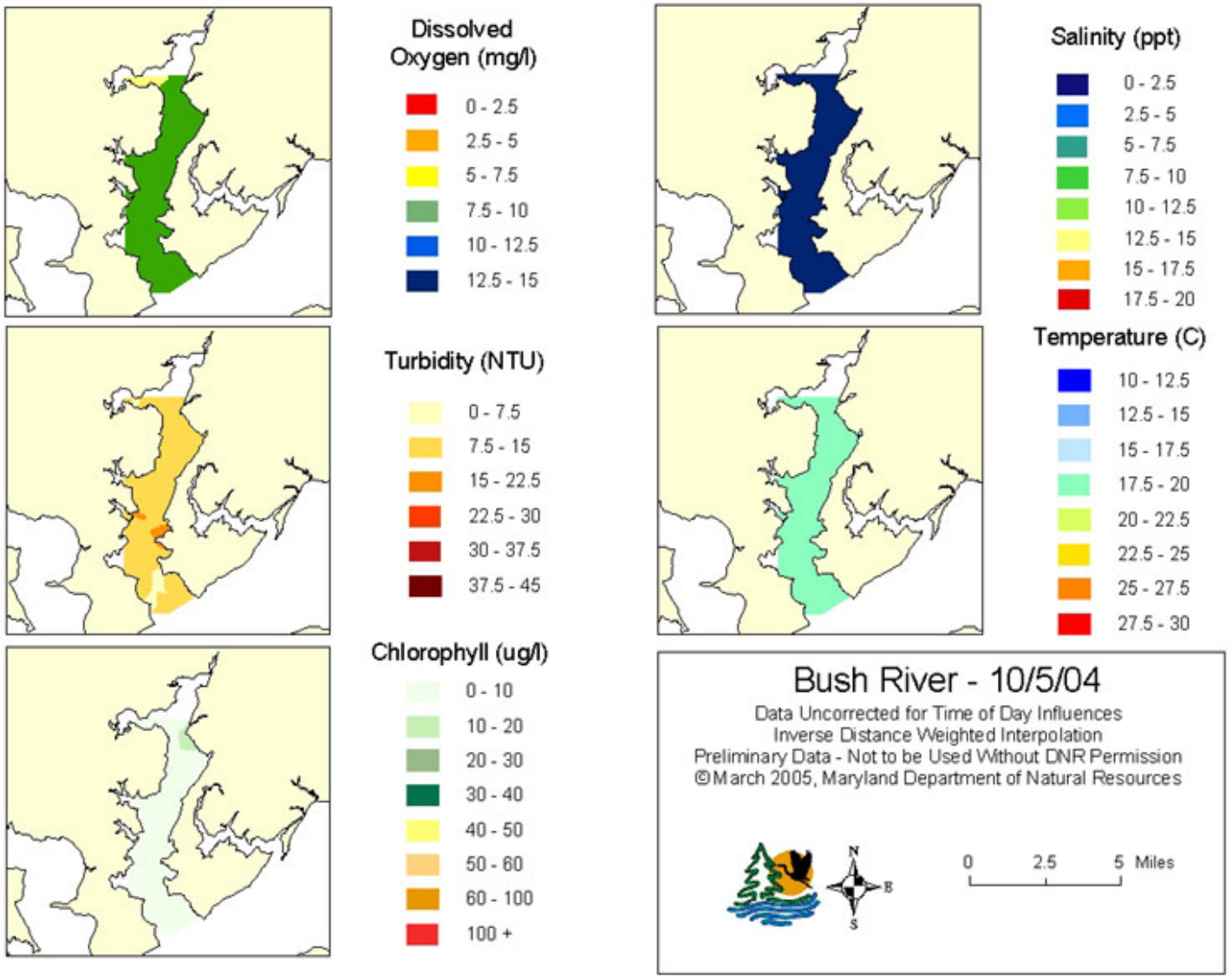


**Figure 14 Bush River Water Quality Mapping from October 5, 2004**