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2003 Upper Patuxent River Shallow Water Monitoring Data Report

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2003 Upper Patuxent River Shallow Water Monitoring Data Report

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1. Introduction

The Maryland Department of Natural Resources (DNR) maintained three shallow water continuous monitoring sites and one weather station in the Jug Bay Reserve in the upper Patuxent River within the Chesapeake Bay National Estuarine Research Reserve (CBNERR-MD) system, through funding provided by the NOAA National Estuarine Research Reserve System (NERRS) program in 2003. DNR has been maintaining shallow water monitoring technologies over the last several years in cooperation with the University of Maryland's Chesapeake Biological Laboratory, EPA and NOAA and implemented a Maryland-wide program in 2003. These shallow water monitoring technologies have been extremely successful, providing a wealth of physical and nutrient information that supplies the necessary data to evaluate new water quality criteria for dissolved oxygen, water clarity and chlorophyll, assess potential submerged aquatic vegetation (SAV) restoration sites and determine if areas are meeting their designated use.

The Jug Bay project's aim was to monitor ambient water quality parameters, nutrient concentrations and meteorological conditions in order to characterize water quality and habitat conditions. This report focuses on data collected between April and December 2003 (Table 1-1). Water quality measurements were collected every 15 minutes from April to December using YSI 6600 data loggers. Data collection at Railroad Bridge and Iron Pot Landing began on April 4 and ended on December 31, 2003, while data collection began on April 22 and ended on December 31, 2003 at Mataponi Creek. Real-time water quality data (updated hourly) for the Railroad Bridge site and near-time data (updated biweekly) for the Iron Pot Landing and Mataponi Creek sites are available on DNR's "Eyes on the Bay" web site (http://www.eyesonthebay.net). Grab samples were collected by Maryland DNR on a weekly basis from April to October at all three sites. During these months a full suite of nutrients (particulate carbon, particulate nitrogen, total dissolved nitrogen, total dissolved phosphorus, particulate phosphorus, total nitrogen, total phosphorus, nitrite, ammonium, orthophosphate, nitrite + nitrate, silica, volatile suspended solids, total suspended solids, chlorophyll and turbidity) were processed and analyzed. Only the core NERR nutrients (total dissolved nitrogen, total dissolved phosphorus, nitrite, ammonium, orthophosphate, nitrite + nitrate, volatile suspended solids, total suspended solids and chlorophyll) were collected and analyzed on a biweekly basis during November and December. Diel nutrient sampling was conducted once monthly at the Railroad Bridge station from July through December 2003 and only included the core NERR nutrients. Upper Patuxent River water quality mapping data were collected monthly from April-October 2003. Water quality mapping collects surface data every four seconds aboard a moving boat, creating thousands of data points in a daily cruise, and allows for the creation of highly detailed spatial maps of water quality. Weather data (air temperature, relative humidity, barometric pressure, rainfall, wind speed, wind direction and photosynthetically active radiation) was collected from January 1 through December 31, 2003; however, only data collected after July 22 was reported due to calibration and time coding concerns. Water quality, nutrient and meteorological data are available through the NERRS national database (http://cdmo.baruch.sc.edu/).

The 2003 sampling year was an unusually wet and cool year for the Chesapeake Bay region. Precipitation and River Discharge was significantly higher in 2003 than in previous years (Figures 1-1 and Table 1-2). Further compounding 2003 high flows was a tidal surge and over three inches of rainfall from Hurricane Isabel on September 18, 2003 and a subsequent rain event several days later. Data collected during this extremely wet year may be atypical when compared to “normal” years.

Table 1-1. Dates of 2003 grab sample collection, water quality mapping cruises and other events and details.

Dates	Iron P Landing	Railr d Bridge	Mata ni Creek	DataF Cruise Dates	Other Events and Details
04/04/03	X	X			
04/08/03	X	X			
04/15/03	X	X			
04/22/03	X	X	X		
04/29/03	X	X	X	X	
05/06/03	X	X	X		
05/13/03	X	X	X		
05/20/03	X	X	X		
05/28/03	X	X	X	X	
06/03/03	X	X	X		
06/10/03	X	X	X		
06/17/03	X	X	X		
06/18/03				X	
06/24/03	X	X	X		
07/01/03	X	X	X		
07/08/03	X	X	X		
07/15/03	X	X	X		
07/22/03	X	X	X		
07/29/03	X	X	X		Duplicate Grab Samples collected; Railroad Bridge Diel Grab sampling
07/30/03				X	
08/05/03	X	X	X		
08/12/03	X	X	X		
08/19/03	X	X	X		
08/26/03	X	X	X		Duplicate Grab Samples collected
08/27/03				X	
09/02/03	X	X	X		
09/10/03	X	X	X		
09/18/03			X		Hurricane Isabel Landfall
09/23/03	X	X	X		Duplicate Grab Samples collected
09/24/03					Railroad Bridge Diel Grab sampling
09/26/03				X	
10/01/03	X	X	X		Railroad Bridge Diel Grab sampling
10/07/03	X	X	X		
10/14/03	X	X	X	X	
10/22/03	X	X	X		
10/28/03	X	X	X		Duplicate Grab Samples collected; Railroad Bridge Diel Grab sampling
11/13/03	X	X	X		
11/26/03	X	X	X		Duplicate Grab Samples collected
12/02/03					Railroad Bridge Diel Grab sampling
12/11/03	X	X	X		
12/23/03	X	X	X		Duplicate Grab Samples collected

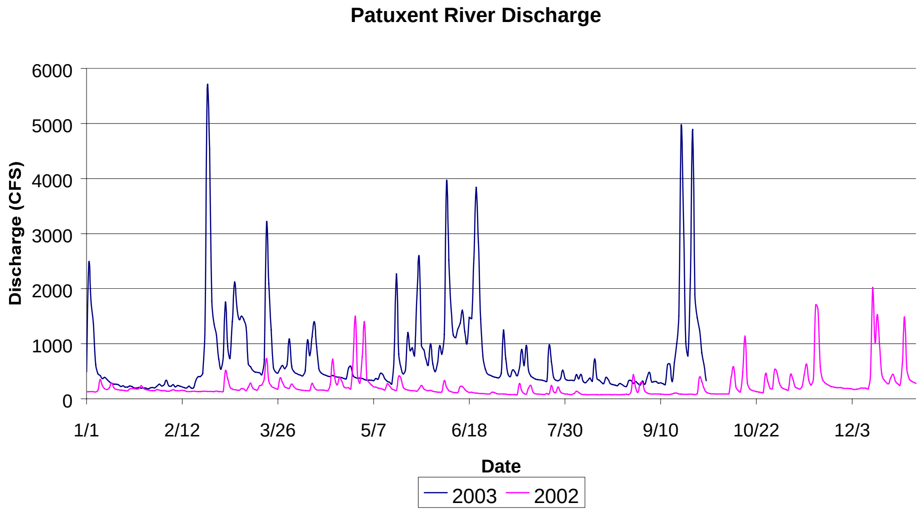


Figure 1-1. Comparison of Daily Discharge of 2002 and 2003. USGS Gage 01594440 near Bowie, MD. (Provisional data subject to revision).

Table 1-2. 2003 Jug Bay Reserve Precipitation Data.

	Total Precipitation (mm)	Average Precipitation (mm)	Departure from Normal (mm)	Greatest in 24 Hour Period (mm)	On Day of Month
January		84.1			
February		80.0			
March		108.2			
April		84.6			
May		110.2			
June		86.6			
July	28.7	89.2	-60.5	25.9	29
August	136.6	79.2	57.4	23.3	17
September	141.1	95.8	45.3	40.1	24
October	36.4	85.3	-48.9	30.5	15
November	94.5	82.6	12.0	27.9	20
December	129.1	71.9	57.2	25.4	15

***** Average precipitation data collected at Patuxent Naval Air Test Center.

2. Site Locations and Descriptions

Mataponi Creek 38° 44.599'N, 76° 42.446'W (NAD83)

The Mataponi Creek site is located in a small tributary (Mataponi Creek) off the upper tidal headwaters of the Patuxent River (Figures 2-1 and 2-2). The site is 2.4 km upstream from the mouth and located in the midchannel of the creek, which is approximately 7 m wide. Average depth at the site is 0.7 m with a mean tidal fluctuation of approximately 0.6 m. The bottom habitat is soft sediment, with submerged aquatic vegetation (SAV) abundant and dense during the summer months. Because of the dense SAV and limited degree of anthropogenic activities occurring within the watershed of this site, Mataponi Creek is thought to be a "reference" water quality site for the Jug Bay Reserve.

Railroad Bridge 38° 46.877'N, 76° 42.822'W (NAD83)

Railroad Bridge site is located slightly upstream (0.3 km) from Jackson's Landing at the Patuxent River Park. The site is roughly 1 km downstream of the confluence of the Western Branch tributary and the Patuxent River Mainstem (Figures 2-1 and 2-2). This section of the Patuxent River is approximately 70 m wide, with an average depth at the site of 1.4 m. Mean tidal fluctuation is approximately 0.6 m. The bottom habitat is characterized by soft sediment, with SAV evident in the shallow areas during the summer.

Iron Pot Landing 38° 47.760'N, 76° 43.248'W (NAD83)

Iron Pot Landing is located 2.09 km from the mouth of the Western Branch. The monitoring site is attached to a small pier near midchannel of the river and has an average depth of 1.6 m. The site is roughly 1 km downstream of a large (10-20 mgd) wastewater treatment plant effluent discharge site (Figures 2-1 and 2-2). The river is approximately 15m wide at this site and flows through extensive riparian buffers. Tides are semi-diurnal and mean tidal fluctuation is approximately 0.6 m. Bottom habitat is soft sediment, with narrow SAV beds occasionally evident in the summer. Because of the proximity of this site to the discharge location for the wastewater treatment plant, this site is considered "impacted".

Figure 2-1. Map of continuous monitoring sites in the upper Patuxent River.

Iron Pot Landing | **Railroad Bridge** | **Mataponi Creek**

Figure 2-2. Site map of continuous monitoring sites in the upper Patuxent River.

3. Ambient Water Quality (Continuous Monitoring)

The purpose of the water quality monitoring program was to conform to the NERR System Wide Monitoring Program (SWMP) and to identify trends in water quality (water temperature, salinity, pH, dissolved oxygen, chlorophyll and turbidity) over both temporal and spatial scales. Water quality measurements were collected every 15 minutes from April to December using YSI 6600 data loggers. Data collection at Railroad Bridge and Iron Pot Landing began on April 4 and ended on December 31, 2003, while collected began on April 22 and ended on December 31, 2003 at Mataponi Creek. Missing data was rejected and deleted through QA/QC procedures.

Water quality conditions at each of the three sites exhibited temporal and spatial trends in response to a variety of biological, geochemical and meteorological conditions that occurred in 2003 (Figures 3-1 through 3-7). Spring algal blooms (as characterized by chlorophyll values greater than 50 mg/L) were evident at Iron Pot Landing and Railroad Bridge in late spring/early summer (Fig. 3-2 and 3-4). The dissolved oxygen dropped severely during the summer months at Mataponi Creek (Fig. 3-6). Mataponi Creek exceeded the 5 mg/L dissolved oxygen threshold 42% of the time and the 2 mg/L threshold 16% of the time (Table 3-1). Oxygen concentrations below 5 mg/l exceed the threshold of the Chesapeake Bay's more sensitive organisms, such as fish, especially if exposed to these conditions for prolonged periods. The Mataponi Creek site was shallow compared to Iron Pot Landing and Jug Bay, and increased water temperatures and oxygen demand during the summer may have contributed to the steep drop in DO concentrations in May and subsequent low concentrations throughout the summer at this site. The late fall/early winter increases in turbidity at Mataponi Creek (Fig. 3-6) may have been the result of increased freshwater flows, since nutrient concentrations also increased during this time. All three sites exceeded turbidity threshold limits (15 NTU) 44% of the time (see Table 3-1). Turbidity levels greater than 15 NTU have been shown to negatively impact SAV. The majority of high turbidity values; however, were short-lived and corresponded with high chlorophyll values, suggesting that most periods of high turbidity were the result of algal biomass, rather than suspended solids.

The impact of Hurricane Isabel in mid-September can be observed in the continuous monitoring data. Turbidity spikes immediately following the passing of Hurricane Isabel were evident at all three sites (Fig. 3-2, 3-4 and 3-6). Since all three sites are freshwater, only small dips in salinity were observed trailing the hurricane (Fig. 3-3, 3-5 and 3-7). The greatest effect of Hurricane Isabel on water quality was the large increases in water depth, due to increased precipitation and run-off (Fig. 1-1 and 3-1 and Table 1-2).

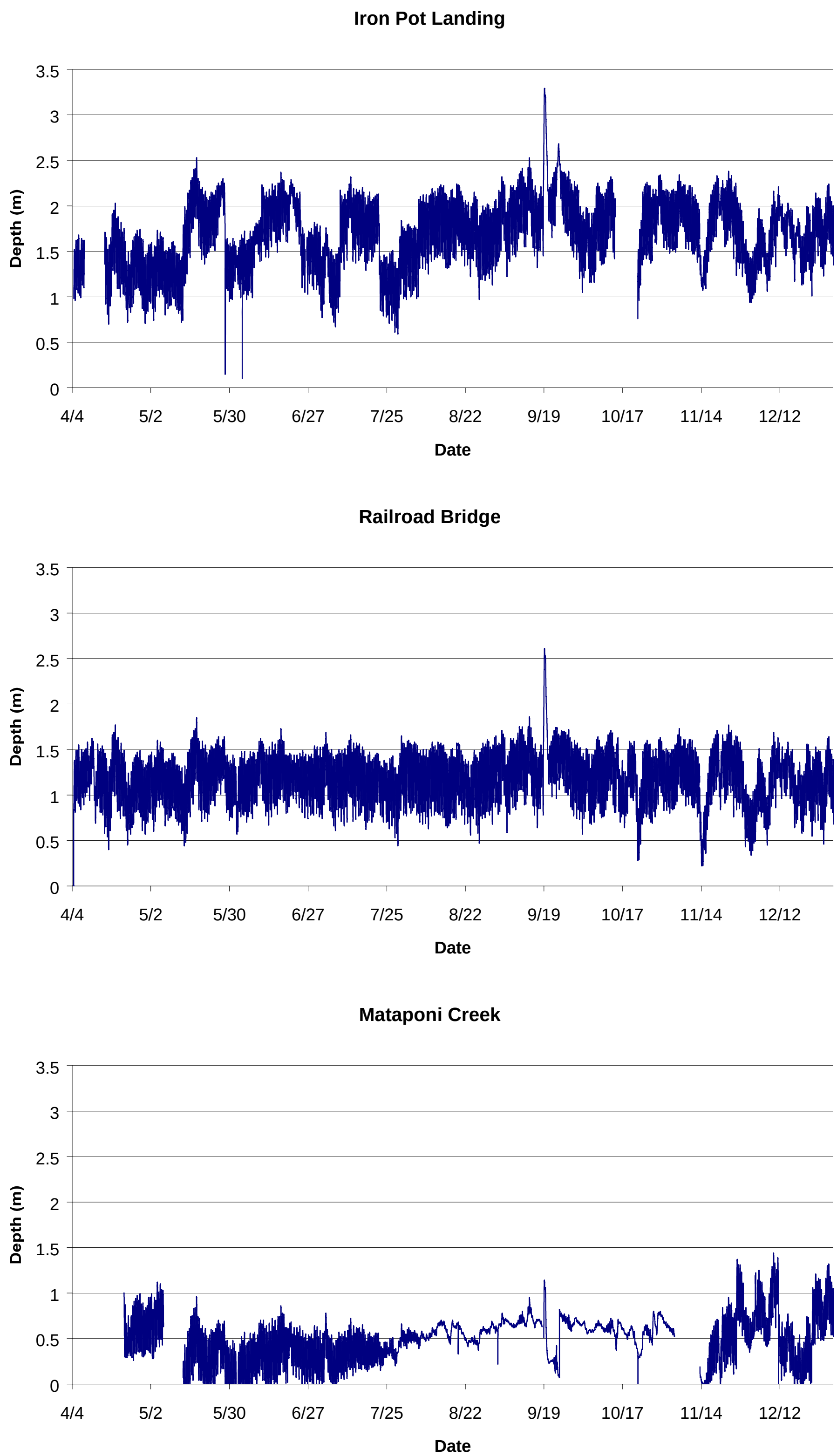


Figure 3-1. 2003 Time series of site depth for Iron Pot Landing, Railroad Bridge and Mataponi Creek.

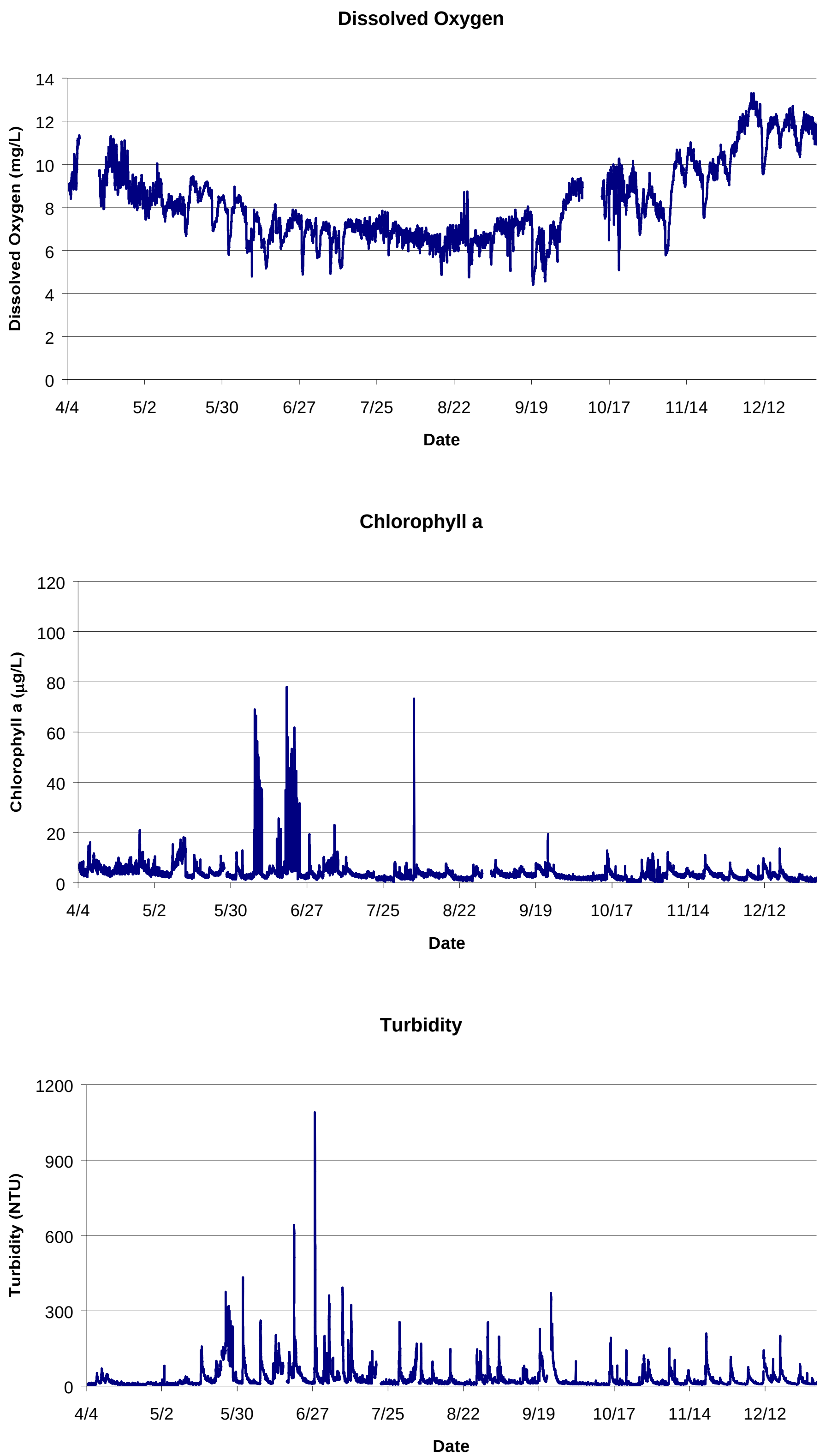
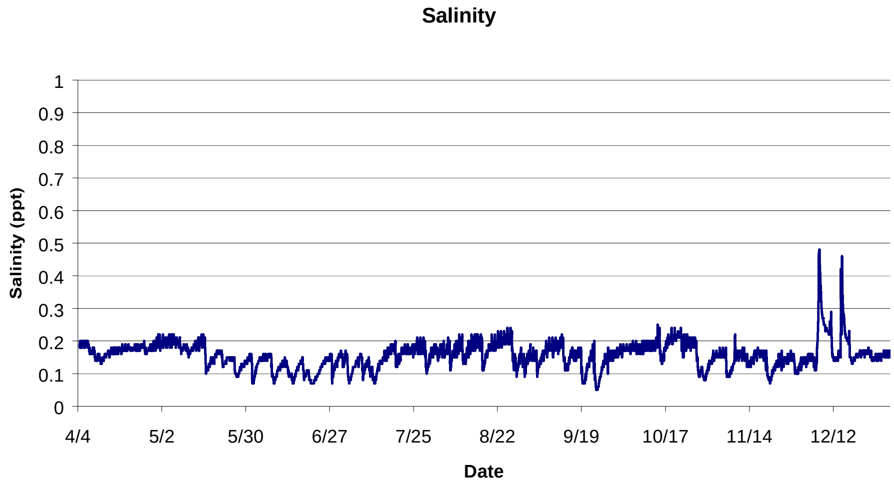
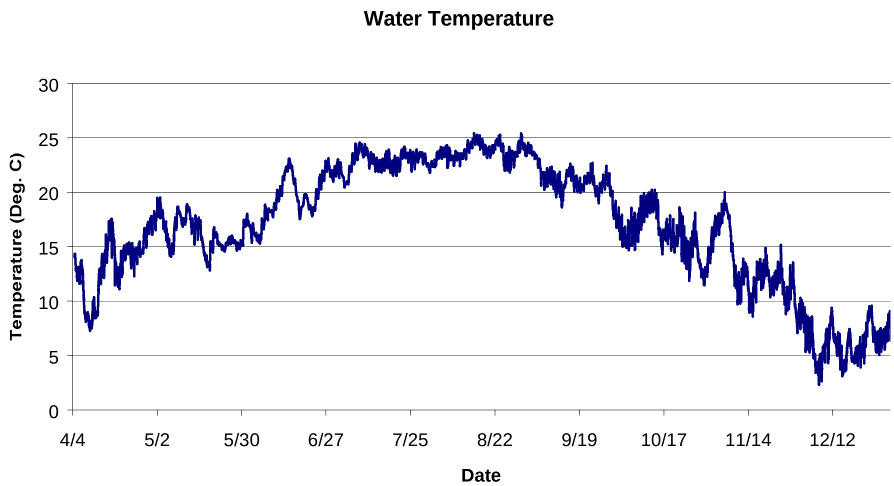


Figure 3-2. 2003 Time series of Dissolved Oxygen, Chlorophyll a and Turbidity values for Iron Pot Landing.





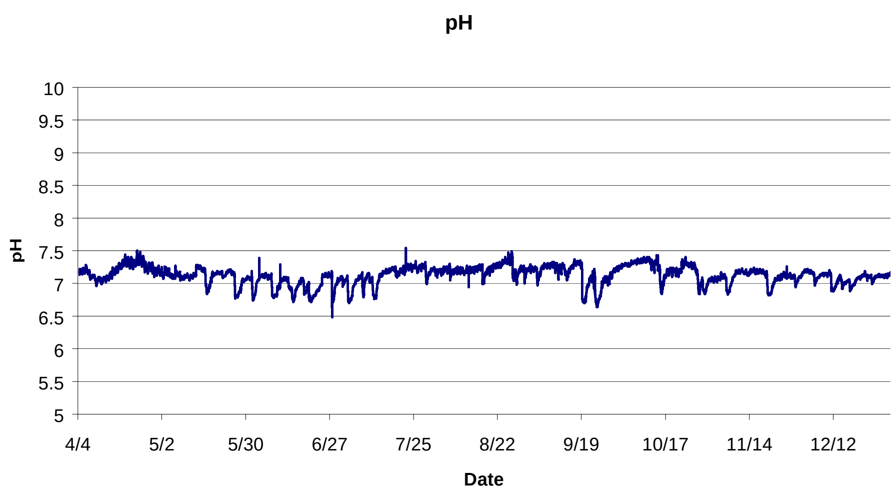


Figure 3-3. 2003 Time series of Salinity, Water Temperature and pH values for Iron Pot Landing.

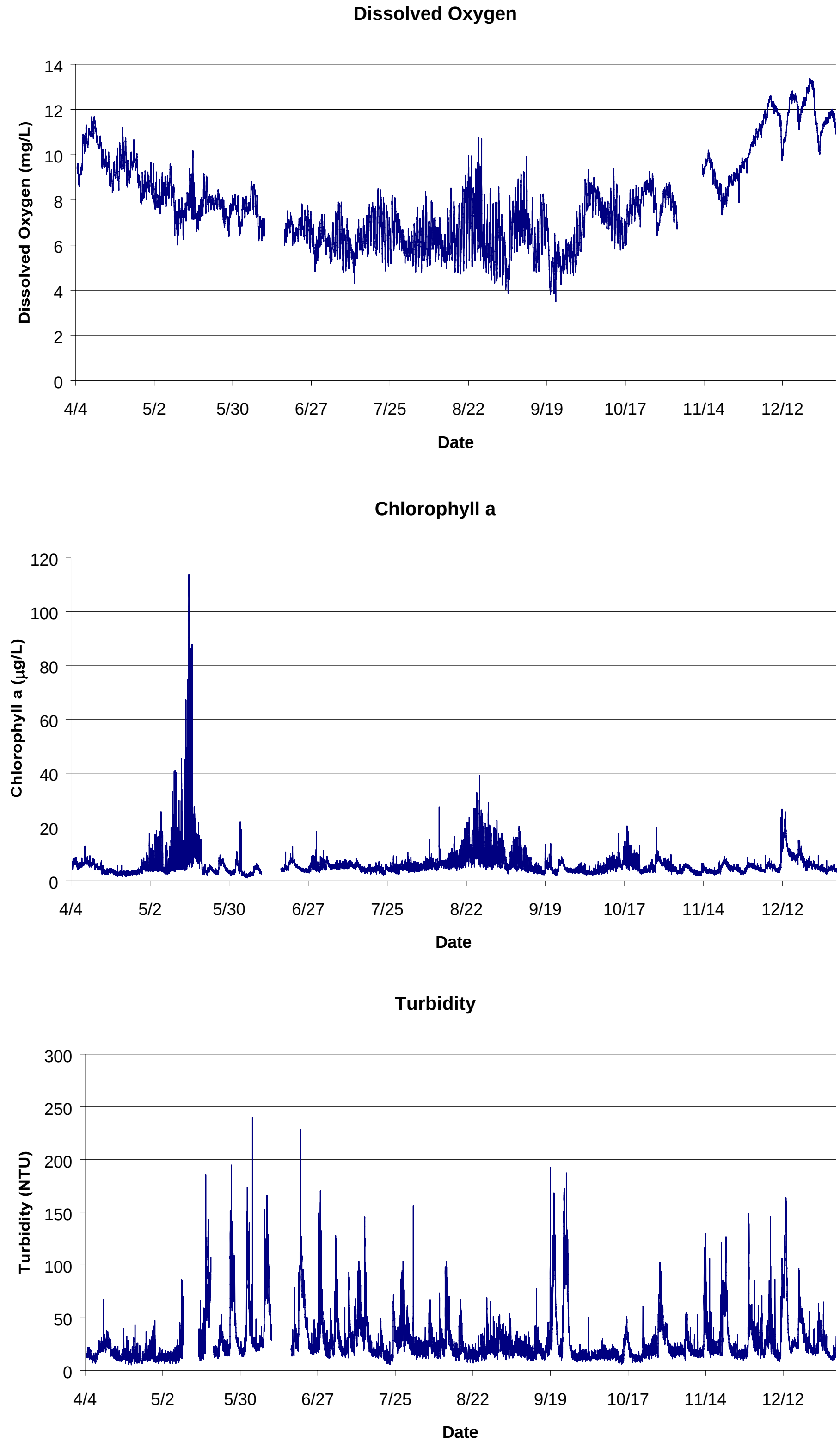


Figure 3-4. 2003 Time series of Dissolved Oxygen, Chlorophyll a and Turbidity values for Railroad Bridge.

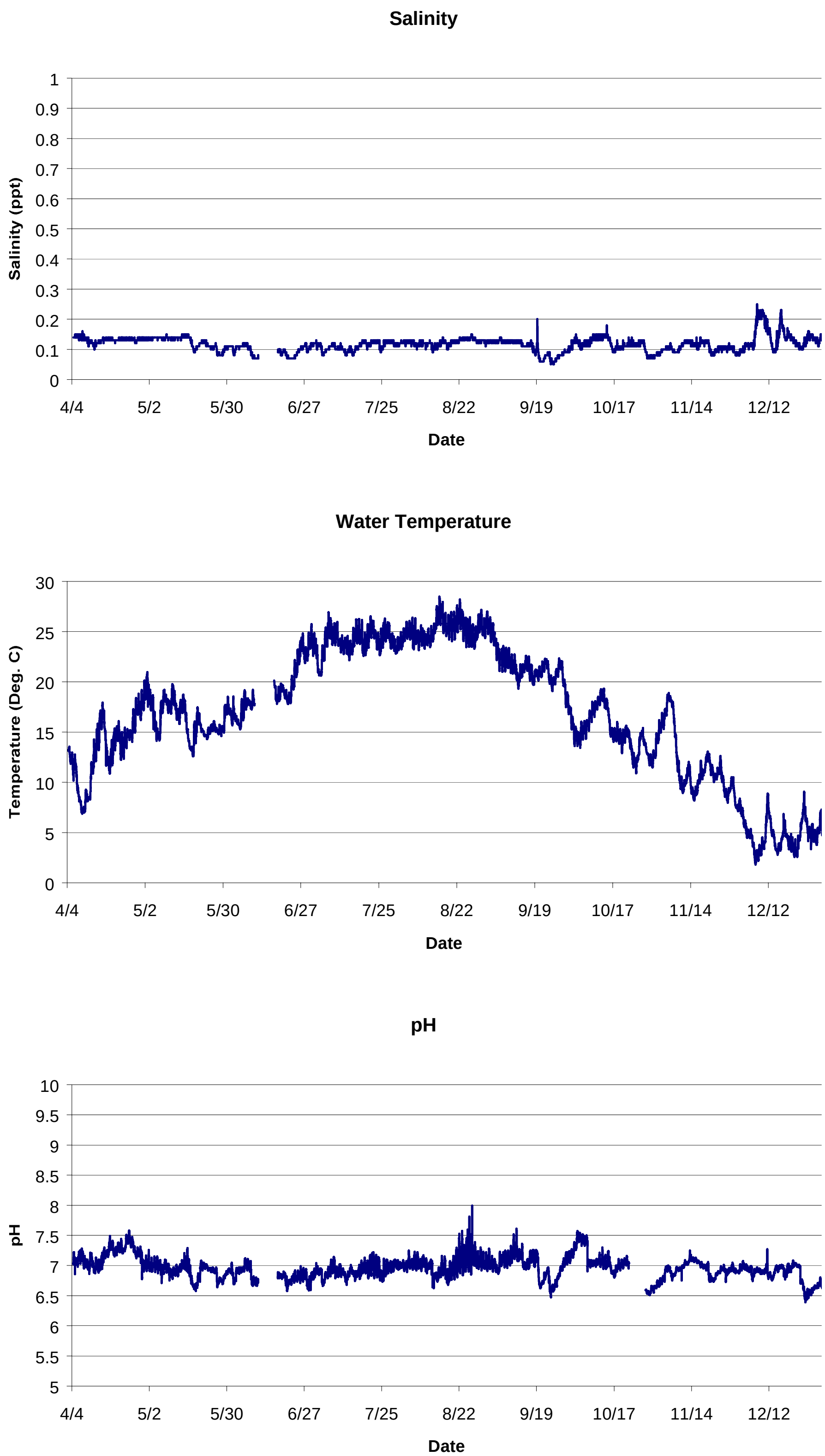
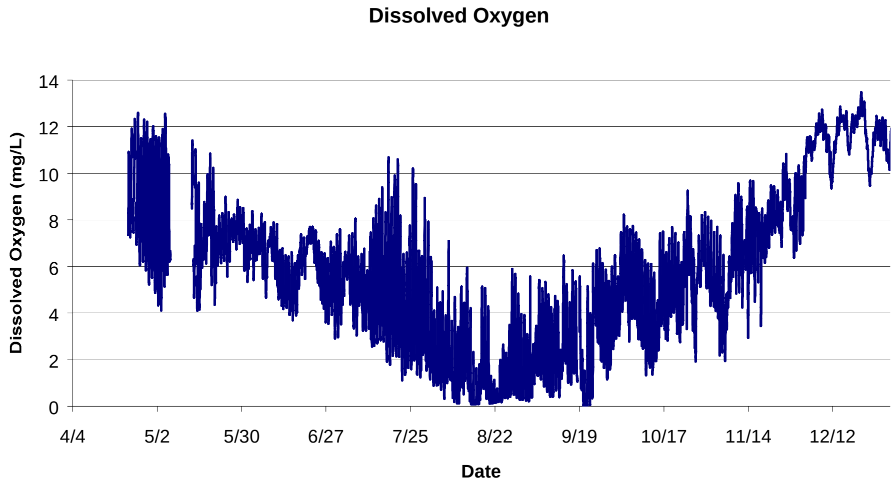
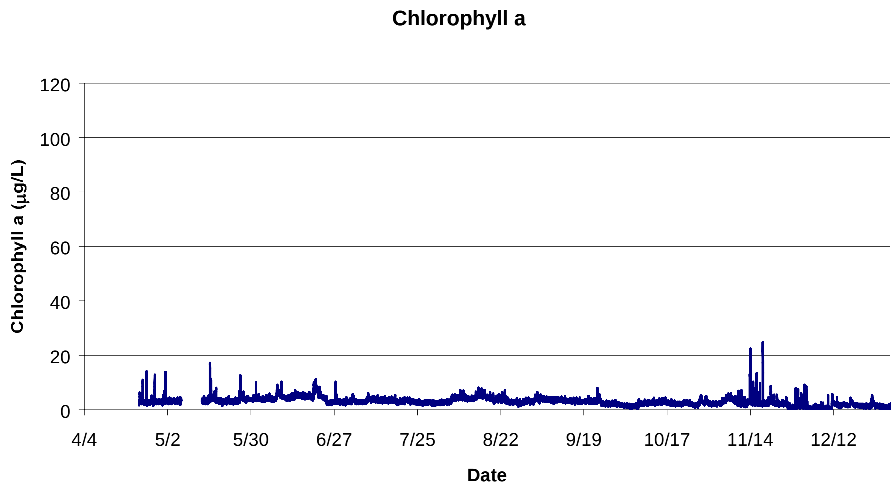


Figure 3-5. 2003 Time series of Salinity, Water Temperature and pH values for Railroad Bridge.





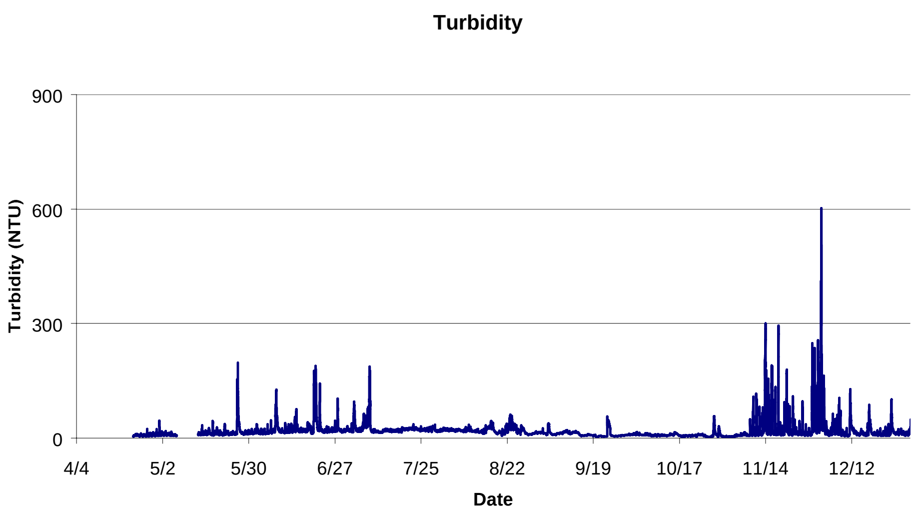


Figure 3-6. 2003 Time series of Dissolved Oxygen, Chlorophyll a and Turbidity values for Mataponi Creek.

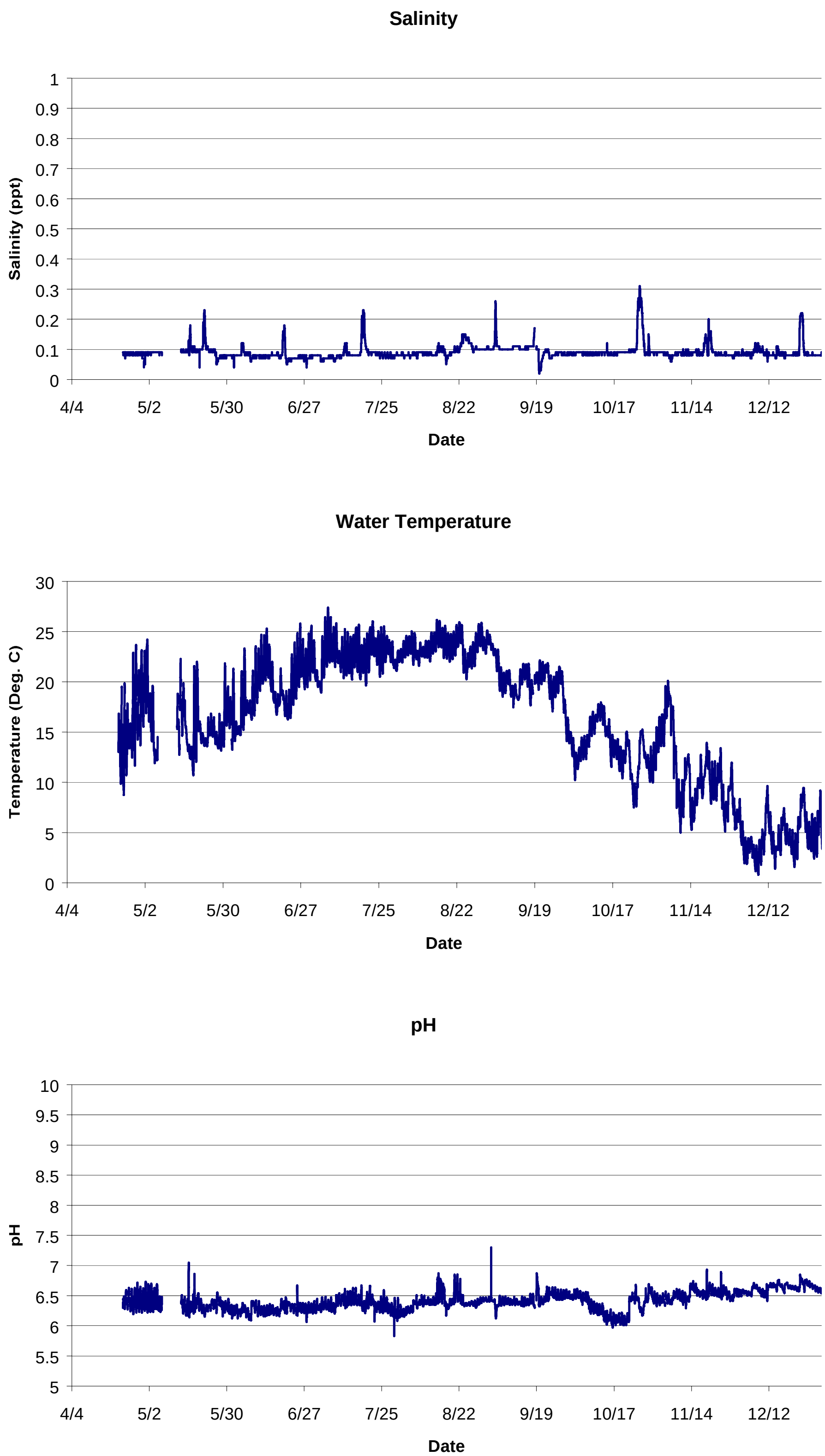


Figure 3-7. 2003 Time series of Salinity Water Temperature and pH values for Mataponi Creek.

Table 3-1. Indicator threshold values and percent exceedance for continuous monitoring data at Iron Pot Landing, Railroad Bridge and Mataponi Creek.

Iron Pot Landing

Indicator (Threshhold value)	Chlorophyll a (15 μg/L)	Chlorophyll a (50 μg/L)	Dissolved Oxygen (5 mg/L)	Dissolved Oxygen (2 mg/L)	Turbidity (15 NTU)
# of observations exceeding threshhold	386	24	124	0	11740
# of total observations	25434	25434	24678	24678	25205
% failure	1.5%	0.1%	0.5%	0.0%	46.58%

Railroad Bridge

Indicator (Threshhold value)	Chlorophyll a (15 μg/L)	Chlorophyll a (50 μg/L)	Dissolved Oxygen (5 mg/L)	Dissolved Oxygen (2 mg/L)	Turbidity (15 NTU)
# of observations exceeding threshhold	762	17	613	0	18461
# of total observations	25363	25363	24515	24515	24722
% failure	3.0%	0.1%	2.5%	0.0%	74.7%

Mataponi Creek

Indicator (Threshhold value)	Chlorophyll a (15 μg/L)	Chlorophyll a (50 μg/L)	Dissolved Oxygen (5 mg/L)	Dissolved Oxygen (2 mg/L)	Turbidity (15 NTU)
# of observations exceeding threshhold	12	0	9879	3682	10536
# of total observations	23433	23513	23513	23513	23524
% failure	0.1%	0.0%	42.0%	15.7%	44.8%

4. Monthly Grab Sampling

The goals of the monthly nutrient sampling were to create a long-term database of nutrient information at each site for the purpose of detecting changes over time and across sites. Grab samples were collected by Maryland DNR on a weekly basis from April to October at all three sites. During these months a full suite of nutrients (particulate carbon, particulate nitrogen, total dissolved nitrogen, total dissolved phosphorus, particulate phosphorus, total nitrogen, total phosphorus, nitrite, ammonium, orthophosphate, nitrite + nitrate, silica, volatile suspended solids, total suspended solids, chlorophyll and turbidity) were processed and analyzed. Only the core NERR nutrients (total dissolved nitrogen, total dissolved phosphorus, nitrite, ammonium, orthophosphate, nitrite + nitrate, volatile suspended solids, total suspended solids and chlorophyll) were collected and analyzed on a biweekly basis during November and December. Missing data was rejected and deleted through QA/QC procedures.

Highest median chlorophyll concentrations occurred in the fall with lowest concentrations occurring in the spring at Mataponi Creek and in the summer at Iron Pot Landing and Railroad

Bridge (Tables 4-1, 4-3 and 4-5). Chlorophyll concentrations at Railroad Bridge were greater throughout the deployment period when compared to Iron Pot Landing and Mataponi Creek. The high fall chlorophyll values at Railroad Bridge and Mataponi Creek corresponded with high suspended solids values. The greatest amount of suspended solids at Iron Pot Landing occurred during the summer, when chlorophyll concentrations were the lowest. Overall, total suspended solids were greatest throughout the monitoring period at Railroad Bridge (Tables 4-1, 4-3 and 4-5). Consequently, water clarity (as measured by secchi depth) was lowest at this site compared to Iron Pot Landing. All three sites exceeded the 15 mg/L total suspended solid threshold at least 30% of time (Table 4-7). TSS values over a threshold of 15 mg/L are normally considered to be detrimental to bay grass growth. Increased turbidity can also lead to decreased fish health by increasing susceptibility to infectious diseases through increased stress, and reducing the ability of fish's gills to extract oxygen from the water.

Nutrient concentrations also varied by season and site. Nitrogen and phosphorous concentrations were highest at Railroad Bridge and lowest at Mataponi Creek (Tables 4-2, 4-4 and 4-6). However, Mataponi Creek contained greater amounts of particulate carbon and silica. Nitrogen species were generally greater in the spring and summer, while phosphorus species were greater in the summer and fall. Particulate organic carbon was highest in the fall and silica was highest in the summer (Tables 4-2, 4-4 and 4-6).

Results of the monthly grab sampling indicate Iron Pot Landing was significantly influenced by Hurricane Isabel, while Railroad Bridge and Mataponi Creek were not (Tables 4-2, 4-4 and 4-6). Increases in total suspended solids, total nitrogen, particulate organic nitrogen, total phosphorus, particulate phosphorus and particulate organic carbon were significantly higher following the passing of Hurricane Isabel on September 19, 2003 (Table 4-2). These increases in nutrients illustrate the influence of the Western Branch and wastewater treatment plant on Iron Pot Landing, particularly following large storm events.

Table 4-1. Iron Pot Landing 2003 Weekly Pigment, Suspended Solid and Secchi Depth values.

	Date mm/dd/yyyy	Time hh:mm	Replicate	Chlorophyll a ug/L	Pheophytin a ug/L	Total Suspended Solids mg/L	Total Volatile Solids mg/L	Secchi Depth m
Spring	04/04/03	14:00	1	6.9	0.4	8.4	2.8	1.3
	04/08/03	9:45	1	29.9	1.0	33.0	6.0	0.3
	04/15/03	12:30	1	6.0	1.0	20.7	4.0	0.5
	04/22/03	8:00	1	3.6	0.4	9.2	3.2	1.5
	04/29/03	9:00	1	3.7		5.0		1.0
	05/06/03	11:30	1	3.0	1.8	16.4	6.4	0.8
	05/13/03	9:45	1	3.4	1.1	11.6	5.6	0.8
	05/20/03	9:30	1	5.2	3.1	45.0	7.0	0.5
	05/28/03	10:15	1	3.7	2.5	73.0	13.0	0.3
Mean				**7.3**	**1.4**	**24.7**	**6.0**	**0.8**
Median				**3.7**	**1.1**	**16.4**	**5.8**	**0.8**
St. Dev.				**8.6**	**1.0**	**22.3**	**3.2**	**0.4**
Summer	06/03/03	12:15	1			22.0	4.7	0.7
	06/10/03	12:30	1			23.0	6.0	0.9
	06/17/03	9:45	1			10.7	3.3	0.5
	06/24/03	9:45	1	2.0	0.1	48.7	6.7	0.2
	07/01/03	8:00	1			234.0	22.0	0.1
	07/08/03	9:45	1	1.5		66.0	14.0	0.1
	07/15/03	9:15	1			8.7	3.3	0.5
	07/22/03	8:30	1	1.9	0.5	17.0	3.0	0.8
	07/29/03	9:45	1	1.0		180.0	26.7	0.1
	07/29/03	9:45	2	1.0	0.9	330.0	56.7	0.1
	08/05/03	9:15	1	1.1	0.2	15.5	5.5	0.7
	08/12/03	9:45	1	2.2	0.6	18.0	5.5	0.6
	08/19/03	10:00	1	4.0		12.0	6.0	0.6
	08/26/03	11:15	1	3.0		12.5	4.5	0.8
	08/26/03	11:15	2	2.2	0.1	7.5	4.0	0.8
Mean				**2.0**	**0.4**	**67.0**	**11.5**	**0.5**
Median				**2.0**	**0.4**	**18.0**	**5.5**	**0.6**
St. Dev.				**1.0**	**0.3**	**99.2**	**14.4**	**0.3**
Fall	09/02/03	13:30	1			20.0	8.0	0.4
	09/10/03	8:45	1			8.0	4.0	0.8
	09/23/03	10:30	1	7.5		484.0	64.0	0.1
	09/23/03	10:30	2	7.5	4.9	344.0	60.0	0.1
	10/01/03	9:45	1	0.9		4.0	3.6	1.4
	10/07/03	9:30	1			6.0	2.7	1.2
	10/14/03	9:45	1	1.2	0.1	2.4	2.0	1.4
	10/22/03	10:00	1	1.1		7.5	3.5	0.8
	10/28/03	12:30	1	5.2		39.0	8.0	0.2
	10/28/03	12:30	2	4.5		39.0	7.0	0.2
	11/13/03	10:45	1			67.0	13.0	
	11/26/03	11:45	1			4.0	1.6	
	11/26/03	11:45	2			7.0	2.4	
Mean				**4.0**	**2.5**	**79.4**	**13.8**	**0.7**
Median				**4.5**	**2.5**	**8.0**	**4.0**	**0.6**
St. Dev.				**2.9**	**3.4**	**152.4**	**21.6**	**0.5**
Winter	12/11/03	11:15	1			115.0	16.3	
	12/23/03	9:00	1			3.5	3.0	
	12/23/03	9:00	2			4.0	3.5	
Annual								
Mean				**4.4**	**1.2**	**59.6**	**10.8**	**0.6**
Median				**3.2**	**0.8**	**16.7**	**5.5**	**0.6**
St. Dev.				**5.6**	**1.3**	**107.0**	**15.4**	**0.4**

Table 4-2. Iron Pot Landing 2003 Ammonium (NH_4), Nitrite (NO_2), Nitrate (NO_3), Total Dissolved Nitrogen (TDN), Total Nitrogen (TN), Particulate Organic Nitrogen (PON), Orthophosphate (PO_4), Total Dissolved Phosphorus (TDP), Total Phosphorus (TP), Particulate Phosphorus (PP), Particulate Organic Carbon (POC) and Silica (SiO_2) data.

	Date mm/dd/yyyy	Time hh:mm	Replicate	NH_4 mg/L	NO_2 mg/L	NO_3 mg/L	TDN mg/L	TN mg/L	PON mg/L	PO_4 mg/L	TDP mg/L	TP mg/L	PP mg/L	POC mg/L	SiO_2 mg/L
Spring	04/04/03	14:00	1	0.267	0.005	0.315	1.040	1.19	0.154	0.011	0.03	0.103	0.076	1.04	5.53
	04/08/03	9:45	1	0.085	0.011	0.960	1.530	1.85	0.318	0.016	0.04	0.134	0.091	2.47	2.61
	04/15/03	12:30	1	0.058	0.004	0.412	0.930	1.07	0.143	0.021	0.03	0.095	0.063	1.20	5.50
	04/22/03	8:00	1	0.023	0.003	0.399	0.850	0.93	0.079	0.021	0.05	0.126	0.076	0.69	4.92
	04/29/03	9:00	1	0.034	0.004	0.262	0.680	0.78	0.098	0.020	0.04	0.063	0.028	0.61	5.01
	05/06/03	11:30	1	0.094	0.007	0.310	0.790	1.22	0.429	0.087	0.12	0.331	0.213	2.80	5.94
	05/13/03	9:45	1	0.112	0.022	0.343	1.230	1.37	0.144	0.022	0.06	0.156	0.100	1.24	6.04
	05/20/03	9:30	1	0.071	0.014	0.444	1.030	1.23	0.197	0.018	0.06	0.221	0.166	2.04	5.91
	05/28/03	10:15	1	0.228	0.014	0.301	0.940	1.20	0.260	0.029	0.07	0.301	0.234	2.98	5.44
Mean				**0.108**	**0.009**	**0.416**	**1.002**	**1.20**	**0.202**	**0.027**	**0.05**	**0.170**	**0.116**	**1.68**	**5.21**
Median				**0.085**	**0.007**	**0.343**	**0.940**	**1.20**	**0.154**	**0.021**	**0.05**	**0.134**	**0.091**	**1.24**	**5.50**
St. Dev.				**0.084**	**0.006**	**0.212**	**0.253**	**0.30**	**0.114**	**0.023**	**0.03**	**0.094**	**0.071**	**0.91**	**1.05**
Summer	06/03/03	12:15	1	0.214	0.021	0.340	1.010	1.16	0.146	0.037	0.07	0.159	0.089	1.37	6.92
	06/10/03	12:30	1	0.115	0.018	0.328	0.960	1.12	0.164	0.031	0.07	0.139	0.068	1.40	6.06
	06/17/03	9:45	1	0.088	0.011	0.431	1.050	1.18	0.133	0.027	0.07	0.120	0.047	0.86	6.69
	06/24/03	9:45	1	0.050	0.012	0.405	0.980	1.19	0.214	0.026	0.07	0.178	0.110	2.12	6.70
	07/01/03	8:00	1	0.061	0.021	0.680	1.140	1.75	0.606	0.033	0.06	0.510	0.455	6.16	6.08
	07/08/03	9:45	1	0.125	0.020	0.412	1.100	1.89	0.787	0.041	0.09	0.245	0.156	5.70	4.56
	07/15/03	9:15	1	0.045	0.010	0.676	1.180	1.26	0.082	0.060	0.09	0.132	0.042	0.73	6.64
	07/22/03	8:30	1	0.048	0.006	0.617	1.110	1.23	0.117	0.140	0.17	0.275	0.108	1.02	7.86
	07/29/03	9:45	1	0.035	0.019	0.549	0.950	1.62	0.673	0.045	0.08	0.420	0.337	7.14	4.28
	07/29/03	9:45	2	0.030	0.020	0.563	0.960			0.042	0.09				
	08/05/03	9:15	1	0.048	0.007	0.633	1.250	1.36	0.111	0.207	0.24	0.336	0.096	1.10	7.15
	08/12/03	9:45	1	0.025	0.007	0.750	1.240	1.31	0.073	0.128	0.16	0.232	0.071	0.85	6.72
	08/19/03	10:00	1	0.035	0.006	0.510	1.060	1.16	0.099	0.131	0.19	0.263	0.073	1.00	7.04
	08/26/03	11:15	1	0.064	0.006	0.612	1.160	1.28	0.124	0.141	0.22	0.282	0.066	1.14	7.26
	08/26/03	11:15	2	0.045	0.005	0.607	1.090			0.138	0.18				
Mean				**0.069**	**0.013**	**0.541**	**1.083**	**1.35**	**0.256**	**0.082**	**0.12**	**0.253**	**0.132**	**2.35**	**6.46**
Median				**0.048**	**0.011**	**0.563**	**1.090**	**1.26**	**0.133**	**0.045**	**0.09**	**0.245**	**0.089**	**1.14**	**6.70**
St. Dev.				**0.050**	**0.006**	**0.131**	**0.099**	**0.25**	**0.252**	**0.059**	**0.06**	**0.116**	**0.123**	**2.32**	**1.02**
Fall	09/02/03	13:30	1	0.048	0.007	0.391	1.000	1.16	0.156	0.092	0.14	0.219	0.079	1.47	6.18
	09/10/03	8:45	1	0.034	0.005	0.449	1.030	1.13	0.099	0.221	0.28	0.319	0.042	0.89	7.07
	09/23/03	10:30	1	0.010	0.007	0.437	0.960	3.19	2.230	0.046	0.09	1.125	1.037	24.60	4.71
	09/23/03	10:30	2	0.008	0.007	0.495	1.020			0.051	0.09				
	10/01/03	9:45	1	0.036	0.005	0.484	0.970	1.03	0.059	0.065	0.09	0.130	0.039	0.51	7.46
	10/07/03	9:30	1	0.031	0.006	0.478	0.900	0.95	0.054	0.141	0.17	0.208	0.036	0.52	8.07
	10/14/03	9:45	1	0.023	0.002	1.028	1.460	1.53	0.068	0.380	0.45	0.484	0.034	0.48	7.42
	10/22/03	10:00	1	0.026	0.004	0.200	0.630	0.68	0.053	0.119	0.14	0.198	0.060	0.62	7.72
	10/28/03	12:30	1	0.019	0.005	0.216	0.620	0.88	0.260	0.032	0.07	0.184	0.112	2.27	3.92
	10/28/03	12:30	2	0.024	0.006	0.214	0.590			0.035	0.07				
	11/13/03	10:45	1	0.020	0.007	1.053	1.440			0.694	0.10				
	11/26/03	11:45	1	0.076	0.007	1.433	2.050			0.062	0.08				
	11/26/03	11:45	2	0.055	0.006	1.454	3.620			0.052	0.09				
Mean				**0.032**	**0.006**	**0.641**	**1.253**	**1.32**	**0.372**	**0.153**	**0.14**	**0.358**	**0.180**	**3.92**	**6.57**
Median				**0.026**	**0.006**	**0.478**	**1.000**	**1.08**	**0.084**	**0.065**	**0.09**	**0.214**	**0.051**	**0.75**	**7.25**
St. Dev.				**0.019**	**0.001**	**0.445**	**0.817**	**0.80**	**0.754**	**0.189**	**0.11**	**0.328**	**0.347**	**8.38**	**1.51**
Winter	12/11/03	11:15	1	0.088	0.008	0.718	1.280			0.037	0.06				
	12/23/03	9:00	1	0.074	0.036	1.794	2.320			0.014	0.03				
	12/23/03	9:00	2	0.074	0.036	1.834	2.240			0.013	0.03				
Annual															
Mean				**0.066**	**0.011**	**0.613**	**1.185**	**1.30**	**0.271**	**0.088**	**0.11**	**0.256**	**0.140**	**2.57**	**6.11**
Median				**0.048**	**0.007**	**0.481**	**1.035**	**1.20**	**0.144**	**0.044**	**0.08**	**0.214**	**0.078**	**1.17**	**6.13**
St. Dev.				**0.057**	**0.008**	**0.402**	**0.545**	**0.45**	**0.414**	**0.123**	**0.08**	**0.198**	**0.193**	**4.49**	**1.28**

Table 4-3. Railroad Bridge 2003 Weekly Pigment, Suspended Solid and Secchi Depth values.

Spring	Date mm/dd/yyyy	Time hh:mm	Replicate	Chlorophyll a ug/L	Pheophytin a ug/L	Total Suspended Solids mg/L	Total Volatile Solids mg/L	Secchi Depth m
	04/04/03	14:00	1	4.9	1.4	15.0	3.0	0.7
	04/08/03	9:45	1	5.0	0.2	10.7	2.7	0.6
	04/15/03	12:30	1	4.5		13.3	2.7	0.6
	04/22/03	8:00	1	3.5	1.7	12.0	4.0	0.5
	04/29/03	9:00	1	4.0	1.9	13.3	2.0	0.6
	05/06/03	11:30	1	17.0	3.3	14.7	4.7	0.6
	05/13/03	9:45	1	4.5	0.2	10.0	3.5	0.5
	05/20/03	9:30	1	4.5	1.3	18.0	5.0	0.4
	05/28/03	10:15	1	3.7		33.0	9.0	0.2
Mean				**5.7**	**1.4**	**15.6**	**4.1**	**0.5**
Median				**4.5**	**1.4**	**13.3**	**3.5**	**0.5**
St. Dev.				**4.3**	**1.1**	**7.0**	**2.1**	**0.2**
Summer	06/03/03	12:15	1	2.0	1.1	28.7	4.7	0.3
	06/10/03	12:30	1	2.0	0.1	16.7	4.0	0.3
	06/17/03	9:45	1	3.0		16.0	3.3	0.4
	06/24/03	9:45	1			14.7	2.7	0.3
	07/01/03	8:00	1	7.5	0.5	17.3	4.7	0.5
	07/08/03	9:45	1	3.0	0.2	78.0	12.0	0.1
	07/15/03	9:15	1	3.7		26.0	9.0	0.3
	07/22/03	8:30	1	5.2	0.8	16.0	3.5	0.7
	07/29/03	9:45	1	3.0	0.2	26.0	6.0	0.4
	07/29/03	9:45	2	0.7	1.9	27.0	7.0	0.4
	08/05/03	9:15	1	4.0	0.5	18.7	5.3	0.3
	08/12/03	9:45	1	3.7	0.8	77.5	17.5	0.1
	08/19/03	10:00	1	13.0	0.6	24.0	8.0	0.4
	08/26/03	11:15	1	10.5	0.3	16.0	5.3	0.4
	08/26/03	11:15	2	11.5		16.0	5.3	0.4
Mean				**5.2**	**0.6**	**27.9**	**6.6**	**0.3**
Median				**3.7**	**0.5**	**18.7**	**5.3**	**0.4**
St. Dev.				**3.9**	**0.5**	**20.8**	**3.9**	**0.1**
Fall	09/02/03	13:30	1	17.2	0.6	19.0	7.0	0.4
	09/10/03	8:45	1	22.9	4.3	20.7	6.7	0.4
	09/23/03	10:30	1	2.5	0.3	27.3	7.3	
	09/23/03	10:30	2	3.0		39.0	10.0	0.6
	10/01/03	9:45	1	6.7	0.6	26.0	9.0	0.6
	10/07/03	9:30	1	4.5	0.7	23.0	7.0	0.5
	10/14/03	9:45	1	15.0	1.1	16.0	4.0	0.7
	10/22/03	10:00	1	3.0	3.8	82.0	11.0	0.5
	10/28/03	12:30	1			38.7	10.0	0.3
	10/28/03	12:30	2	3.7	1.5	62.5	10.0	0.1
	11/13/03	10:45	1			24.0	4.5	0.1
	11/26/03	11:45	1			12.0	4.7	
	11/26/03	11:45	2			16.0	6.0	
Mean				**8.7**	**1.6**	**31.2**	**7.5**	**0.4**
Median				**4.5**	**0.9**	**24.0**	**7.0**	**0.5**
St. Dev.				**7.6**	**1.6**	**20.3**	**2.3**	**0.2**
Winter	12/11/03	11:15	1			37.0	6.0	
	12/23/03	9:00	1			49.0	11.0	
	12/23/03	9:00	2			38.0	10.0	
Annual								
Mean				**6.3**	**1.2**	**27.2**	**6.5**	**0.4**
Median				**4.3**	**0.8**	**19.9**	**5.7**	**0.4**
St. Dev.				**5.3**	**1.1**	**18.6**	**3.2**	**0.2**

Table 4-4. Railroad Bridge 2003 Ammonium (NH_4), Nitrite (NO_2), Nitrate (NO_3), Total Dissolved Nitrogen (TDN), Total Nitrogen (TN), Particulate Organic Nitrogen (PON), Orthophosphate (PO_4), Total Dissolved Phosphorus (TDP), Total Phosphorus (TP), Particulate Phosphorus (PP), Particulate Organic Carbon (POC) and Silica (SiO_2) data.

	Date	Time	Replicate	NH_4	NO_2	NO_3	TDN	TN	PON	PO_4	TDP	TP	PP	POC	SiO_2
Spring	mm/dd/yyyy	hh:mm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	04/04/03	14:00	1	0.052	0.012	1.218	1.650	1.81	0.164	0.012	0.028	0.088	0.060	1.20	4.47
	04/08/03	9:45	1	0.071	0.013	1.197	1.670	1.78	0.113	0.020	0.040	0.090	0.050	1.11	4.67
	04/15/03	12:30	1	0.069	0.012	1.098	1.440	1.47	0.032	0.016	0.031	0.078	0.047	0.76	4.34
	04/22/03	8:00	1	0.104	0.011	0.904	1.470	1.56	0.086	0.027	0.050	0.087	0.037	0.98	4.03
	04/29/03	9:00	1	0.047	0.011	0.860	1.290	1.43	0.136	0.020	0.033	0.083	0.050	0.95	3.86
	05/06/03	11:30	1	0.056	0.014	0.820	1.250	1.54	0.286	0.010	0.029	0.090	0.061	1.72	3.50
	05/13/03	9:45	1	0.156	0.027	1.023	1.670	1.80	0.134	0.027	0.058	0.101	0.043	1.19	4.70
	05/20/03	9:30	1	0.104	0.014	0.747	1.370	1.51	0.144	0.021	0.055	0.117	0.062	1.23	4.81
	05/28/03	10:15	1	0.093	0.016	0.543	1.180	1.33	0.148	0.021	0.056	0.138	0.082	2.28	3.85
Mean				**0.084**	**0.014**	**0.934**	**1.443**	**1.58**	**0.138**	**0.019**	**0.042**	**0.097**	**0.055**	**1.27**	**4.25**
Median				**0.071**	**0.013**	**0.904**	**1.440**	**1.54**	**0.136**	**0.020**	**0.040**	**0.090**	**0.050**	**1.19**	**4.34**
St. Dev.				**0.035**	**0.005**	**0.221**	**0.188**	**0.18**	**0.068**	**0.006**	**0.013**	**0.019**	**0.013**	**0.46**	**0.46**
Summer	06/03/03	12:15	1	0.098	0.014	1.096	1.580	1.73	0.146	0.033	0.042	0.109	0.067	1.57	4.88
	06/10/03	12:30	1	0.064	0.019	0.779	1.340	1.47	0.127	0.018	0.047	0.088	0.041	0.96	3.74
	06/17/03	9:45	1	0.079	0.028	0.761	1.340	1.49	0.148	0.026	0.066	0.116	0.050	1.04	4.45
	06/24/03	9:45	1	0.052	0.024	0.864	1.330	1.44	0.108	0.023	0.057	0.095	0.038	0.92	4.83
	07/01/03	8:00	1	0.041	0.020	0.940	1.340	1.50	0.163	0.026	0.060	0.115	0.055	1.16	6.10
	07/08/03	9:45	1	0.069	0.020	0.932	1.370	1.77	0.400	0.033	0.078	0.267	0.189	3.46	5.20
	07/15/03	9:15	1	0.069	0.015	0.647	1.110	1.26	0.146	0.048	0.068	0.130	0.062	1.32	5.21
	07/22/03	8:30	1	0.039	0.014	0.944	1.310	1.46	0.148	0.057	0.068	0.170	0.102	1.08	6.12
	07/29/03	9:45	1	0.044	0.014	1.126			0.173	0.023	0.049	0.129	0.080	1.59	5.39
	07/29/03	9:45	2	0.040	0.014	1.126	1.420			0.021					
	08/05/03	9:15	1	0.070	0.014	0.819	1.520	1.63	0.107	0.048	0.075	0.134	0.059	1.00	5.76
	08/12/03	9:45	1	0.046	0.015	0.846	1.380	1.68	0.295	0.038	0.070	0.243	0.173	2.49	5.50
	08/19/03	10:00	1	0.071	0.017	0.914	1.340	1.56	0.215	0.030	0.072	0.151	0.079	1.46	5.71
	08/26/03	11:15	1	0.044	0.013	1.057	1.790	2.00	0.210	0.047	0.121	0.177	0.056	1.53	5.55
	08/26/03	11:15	2	0.049	0.014	1.036				0.033					
Mean				**0.058**	**0.017**	**0.926**	**1.398**	**1.58**	**0.184**	**0.034**	**0.067**	**0.148**	**0.081**	**1.51**	**5.26**
Median				**0.052**	**0.015**	**0.932**	**1.340**	**1.53**	**0.148**	**0.033**	**0.068**	**0.130**	**0.062**	**1.32**	**5.39**
St. Dev.				**0.017**	**0.004**	**0.143**	**0.161**	**0.19**	**0.082**	**0.012**	**0.020**	**0.054**	**0.048**	**0.72**	**0.67**
Fall	09/02/03	13:30	1	0.086	0.014	0.728	1.190	1.43	0.243	0.033	0.075	0.146	0.071	2.08	5.13
	09/10/03	8:45	1	0.038	0.011	0.547	2.450	2.72	0.272	0.020	0.081	0.150	0.069	1.74	4.23
	09/23/03	10:30	1	0.056	0.012	0.686	1.120	1.28	0.164	0.034	0.162	0.225	0.063	1.43	4.54
	09/23/03	10:30	2	0.045	0.013	0.686	1.380			0.034	0.082				
	10/01/03	9:45	1	0.050	0.007	0.552	1.060	1.24	0.182	0.032	0.063	0.136	0.073	1.50	5.29
	10/07/03	9:30	1	0.043	0.010	1.120	1.450	1.58	0.135	0.033	0.061	0.124	0.063	1.37	6.03
	10/14/03	9:45	1	0.019	0.009	0.828	1.290	1.49	0.196	0.030	0.063	0.126	0.063	1.18	5.10
	10/22/03	10:00	1	0.060	0.008	0.933	1.400	1.80	0.395	0.048	0.058	0.293	0.235	4.70	5.62
	10/28/03	12:30	1	0.028	0.009	0.729	1.460	1.78	0.321	0.040	0.071	0.186	0.115	2.32	4.38
	10/28/03	12:30	2	0.020	0.008	0.703	1.200			0.043	0.079				
	11/13/03	10:45	1	0.092	0.013	1.237	1.710			0.044	0.068				
	11/26/03	11:45	1	0.060	0.010	1.200	1.590			0.024	0.046				
	11/26/03	11:45	2	0.083	0.011	1.189	1.650			0.024	0.040				
Mean				**0.052**	**0.010**	**0.857**	**1.458**	**1.67**	**0.239**	**0.034**	**0.073**	**0.173**	**0.094**	**2.04**	**5.04**
Median				**0.050**	**0.010**	**0.729**	**1.400**	**1.54**	**0.220**	**0.033**	**0.068**	**0.148**	**0.070**	**1.62**	**5.12**
St. Dev.				**0.024**	**0.002**	**0.250**	**0.359**	**0.47**	**0.088**	**0.008**	**0.030**	**0.059**	**0.060**	**1.14**	**0.62**
Winter	12/11/03	11:15	1	0.105	0.010	1.180	1.850			0.020	0.041			37.00	6.00
	12/23/03	9:00	1	0.108	0.019	1.611	2.000			0.011	0.020			49.00	11.00
	12/23/03	9:00	2	0.103	0.019	1.591	2.020			0.010	0.024			38.00	10.00
Annual															
Mean				**0.066**	**0.014**	**0.945**	**1.473**	**1.60**	**0.185**	**0.029**	**0.060**	**0.139**	**0.077**	**5.19**	**5.27**
Median				**0.060**	**0.014**	**0.923**	**1.390**	**1.54**	**0.156**	**0.027**	**0.059**	**0.128**	**0.063**	**1.43**	**5.10**
St. Dev.				**0.028**	**0.005**	**0.251**	**0.282**	**0.28**	**0.086**	**0.012**	**0.026**	**0.055**	**0.046**	**11.75**	**1.53**

Table 4-5. Mataponi Creek 2003 Weekly Pigment, Suspended Solid and Secchi Depth values.

Spring	Date mm/dd/yyyy	Time hh:mm	Replicate	Chlorophyll a ug/L	Pheophytin a ug/L	Total Suspended Solids mg/L	Total Volatile Solids mg/L	Secchi Depth m
	04/22/03	8:00	1	1.5	0.2	6.7	2.7	0.4
	04/29/03	9:00	1	2.5		8.0	2.0	0.6
	05/06/03	11:30	1	3.5	0.7	7.3	3.3	0.6
	05/13/03	9:45	1	2.2	1.9	13.0	4.0	0.6
	05/20/03	9:30	1	1.1	0.4	6.0	2.0	0.6
	05/28/03	10:15	1	2.2	0.6	9.5	5.0	0.6
Mean				**2.5**	**0.8**	**8.4**	**3.2**	**0.6**
Median				**1.5**	**0.6**	**7.7**	**3.0**	**0.6**
St. Dev.				**3.0**	**0.7**	**2.5**	**1.2**	**0.1**
								0.3
Summer	06/03/03	12:15		1.1	0.4	9.5	2.5	0.6
	06/10/03	12:30		2.5		9.3	3.3	0.4
	06/17/03	9:45		1.5		9.3	4.7	0.6
	06/24/03	9:45		3.0	0.2	22.0	5.0	0.4
	07/01/03	8:00		1.5		10.0	5.0	0.1
	07/08/03	9:45		4.5		24.0	10.0	0.4
	07/15/03	9:15		3.0		7.0	5.0	0.3
	07/22/03	8:30		3.0		12.0	6.0	0.4
	07/29/03	9:45		2.2	0.4			0.4
	07/29/03	9:45		3.0		5.0	8.0	0.5
	08/05/03	9:15		3.0	0.2			0.4
	08/12/03	9:45		3.3	0.7			0.4
	08/19/03	10:00		7.5	1.9	10.0	9.0	0.4
	08/26/03	11:15		8.5	3.4	16.0	7.3	0.4
	08/26/03	11:15		6.5	2.2	12.7	6.7	0.4
Mean				**3.6**	**1.2**	**12.2**	**6.0**	**0.4**
Median				**3.0**	**0.6**	**10.0**	**5.5**	**0.4**
St. Dev.				**2.2**	**1.2**	**5.7**	**2.2**	**0.1**
Fall	09/02/03	13:30	1	9.0	3.1			0.2
	09/10/03	8:45	1	10.0	2.6	13.3	7.3	0.6
	09/18/05			4.5	1.8	0.0		0.2
	09/23/03	10:30	1	6.0		9.3	8.0	0.3
	09/23/03	10:30	2	8.5	3.7	17.3	9.3	0.3
	10/01/03	9:45	1	2.1				1.5
	10/07/03	9:30	1	10.5	15.0	14.7	6.0	1.2
	10/14/03	9:45	1	8.0	8.4	10.0	6.0	0.4
	10/22/03	10:00	1	22.4	10.3	20.0	10.0	0.3
	10/28/03	12:30	1	5.2		21.0	6.0	0.2
	10/28/03	12:30	2	5.2	1.6	18.0	7.0	0.2
	11/13/03	10:45	1			25.0	5.3	
	11/26/03	11:45	1			13.0	3.3	
	11/26/03	11:45	2			14.0	4.0	
Mean				**8.3**	**5.8**	**14.0**	**4.0**	**0.5**
Median				**8.0**	**3.4**	**14.4**	**6.0**	**0.3**
St. Dev.				**5.3**	**4.9**	**6.5**	**2.0**	**0.5**
Winter	12/11/03	11:15	1			98.0	20.0	
	12/23/03	9:00	1			15.5	4.5	
	12/23/03	9:00	2			9.5	4.5	
Annual								
Mean				**5.0**	**2.8**	**15.0**	**6.0**	**0.5**
Median				**3.2**	**1.8**	**12.0**	**5.2**	**0.4**
St. Dev.				**4.2**	**3.8**	**15.9**	**3.4**	**0.3**

Table 4-6. Mataponi Creek 2003 Ammonium (NH_4), Nitrite (NO_2), Nitrate (NO_3), Total Dissolved Nitrogen (TDN), Total Nitrogen (TN), Particulate Organic Nitrogen (PON), Orthophosphate (PO_4), Total Dissolved Phosphorus (TDP), Total Phosphorus (TP), Particulate Phosphorus (PP), Particulate Organic Carbon (POC) and Silica (SiO_2) data.

	Date mm/dd/yyyy	Time hh:mm	Replicate	NH_4 mg/L	NO_2 mg/L	NO_3 mg/L	TDN mg/L	TN mg/L	PON mg/L	PO_4 mg/L	TDP mg/L	TP mg/L	PP mg/L	POC mg/L	SiO_2 mg/L
Spring	04/22/03	8:00	1	0.025	0.005	0.398	0.860	0.89	0.034	0.009	0.026	0.056	0.030	6.70	2.70
	04/29/03	9:00	1	0.025	0.004	0.261	0.620	0.70	0.077	0.008	0.026	0.056	0.030	8.00	2.00
	05/06/03	11:30	1	0.033	0.005	0.272	0.700	0.79	0.087	0.007	0.032	0.061	0.029	7.30	3.30
	05/13/03	9:45	1	0.062	0.007	0.279	0.900	1.01	0.110	0.011	0.040	0.089	0.049	13.00	4.00
	05/20/03	9:30	1	0.065	0.009	0.300	0.770	0.83	0.064	0.010	0.034	0.075	0.041	6.00	2.00
	05/28/03	10:15	1	0.154	0.013	0.391	0.940	1.01	0.070	0.010	0.040	0.089	0.049	9.50	5.00
Mean				**0.061**	**0.007**	**0.317**	**0.798**	**0.87**	**0.074**	**0.009**	**0.033**	**0.071**	**0.038**	**8.42**	**3.17**
Median				**0.048**	**0.006**	**0.290**	**0.815**	**0.86**	**0.074**	**0.010**	**0.033**	**0.068**	**0.036**	**7.65**	**3.00**
St. Dev.				**0.049**	**0.003**	**0.062**	**0.124**	**0.12**	**0.025**	**0.001**	**0.006**	**0.016**	**0.010**	**2.55**	**1.18**
Summer	06/03/03	12:15	1	0.102			0.980	1.06	0.085	0.010	0.039	0.100	0.061	1.11	11.60
	06/10/03	12:30	1	0.064			0.820	0.92	0.100	0.013	0.057			1.01	10.90
	06/17/03	9:45	1	0.078			0.810	0.92	0.106	0.017	0.069	0.138	0.069	1.14	11.98
	06/24/03	9:45	1	0.064			0.930	1.07	0.138	0.020	0.060	0.178	0.118	1.59	11.71
	07/01/03	8:00	1	0.044	0.012	0.313	0.810	0.90	0.088	0.027	0.084	0.156	0.072	1.31	11.78
	07/08/03	9:45	1	0.052	0.008	0.285	0.760	0.94	0.181	0.025	0.075	0.140	0.065	1.87	9.37
	07/15/03	9:15	1	0.045	0.006	0.164	0.600	0.70	0.100	0.044	0.074	0.136	0.062	1.28	11.31
	07/22/03	8:30	1	0.063	0.007	0.272	0.910	1.03	0.119	0.044	0.088	0.169	0.081	1.53	12.70
	07/29/03	9:45	1	0.015	0.005	0.202	0.570	0.72	0.155	0.022	0.069	0.132	0.063	1.64	11.52
	07/29/03	9:45	2	0.016	0.005	0.195	0.590			0.025	0.060				
	08/05/03	9:15	1	0.027	0.006	0.271	0.710	0.80	0.087	0.031	0.085	0.143	0.058	1.03	12.02
	08/12/03	9:45	1	0.034	0.005	0.135	0.620	0.72	0.100	0.028	0.078	0.139	0.061	1.38	10.40
	08/19/03	10:00	1	0.018	0.005	0.090	0.640	0.81	0.166	0.021	0.064	0.138	0.074	1.74	11.43
	08/26/03	11:15	1	0.023	0.003	0.029	0.660	0.92	0.255	0.021	0.054	0.167	0.113	2.50	11.40
	08/26/03	11:15	2	0.045	0.004	0.024	0.470			0.014	0.081				
Mean				**0.046**	**0.006**	**0.180**	**0.725**	**0.89**	**0.129**	**0.024**	**0.069**	**0.145**	**0.075**	**1.47**	**11.39**
Median				**0.045**	**0.005**	**0.195**	**0.710**	**0.92**	**0.106**	**0.022**	**0.069**	**0.140**	**0.067**	**1.38**	**11.52**
St. Dev.				**0.025**	**0.002**	**0.102**	**0.149**	**0.13**	**0.049**	**0.010**	**0.014**	**0.021**	**0.020**	**0.41**	**0.82**
Fall	09/02/03	13:30	1	0.052	0.004	0.042	0.830	1.04	0.212	0.040	0.067	0.144	0.077	1.98	10.10
	09/10/03	8:45	1	0.008	0.007	0.067	0.640	0.89	0.251	0.036	0.066	0.155	0.089	2.29	10.70
	09/18/05	8:15	1	0.006	0.001	0.026	0.480	0.58	0.100	0.020	0.037	0.089	0.052	0.75	10.00
	09/23/03	10:30	1	0.010	0.006	0.178	0.690	0.84	0.154	0.015	0.048	0.120	0.072	1.45	9.45
	09/23/03	10:30	2	0.033	0.011	0.172	0.630			0.014	0.055				
	10/01/03	9:45	1	0.012	0.003	0.027	0.630	0.66	0.034	0.015	0.056			0.49	11.40
	10/07/03	9:30	1	0.014	0.003	0.140	0.480	0.71	0.227	0.014	0.038	0.105	0.067	1.94	11.20
	10/14/03	9:45	1	0.007	0.003	0.251	0.560	0.72	0.157	0.011	0.046	0.112	0.066	1.36	11.60
	10/22/03	10:00	1	0.012	0.006	0.058	0.470	0.80	0.333	0.015	0.042	0.154	0.112	2.91	11.00
	10/28/03	12:30	1	0.035	0.006	0.274	0.670	0.77	0.102	0.014	0.045	0.110	0.065	1.47	7.04
	10/28/03	12:30	2	0.041	0.008	0.271	0.680			0.015	0.046				
	11/13/03	10:45	1	0.066	0.007	0.319	0.770			0.023	0.048				
	11/26/03	11:45	1	0.082	0.010	0.530	0.960			0.019	0.037				
	11/26/03	11:45	2	0.080	0.010	0.530	1.160			0.021	0.043				
Mean				**0.033**	**0.006**	**0.206**	**0.689**	**0.78**	**0.174**	**0.019**	**0.048**	**0.124**	**0.075**	**1.63**	**10.28**
Median				**0.024**	**0.006**	**0.175**	**0.655**	**0.77**	**0.157**	**0.015**	**0.046**	**0.116**	**0.070**	**1.47**	**10.70**
St. Dev.				**0.028**	**0.003**	**0.169**	**0.193**	**0.14**	**0.091**	**0.009**	**0.010**	**0.025**	**0.018**	**0.75**	**1.41**
Winter	12/11/03	11:15	1	0.103	0.011	0.498	1.030			0.015	0.045				
	12/23/03	9:00	1	0.102	0.013	0.924	1.190			0.010	0.018				
	12/23/03	9:00	2	0.096	0.013	0.910	1.330			0.010	0.020				
Annual															
Mean				**0.048**	**0.007**	**0.268**	**0.760**	**0.85**	**0.132**	**0.019**	**0.052**	**0.121**	**0.066**	**3.01**	**9.27**
Median				**0.043**	**0.006**	**0.266**	**0.705**	**0.84**	**0.104**	**0.015**	**0.048**	**0.134**	**0.065**	**1.62**	**10.95**
St. Dev.				**0.034**	**0.003**	**0.216**	**0.205**	**0.13**	**0.071**	**0.010**	**0.019**	**0.036**	**0.023**	**3.12**	**3.45**

Table 4-7. Indicator threshold values and percent exceedance for monthly grab samples at Iron Pot Landing, Railroad Bridge and Mataponi Creek.

Iron Pot Landing

Indicator (Threshhold value)	Chlorophyll a (15 μg/L)	Chlorophyll a (50 μg/L)	Total Suspended Solids (15 mg/L)
# of observations exceeding threshhold	1	0	22
# of total observations	26	26	40
% failure	3.8%	0.0%	55.0%

Railroad Bridge

Indicator (Threshhold value)	Chlorophyll a (15 μg/L)	Chlorophyll a (50 μg/L)	Total Suspended Solids (15 mg/L)
# of observations exceeding threshhold	4	0	31
# of total observations	32	32	40
% failure	12.5%	0.0%	77.5%

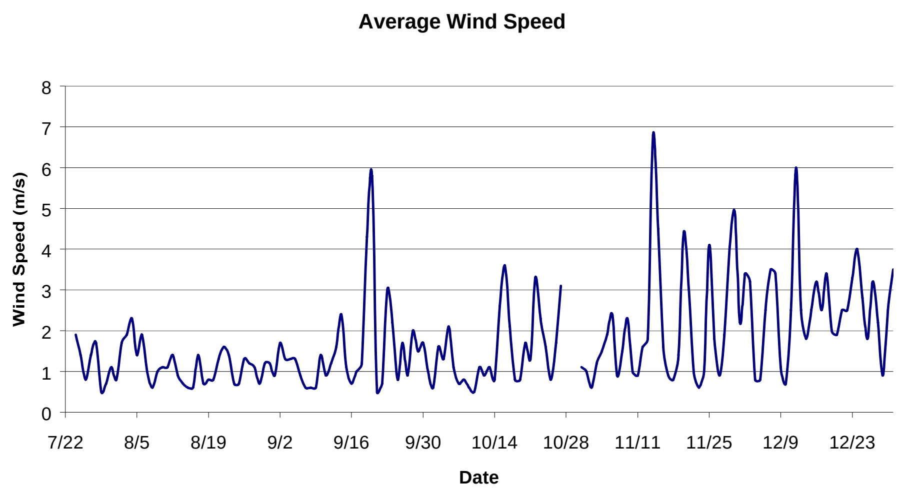
Mataponi Creek

Indicator (Threshhold value)	Chlorophyll a (15 μg/L)	Chlorophyll a (50 μg/L)	Total Suspended Solids (15 mg/L)
# of observations exceeding threshhold	1	0	10
# of total observations	32	32	33
% failure	3.1%	0.0%	30.3%

5. Meteorological Data

The principle objectives of the meteorological information was to track and record atmospheric and meteorological conditions, create a database capable of detecting long-term changes in weather patterns, and to record and identify the impact of storms, hurricanes, heavy rain and other episodic weather events capable of influencing other environmental conditions, such as water quality. The Campbell Scientific weather station was located on the north end of the Jug Bay marsh, along a tidal creek that feeds the Patuxent River. Meteorological data was collected every 5 seconds and stored on a Campbell Scientific CR10X data logger. The data was then used by the CR10X to produce 15 minute averages, maximum and minimums, hourly averages, maximums and minimums and daily averages, maximums and minimums of air temperature, relative humidity, barometric pressure, rainfall, wind speed, wind direction and light. Weather data was collected from January 1 through December 31, 2003; however, only data collected after July 22 was reported due to calibration and time coding concerns. Data quality assurance and control was conducted using either the NERRs WDMP or EQWin programs. Data from October 27 to 29 are missing due to user error; all other missing data were rejected and deleted through QA/QC procedures.

The weather station successfully captured the passing of several storms, including Hurricane Isabel, during 2003 (Fig. 5-1, 5-2 and 5-3). Drops in barometric pressure and increases in average and maximum wind speeds and precipitation on September 19 show the influence of the hurricane through meteorological changes (Fig. 5-1, 5-2 and 5-3).



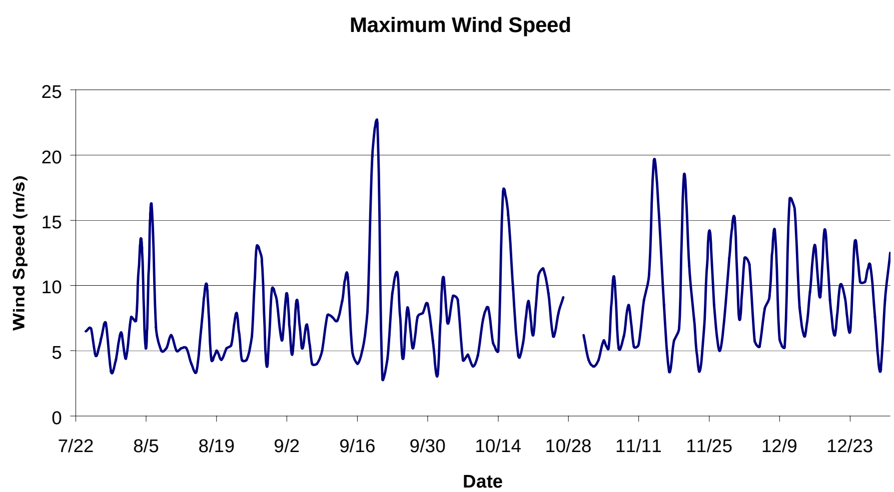


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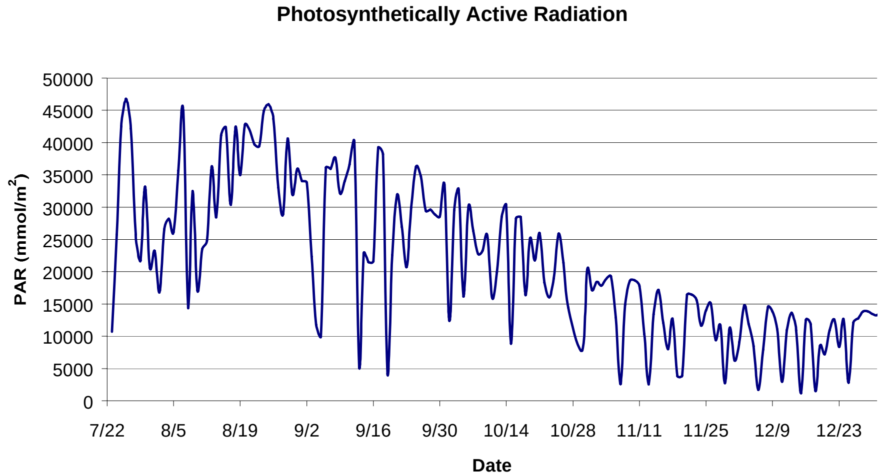
Figure 5-1. 2003 Time series of average wind speed and maximum wind speed observed by the Jug Bay weather station.

Table 5-1. 2003 average daily wind direction observed by the Jug Bay weather station.

Direction	Degrees	% of observations
N-NNE	0-22.5	6.3%
NNE-NE	22.5-45	4.5%
NE-ENE	45-67.5	4.4%
ENE-E	67.5-90	4.1%
E-ESE	90-112.5	2.9%
ESE-SE	112.5-135	3.3%
SE-SSE	135-157.5	9.7%
SSE-S	157.5-180	12.1%
S-SSW	180-202.5	8.0%
SSW-SW	202.5-225	4.7%
SW-WSW	225-247.5	3.6%
WSW-W	247.5-270	3.3%
W-WNW	270-292.5	4.6%
WNW-NW	292.5-315	8.0%
NW-NNW	315-337.5	10.9%
NNW-N	337.5-360	9.5%



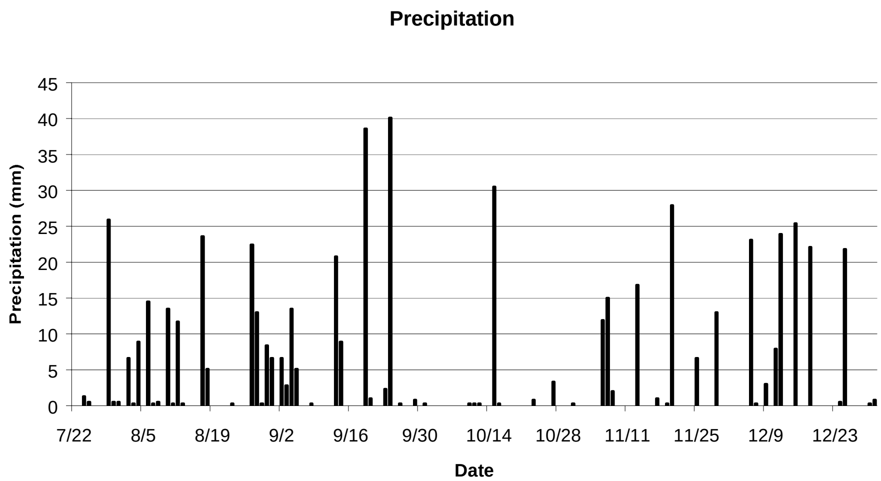


Figure 5-2. 2003 Time series of average photosynthetically active radiation and precipitation observed by the Jug Bay weather station.

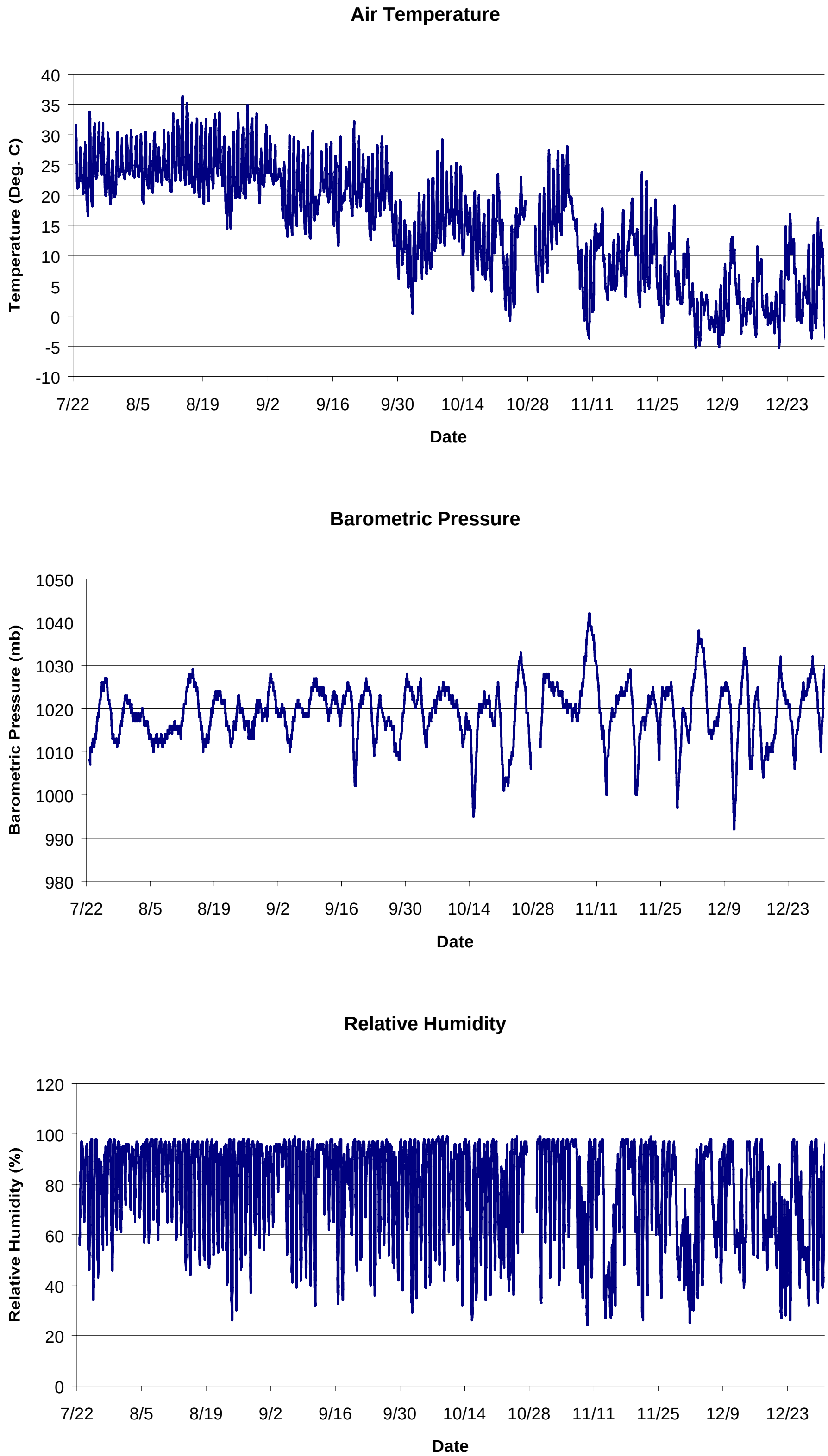


Figure 5-3. 2003 Time series of average daily air temperature, barometric pressure and relative humidity.

6. Water Quality Mapping

Upper Patuxent River water quality mapping data were collected monthly from April-October 2003. Water quality mapping collects surface data every four seconds aboard a moving boat, creating thousands of data points in a daily cruise, and allows for the creation of highly detailed spatial maps of water quality. Data for dissolved oxygen, turbidity, chlorophyll, water temperature and salinity were interpolated into spatially continuous surface maps using the inverse distance weighted method. Data were quality assured and controlled, but not standardized for time-of-day influences before interpolation.

Overall results show that surface dissolved oxygen levels were mostly above 5 mg/L during collection, with concentrations of 2.5 – 5 mg/L occurring during June and September (Figs. 6-1 through 6-7). Due to high water flows and runoff during 2003, turbidities were high throughout the upper Patuxent River, especially during the May and September sampling cruises (Fig.6-26-6). The high turbidities accounted for low light availability in the water column, restricting chlorophyll values to less than 20 μg/L throughout the river (Figs. 6-1 through 6-7). Chlorophyll concentrations were generally greater downriver (Figs. 6-1 and 6-7). It is not yet known how the low light availability impacted SAV in the upper Patuxent.

7. Conclusion

The purpose of the Chesapeake Bay National Estuarine Research Reserve (CBNERR-MD) is to manage protected estuarine areas as natural field laboratories and to develop and implement a coordinated program of research, monitoring, education and volunteer activities. The partnership between CBNERR-MD and Maryland DNR's Shallow Water Monitoring Program is designed to collect water quality data in an effort to discern the links between water quality, harmful algal blooms, and fish kills. Shallow water monitoring provides the necessary data to evaluate new water quality criteria set forth in the Chesapeake Bay Agreement and to determine if shallow water monitoring areas are meeting their designated fishable and swim able use. CBNERR-MD's System Wide Monitoring Program in conjunction with DNR's Shallow Water Monitoring Program provides information needed to measure changes in estuarine waters in order to understand how human activities and natural events can affect coastal resources. It also provides valuable data on the short-term variability and long-term changes in estuaries to researchers, natural resource managers, land managers and other coastal decision makers.

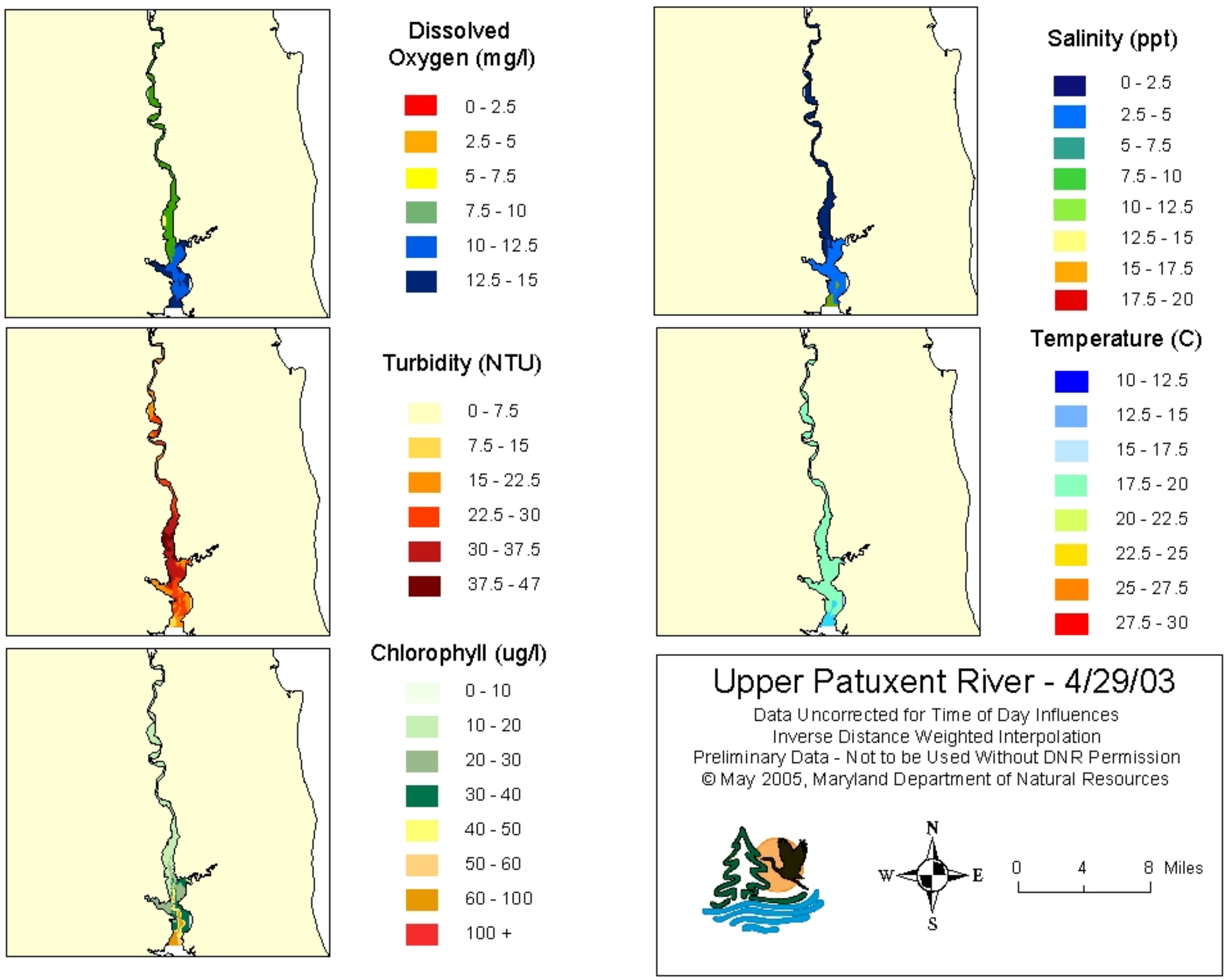


Figure 6-1. Upper Patuxent River water quality mapping for April 29, 2003.

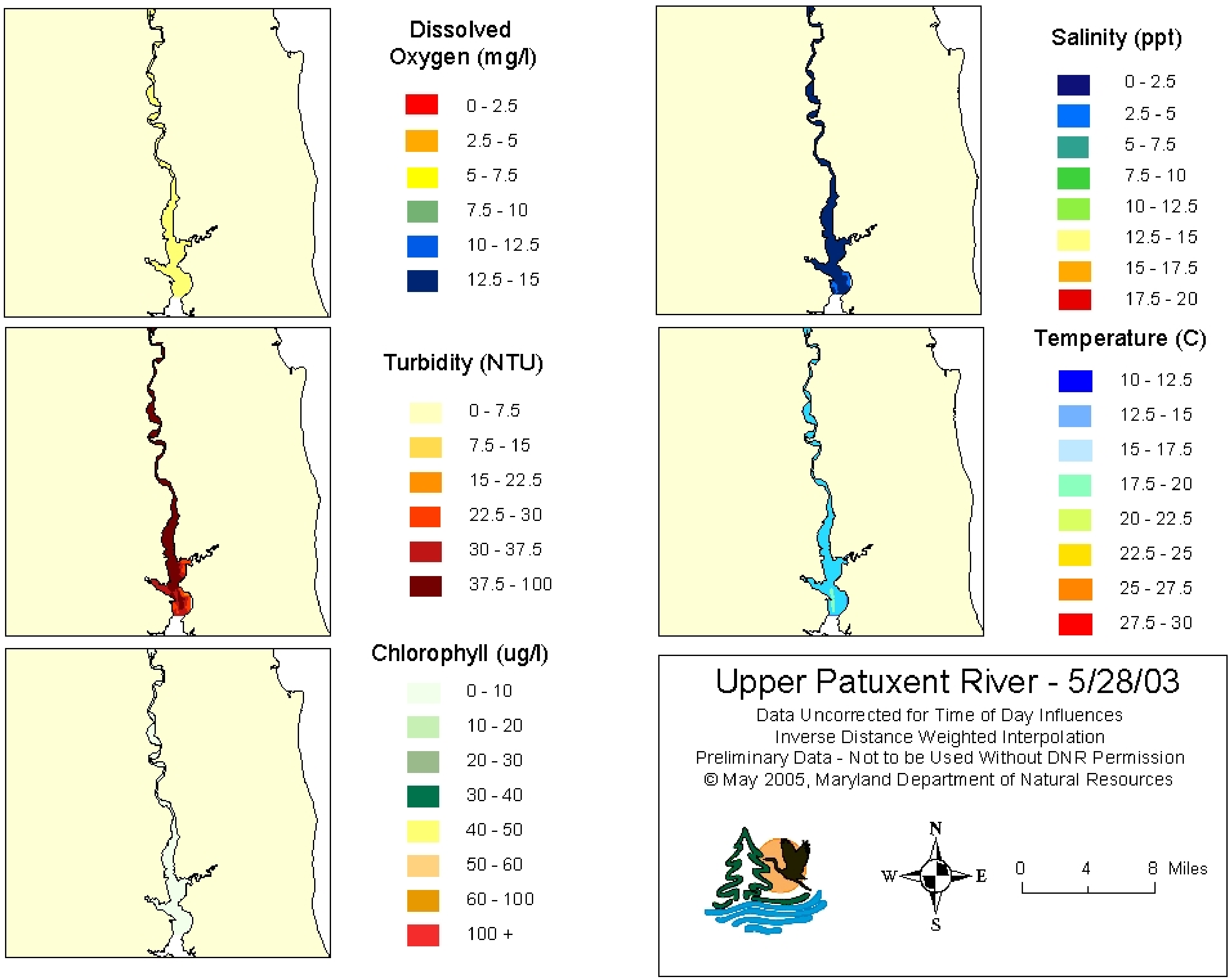


Figure 6-2. Upper Patuxent River water quality mapping for May 28, 2003.

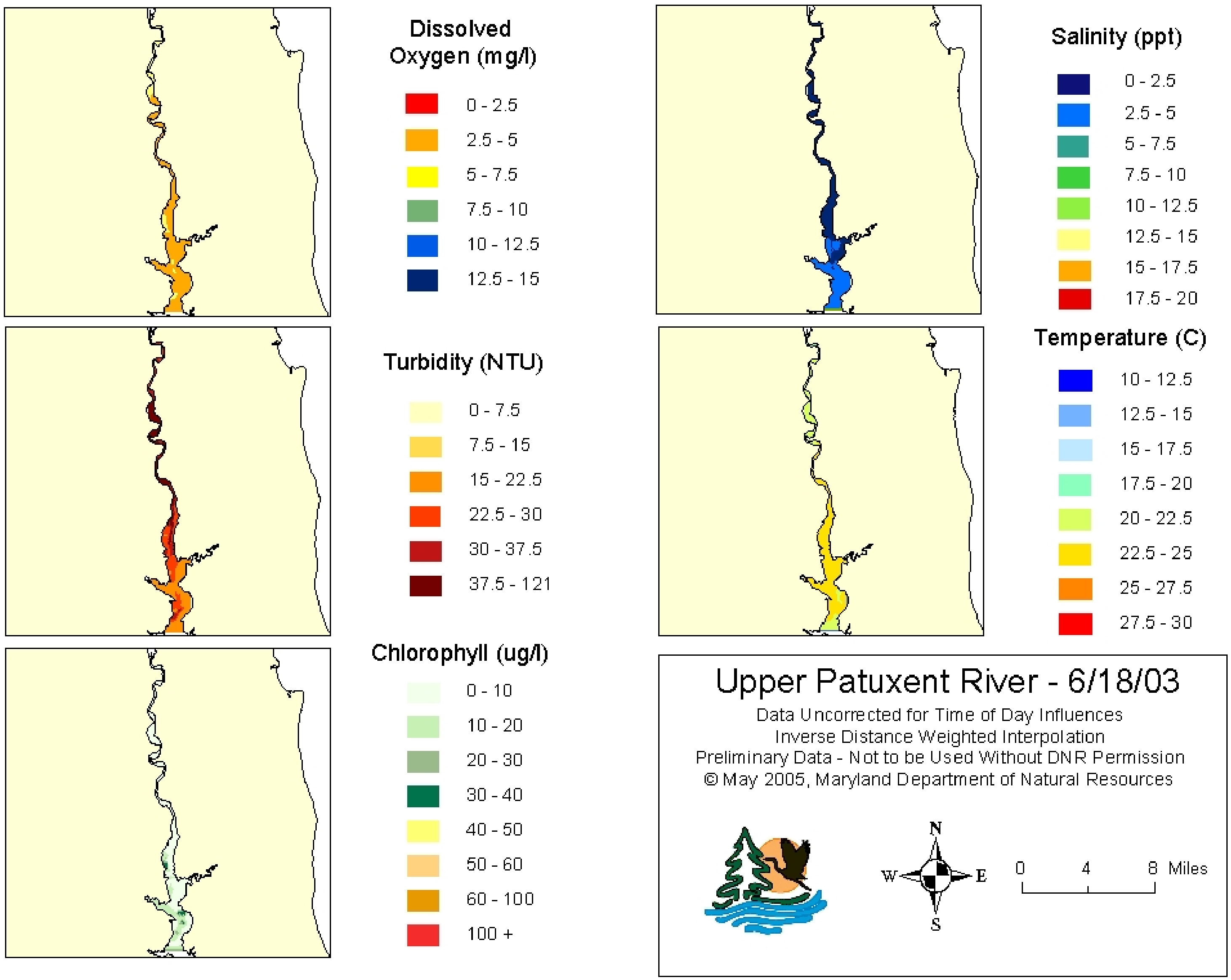


Figure 6-3. Upper Patuxent River water quality mapping for June 18, 2003.

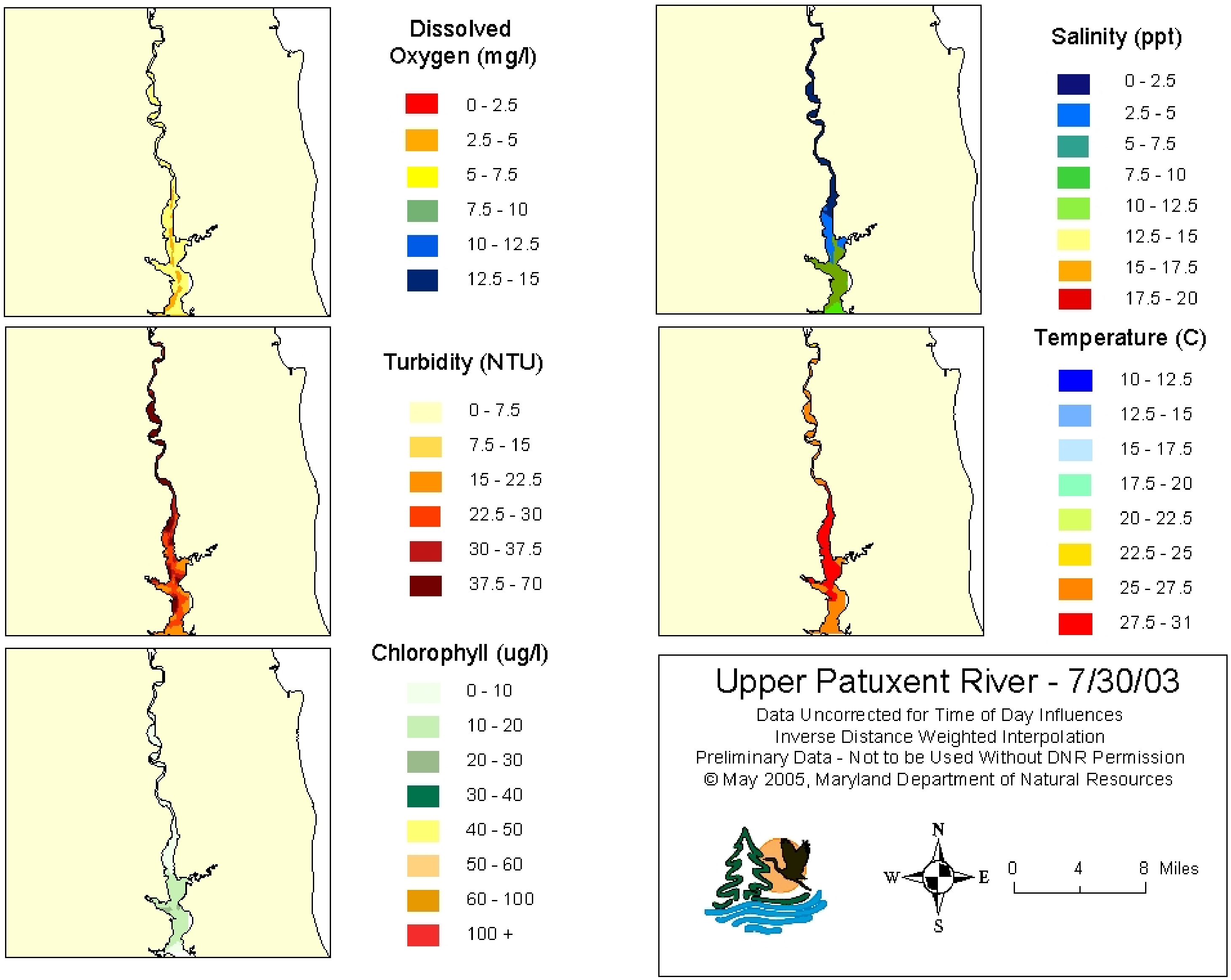


Figure 6-4. Upper Patuxent River water quality mapping for July 30, 2003.

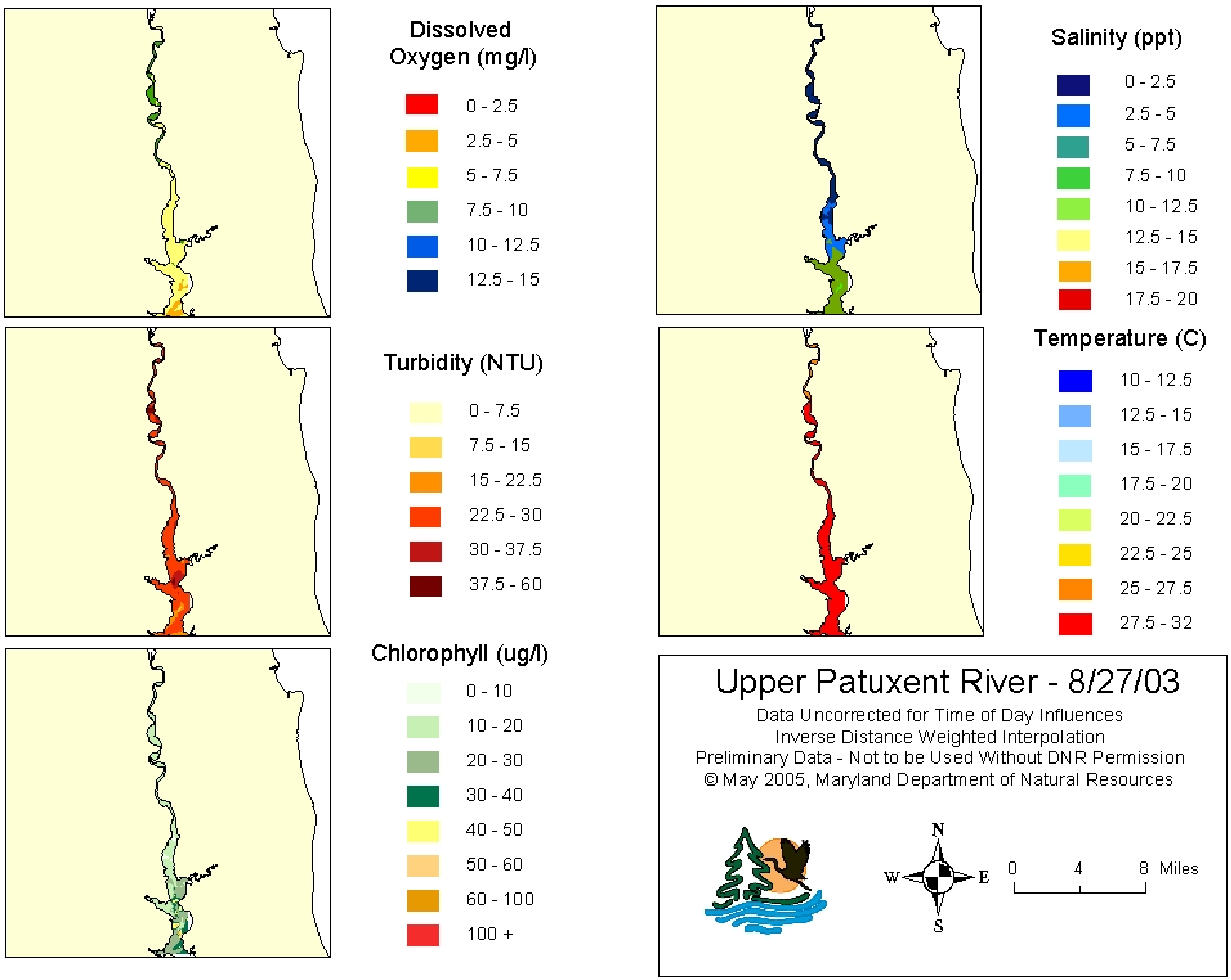


Figure 6-5. Upper Patuxent River water quality mapping for August 27, 2003.

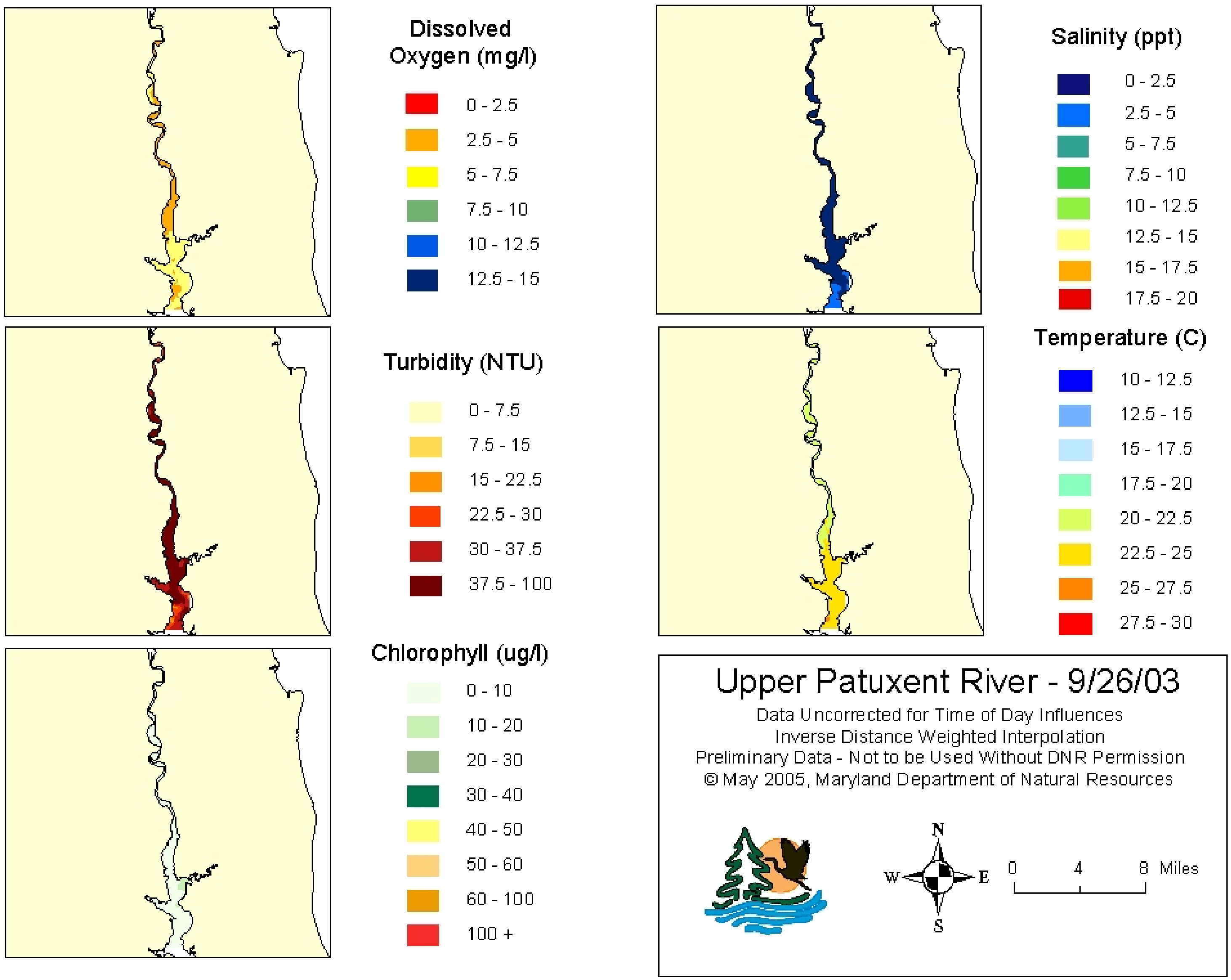


Figure 6-6. Upper Patuxent River water quality mapping for September 26, 2003.

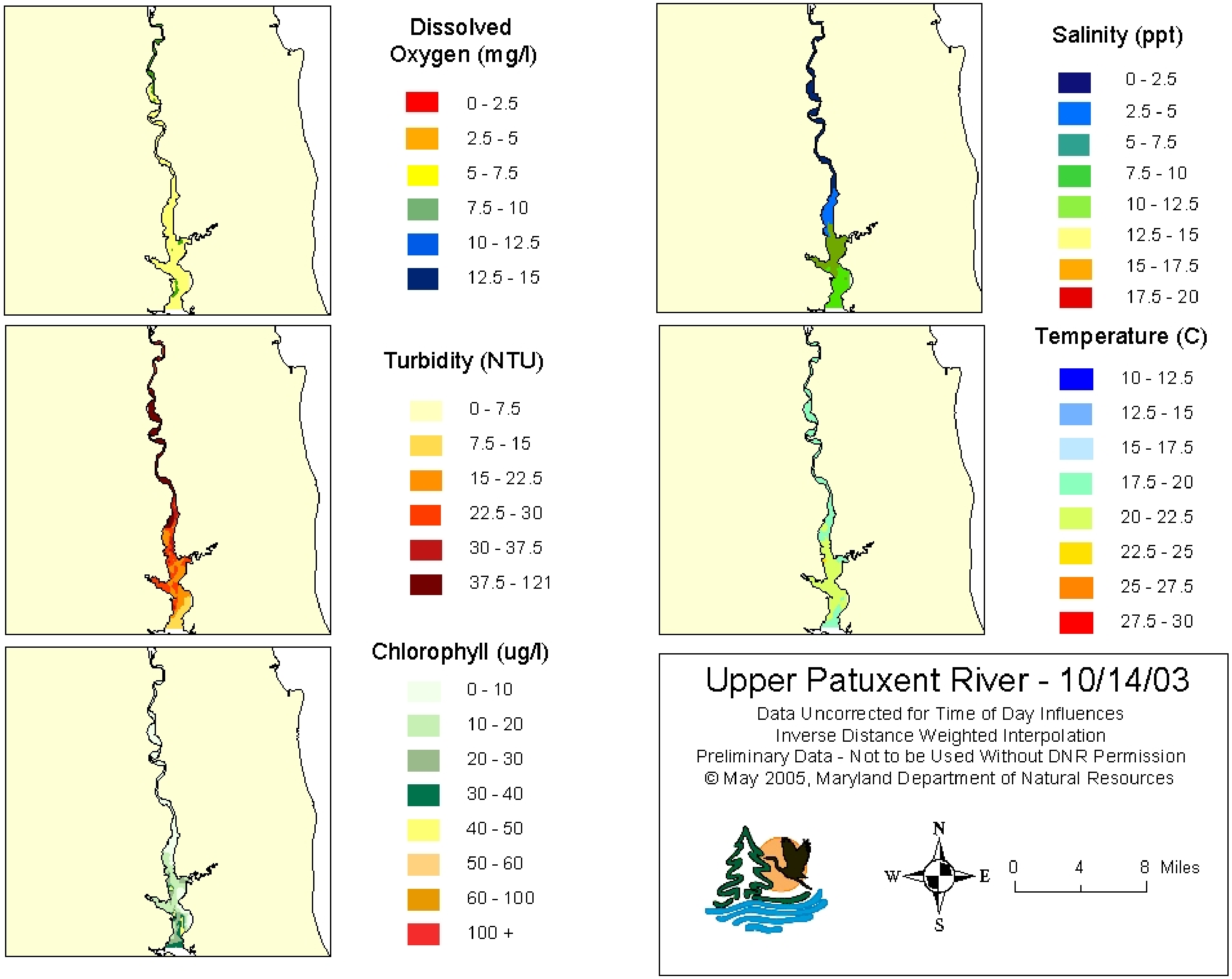


Figure 6-7. Upper Patuxent River water quality mapping for October 14, 2003.

Appendix A

Diel Nutrient Sampling

The goal of the diel nutrient sampling was to catalog short-term variability in nutrient concentrations across different tidal cycles. Diel data (total nitrogen, total phosphorus, nitrite, ammonium, orthophosphate, nitrite + nitrate, total suspended solids, volatile suspended solids and chlorophyll) was collected once monthly from July through December at the Railroad Bridge station. Automated samplers (ISCO and SIGMA samplers) were programmed to sample every two and one half hours over a twenty-four hour period. Missing data for June and September diel samples were due to power failure. No diel samples were collected during August because an automated sampler was not available. November samples were collected October 28-29, 2003. Samples missing during December collection were due to a frozen intake tube. All other missing data was rejected and deleted through QA/QC procedures.

All parameters sampled exhibited responses to diel cycles (Figs. A-1 through A-10). Chlorophyll, total suspended solids and ammonium showed the greatest response to tidal cycle (Figs. A-1, A-3, A-4, A-5, A-8, and A-9). Chlorophyll concentrations either increased with high tide or decreased with high tide, depending on the month (Figs. A-1, A-3, A-5, A-7 and A-9). Peaks in total suspended solids generally corresponded with flood and ebb tide (Figs. A-1, A-3, A-5, A-7 and A-9). Ammonium concentrations peaked during high or low tide and were inversely related to chlorophyll concentrations (Figs. A-1, A-2, A-3, A-4, A-7 and A-8). All other nutrient parameters showed slight responses to tidal cycle, and did not appear to be influenced by chlorophyll concentrations.

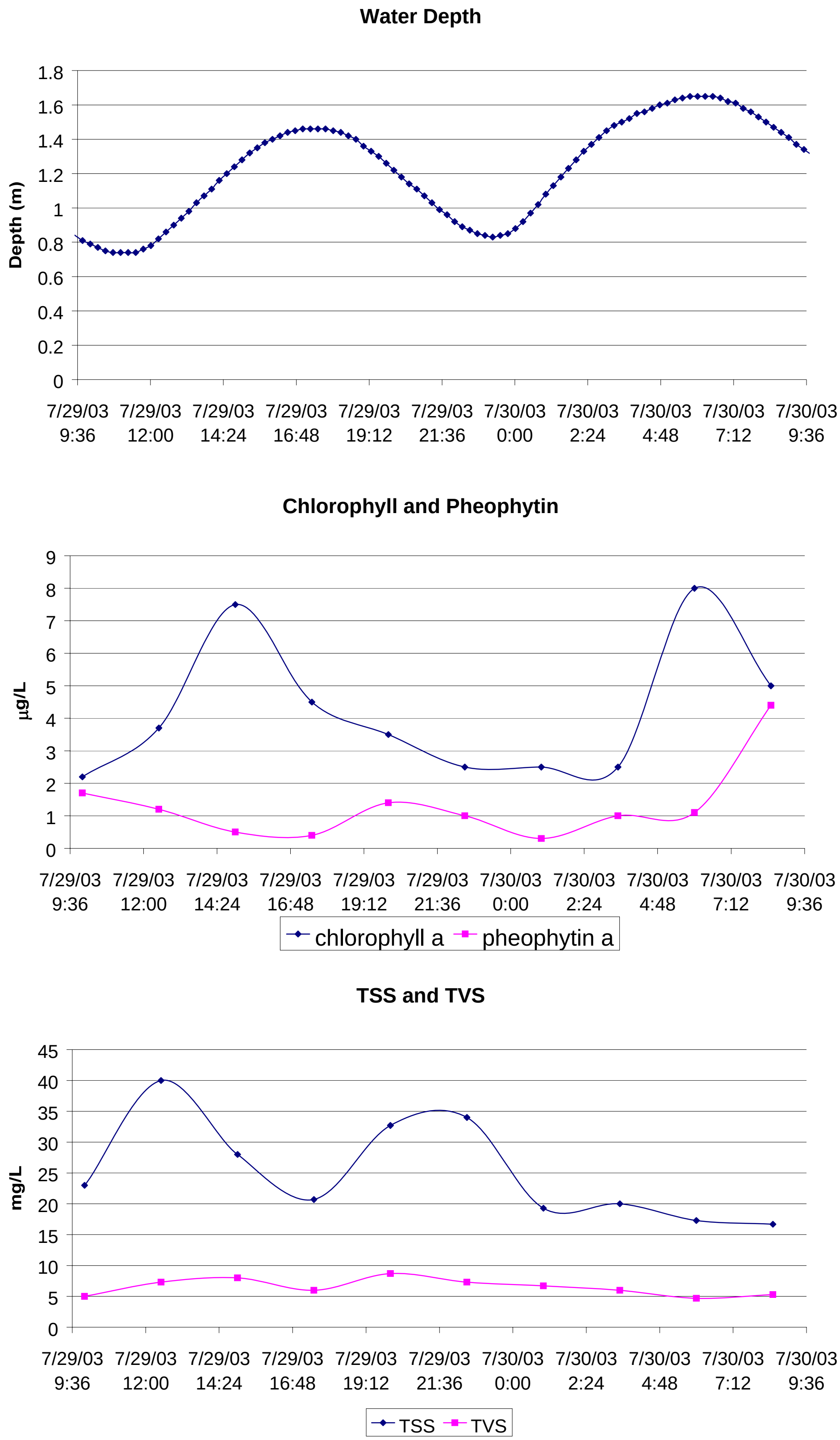


Figure A-1. Time series of July 2003 diel water depth, chlorophyll and pheophytin concentrations, total suspended solids (TSS) and total volatile solids (TVS).

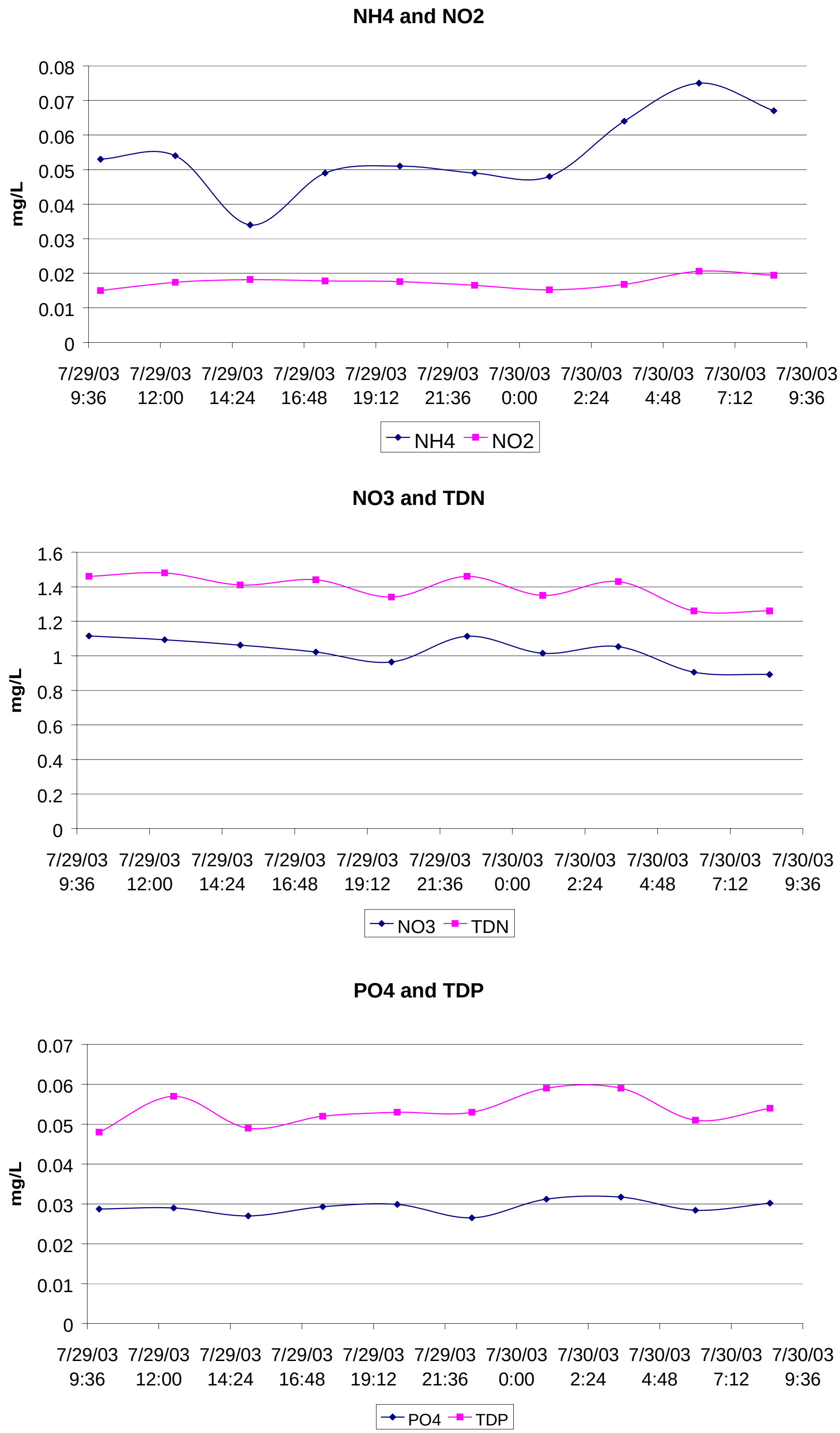
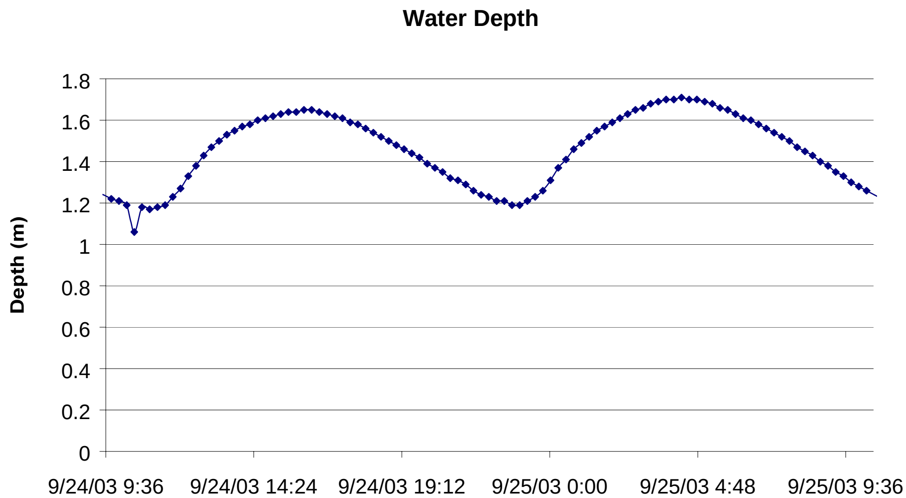
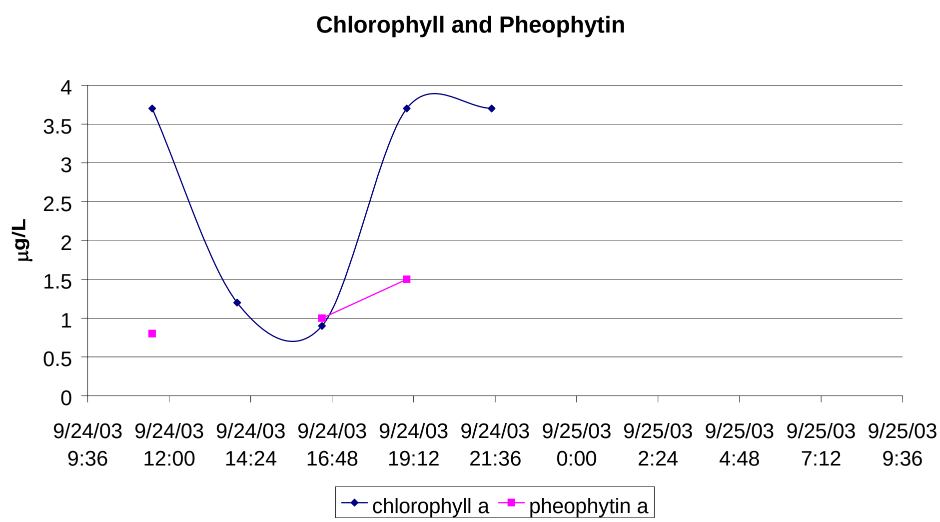


Figure A-2. Time series of July 2003 diel ammonium (NH_4), nitrite (NO_2), nitrate (NO_3), total dissolved nitrogen (TDN), orthophosphate (PO4) and total dissolved phosphorus (TDP).





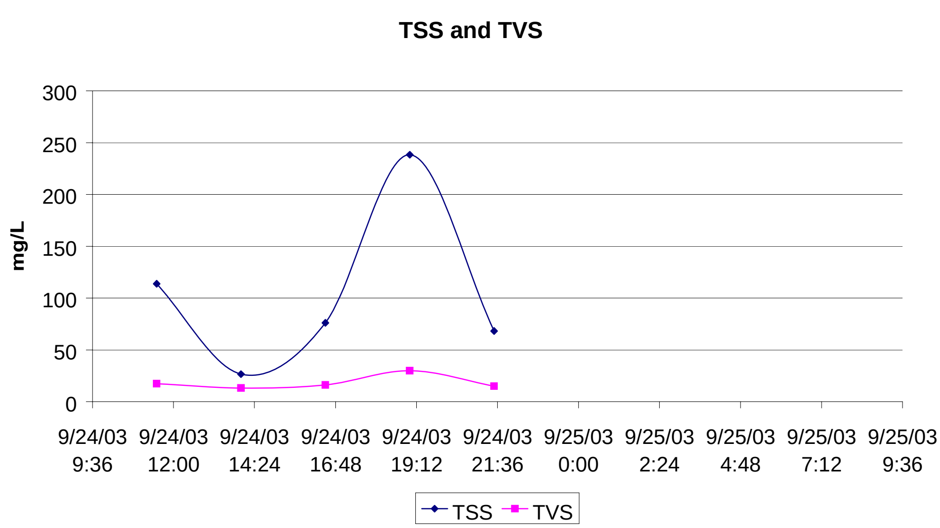


Figure A-3. Time series of September 2003 diel water depth, chlorophyll and pheophytin concentrations, total suspended solids (TSS) and total volatile solids (TVS).

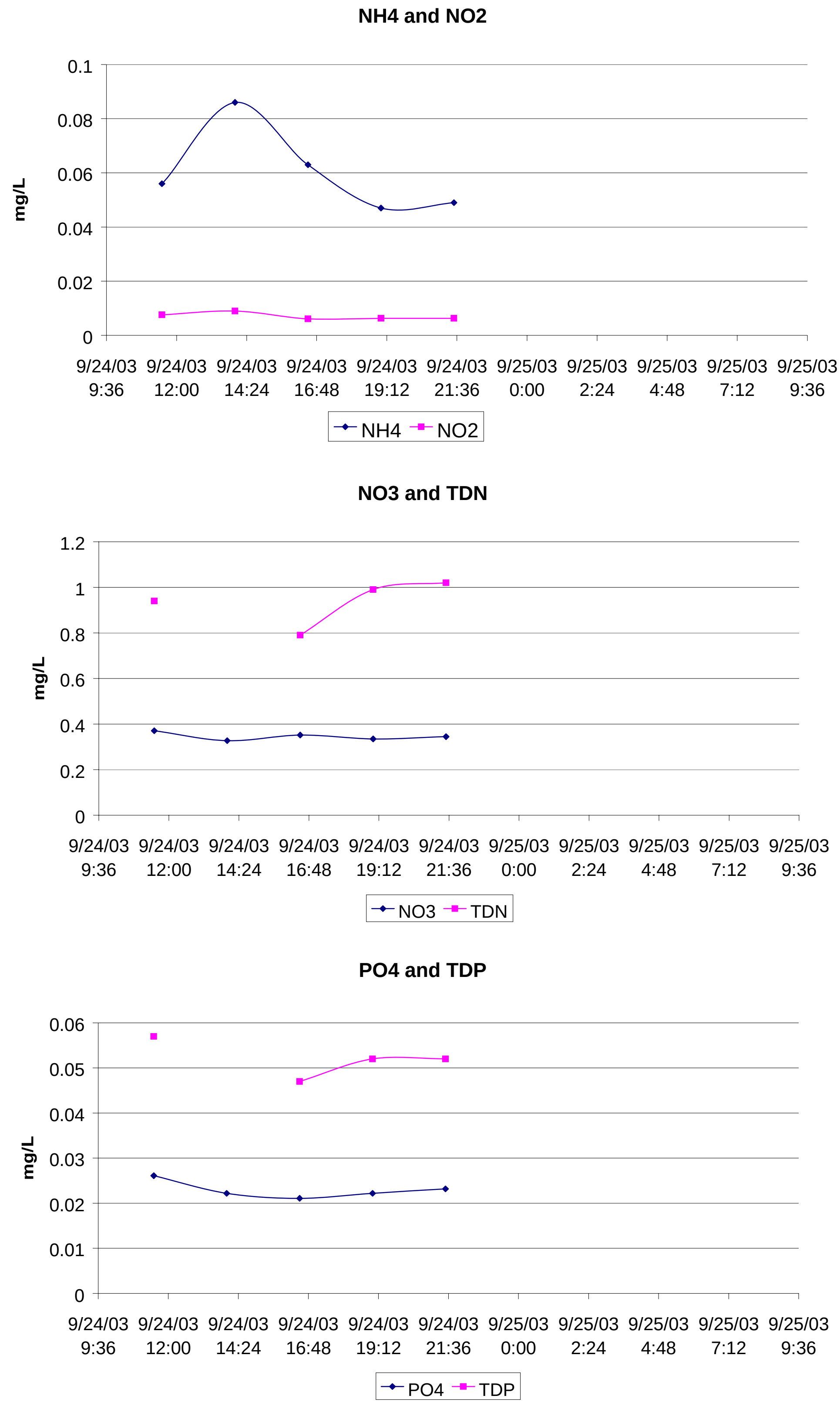
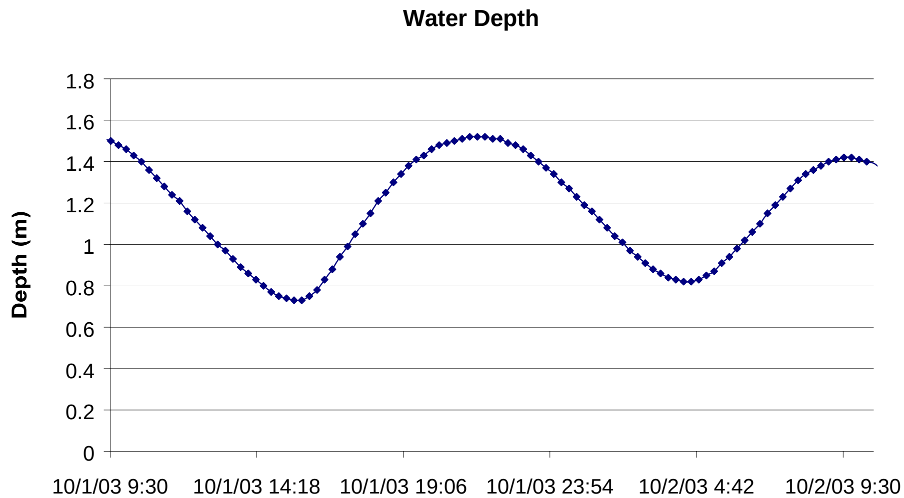
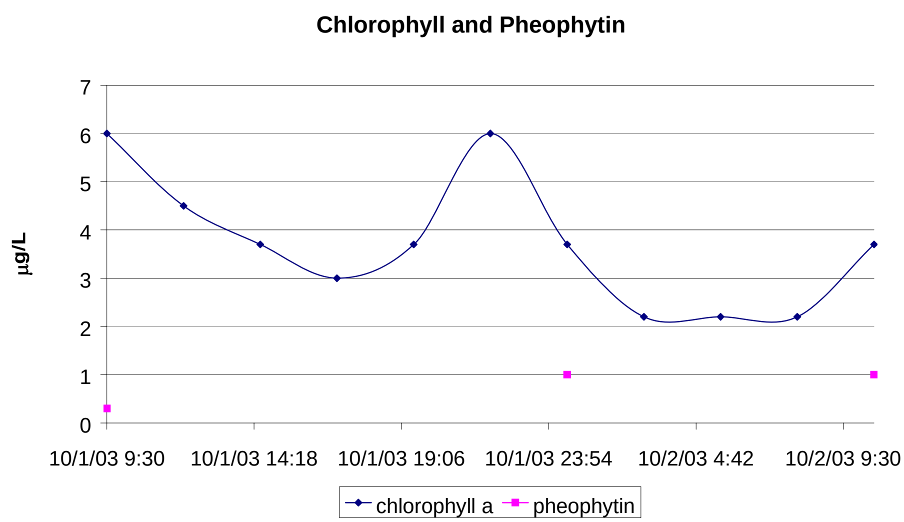


Figure A-4. Time series of September 2003 diel ammonium (NH_4), nitrite (NO_2), nitrate (NO_3), total dissolved nitrogen (TDN), orthophosphate (PO4) and total dissolved phosphorus (TDP).





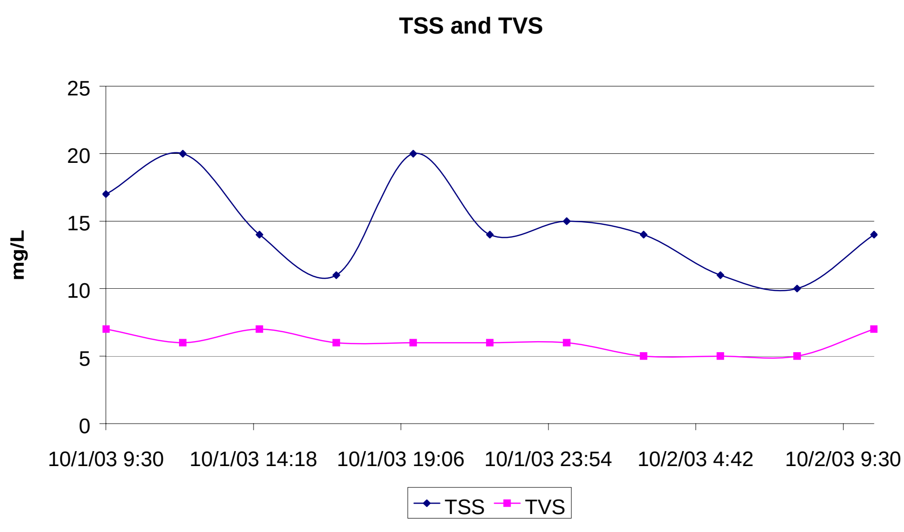
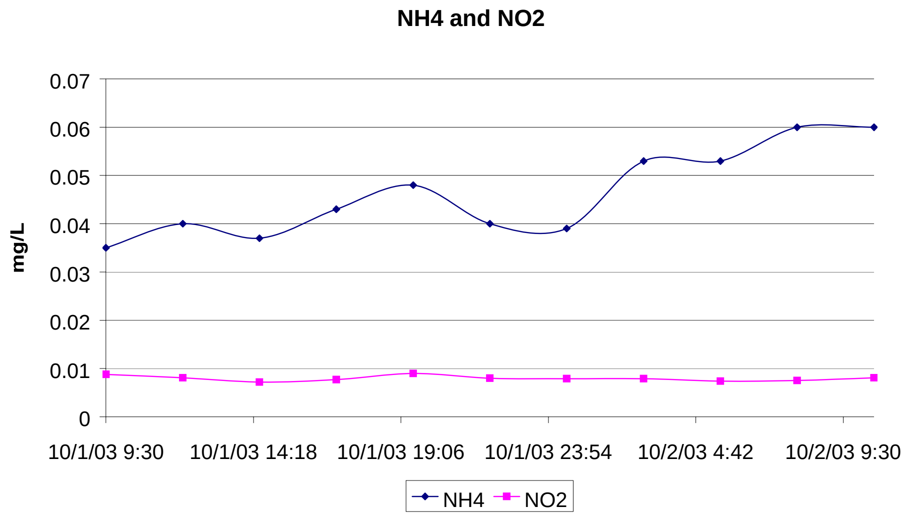
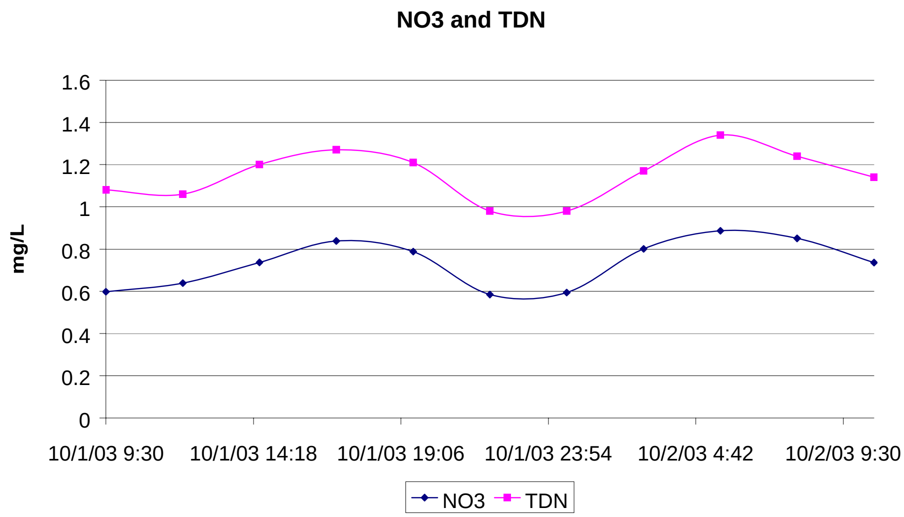


Figure A-5. Time series of October 2003 diel water depth, chlorophyll and pheophytin concentrations, total suspended solids (TSS) and total volatile solids (TVS).





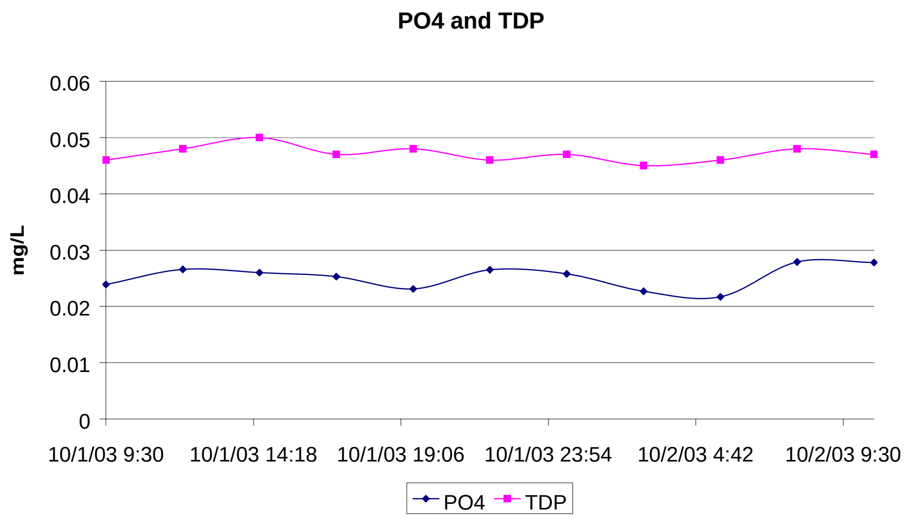


Figure A-6. Time series of October 2003 diel ammonium (NH_4), nitrite (NO_2), nitrate (NO_3), total dissolved nitrogen (TDN), orthophosphate (PO4) and total dissolved phosphorus (TDP).

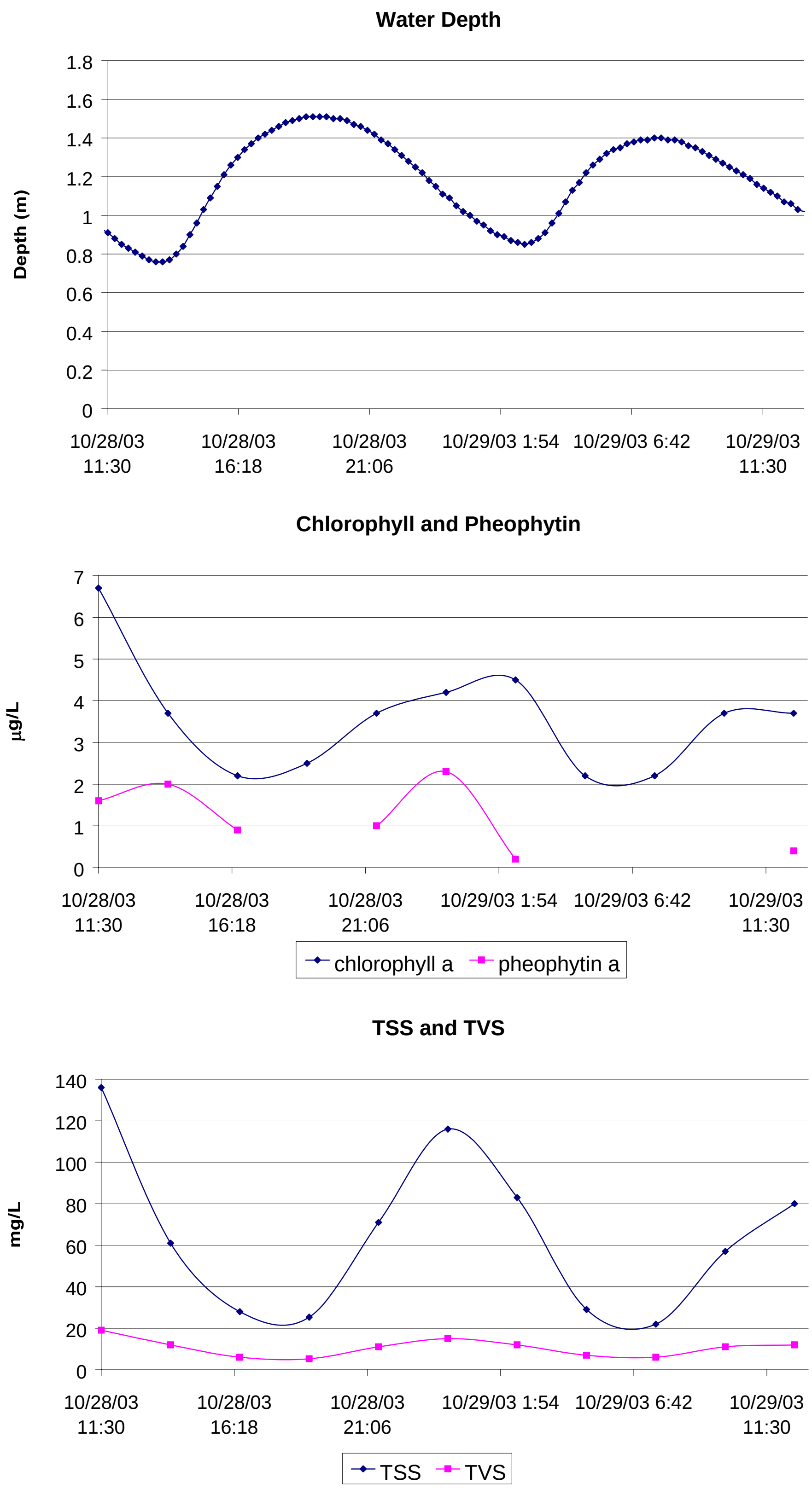


Figure A-7. Time series of November 2003 diel water depth, chlorophyll and pheophytin concentrations, total suspended solids (TSS) and total volatile solids (TVS).

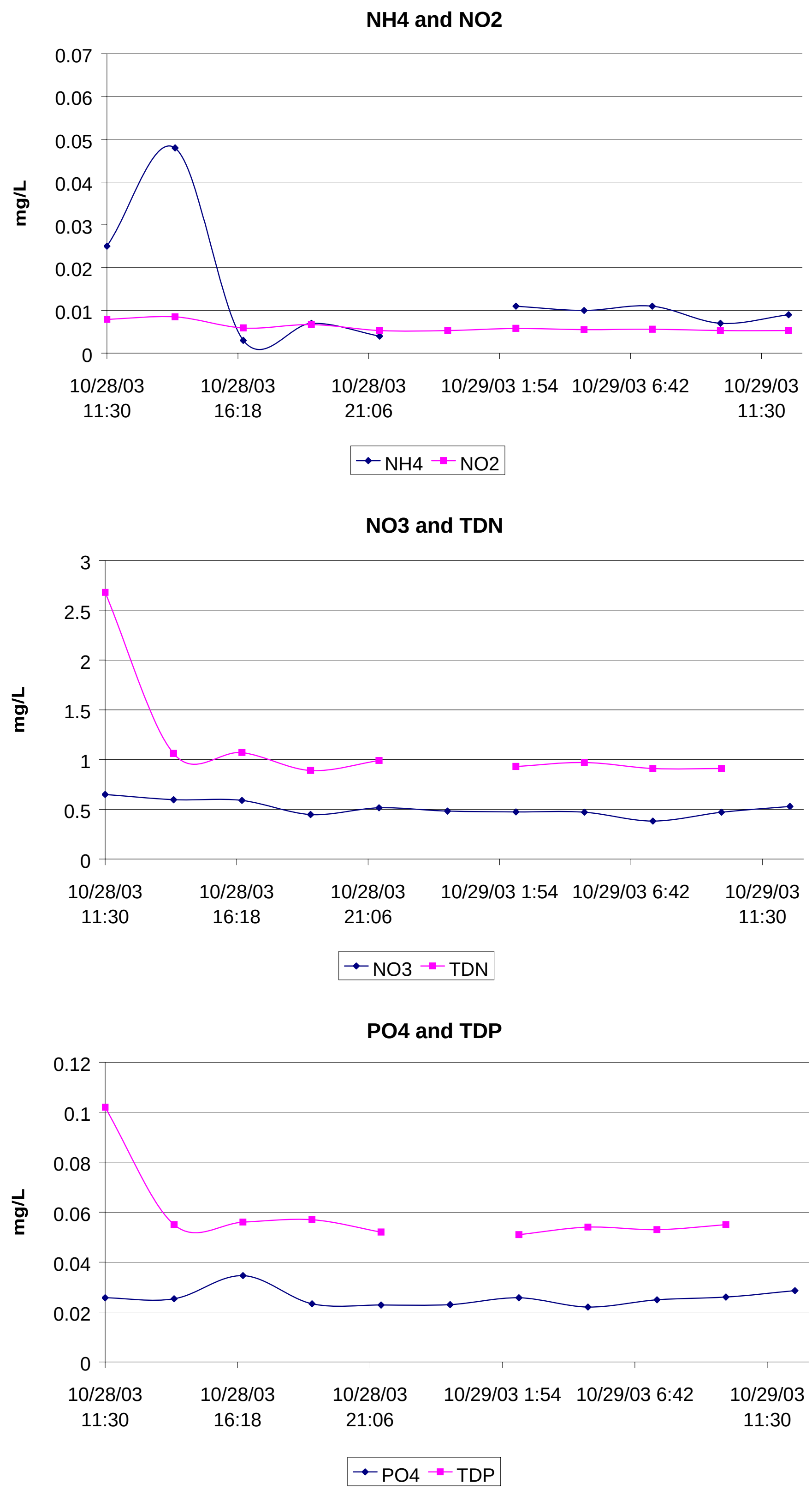


Figure A-8. Time series of November 2003 diel ammonium (NH_4), nitrite (NO_2), nitrate (NO_3), total dissolved nitrogen (TDN), orthophosphate (PO4) and total dissolved phosphorus (TDP).

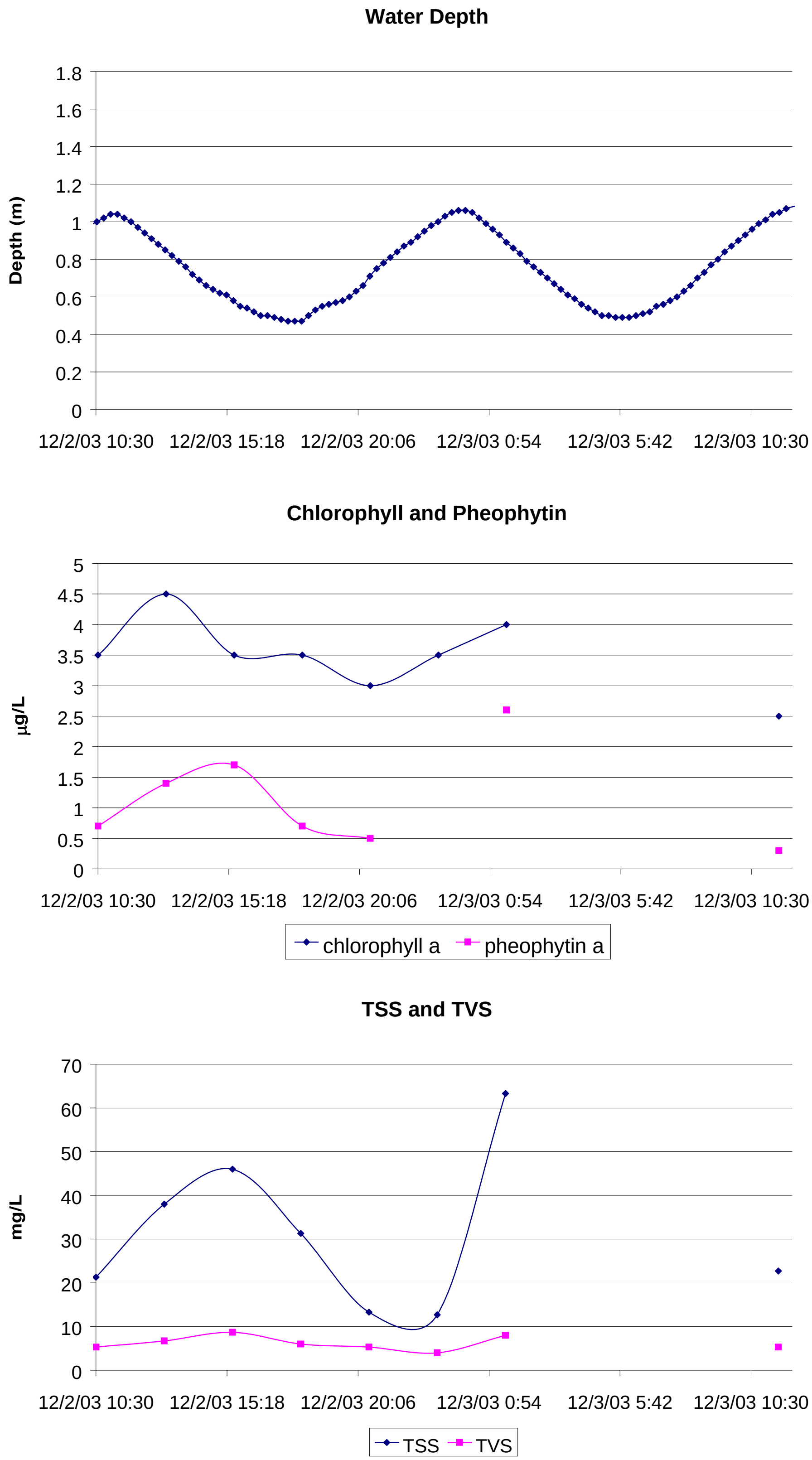


Figure A-9. Time series of December 2003 diel water depth, chlorophyll and pheophytin concentrations, total suspended solids (TSS) and total volatile solids (TVS).

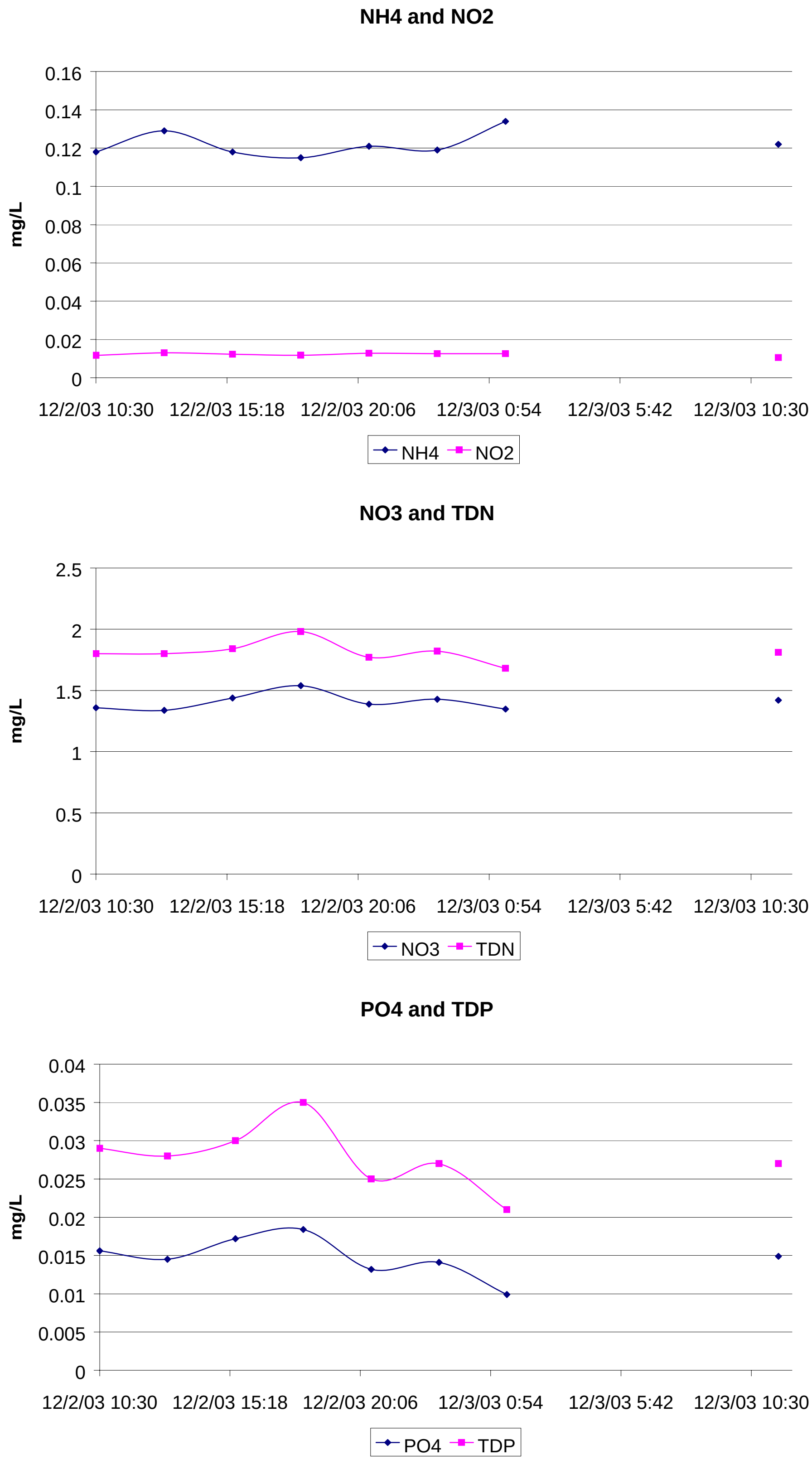


Figure A-10. Time series of December 2003 diel ammonium (NH_4), nitrite (NO_2), nitrate (NO_3), total dissolved nitrogen (TDN), orthophosphate (PO4) and total dissolved phosphorus (TDP).