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An Assessment of SAV Epiphyte Loading and Local Water Quality Conditions at Blossom Point, Maryland 2002

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An Assessment of SAV Epiphyte Loading and Local Water Quality Conditions at Blossom Point, Maryland 2002

PREPARED FOR:

US Army Research Laboratory
2800 Powder Mill Rd
Adelphi, MD 20783

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R.M. Stankelis, Sr. FRA, Program Coordinator
P.W. Smail, Faculty Research Assistant
E.M. Bailey, Sr. Faculty Research Assistant
W.R. Boynton, Professor

Chesapeake Biological Laboratory
University of Maryland Center for Environmental Science
P.O. Box 38, Solomons, MD 20688-0038

TABLE OF CONTENTS

Page No.

APPENDIX A

Water quality and epiphyte data sets.

Tables

1.0 ABSTRACT

Epiphyte fouling rates were measured at one location, along each of three permanent transects (PR05, BP03, and KC01) at Blossom Point Maryland in 2000, 2001, and 2002. Each year, measurements were made weekly for three consecutive weeks in the spring, summer, and fall using artificial substrates in the form of rectangular Mylar® strips. In 2002, additional measurements of epiphyte fouling rates were made with complex artificial SAV mimics to better assess fouling rates on the canopy forming species present at Blossom Pt. Over the course of sampling, several patterns were consistently observed. Epiphyte fouling rates (dry mass and chlorophyll-a) at station PR05 were consistently higher compared to the other stations BP03, and KC01 where SAV beds were much more dense and composed primarily of canopy forming species. Preliminary results suggest that at stations BP03 and KC01, epiphyte fouling rates on Mylar strips were not dramatically different from those measured with complex SAV mimics. Even at station PR05, which had the highest fouling rates, percent light at the leaf surface (PLL) was remarkably stable over the sampling period with values typically above the established 9% SAV habitat limit. For example, in 2002, seasonal PLL values ranged from 14% in the spring, to 11% during the summer and 10% during the fall. This pattern was also observed in 2000 and 2001. These results suggest that SAV at these locations are receiving adequate light for growth and survival.

In 2002, measurements of dissolved nutrient concentrations were also taken approximately bi-monthly at both an in-shore and off-shore location along each transect. Each of these locations was selected to sample within, and outside of, existing SAV beds. Drought conditions in 2002 resulted in the lowest median dissolved nutrient conditions found at Blossom Pt, since 2000. In 2002, growing season median dissolved inorganic nitrogen (DIN) concentrations ranged from 2.90 µM N at the in-shore sampling location along BP03 to 8.83 µM N at the off-shore location along BP03. Median concentrations of dissolved inorganic phosphorus (DIP) ranged from 0.34 µM P at the inshore location along BP03 to 0.68 µM P at the in-shore location of PR05. While there was a trend in lower dissolved nutrient concentrations at in-shore stations compared to off-shore stations, there was no statistical difference.

2.0 INTRODUCTION

Chesapeake Bay, like many other shallow coastal estuaries worldwide, has experienced declines in submerged aquatic vegetation (SAV) populations during the last half of the twentieth century (Den Hartog and Polderman, 1975; Kemp *et al*., 1983; Orth and Moore, 1983, 1984; and Cambridge *et al*., 1986). While coverage of SAV in Chesapeake Bay and its tributaries remains well below historic levels (Moore *et.al*., 2000) certain areas have remained vegetated or have even recovered in recent years (Carter and Rybicki, 1986). Consequently, there is keen interest in preserving and protecting SAV populations where they exist. One of these is the Nanjemoy Creek area, which has had various species of SAV present since 1985 when many other locations had become barren (N. Rybicki, personal communication). The proposed construction of off-shore breakwaters and shoreline riprap along portions of the shoreline at the Adelphi Laboratory's Blossom Research Facility have the potential to impact healthy SAV populations at this location. However, the extent of this impact is uncertain. In order to properly evaluate this impact, it is necessary to assess the baseline conditions at this site prior to construction. This portion of the assessment has focused on the contribution of epiphyte accumulation on light attenuation to SAV as well as the dissolved nutrient conditions in this area.

In 1999, three monitoring sites were established along each of three permanent transects (PR5, BP3, and KC1) at approximately 1m mean water depth to evaluate epiphyte accumulation rates. Epiphyte accumulation rate measurements were made in the summer and fall of 1999 and the spring, summer and fall of 2000, 2001, and 2002. As a part of this contract, water column dissolved nutrients were also measured in 2002. This report provides an evaluation of epiphyte fouling rates, and dissolved nutrient concentrations at these sites, and compares these results to other regions within the Chesapeake Bay system.

3.0 METHODS

3.1. Water Quality Sampling

Water samples were collected independently by the US Army and Chesapeake Biological Laboratory (CBL) to insure that sufficient information was gathered for an adequate analysis of the SAV habitat throughout the growing season. The analysis of water column dissolved nutrient concentrations from both sets of samples were completed at the Nutrient and Analytical Services Laboratory (NASL) and are included in this report.

3.1.1 Station Locations

All water quality samples were collected along three fixed transects (KC1, BP3, and PR5) located at the Blossom Point Facility (Figure 3-1). The US Army collected water samples at two locations along each transect within and outside of existing SAV beds. Station codes for these data reflect the distance from shore at which water samples were collected. The Chesapeake Biological Laboratory (CBL) collected water quality samples (0.5m below surface) from a single location along each transect adjacent to each epiphyte collection array, which was located at a total water depth of approximately 1 m average water depth (Table 3-1).

3.1.2. Sampling Frequency

Sampling by CBL was conducted for several consecutive weeks in the spring, summer, and fall of 2002. The exact sampling dates are shown in Table 3-2. This sampling was scheduled to coincide with the measurement of epiphyte fouling rates being conducted at other locations around Chesapeake Bay. A total of 16 water samples were made during this time by CBL. The US Army collected water samples approximately bi-weekly from May 9, through November 26, 2002.

3.1.3. Water Quality Methods

The following field procedures apply to data collected by CBL. Water samples collected by the US Army may have followed separate procedures.

3.1.3.1. Physical Parameters

Temperature, salinity, conductivity, and dissolved oxygen measurements were measured at 0.5 meters below the water surface using a Yellow Springs International (YSI) 600R or YSI 6920 multi-parameter water quality monitor. Water column turbidity was estimated with a secchi disk where possible, while water column light flux, in the photosynthetically active frequency range, (PAR) was measured with a *Li-Cor* LI-192SA underwater quantum sensor. When possible, measurements were collected at three discrete water depths in order to calculate water column light attenuation (Kd). Weather and sea-state conditions such as air temperature, percent cloud cover, wind speed and direction, total water depth, and wave height, were also recorded.

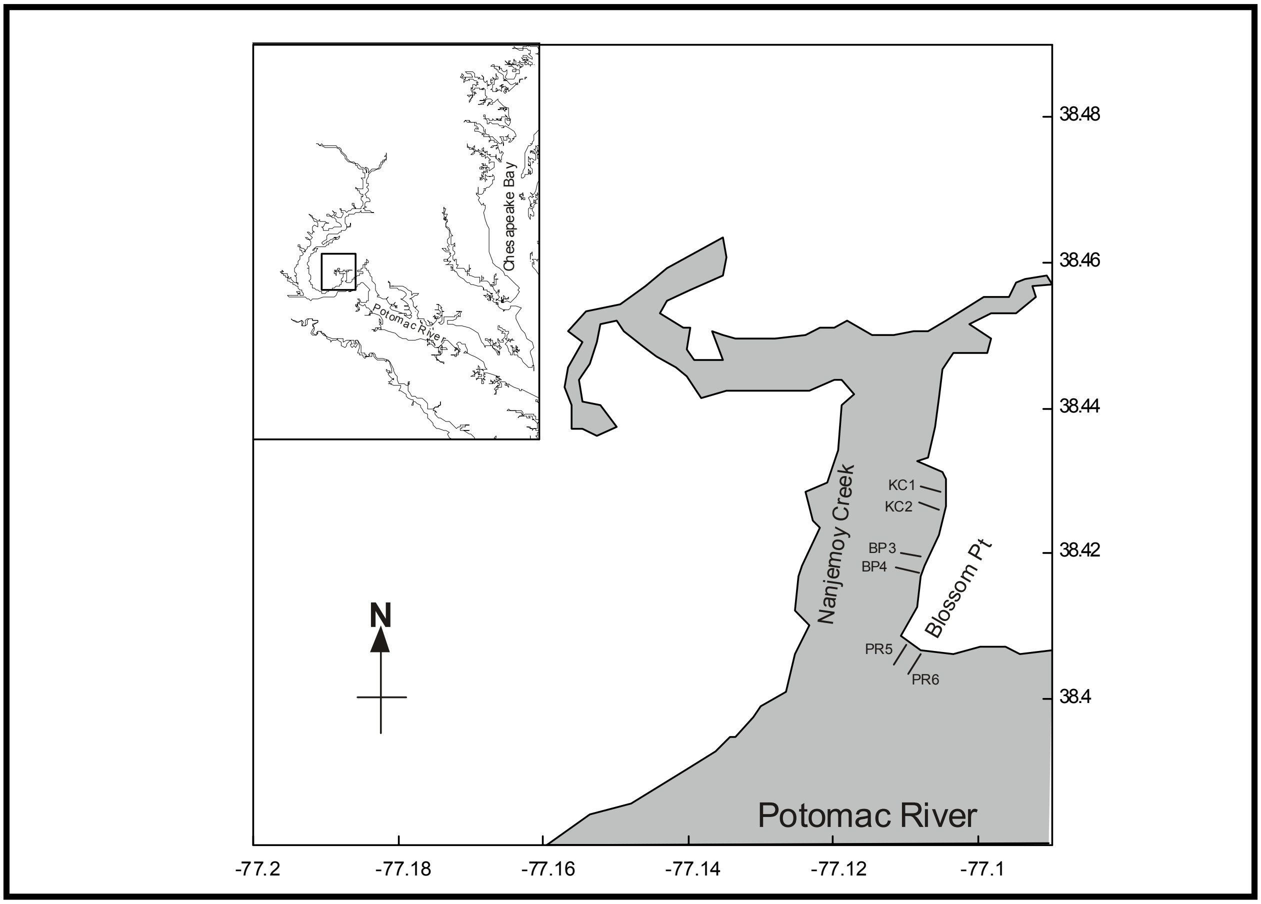


Figure 3-1. Location of Submerged Aquatic Vegetation (SAV) epiphyte monitoring stations at Blossom Point, MD.
Latitude and longitude are in decimal degrees.

Table 3-1. Blossom Point: Submerged aquatic (SAV) station code and geographical coordinates.

STATION CODE	LATITUDE (DGPS) NAD 83	LONGITUDE (DGPS) NAD 83
KC1	38° 01.620’	75° 50.509’
BP3	37° 58.249’	75° 52.609’
PR5	38° 08.835’	75° 50.349’

Table 3-2. Sampling dates for water quality measurements and epiphyte rate measurements collected by CBL at Blossom Point in 2002.

Stations	CBL Water Quality Measurements (at all stations)	Standard Strip Epiphyte Measurements	Complex Morphology Epiphyte Measurements
KC1, BP3, PR5	5/15, 5/21, 5/28, 6/4,6/12 7/9, 7/16, 7/22, 7/30, 8/13, 8/19, 8/27 9/10, 9/17, 9/23, 10/1	5/17, 5/25, 6/1 7/19, 7/27, 8/3 9/27, 10/4, 10/11	8/27,9/17

3.1.3.2. Water Column Nutrients, Chlorophyll-*a* and Suspended Solids

Whole water samples were collected by CBL at approximately 0.5 meters below the water surface by carefully dipping a sample bottle beneath the water surface. A portion was immediately filtered with a 25 mm, 0.7 µm (GF/F) glass fiber filter. Both the filtered portion and the remaining whole water samples were placed in coolers for transport back to the laboratory for further processing. The filtered portion was analyzed by the Nutrient Analytical Services Laboratory (NASL) for ammonium (NH_4^+), nitrate (NO_2^-), nitrite plus nitrate ($NO_2^- + NO_3^-$) and phosphate (PO_4^{-3}). Whole water portions were filtered in the laboratory using 47 mm, 0.7 µm (GF/F) glass fiber filters and were transferred to NASL for analysis of the following parameters: total suspended solids (TSS), total volatile solids (TVS), and total and active chlorophyll-*a* concentrations, where total chlorophyll-*a* includes chlorophyll-*a* plus breakdown products.

3.1.3.3. Chemical Analysis Methodology

Methods for the determination of dissolved nutrients collected by both CBL and the US Army were as follows: ammonium (NH_4^+), nitrite (NO_2^-), nitrite plus nitrate ($NO_2^- + NO_3^-$), and dissolved inorganic phosphorus (DIP or PO_4^-) were measured using the automated method of EPA (1979). Methods of Strickland and Parsons (1972) and Parsons *et al.* (1984) are followed for chlorophyll-*a* analysis. Total suspended solids (TSS) and total volatile solids (TVS) were measured with a gravimetric method.

3.2. Epiphyte Growth Survey

In 2002 CBL also began an epiphyte study utilizing artificial substrates with complex morphology in addition to studies with the standard Mylar strip design that has been used previously. The use of complex morphology substrates was investigated as a way to better assess epiphyte fouling rates on SAV species found at Blossom Point such as *Myriophyllum spicatum*, and *Hydrilla verticillata*. The details of both methodologies as well as sampling schedules are described below.

3.2.1 Station locations and Sampling Frequency

Epiphyte collection arrays were placed at a single location, on each of three fixed transects (KC1, BP3, PR5) in water averaging 1 m depth at Blossom Point, Maryland (Figure 3-1, Table 3-1). Three week-long epiphyte fouling rate measurements were collected during spring, summer and fall of 2002. Sampling dates are shown in Table 3-2. Data collected with the complex morphology mimics was done in the fall and summer of 2002.

3.2.2 Standard Mylar Strip Epiphyte Measurement Method

In order to assess the light attenuation potential of epiphytic growth on the leaves of submerged aquatic vegetation (SAV) artificial substrata, (thin strips of Mylar® polyester plastic), were deployed at a single location along each transect for a period of 6 to 8 days. The use of transparent Mylar® plastic provided a means to estimate light attenuation due to epiphytic growth and sediment accumulation, as well as to quantify the organic and inorganic components of the fouling.

3.2.2.1 Description of Epiphyte Collector Arrays

Each collector array (Figure 3-2) consisted of a square PVC frame with a vertical PVC shaft in the center of the square. A line was attached to the center shaft with a foam float at the end of the line that allowed for easy location of the collector. Each collector array held up to six strips. Mylar® strips (2.5 cm wide x 51 cm long and 0.7 mil thick) were attached to the frame so that the top was allowed to move freely in the water column. Small foam floats (~3.5 x 3.3 cm) were attached to the top of the strip to help maintain the strip in a vertical position in the water column at all times.

3.2.2.2 Sampling the Standard Mylar® Epiphyte Stips

On each sampling date, six replicate Mylar® strips were collected. Three strips were analyzed for chlorophyll-*a*, and three for total dry mass/inorganic dry mass. While suspended in the water, Mylar® strips were gently removed from the array and cut with scissors to remove the middle 1/3 marked section (64.5 cm^2, Figure 3-2). This section was once again cut in half and placed in a 60 ml plastic centrifuge tube for transport back to the laboratory. The tube was then placed in a cooler for transport back to the laboratory. The samples were immediately frozen upon arrival at the laboratory prior to further processing.

3.2.2.3 Processing the Standard Mylar Epiphyte Strips

The Mylar® strip sections collected for dry mass/inorganic mass analysis were scraped of all material and rinsed with distilled water. Scraped material and rinse water were diluted to a fixed volume (300 - 500 ml). The solution was mixed as thoroughly as possible on a stir plate until homogenized. A small aliquot (10 to 50 ml) was then extracted with a glass pipette and filtered through a 47 mm, 0.7µm (GF/F) glass fiber filter. Once filtered, the pads were immediately frozen and delivered to NASL for analysis. Estimates of chlorophyll-a mass on the strips was done through direct acetone extraction and no scraping was required.

3.2.3 Complex Morphology Epiphyte Measurement Method

In order to more accurately assess the light attenuation potential of epiphytic growth on compound leaved species of submerged aquatic vegetation (SAV), complex morphology mimics were deployed at a single location along each transect for a period of approximately 7 days. Artificial structures made with plastic aquarium *Cobomba* plants were used to simulate the canopy forming SAV found at Blossom point *(Myriophyllum spicatum* and *Hydrilla vericillata)*. The use of this mimic provided a more realistic method to estimate light attenuation due to epiphytic growth and sediment accumulation on complex morphology SAV, as well as to quantify the organic and inorganic components of the fouling.

3.2.3.1 Description of Complex SAV Mimics

Each complex morphology epiphyte collector array (Figure 3-3) consisted of a square PVC frame with a vertical PVC shaft in the center of the square, identical to the arrays used in the Mylar® epiphyte strip collector array. A line was attached to the center shaft with a foam float at the end of the line that allowed for easy location of the collector. While each collector array could hold up to six assembled complex morphology mimics, only four positions were occupied, leaving two positions open for Mylar® epiphyte strips that served as a control during one deployment.

Each complex morphology structure consisted of a 0.50m (+/- 0.03m) length of 1.5mm diameter nylon weed-trimmer line with one 10cm length of artificial *Cobomba* leaf structure at the end of the trimmer line, and one 10cm length of artificial leaf structure at approximately 0.20m from the trimmer line anchor point. A small float was attached to the top end of the trimmer line in order to imitate the canopy forming nature of local SAV such as *Myriophyllum* and *Hydrilla* (Fig 3-3).

3.2.3.2 Sampling the Complex Morphology Mimics

On each sampling date, two replicate complex mimics were collected from each depth (surface and bottom) by gently removing them from the water. From each leaf assemblage three individual frond sections were trimmed, (Fig 3-3) and placed in a 60 ml plastic centrifuge tube for transport back to the laboratory. The tubes were later placed in a cooler for transport back to the laboratory where the samples were immediately frozen prior to further processing.

3.2.3.3 Processing the Complex Morphology Mimics

The complex morphology leaf sections collected for the analysis of both epiphyte dry mass/inorganic mass, and chlorophyll-*a* were placed in a beaker of distilled water with a fixed volume (300-500 ml). They were then agitated using a magnetic stir bar at moderate speed in order to remove epiphyte material. Stirring lasted approximately 30 minutes or until the sample appeared homogenized. A small aliquot (10 to 60 ml) was then extracted with a glass pipette and filtered through a 47 mm, 0.7μm (GF/F) glass fiber filter. Once filtered, the pads were immediately frozen and delivered to the Nutrient and Analytical Services Laboratory at CBL for analysis. Total surface area of the sub-sampled leaf assemblies was calculated from a high-resolution scanned image using a Hewlett-Packard flatbed scanner (color, 300dpi) and Scion® Image Analysis software.

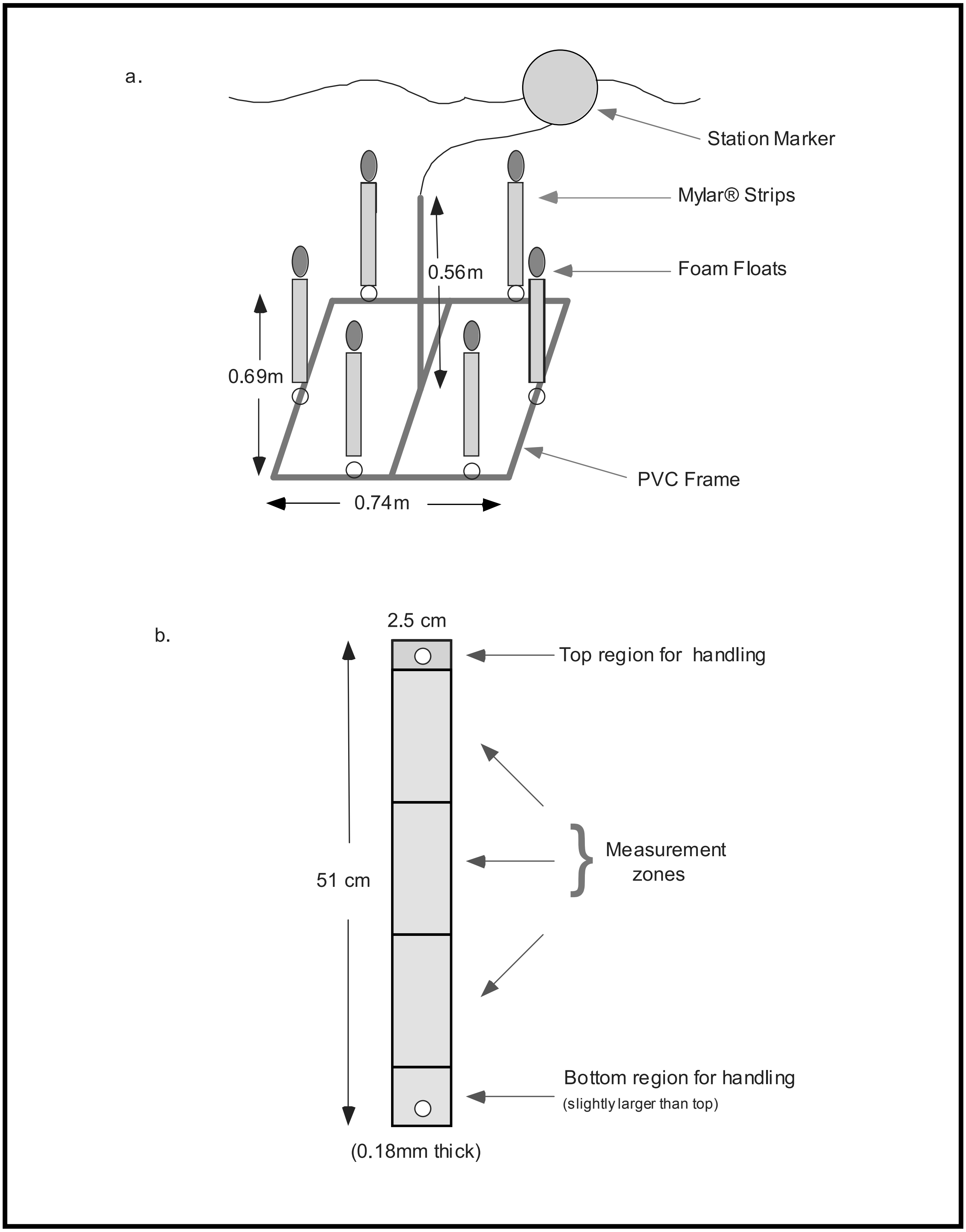


Figure 3-2. a) Diagram of SAV epiphyte collector array, and b) detail of standard Mylar® strip.

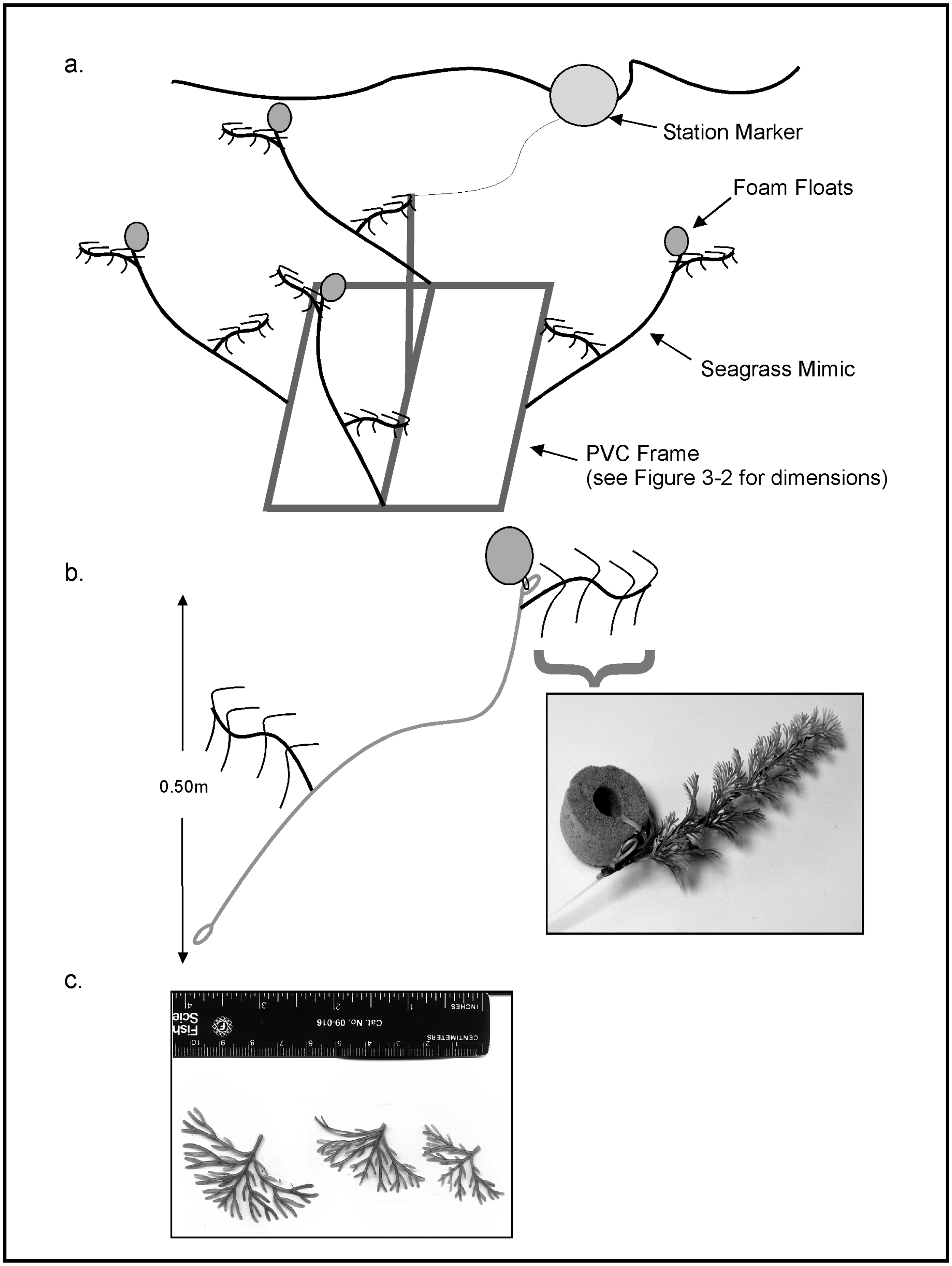


Figure 3-3. a) Diagram of an epiphyte collector array with complex SAV mimics, b) detail of complex morphology mimic (including photo), and c) example of individual frond sections used in the analysis.

3.3 Estimating Epiphyte Light Attenuation

The use of artificial substrates for an assessment of epiphyte fouling rates can provide first order estimates of fouling rates that are much less costly than manipulating live SAV blades. Previous studies comparing epiphyte fouling rates on *Zostera marina* (eelgrass) and *Valisneria american* (wild celery) to Mylar® strips over short deployment intervals (7-10 days) have shown no statistical difference in biomass accumulation (Stankelis *et al.,* 1999). In addition, standardization of these estimates allows more rigorous comparison among other locations and studies.

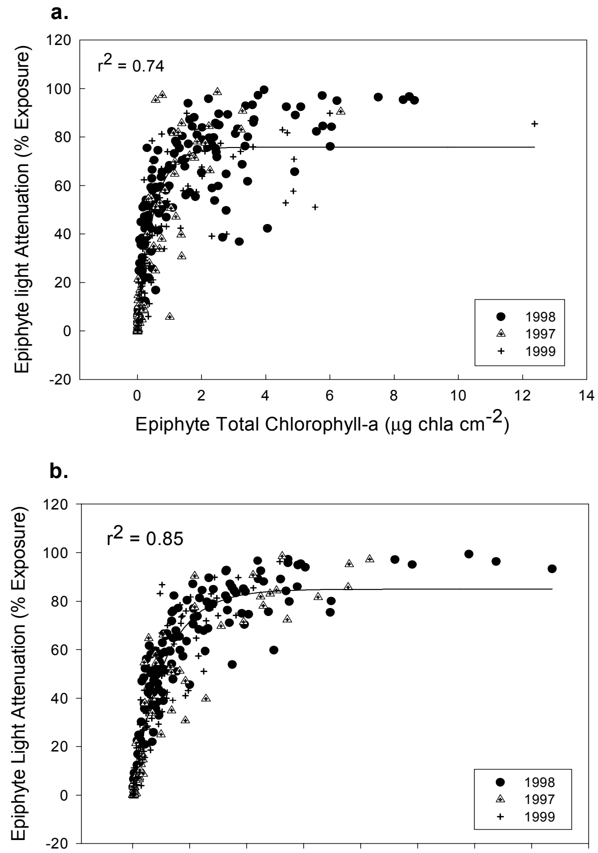


Figure 3-3. a. Epiphyte light attenuation vs. epiphyte chlorophyll-*a*, where light attenuation (LA) = $77.36*(1-e^{-2.082*\text{Epi Chla}})$ and b. epiphyte light attenuation vs. epiphyte dry mass where LA = $84.634*(1-e^{-0.963*\text{Epi drywt}})$.

In this study, epiphyte light attenuation (LA) was not measured directly, but was calculated from existing relationships between epiphyte dry mass and epiphyte light attenuation (Figure 2-3 a, b). These estimates of epiphyte light attenuation were then used to calculate the percentage of surface light reaching the leaf surface or PLL, (Batuik *et al*., 2000). This statistic was used to evaluate compliance with SAV habitat requirements at each location. This required calculation of the percentage of surface light reaching the depth of SAV blade through the water column (PLW), and the percentage of surface light reaching the blade of SAV through the epiphyte layer at the leaf surface (PLL). These parameters are explained in Table 3-3.

Table 3-3. Calculation of percentage of surface light reaching the leaf surface (PLL).

Calculation of % Surface Light Reaching Leaf Surface (PLL)	
$PLW = (I_Z/I_0)*100 = [e^{-kd*Z}]$	Where: Iz = Light flux (PAR) at depth
$PLL = [e^{-kd*Z}][1-LA/100]$	I_0 = Light flux (PAR) at surface LA = Epiphyte light attenuation Z = Observation depth (m)

3.4 Data management procedures

All field data were recorded on specially prepared field data sheets. The initials of the person recording the data were entered on each data sheet. The raw data sheets were reviewed for possible missing data values due to sample collection problems prior to data entry. These sheets were filed in the laboratory.

3.4.1. Incorporation of Error Codes in Data Tables

In order to keep a record of problems experienced during data collection, an alphanumeric code was entered in the data table describing the problem associated with each questionable parameter value (Table 3-4).

3.4.2. Data Tables QA/QC Control

After data were entered into spreadsheet files, hard copies of the files were manually checked for errors against original data sheets. Any errors were corrected, and a second printout produced which was re-verified by a different staff member.

3.4.6. Blossom Point SAV Habitat Evaluation Data Sets

Data file names had a unique alphanumeric code reflecting the type of data and year (yyyy) data were collected.

WATER QUALITY MEASUREMENTS
Filename: **BPWCNDyyyy,** (Appendix A, Table A-1) contains temperature, salinity and dissolved oxygen data measured at 0.5 m below the water surface.

WATER COLUMN NUTRIENT MEASUREMENTS
Filename: **BPWCNTyyyy**, (Appendix A, Table A-2) contains water column dissolved nutrient concentrations, chlorophyll-*a* (active and total) concentrations, and suspended solids concentrations (total and inorganic) collected at 0.5 m below the water surface.

WATER COLUMN LIGHT ATTENUATION MEASUREMENTS
Filename: **BPWCLTyyyy**, (Appendix A, Table A-3) contains photosynthetically active radiation (PAR) measurements at a minimum of two depths and the subsequent calculated Kd values for each station.

EPIPHYTE BIOMASS MEASUREMENTS
Filename: **BPSMEPIyyyy** (Appendix A, Table A-4) contains epiphyte chlorophyll-*a* concentrations (total and active), and total epiphyte dry mass for standard Mylar strip measurements. Filename: **BPCMEPIyyyy** (Appendix A, Table A-5) contains chlorophyll-*a* concentrations (total and active), and total epiphyte dry mass for complex morphology measurements.

Table 3-4. Analysis Problem Codes

ANALYSIS PROBLEM CODE	DESCRIPTION
D	Insufficient sample
N	Sample Lost
P	Lost results
R	Sample contaminated
V	Sample results rejected due to QA/QC criteria
X	Sample not preserved properly
AA	Sample thawed when received
BB	Torn filter paper
DA	Damaged epiphyte array
DS	Damaged epiphyte strip
HH	Sample not taken
JJ	Amount filtered not recorded (Calculation could not be done)
LA	Lost epiphyte array
LL	Mislabeled
NI	Data non-interpretable
NR	No replicate analyzed for epiphyte strip chlorophyll-*a* concentration
SS	Sample contaminated in field
SW	Shallow water, light flux measured at two points only
TT	Instrument failure
UU	Analysis discontinued
XX	Sampling for this variable was not included in the monitoring program at this time or was not monitored during a specific cruise
<	Below detection limit
+	True secchi depth deeper than water column at station.

4.0 RESULTS AND DISCUSSION

4.1. Water Quality

Because of drought conditions in 2002, dissolved nutrient concentrations were lower compared to previous years (Table 4-1). In fact, median concentrations in 2002 were often 4 to 10 times lower than in 2000. As in previous years, water column dissolved nutrient concentrations exhibited seasonal changes in concentration. For example, nitrite plus nitrate ($N0_2^- + N0_3^-$) concentrations dropped dramatically during the spring, while dissolved inorganic phosphorus (DIP) concentrations increased slightly during the fall. These temporal trends are displayed in the asymmetric shape of the box-and-whisker plots for DIN and DIP concentrations at all stations (Fig 4-1, 4-2). While median DIN concentrations at the inshore locations on each transect were lower than the off-shore locations, there were no statistical differences between inshore and off-shore locations (Sign Rank test, $P > 0.05$). Median DIP concentrations were also consistently lower at the in-shore locations compared to the off-shore locations concentrations. No significant differences in median DIP concentrations were found between near-shore and off-shore locations along the PR5 or KC1 transects (Sign Rank test, $P > 0.05$). However, median DIP concentrations were significantly higher at the off-shore BP3 location compared to the near-shore location (Sign rank test $P < 0.05$). Although not statistically tested, DIP concentrations do appear to be substantially higher at all the sites sampled by CBL compared to those sites sampled by the ARMY (Fig 4-1b). We are unsure at this time why this might be the case, but it does not appear to be caused by sampling error.

Median TSS concentrations among all stations were both above (21.8 mg l^{-1} at KC01 off-shore) and below (10.20 mg l^{-1} at KC01 off-shore) the habitat limit established by the USEPA (Batuik et al., 2000) for oligohaline waters (Fig 4-2a). There was a general trend of lower TSS concentrations at all in-shore locations compared to off-shore locations although no statistical differences were found (Sign Rank test, $P > 0.05$). Although TSS concentrations collected by CBL were often higher than values collected by the ARMY, differences in sampling frequency precluded making statistical comparisons between the two groups. Median water column total chlorophyll-a concentrations were at or below the habitat limit (15 μg l^{-1}) established by the USEPA (Batuik et al., 2000; Fig 4-2b). No differences in water column total chlorophyll-a concentrations were found between the near-shore and off-shore stations (Sign Rank test, $P > 0.05$; Fig 4-2b).

Table 4-1. Median water column dissolved nutrient concentrations at Blossom Pt, 2000 to 2002 during the SAV growing season (April – October). Additional data may have been collected earlier or later during each sampling year but was not included in the calculation.

Transect	Distance (m)	DIN (µmol N)			DIP (µmol P)		
		2000	2001	2002	2000	2001	2002
PR05	50-100	38.50	10.50	7.68	1.20	0.80	0.68
	150-200	43.95	18.6	8.31	1.31	1.10	0.67
BP03	100	30.20	13.4	2.90	1.25	0.90	0.34
	300-350	38.05	12.0	8.83	1.38	0.90	0.48
KC01	75-100	21.25	10.80	5.79	0.85	0.80	0.42
	250-300	43.10	8.9	7.21	1.20	0.70	0.53

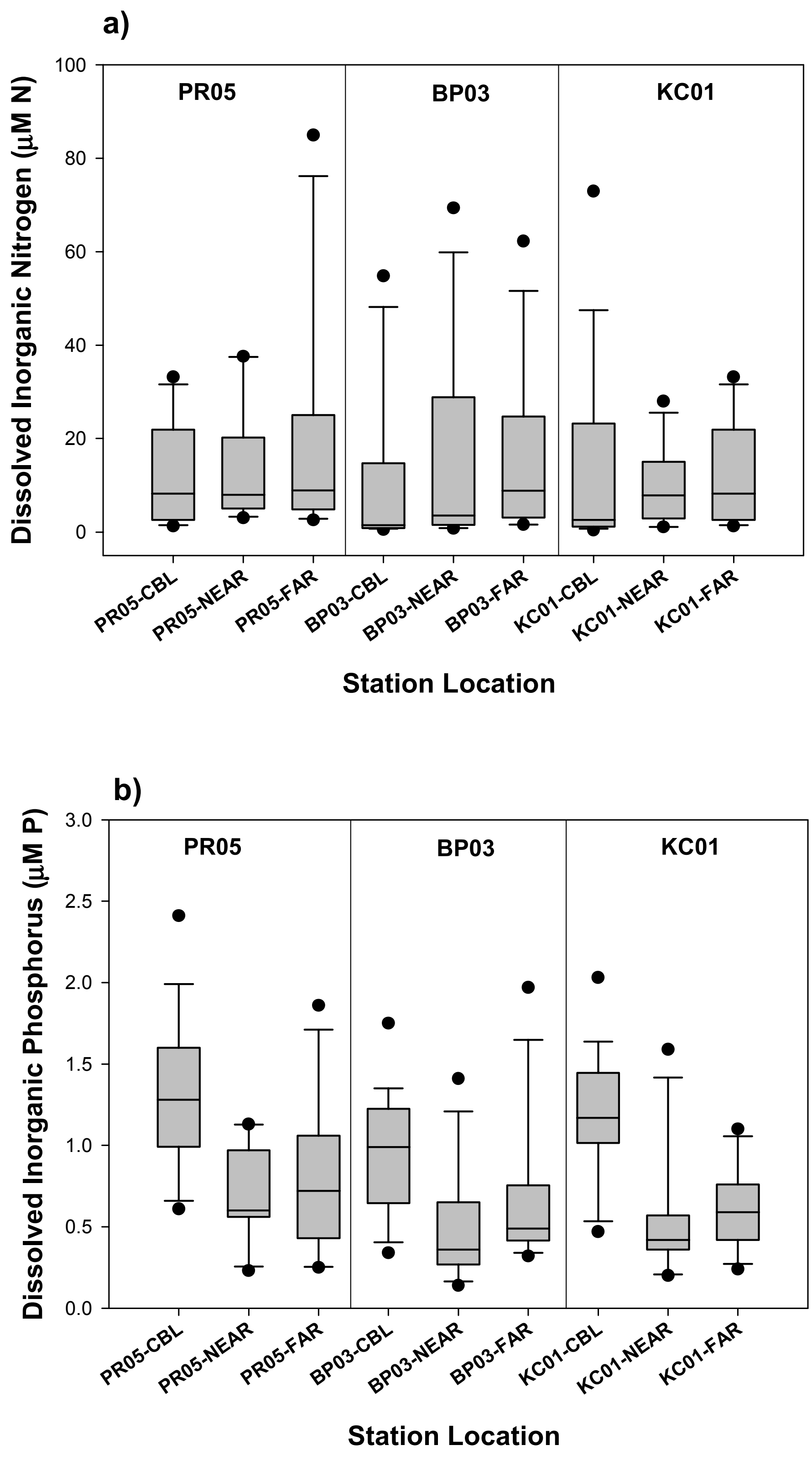
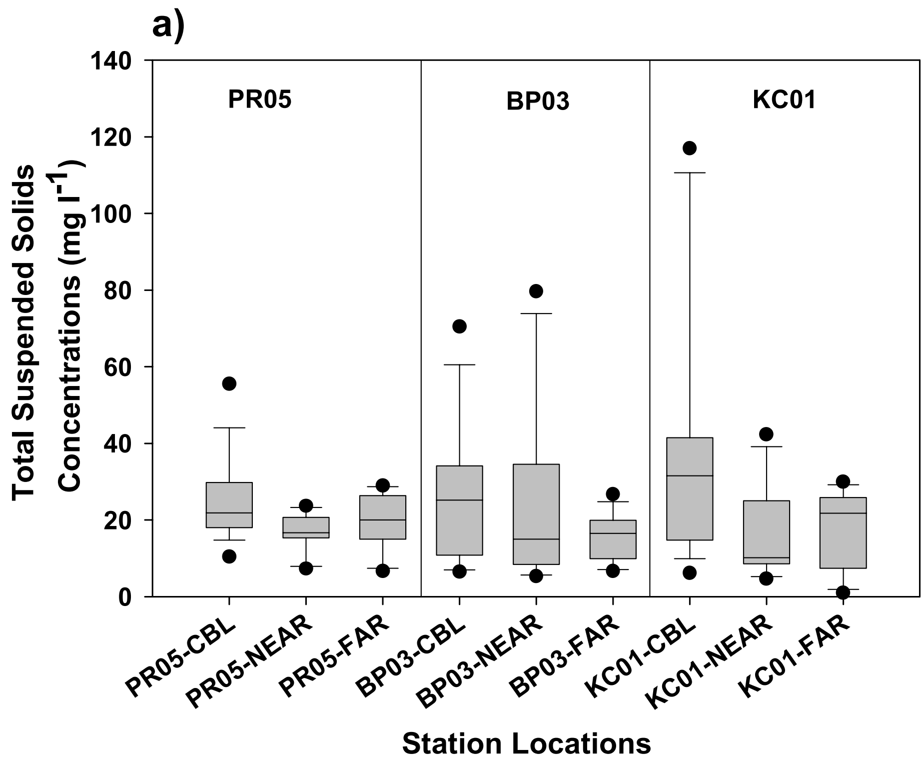


Fig. 4-1. Comparison of CBL collected data, near-shore, and off-shore concentrations of a) dissolved inorganic nitrogen (DIN), and b) dissolved inorganic phosphorus (DIP) at stations PR05, BP03, and KC01 at Blossom Point MD 2002. *Dots represent values beyond 5th and 95th percentiles.*



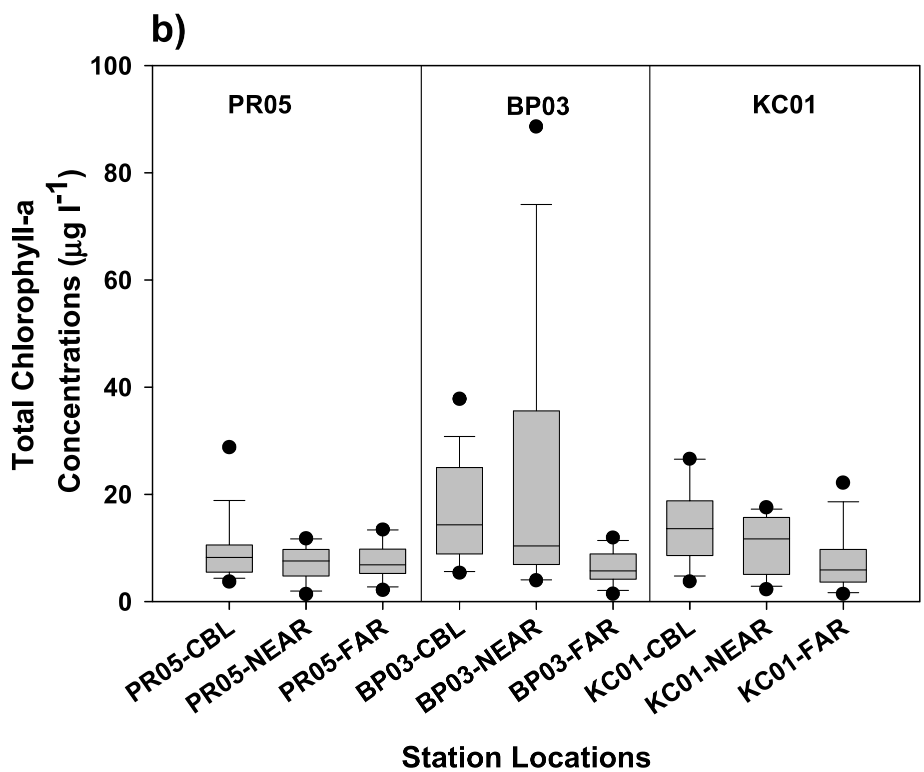


Fig. 4-2. Comparison of CBL collected data, near-shore, and off-shore concentrations of a) total suspended solids (TSS), and b) total chlorophyll-a (Tchla) at stations PR05, BP03, and KC01 at Blossom Point MD 2002. *Dots represent values beyond 5th and 95th percentiles.*

4.2 Epiphyte Fouling Rates

4.2.1 Standard Mylar Strips

In 2002, epiphyte fouling rates (measured on a weekly basis) ranged from essentially 0 mg dry mass cm^{-1} $week^{-1}$, to more than 6.44 mg dry mass cm^{-2} $week^{-1}$ at station PR05 at the end of the spring deployment. The temporal and spatial patterns found among the stations at Blossom Point are fully consistent with patterns observed at other locations around Chesapeake Bay. An analysis of fouling rates and simultaneous water quality conditions using data from multiple years and locations helps to explain some of the temporal and spatial patterns observed at Blossom Pt. A technique called classification and regression tree analysis (CART) was used to partition variation in fouling rates into discrete groups based upon measured water quality and site-specific data. Results of this analysis show that water temperature imposes the primary restraint on epiphyte fouling rates during certain times of the year (Stankelis et al., 2003). Surprisingly, this analysis also indicates that at water temperatures below 21.2 °C, high fouling rates are generally not supported, regardless of nutrient or light availability. As a consequence, most measurements made in early spring were extremely low. For example, the first set of epiphyte rate measurements collected in the spring of 2002 at Blossom Pt. ranged from 0.12 to 1.6 μg chlorophyll-a cm^{-2} $week^{-1}$ when water temperatures were approximately 17 °C (Fig 4-3a). Several weeks later when water temperatures had risen to between 24 °C and 27 °C, epiphyte fouling rates also increased dramatically with values ranging from 2.5 to 21.5 μg chlorophyll-a cm^{-2} $week^{-1}$ (Fig 4-3a). Similar patterns were also observed in previous years at Blossom Pt (Figs 4-3b and 4-3c).

At water temperatures above 25 °C, it appears that a variety of other parameters can be responsible for stimulating or inhibiting high fouling rates. For example, at high DIN concentrations (> 12.7 μM N) high fouling rates (mean = 3.3 μg chla cm^{-2} $week^{-1}$, n=8) can be possible. These extremely high values were found at stations PR05 (Blossom Pt) and SV09 (at the mouth of the Patuxent River). While a number of other locations had moderately high DIN concentrations in this temperature range, other parameters such as light availability (either because of turbid water or short-term weather patterns) limited the rate at which epiphytes accumulated. However, the recognition that extreme fouling rates are possible at moderately low temperatures given high nutrient concentrations could have important consequences for SAV growth or recovery even if high fouling rates are not sustained over the entire SAV growing season. Moore *et al*., (1997) found relatively short pulses of highly turbid water could negatively impact SAV populations. Similarly, even short intervals with extremely high fouling rates stimulated by temporarily high nutrient concentrations could depress light availability to the leaf surface sufficiently to impair SAV growth or survival. Further analysis of SAV biomass and fouling rates over time at Blossom Point may shed light on this interaction.

Another recurring pattern at Blossom Point was consistently higher epiphyte fouling rates at station PR05 compared to stations BP03 and KC01. With few exceptions, this pattern was found among all seasons and years (Fig 4-3). While there are several possible reasons for this difference, the most probable is a consequence of differences in SAV species composition and biomass among these sites. Station PR05 had the overall lowest SAV biomass and was dominated by the meadow forming *Valisneria americana*, while the other stations were dominated by the canopy forming species *Myriaphyllum spicatum* and *Hydrilla verticulata*. The canopy forming species were able to restrict water flow and shade the epiphyte collectors to a much greater degree compared to the much less dense *V. americana*. This is especially true during the summer and fall sampling periods when SAV biomass was at its maximum. In addition, the rectangular Mylar strips were originally designed to broadly mimic SAV species with similar morphologies such as *V. Americana*; not species with complex morphology such as *M. spicatum,* or *H. verticulata.* Thus using Mylar strips to estimate epiphtye fouling rates on these canopy forming species may underestimate the light attenuation potential of epiphytes at these locations. For that reason, we began the complex morphology study. Results of these experiments are discussed in section 4.2.2. Figure 4-5 shows that fouling rates at station PR05 were among the highest observed in all seasons among those sites monitored in 2002. While this is noteworthy, station PR05 was the only oligohaline location among those stations monitored.

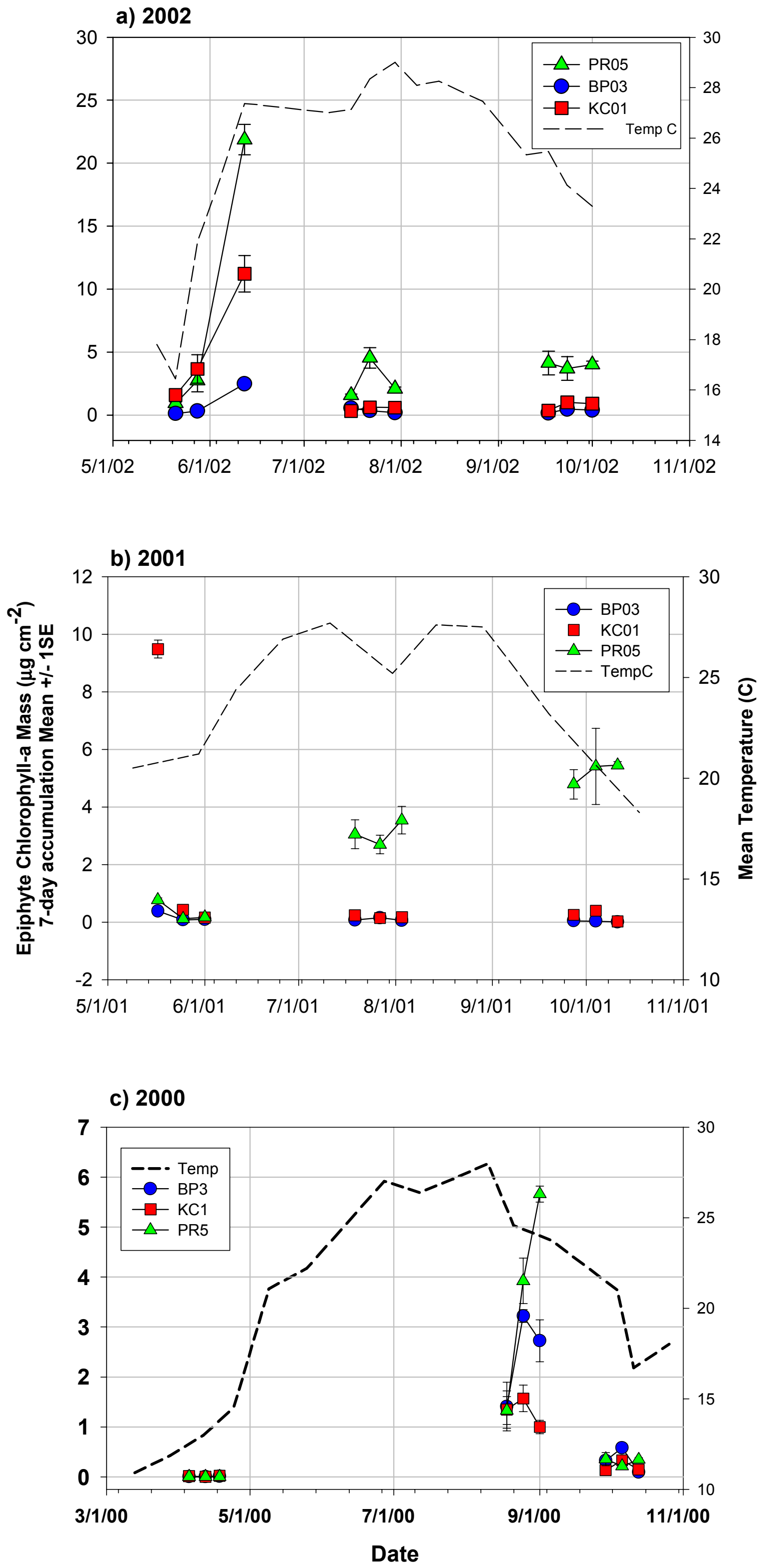


Fig 4-3. Epiphyte total chlorophyll-a mass accumulation rates and water temperature in a) 2002, b) 2001 and c) 2000 at stations PR05, BP03, and KC01 at Blossom Pt. Md.

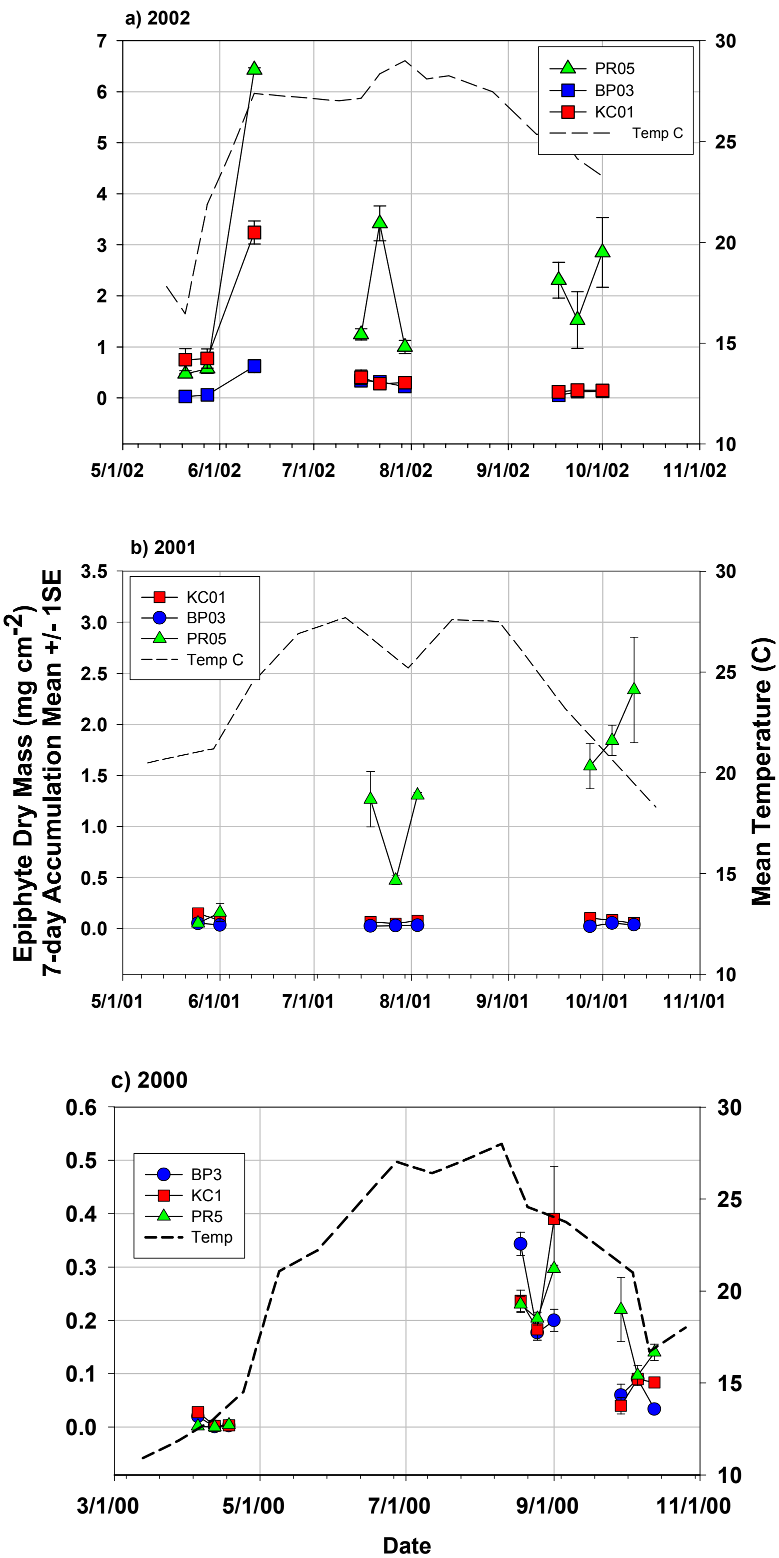


Fig 4-4. Epiphyte dry mass accumulation rates and water temperature in a) 2002 and b) 2001 at stations PR05, BP03, and KC01 at Blossom Pt. Md.

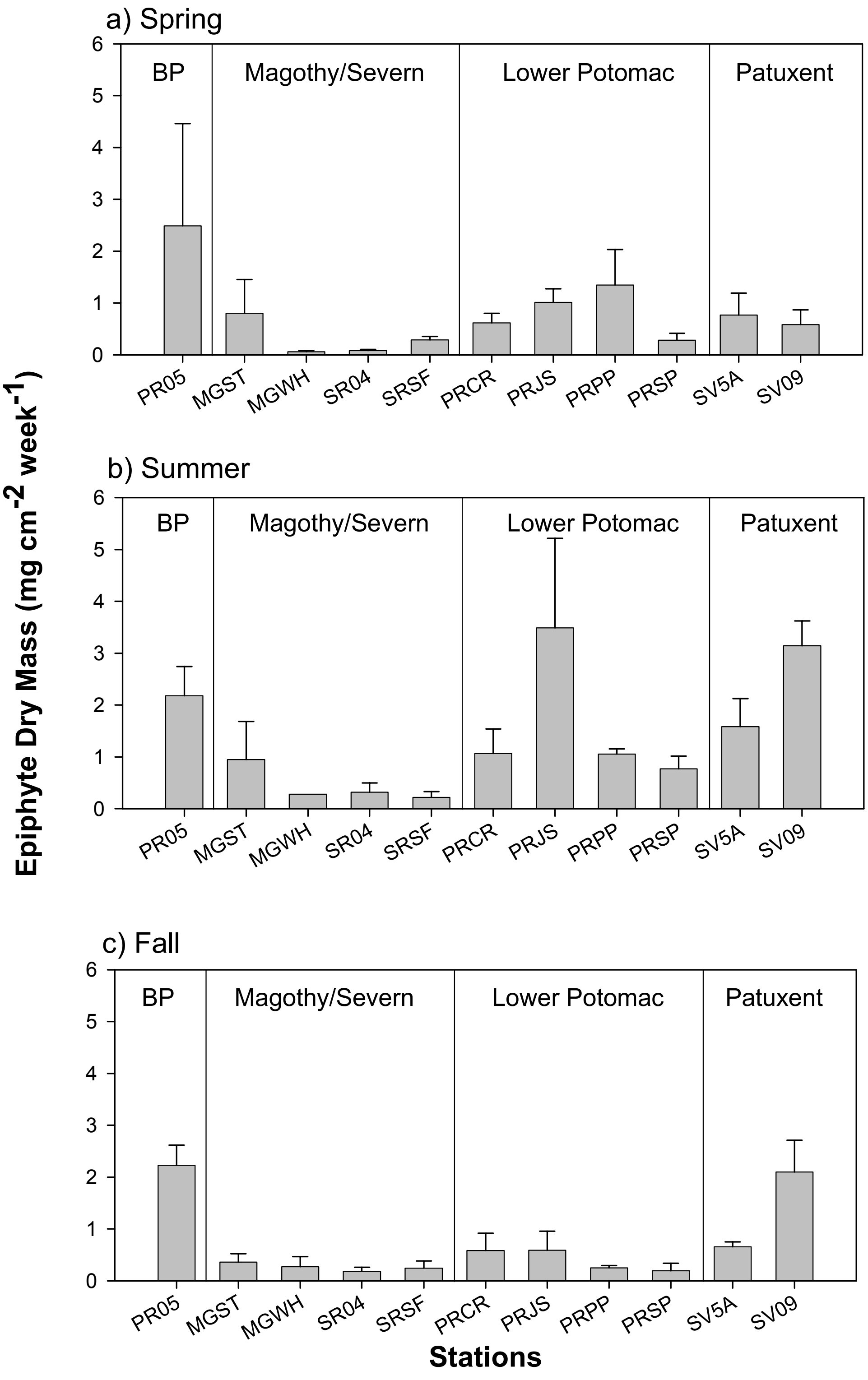


Fig 4-5. Epiphyte dry mass accumulation rates at various monitoring stations in Chesapeake Bay in a) spring, b) summer, and c) fall of 2002.

4.2.2 Complex Morphology Results

In several ways this pilot study provided a solid foundation for further study of complex morphology SAV mimics. Techniques were developed and refined, easier and more efficient. Because of technical difficulties, the dataset was not robust enough for rigorous statistical analysis; however, data provided strong evidence of spatial pattern in epiphyte fouling rates on SAV with complex morphology. Based upon this data, two questions were asked: is there a difference in accumulation rates between standard Mylar® strips and complex morphology mimics, and what is the influence of depth on accumulation rates of epiphyte material on complex morphology arrays.

4.2.2.1 Variation in Accumulation Rates Between Standard Mylar® Strips and Complex Morphology Arrays

Comparisons of both epiphyte dry mass, and epiphyte chlorophyll-a accumulation rates between standard Mylar® strips and complex morphology mimics for all stations are shown in Fig 4-7. These accumulation rates represent mean values for data collected on two separate deployments (September 17 and August 27, 2002). Overall, the magnitude of the epiphyte fouling rates, as well as the difference between the collection substrate (complex mimic vs. standard strip) varied among stations. Further these patterns differed with the parameter measured (dry mass vs. chlorophyll-a).

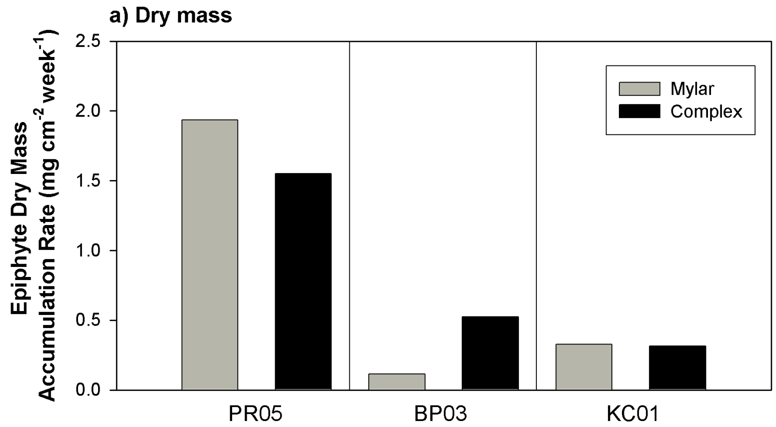
As with previous comparisons, both epiphyte dry mass and chlorophyll-a accumulation rates were greater at station PR05 compared to either of the other stations. This difference was true for both standard Mylar® strips as well as complex mimics. At station PR05, epiphyte accumulation rates were higher on the standard Mylar® strips compared to the complex mimics for both epiphyte dry mass (1.9367 mg cm^{-2} $week^{-1}$ vs. 1.5514 mg cm^{-2} $week^{-1}$) as well as chlorophyll-a (4.0327 µg cm^{-2} $week^{-1}$ vs. 1.5870 µg cm^{-2} $week^{-1}$). However, the difference was much greater for chlorophyll-a fouling rates (Fig 4-6). In contrast, observed accumulation rates at station BP03, were higher for the complex morphology arrays in both dry mass (0.5221 mg cm^{-2} $week^{-1}$ vs. 0.1134 mg cm^{-2} $week^{-1}$) and chlorophyll-*a* (0.6212 µg cm^{-2} $week^{-1}$ vs. 0.2159 µg cm^{-2} $week^{-1}$). In addition, the difference between the standard strips and the complex mimics was greater for epiphyte dry mass compared to chlorophyll-a (Fig 4-6). At station KC01, epiphyte accumulation rates were higher for the standard Mylar strips compared to the complex mimics for both epiphyte chlorophyll-a (0.6838 µg cm^{-2} $week^{-1}$ vs. 0.4153 µg cm^{-2} $week^{-1}$) as well as dry mass accumulation (0.3249 mg cm^{-2} $week^{-1}$ vs. 0.3139 mg cm^{-2} $week^{-1}$). The pattern found here was similar to that found at station PR05 with the greatest difference between the complex mimics and the standard strips being found with epiphyte chlorophyll-a compared to dry mass (Fig 4-6).

4.2.2.2 Variation of Complex Morphology Chlorophyll-*a* Accumulation Rates Between Sample Depths

Some variations in weekly accumulation rates were observed between sample depths during the two complex morphology array deployments. The data presented in figure 4-7 illustrate the difference in weekly chlorophyll-*a* accumulation rates between upper (0.5m from sediment) and lower (0.2m from sediment) components of the complex morphology array. A positive number indicates a greater accumulation on the top component, while a negative number represents a greater accumulation on the bottom component. Higher accumulation rates on the top component for both deployments were observed at PR05. This was a high-energy site, characterized by wind driven mixing and generally turbid waters. The Nanjemoy Creek sites, BP03 and KC01, exhibited some variability in observed accumulation rates between the top and bottom components. Fouling rates were generally somewhat higher on the bottom components of the complex morphology mimics at these sites. A high density of *Myriophyllum spicatum* was present at station BP03 but was moderately dense at station KC01.

4.3 Epiphyte Light Attenuation

Because of very little epiphyte accumulation at stations KC1 and BP3 during the summer and fall seasons, as well as difficulty obtaining accurate measurements of water column light attenuation, calculations of percent light at the leaf surface (PLL-with epiphytes) were not made for those stations. However, adequate measurements were made at station PR5 to calculate percent light through the water (PLW- without epiphytes) as well as PLL. During each season, values for these statistics at PR5 fell within the variation observed among other mesohaline stations (Fig 4-8). The additional light attenuation resulting from epiphyte accumulation was smallest during the spring season and greatest during the fall. During the spring deployment, epiphytes made a moderate contribution to light attenuation despite a short period of extremely high fouling rates. On average, after a week of accumulation, epiphytes reduced the available light at the leaf surface to 14% of surface irradiance down from 27% reaching that depth. During the summer deployment, epiphytes reduced light at the leaf surface to 11% of surface irradiance down from 27% reaching that depth. During the fall deployment, light available to the leaf surface was reduced to 10% of surface irradiance after a week of epiphyte accumulation compared to 39% surface light reaching that depth. While epiphyte accumulation at station PR5 had the potential to significantly reduce the amount of light reaching the blade surface, these estimates do not take into account the age of SAV blades at these locations or the blade turnover rate. As a consequence, whole shoots comprised of both older and younger blades will experience differences in light availability. The PLL values calculated indicate that over the SAV growing season, light available to the leaf surface is at least greater than the minimum 9% recommended for healthy SAV populations. Clearly, the persistence of SAV at this location suggests that light availability is adequate to sustain a SAV population.



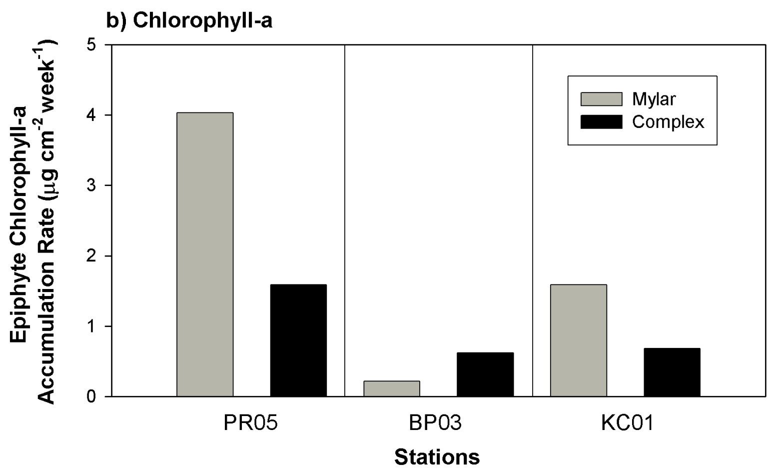


Figure 4-6. Variation in epiphyte accumulation rates between standard Mylar® Strips and complex morphology arrays for a) epiphyte dry mass, and b) epiphyte chlorophyll-a.

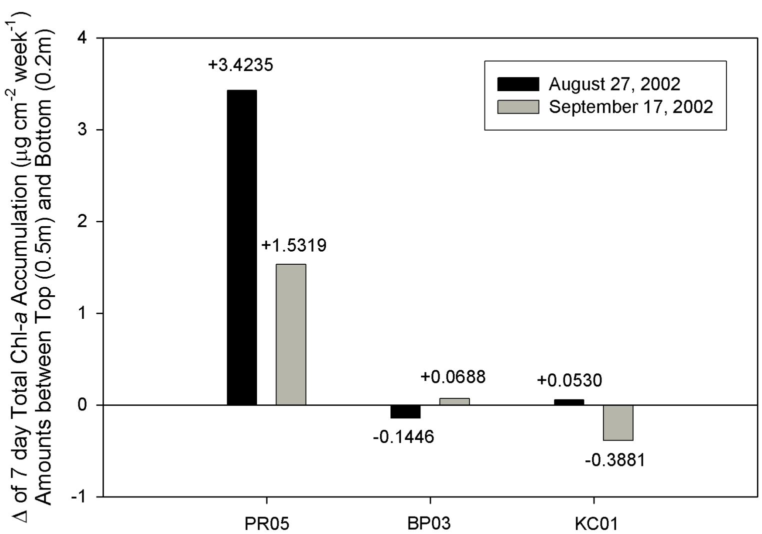


Figure 4-7 Complex morphology array top (0.5m) and bottom (0.2m) comparison for August and September deployments.

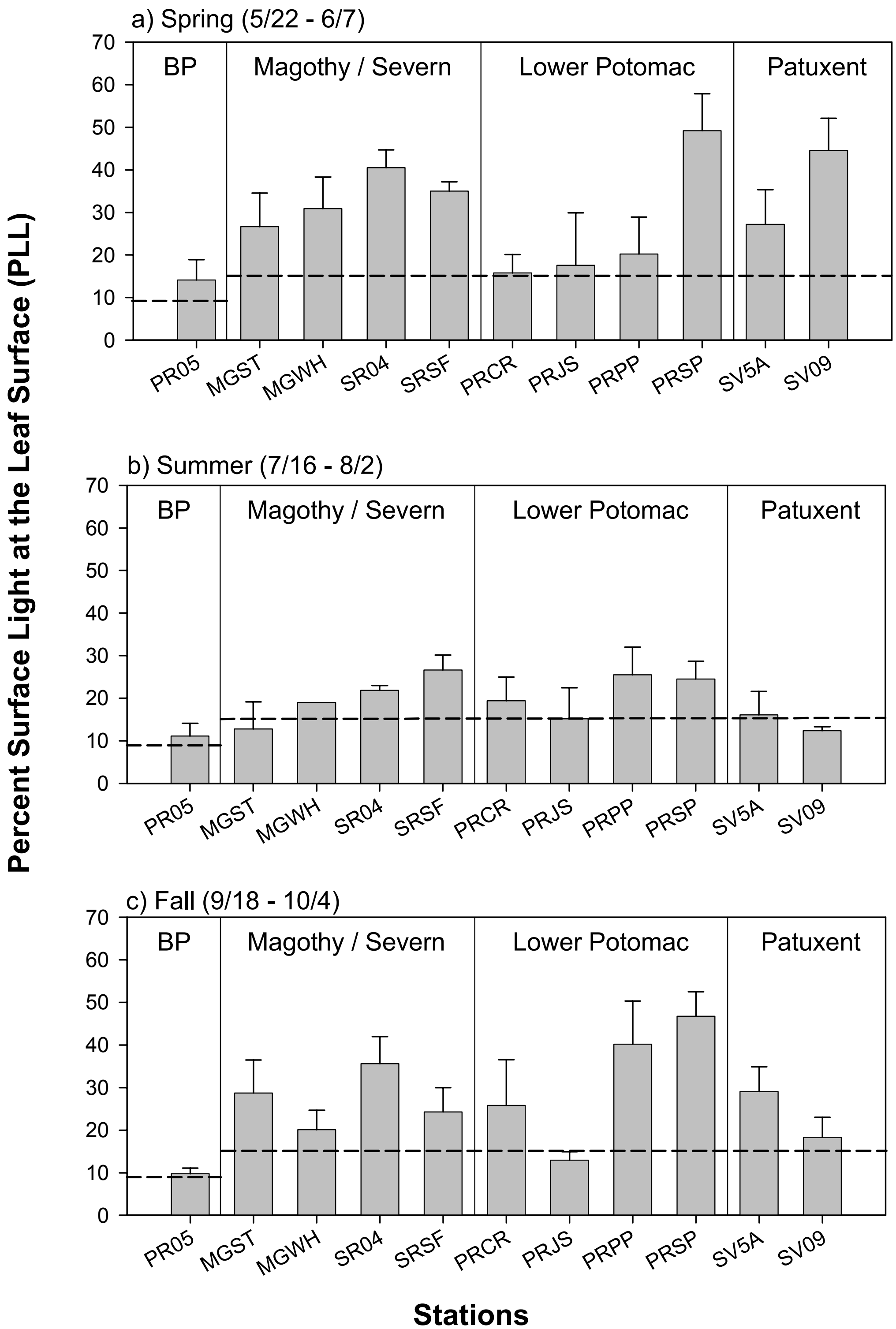


Fig. 4-8. A comparison of PLL among several stations in Chesapeake Bay in a) spring, b) summer, and c) fall. *Dashed lines indicate USEPA SAV habitat criteria (Batuik et al., 2000).*

5.0 Conclusions

Mylar® strips have been used to assess epiphytic fouling rates at Blossom Point, as well as other monitoring locations around Chesapeake Bay, during the last few years. The standardization of methods employed, while having some disadvantages, provide a powerful tool for comparison of fouling rates among seasons and locations. Monitoring during 2000, 2001, and 2002 at Blossom Point has provided the necessary data for a thorough assessment of epiphytic fouling rates at this location and provides the background to assess possible changes in SAV due to the construction of off-shore breakwaters and shoreline riprap.

Several meaningful and recurring patterns have been identified during the last few years of monitoring at Blossom Point. First, epiphyte fouling rates vary substantially among locations at Blossom Point. The highest rates were typically found at station PR05 compared to BP03, or KC01. The presence of dense beds of canopy forming species at stations BP03 and KC01 are the likely cause of the reduced fouling rates at these locations. Numerous studies have shown that dense SAV beds are capable of modifying their own local environments by significantly reducing sediment re-suspension and nutrient transport to the interiors of the bed (Bartelson, R.D., 1988). While fouling rates at station PR05 have remained the highest of the stations monitored, light availability at the leaf surface has generally remained above the established 9% PLL habitat limit established by the USEPA (Batuik, et al., 2000). For example, in 2002, seasonally averaged PLL values ranged from 14% in the spring to 10% in the fall. The persistence of SAV at this location support the assessment made using standard Mylar strips for epiphyte measurements. In 2002 epiphyte measurements using complex morphology mimics indicated that lower fouling rates typically found at stations BP03 and KC01 were not substantially different from measurements made with the standard Mylar® strips (Fig 4-7). This indicates that fouling rates at these locations are likely the result of local water quality modifications resulting from the SAV itself and not an artifact of the measurement method. Currently, epiphyte fouling rates at these locations are clearly not impacting the health and survival of SAV to any great degree.

However, a second insight made at Blossom Point was that epiphyte fouling rates can be extremely responsive to relatively small changes in their local environment. Evidence of this can often be found in the dramatic week-to-week variation seen in epiphyte fouling rates (Fig 4-3). The magnitude of epiphyte fouling depends on a number of factors that may limit or control the accumulation of biomass on the leaves of SAV or artificial substrates. These include, but are not limited to: temperature, light and nutrient availability as well as mechanical abrasion. Small differences in any of these factors may work synergistically to amplify epiphyte fouling at any one time leading to high variability at a single location within a single season. Excellent examples of this were the extremely high fouling found at station KC1 during the first deployment of 2001 (when SAV was not yet dense), and the high fouling rates found at station PR05 during the spring of 2002 (Fig 4-3). Conversely, very low fouling rates have been found at locations where high fouling is the norm. Short-term wind and weather events that can dramatically modify these shallow water environments by reducing light availability, and increasing shear and abrasion on the epiphytes. Results of mesocosm studies have also confirmed the importance of flow-related nutrient transport to epiphyte growth (Thomas and Cornelisen, 2000; Stankelis *et.al.*, 2003). Because water flow rates can be dramatically altered by off-shore breakwaters and shoreline riprap, these structures have the potential to alter the growth of epiphytic material and ultimately impact the health and survival of SAV at these locations. Currently, epiphyte fouling rates are not sufficiently high to cause full mortality of SAV at Blossom Pt, but it may play an important role in the dynamics of the SAV bed due to sub-lethal stresses on the plants. Changes in the flow regime may consequently alter the dynamics and distribution of SAV at this location.

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Sources of Unpublished Materials

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APPENDIX A

DATA FILES FOR:

An Assessment of SAV Epiphyte Loading and Local Water Quality Conditions at Blossom Point, Maryland 2002

Page No.

Table A-1 **Water Column Physical Conditions**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: **BPWCND2002** + symbol denotes a secchi depth
Revised through 11/08/2002 pws greater than water column depth

Station	Date	Station Depth (m)	Secchi Depth (m)	Temp (C)	COND (mS)	SAL (ppt)	DO (mg l^{-1})	% SAT (%)
BP03	5/15/02	6.00	YY	17.21	4.57	2.91	13.36	141.10
BP03	5/21/02	1.00	YY	15.34	6.34	4.33	10.30	105.70
BP03	5/28/02	0.90	YY	21.47	6.94	4.11	8.93	103.60
BP03	6/4/02	1.40	YY	24.56	7.20	4.06	8.41	103.40
BP03	6/12/02	0.70	0.50	26.65	10.26	5.58	8.97	115.90
BP03	7/9/02	0.60	0.20	26.85	13.42	7.43	8.39	109.80
BP03	7/16/02	1.00	0.50	27.03	15.00	8.35	9.82	129.40
BP03	7/22/02	0.80	0.8 +	28.10	15.81	8.61	8.52	114.60
BP03	7/30/02	1.20	0.50	29.19	15.35	8.18	8.80	120.20
BP03	8/6/02	0.60	YY	28.05	14.65	7.96	7.36	98.60
BP03	8/13/02	1.10	0.60	28.01	16.10	8.82	7.70	104.10
BP03	8/19/02	0.70	0.7 +	YY	YY	YY	YY	YY
BP03	8/27/02	0.90	0.9 +	27.19	17.02	9.97	7.15	98.70
BP03	9/10/02	1.00	0.75	25.22	16.51	9.67	6.02	78.10
BP03	9/17/02	0.90	0.9 +	25.42	16.77	9.76	10.66	137.20
BP03	9/23/02	0.85	0.70	23.91	18.14	10.98	8.28	104.60
BP03	10/1/02	1.10	0.80	23.18	15.21	9.21	9.77	120.70
KC01	5/15/02	0.40	0.20	18.25	3.78	2.33	9.18	99.30
KC01	5/21/02	1.00	0.20	16.25	6.53	4.37	9.54	100.10
KC01	5/28/02	0.70	YY	22.76	8.38	4.90	7.03	84.40
KC01	6/4/02	1.20	YY	24.90	7.46	4.12	8.00	99.90
KC01	6/12/02	0.70	0.50	28.50	10.60	5.57	9.14	121.60
KC01	7/9/02	0.60	0.40	27.40	12.94	7.07	8.74	115.10
KC01	7/16/02	0.90	0.50	27.65	14.95	8.21	9.19	122.30
KC01	7/22/02	0.75	0.60	28.09	15.51	8.46	6.95	9.32
KC01	7/30/02	1.00	0.70	29.62	15.25	8.06	9.00	123.40
KC01	8/6/02	0.70	YY	28.14	14.50	7.89	7.39	99.90
KC01	8/13/02	0.90	0.80	28.79	16.62	9.00	8.01	110.90
KC01	8/19/02	0.60	0.6 +	YY	YY	YY	YY	YY
KC01	8/27/02	0.85	0.85 +	27.58	16.98	9.95	7.59	101.70
KC01	9/10/02	0.85	0.85 +	25.70	16.97	9.96	7.30	95.00
KC01	9/17/02	0.90	0.9 +	26.24	16.96	9.68	11.77	153.20
KC01	9/23/02	0.70	0.50	24.07	17.42	10.47	9.64	122.20
KC01	10/1/02	1.00	1.0 +	23.50	15.40	9.26	11.03	137.40
PR05	5/15/02	0.50	0.20	17.96	3.37	2.07	8.55	91.30
PR05	5/21/02	0.90	0.50	17.76	6.62	4.27	7.11	76.70
PR05	5/28/02	0.90	0.50	21.39	7.09	4.22	6.77	78.50
PR05	6/4/02	1.20	0.40	23.42	6.95	3.93	7.11	87.90
PR05	6/12/02	7.00	0.50	26.97	10.56	5.72	7.32	95.00
PR05	7/9/02	0.60	0.60	26.78	12.94	7.15	8.13	105.90
PR05	7/16/02	1.10	0.60	26.74	13.73	7.64	9.59	124.90
PR05	7/22/02	0.90	0.70	28.84	15.72	8.45	8.10	110.20
PR05	7/30/02	1.00	0.70	28.20	14.57	7.89	6.88	92.10
PR05	8/13/02	1.10	0.70	27.96	15.54	8.51	6.98	93.60
PR05	8/19/02	0.65	0.60	YY	YY	YY	YY	YY
PR05	8/27/02	1.00	0.90	27.60	16.56	9.68	5.83	78.20
PR05	9/10/02	1.00	0.50	25.10	16.88	9.90	6.53	83.90
PR05	9/17/02	0.80	0.8 +	24.73	16.86	9.96	7.29	93.50
PR05	9/23/02	0.85	0.60	24.40	17.72	105.80	6.49	82.50
PR05	10/1/02	1.10	0.60	23.16	15.48	9.39	7.04	87.00

Table A-2 **Water Column Dissolved Nutrient Concentrations**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: BPWCNT2002
Revised: 1/29/03

Station	Collection Agency	DATE	NH4 (umol l^{-1})	NO2 (umol l^{-1})	NO2+NO3 (umol l^{-1})	DIP (umol l^{-1})	CHLA-T (μg l^{-1})	PHAEO (μg l^{-1})	CHLA-A (μg l^{-1})	TSS (mg l^{-1})	TVS (mg l^{-1})
BP03	CBL	5/15/02	1.50	1.50	45.00	0.61	22.23	5.89	19.30	28.00	7.50
BP03	CBL	5/21/02	0.79	0.79	34.00	0.42	27.82	11.10	22.30	57.60	6.80
BP03	CBL	5/28/02	3.50	3.50	51.30	0.92	7.01	2.98	5.52	19.00	2.71
BP03	CBL	6/4/02	1.36	1.36	21.70	1.75	37.78	6.88	34.37	33.40	6.20
BP03	CBL	6/12/02	1.29	1.29	5.09	0.34	26.60	9.96	21.67	58.00	7.20
BP03	CBL	7/9/02	0.81	0.81	0.18	1.00	NI	NI	NI	34.80	18.40
BP03	CBL	7/16/02	0.52	0.52	0.21	0.67	25.26	4.90	22.82	25.20	6.00
BP03	CBL	7/22/02	1.10	1.10	0.25	0.62	8.59	2.77	7.21	8.70	2.00
BP03	CBL	7/30/02	0.76	0.76	0.18	0.67	17.14	4.93	14.70	27.40	4.80
BP03	CBL	8/6/02	1.14	1.14	0.67	0.99	24.31	9.73	19.47	70.50	12.00
BP03	CBL	8/13/02	1.79	1.79	2.77	1.25	9.97	2.64	8.66	19.60	4.40
BP03	CBL	8/19/02	0.64	0.64	0.19	1.03	9.75	4.14	7.70	16.80	3.60
BP03	CBL	8/27/02	0.36	0.36	1.12	1.21	14.79	4.72	12.44	13.00	3.40
BP03	CBL	9/10/02	0.64	0.64	1.31	1.04	5.34	2.84	3.92	6.50	1.60
BP03	CBL	9/17/02	0.37	0.37	0.55	1.25	11.60	3.37	9.92	7.60	3.20
BP03	CBL	9/23/02	0.29	0.29	0.20	1.24	13.83	6.81	10.44	29.80	4.20
BP03	CBL	10/1/02	0.61	0.61	0.21	0.79	5.68	2.37	4.50	7.10	1.40
BP03-100	US ARMY	5/9/02	2.00	2.00	32.00	0.33	6.92	2.39	5.73	6.33	2.67
BP03-100	US ARMY	5/24/02	4.21	4.21	33.40	0.38	36.65	17.39	28.03	79.67	9.67
BP03-100	US ARMY	6/13/02	2.00	2.00	0.82	0.14	40.30	17.14	31.80	27.67	8.33
BP03-100	US ARMY	6/26/02	2.00	2.00	2.16	0.29	10.40	6.93	6.97	35.00	5.67
BP03-100	US ARMY	7/12/02	0.50	0.50	0.29	0.26	14.17	4.03	12.18	20.33	4.33
BP03-100	US ARMY	8/9/02	1.00	1.00	0.31	0.34	10.39	2.07	9.36	33.33	5.67
BP03-100	US ARMY	8/22/02	0.79	0.79	2.11	1.41	6.92	3.20	5.33	8.67	3.33
BP03-100	US ARMY	9/5/02	0.62	0.62	0.42	0.22	8.56	3.42	6.86	8.33	4.00
BP03-100	US ARMY	9/30/02	1.51	0.02	3.07	0.47	3.92	1.61	3.12	5.3	3.0

Table A-2 **Water Column Dissolved Nutrient Concentrations**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: BPWCNT2002
Revised: 1/29/03

Station	Collection Agency	DATE	NH4 (umol l^{-1})	NO2 (umol l^{-1})	NO2+NO3 (umol l^{-1})	DIP (umol l^{-1})	CHLA-T (μg l^{-1})	PHAEO (μg l^{-1})	CHLA-A (μg l^{-1})	TSS (mg l^{-1})	TVS (mg l^{-1})
BP03-100	US ARMY	10/9/02	1.08	0.53	1.22	0.71	32.25	6.87	28.83	8.70	7.0
BP03-100	US ARMY	10/28/02	2.15	2.24	11.20	0.44	88.60	16.78	80.25	60.30	11.3
BP03-100	US ARMY	11/26/02	2.65	0.76	66.70	0.74	4.19	2.10	3.14	9.70	3.3
BP03-300	US ARMY	8/9/02	0.79	0.79	0.82	0.46	7.51	1.49	6.77	14.67	4.00
BP03-350	US ARMY	5/9/02	2.64	2.64	24.10	0.41	4.67	2.12	3.62	19.67	3.67
BP03-350	US ARMY	5/24/02	2.14	2.14	24.40	0.44	7.39	2.36	6.22	8.33	2.67
BP03-350	US ARMY	6/13/02	1.57	1.57	9.16	0.39	9.30	3.49	7.57	18.00	4.67
BP03-350	US ARMY	6/26/02	1.86	1.86	3.97	0.32	5.76	2.25	4.65	15.00	3.33
BP03-350	US ARMY	7/12/02	0.57	0.57	2.54	0.52	3.60	1.30	2.95	8.00	3.00
BP03-350	US ARMY	8/22/02	0.50	0.50	1.16	0.77	11.90	3.48	10.16	14.67	4.00
BP03-350	US ARMY	9/5/02	1.37	1.37	1.75	0.43	10.10	3.59	8.32	20.00	5.00
BP03-350	US ARMY	9/30/02	1.22	2.11	6.29	0.55	3.99	1.17	3.40	6.7	3.3
BP03-350	US ARMY	10/9/02	1.00	5.79	18.30	1.97	5.71	2.30	4.56	20.30	5.7
BP03-350	US ARMY	10/28/02	1.22	1.36	8.94	0.71	4.62	1.13	4.06	26.70	5.0
BP03-350	US ARMY	11/26/02	6.67	0.61	55.60	0.90	1.43	0.89	0.99	18.00	3.7
KC01	CBL	5/15/02	9.21	9.21	63.70	1.37	19.23	12.28	13.11	117.00	13.50
KC01	CBL	5/21/02	1.50	1.50	39.60	1.17	18.33	6.77	14.96	44.00	5.50
KC01	CBL	5/28/02	1.36	1.36	31.00	0.47	24.35	5.37	21.67	31.57	5.14
KC01	CBL	6/4/02	1.00	1.00	31.40	0.90	17.06	4.02	15.07	38.00	5.20
KC01	CBL	6/12/02	0.50	0.50	13.60	0.55	17.83	5.62	15.04	26.40	4.80
KC01	CBL	7/9/02	1.92	1.92	1.43	1.13	14.32	6.19	11.25	39.00	12.40
KC01	CBL	7/16/02	0.74	0.74	0.20	1.17	12.74	5.05	10.24	38.80	6.00
KC01	CBL	7/22/02	0.61	0.61	1.97	1.14	13.62	4.71	11.29	27.40	4.60
KC01	CBL	7/30/02	0.25	0.25	0.17	0.81	13.12	5.49	10.40	35.60	5.60
KC01	CBL	8/6/02	1.43	1.43	0.25	1.47	26.51	15.71	18.69	109.00	14.50
KC01	CBL	8/13/02	1.50	1.50	0.70	1.36	3.72	1.23	3.10	12.00	3.40

Table A-2 **Water Column Dissolved Nutrient Concentrations**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: BPWCNT2002
Revised: 1/29/03

Station	Collection Agency	DATE	NH4 (umol l^{-1})	NO2 (umol l^{-1})	NO2+NO3 (umol l^{-1})	DIP (umol l^{-1})	CHLA-T (μg l^{-1})	PHAEO (μg l^{-1})	CHLA-A (μg l^{-1})	TSS (mg l^{-1})	TVS (mg l^{-1})
KC01	CBL	8/19/02	0.43	0.43	0.47	1.47	5.00	1.94	4.04	31.00	5.40
KC01	CBL	8/27/02	0.36	0.36	1.06	1.54	7.59	3.25	5.97	10.86	2.43
KC01	CBL	9/10/02	1.62	1.62	3.54	1.42	7.18	2.91	5.73	11.00	1.80
KC01	CBL	9/17/02	0.33	0.33	0.41	1.34	10.04	4.16	7.97	6.20	3.00
KC01	CBL	9/23/02	1.09	1.09	3.52	2.03	26.59	13.88	19.68	45.40	6.00
KC01	CBL	10/1/02	0.43	0.43	1.21	1.16	9.52	3.23	7.91	17.50	3.10
KC01-050	US ARMY	5/24/02	1.93	1.93	13.10	0.20	16.35	3.16	14.78	9.33	4.33
KC01-075	US ARMY	5/9/02	1.71	1.71	14.00	0.24	15.08	3.60	13.29	31.67	5.33
KC01-075	US ARMY	6/26/02	2.00	2.00	5.86	0.36	15.68	6.89	12.27	27.67	6.00
KC01-075	US ARMY	7/12/02	1.50	1.50	1.42	0.40	12.92	2.84	11.51	17.00	4.67
KC01-075	US ARMY	8/22/02	0.50	0.50	3.23	1.59	17.56	4.43	15.36	14.00	4.67
KC01-075	US ARMY	9/5/02	0.68	0.68	0.39	0.51	4.93	2.81	3.53	4.67	3.33
KC01-075	US ARMY	9/30/02	2.87	1.62	4.98	0.72	9.27	2.49	8.03	8.3	4.3
KC01-075	US ARMY	10/9/02	1.22	0.56	1.95	0.43	4.21	1.91	3.26	9.70	4.0
KC01-075	US ARMY	10/28/02	1.43	1.49	9.42	0.57	5.36	10.80	-0.01	9.70	4.3
KC01-075	US ARMY	11/26/02	3.30	0.32	24.70	0.42	2.25	1.32	1.59	6.70	4.3
KC01-100	US ARMY	6/13/02	XX	XX	XX	XX	15.69	4.19	13.61	10.70	5.00
KC01-100	US ARMY	8/9/02	0.64	0.64	0.48	0.36	10.42	2.21	9.32	42.33	6.00
KC01-250	US ARMY	5/9/02	2.21	2.21	23.00	0.43	22.16	4.75	19.81	26.00	5.00
KC01-250	US ARMY	5/24/02	3.00	3.00	18.90	0.42	10.37	2.20	9.28	24.33	4.33
KC01-300	US ARMY	6/13/02	2.29	2.29	5.97	0.24	9.79	3.31	8.15	30.00	6.00
KC01-300	US ARMY	6/26/02	3.07	3.07	3.10	0.47	5.79	2.55	4.52	25.67	4.00
KC01-300	US ARMY	7/12/02	1.93	1.93	2.05	0.59	2.32	1.10	1.77	4.67	3.00
KC01-300	US ARMY	8/9/02	0.86	0.86	0.43	0.61	5.76	1.87	4.83	15.67	4.00
KC01-300	US ARMY	8/22/02	0.71	0.71	1.27	0.76	5.94	2.30	4.79	19.00	4.67
KC01-300	US ARMY	9/5/02	2.10	2.10	0.49	0.40	9.38	3.66	7.56	21.83	7.92

Table A-2 **Water Column Dissolved Nutrient Concentrations**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: BPWCNT2002
Revised: 1/29/03

Station	Collection Agency	DATE	NH4 (umol l^{-1})	NO2 (umol l^{-1})	NO2+NO3 (umol l^{-1})	DIP (umol l^{-1})	CHLA-T ($\mu g\ l^{-1}$)	PHAEO ($\mu g\ l^{-1}$)	CHLA-A ($\mu g\ l^{-1}$)	TSS (mg l^{-1})	TVS (mg l^{-1})
KC01-300	US ARMY	9/30/02	2.58	3.44	10.80	0.88	3.40	0.98	2.91	4.0	3.3
KC01-300	US ARMY	10/9/02	1.94	2.84	9.24	1.10	8.77	2.57	7.49	21.70	5.3
KC01-300	US ARMY	10/28/02	XX	XX	XX	XX	4.35	1.32	3.70	27.30	6.0
KC01-300	US ARMY	11/26/02	6.38	0.35	26.80	0.65	1.40	0.71	1.04	1.00	3.0
PR05	CBL	5/15/02	7.64	7.64	66.70	1.38	10.82	5.46	8.10	55.50	8.00
PR05	CBL	5/21/02	6.50	6.50	54.70	1.17	9.84	1.86	8.91	23.00	3.20
PR05	CBL	5/28/02	5.79	5.79	50.90	1.00	4.59	2.36	3.42	19.33	3.00
PR05	CBL	6/4/02	3.64	3.64	51.60	1.35	5.62	2.56	4.35	30.80	3.60
PR05	CBL	6/12/02	1.43	1.43	25.00	0.68	10.10	3.05	8.60	19.67	3.33
PR05	CBL	7/9/02	2.21	2.21	8.79	0.77	8.54	2.47	7.31	26.80	3.80
PR05	CBL	7/16/02	1.12	1.12	7.60	1.01	28.76	4.12	26.72	19.80	5.40
PR05	CBL	7/22/02	0.55	0.55	1.60	0.99	10.72	2.58	9.44	23.40	4.40
PR05	CBL	7/30/02	0.38	0.38	1.61	0.61	14.60	5.63	11.81	35.20	5.40
PR05	CBL	8/13/02	2.86	2.86	4.28	1.21	7.96	2.32	6.81	39.20	6.20
PR05	CBL	8/19/02	0.50	0.50	4.67	1.46	7.88	3.00	6.38	21.80	3.80
PR05	CBL	8/27/02	0.36	0.36	10.30	1.63	4.65	2.03	3.64	10.43	2.57
PR05	CBL	9/10/02	0.83	0.83	11.20	1.51	5.43	2.60	4.13	17.60	2.20
PR05	CBL	9/17/02	0.39	0.39	11.90	1.68	3.71	1.57	2.93	16.60	3.00
PR05	CBL	9/23/02	11.25	11.25	7.02	2.41	9.88	4.55	7.61	21.90	3.10
PR05	CBL	10/1/02	2.65	2.65	19.90	1.81	7.43	2.50	6.18	16.60	2.20
PR05-075	US ARMY	5/9/02	0.14	0.14	20.10	0.59	4.28	1.93	3.33	23.67	3.67
PR05-075	US ARMY	5/24/02	5.93	5.93	31.30	0.79	6.42	2.82	5.02	21.67	4.33
PR05-075	US ARMY	8/9/02	0.57	0.57	4.50	1.12	9.71	2.32	8.55	20.67	3.67
PR05-100	US ARMY	6/13/02	0.93	0.93	6.47	0.23	11.26	4.47	9.04	19.67	4.33
PR05-100	US ARMY	6/26/02	0.93	0.93	16.90	0.76	4.72	1.95	3.75	16.33	4.00
PR05-100	US ARMY	7/12/02	1.57	1.57	1.47	0.36	11.77	2.96	10.30	16.00	4.67

Table A-2 **Water Column Dissolved Nutrient Concentrations**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: BPWCNT2002
Revised: 1/29/03

Station	Collection Agency	DATE	NH4 (umol l^{-1})	NO2 (umol l^{-1})	NO2+NO3 (umol l^{-1})	DIP (umol l^{-1})	CHLA-T (µg l^{-1})	PHAEO (µg l^{-1})	CHLA-A (µg l^{-1})	TSS (mg l^{-1})	TVS (mg l^{-1})
PR05-100	US ARMY	8/22/02	0.57	0.57	3.74	0.97	8.25	2.97	6.78	16.67	4.00
PR05-100	US ARMY	9/5/02	2.33	2.33	2.70	0.60	7.57	3.97	5.59	18.67	5.00
PR05-100	US ARMY	9/30/02	1.86	2.05	6.10	0.56	8.53	2.23	7.42	10.3	4.0
PR05-100	US ARMY	10/9/02	1.51	3.59	11.10	1.13	7.47	2.55	6.20	15.30	4.3
PR05-100	US ARMY	11/26/02	4.38	0.38	33.20	0.59	1.36	1.01	0.86	7.30	4.0
PR05-150	US ARMY	6/13/02	2.21	2.21	11.70	0.43	9.76	3.72	7.91	27.67	5.00
PR05-150	US ARMY	6/26/02	1.00	1.00	4.99	0.27	8.46	2.34	7.30	15.00	4.00
PR05-150	US ARMY	7/12/02	1.79	1.79	2.00	0.25	13.10	2.79	11.72	23.67	6.00
PR05-150	US ARMY	8/9/02	1.50	1.50	3.35	0.73	5.33	1.47	4.60	16.33	4.33
PR05-150	US ARMY	8/22/02	0.57	0.57	1.99	1.06	9.02	2.95	7.56	26.33	3.33
PR05-150	US ARMY	9/5/02	0.91	0.91	6.78	0.78	5.22	2.49	3.98	17.00	6.00
PR05-150	US ARMY	9/30/02	2.08	2.21	6.84	0.72	6.85	1.88	5.91	10.3	3.7
PR05-150	US ARMY	10/9/02	0.86	5.76	19.60	1.86	5.33	2.40	4.13	20.70	4.7
PR05-150	US ARMY	11/26/02	7.96	0.83	77.00	1.11	2.16	1.29	1.51	6.70	3.7
PR05-200	US ARMY	5/9/02	0.57	0.57	40.50	0.61	13.38	3.73	11.53	29.00	5.33
PR05-200	US ARMY	5/24/02	4.36	4.36	20.70	0.59	4.99	2.21	3.90	20.00	3.67

Table A-3 **Water Column LIGHT FLUX AND LIGHT ATTENUATION DATA**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: **BPWCLT2002**
Revised: **12/2/02**

Station	Date	DEPTH NO	DEPTH (meters)	Light flux $umol/m^2/s$	(D1-D2) Kd1	(D2-D3) Kd2	Mean Kd3
BP03	5/15/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	5/15/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
PR05	5/15/02	D1T1	0.1	864.90	2.06	SW	2.06
		D2T2	0.3	572.50			
		D3T3	SW	SW			
BP03	5/21/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	5/21/02	D1T1	0.1	1304.00	2.88	4.48	3.68
		D2T2	0.5	411.80			
		D3T3	0.7	168.16			
PR05	5/21/02	D1T1	0.1	371.10	2.63	2.06	2.34
		D2T2	0.5	129.41			
		D3T3	0.7	85.78			
BP03	5/28/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	5/28/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
PR05	5/28/02	D1T1	0.1	1179.50	2.12	1.14	1.63
		D2T2	0.5	504.50			
		D3T3	0.6	450.20			
BP03	6/4/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	6/4/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
PR05	6/4/02	D1T1	0.1	1049.50	2.43	2.83	2.63
		D2T2	0.5	397.70			
		D3T3	0.8	170.20			
BP03	6/12/02	D1T1	0.1	1264.95	3.83	SW	3.83
		D2T2	0.5	273.85			
		D3T3	SW	SW			
KC01	6/12/02	D1T1	0.1	895.15	2.76	SW	2.76
		D2T2	0.5	296.75			
		D3T3	SW	SW			
PR05	6/12/02	D1T1	0.1	1216.55	2.02	SW	2.02
		D2T2	0.5	541.25			
		D3T3	SW	SW			
BP03	7/9/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			

Table A-3 **Water Column LIGHT FLUX AND LIGHT ATTENUATION DATA**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: **BPWCLT2002**
Revised: **12/2/02**

Station	Date	DEPTH NO	DEPTH (meters)	Light flux umol/m^2/s	(D1-D2) Kd1	(D2-D3) Kd2	Mean Kd3
KC01	7/9/02	D1T1	0.1	934.40	2.29	SW	2.29
		D2T2	0.3	590.80			
		D3T3	SW	SW			
PR05	7/9/02	D1T1	0.1	1064.60	3.43	SW	3.43
		D2T2	0.5	269.80			
		D3T3	SW	SW			
BP03	7/16/02	D1T1	0.1	1133.20	1.97	SW	1.97
		D2T2	0.5	516.05			
		D3T2	SW	SW			
KC01	7/16/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T2	HH	HH			
PR05	7/16/02	D1T1	0.1	1009.40	2.01	1.92	1.96
		D2T2	0.5	451.70			
		D3T3	0.8	254.20			
BP03	7/22/02	D1T1	0.1	1148.50	1.01	SW	1.01
		D2T2	0.5	767.80			
		D3T3	SW	SW			
KC01	7/22/02	D1T1	0.1	846.60	3.18	SW	3.18
		D2T2	0.5	237.20			
		D3T3	SW	SW			
PR05	7/22/02	D1T1	0.1	1107.90	1.92	2.28	2.10
		D2T1	0.5	514.70			
		D2T2	0.5	643.70			
		D3T2	0.7	408.00			
BP03	7/30/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	7/30/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
PR05	7/30/02	D1T1	0.1	1231.00	1.85	2.00	1.92
		D2T2	0.5	587.70			
		D3T3	0.5	393.90			
BP03	8/6/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	8/6/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
BP03	8/13/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	8/13/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
PR05	8/13/02	D1T1	0.1	1003.70	1.65	1.58	1.61

Table A-3 **Water Column LIGHT FLUX AND LIGHT ATTENUATION DATA**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: **BPWCLT2002**
Revised: **12/2/02**

Station	Date	DEPTH NO	DEPTH (meters)	Light flux umol/m^2/s	(D1-D2) Kd1	(D2-D3) Kd2	Mean Kd3
		D2T2	0.5	518.00			
		D3T3	0.7	378.00			
BP03	8/19/02	D1T1	0.1	565.20	2.03	SW	2.03
		D2T2	0.5	250.60			
		D3T3	SW	SW			
KC01	8/19/02	D1T1	0.1	765.70	1.04	SW	1.04
		D2T2	0.4	561.10			
		D3T3	SW	SW			
PR05	8/19/02	D1T1	0.1	430.40	2.07	SW	2.07
		D2T2	0.5	188.35			
		D3T3	SW	SW			
BP03	8/27/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
KC01	8/27/02	D1T1	HH	HH	HH	HH	HH
		D2T2	HH	HH			
		D3T3	HH	HH			
PR05	8/27/02	D1T1	0.1	561.20	1.21	SW	1.21
		D2T2	0.5	345.70			
		D3T3	SW	SW			
BP03	9/10/02	D1T1	TT	TT	TT	TT	TT
		D2T2	TT	TT			
		D3T3	TT	TT			
KC01	9/10/02	D1T1	TT	TT	TT	TT	TT
		D2T2	TT	TT			
		D3T3	TT	TT			
PR05	9/10/02	D1T1	TT	TT	TT	TT	TT
		D2T2	TT	TT			
		D3T3	TT	TT			
BP03	9/17/02	D1T1	0.1	1151.90	1.81	SW	1.81
		D2T2	0.5	557.40			
		D3T3	SW	SW			
KC01	9/17/02	D1T1	0.1	1349.60	1.08	SW	1.08
		D2T2	0.5	875.40			
		D3T3	SW	SW			
PR05	9/17/02	D1T1	0.1	1045.40	1.25	SW	1.25
		D2T1	0.5	611.00			
		D2T2	0.5	633.10			
		D3T2	SW	SW			
BP03	9/23/02	D1T1	0.1	501.80	2.27	SW	2.27
		D2T2	0.5	202.70			
		D3T3	SW	SW			
KC01	9/23/02	D1T1	0.1	733.70	4.24	SW	4.24
		D2T2	0.5	134.50			
		D3T3	SW	SW			
PR05	9/23/02	D1T1	0.1	528.70	2.05	SW	2.05
		D2T2	0.5	232.80			

Table A-3 **Water Column LIGHT FLUX AND LIGHT ATTENUATION DATA**
Data collected at 0.5 m below the water surface
for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: **BPWCLT2002**
Revised: **12/2/02**

Station	Date	DEPTH NO	DEPTH (meters)	Light flux umol/m^2/s	(D1-D2) Kd1	(D2-D3) Kd2	Mean Kd3
		D3T3	SW	SW			
BP03	10/1/02	D1T1	0.1	1062.70	1.28	SW	1.28
		D2T2	0.5	636.80			
		D3T3	SW	SW			
KC01	10/1/02	D1T1	0.1	1213.00	2.01	SW	2.01
		D2T2	0.5	542.30			
		D3T3	SW	SW			
PR05	10/1/02	D1T1	0.1	854.70	1.74	SW	1.74
		D2T2	0.5	426.30			
		D3T3	SW	SW			

Table A-4 **Standard Mylar Strip Epiphyte accumulation rates for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD**

Filename: BPSMEPI2002
Revised: 11/7/02

Station	Date	Days *in situ*	Replicate No.	Observed Dry Wt. (mg cm^{-2})	Observed Org Wt. (mg cm^{-2})	Dry Wt. Accum Rate (mg cm^{-2} day^{-1})	Org Wt. Accum Rate (mg cm^{-2} day^{-1})	Epiphtyte Chlorophyll observed Total (µg cm^{-2})	Phaeo (µg cm^{-2})	Active (µg cm^{-2})	Epiphtyte Chlorophyll accum rate Total (µg cm^{-2} day^{-1})	Phaeo (µg cm^{-2} day^{-1})	Active (µg cm^{-2} day^{-1})
BP03	05/21/02	6	1	0.033	0.021	0.006	0.003	0.0806	0.0082	0.0766	0.0134	0.0014	0.0128
BP03	05/21/02	6	2	0.014	0.014	0.002	0.002	0.1327	0.0113	0.1269	0.0221	0.0019	0.0212
BP03	05/21/02	6	3	0.024	0.017	0.004	0.003	0.1000	0.0121	0.0941	0.0167	0.0020	0.0157
BP03	05/28/02	7	1	0.068	0.031	0.010	0.004	0.1094	0.0147	0.1020	0.0156	0.0021	0.0146
BP03	05/28/02	7	2	0.025	0.019	0.004	0.003	0.2686	0.0251	0.2561	0.0384	0.0036	0.0366
BP03	05/28/02	7	3	0.089	0.025	0.013	0.004	0.5723	0.0732	0.5358	0.0818	0.0105	0.0765
BP03	06/12/02	8	1	0.977	0.240	0.122	0.030	2.8204	0.5682	2.5386	0.3525	0.0710	0.3173
BP03	06/12/02	8	2	0.692	0.186	0.086	0.023	2.7302	0.5972	2.4340	0.3413	0.0747	0.3042
BP03	06/12/02	8	3	0.465	0.150	0.058	0.019	2.9380	0.5206	2.6796	0.3673	0.0651	0.3350
BP03	07/16/02	7	1	0.191	0.049	0.027	0.007	0.5355	0.1789	0.4469	0.0765	0.0256	0.0638
BP03	07/16/02	7	2	0.397	0.093	0.057	0.013	0.4918	0.1882	0.3985	0.0703	0.0269	0.0569
BP03	07/16/02	7	3	0.425	0.081	0.061	0.012	0.6011	0.1561	0.5237	0.0859	0.0223	0.0748
BP03	07/22/02	6	1	0.276	0.066	0.046	0.011	0.4193	0.1246	0.3574	0.0699	0.0208	0.0596
BP03	07/22/02	6	2	0.339	0.076	0.056	0.013	0.2748	0.0727	0.2387	0.0458	0.0121	0.0398
BP03	07/22/02	6	3	0.206	0.056	0.034	0.009	0.2148	0.0561	0.1869	0.0358	0.0094	0.0312
BP03	07/30/02	8	1	0.234	0.072	0.029	0.009	0.2964	0.0862	0.2536	0.0370	0.0108	0.0317
BP03	07/30/02	8	2	0.269	0.064	0.034	0.008	0.2378	0.0558	0.2100	0.0297	0.0070	0.0263
BP03	07/30/02	8	3	LL	LL	LL	LL	0.1283	0.0392	0.1088	0.0160	0.0049	0.0136
BP03	08/13/02	7	1	0.307	0.077	0.044	0.011	0.2275	0.0450	0.2054	0.0325	0.0064	0.0293
BP03	08/19/02	6	1	0.360	0.093	0.060	0.016	0.1877	0.0395	0.1681	0.0313	0.0066	0.0280
BP03	08/27/02	8	1	0.202	0.093	0.025	0.012	0.3107	0.0763	0.2727	0.0388	0.0095	0.0341
BP03	09/17/02	7	1	0.078	0.041	0.011	0.006	0.1499	0.0335	0.1331	0.0214	0.0048	0.0190
BP03	09/17/02	7	2	0.054	0.039	0.008	0.006	0.1722	0.0425	0.1510	0.0246	0.0061	0.0216
BP03	09/17/02	7	3	0.019	0.027	0.003	0.004	0.1576	0.0386	0.1384	0.0225	0.0055	0.0198
BP03	09/23/02	6	1	0.070	0.034	0.012	0.006	0.3633	0.1028	0.3122	0.0606	0.0171	0.0520
BP03	09/23/02	6	2	0.160	0.057	0.027	0.009	0.3415	0.0930	0.2951	0.0569	0.0155	0.0492
BP03	09/23/02	6	3	0.083	0.034	0.014	0.006	0.4982	0.1376	0.4298	0.0830	0.0229	0.0716
BP03	10/01/02	8	1	0.140	0.066	0.017	0.008	0.7124	0.1105	0.6575	0.0890	0.0138	0.0822
BP03	10/01/02	8	2	0.048	0.033	0.006	0.004	0.4307	0.0800	0.3909	0.0538	0.0100	0.0489
BP03	10/01/02	8	3	0.262	0.097	0.033	0.012	0.2213	0.0397	0.2015	0.0277	0.0050	0.0252
KC01	05/21/02	6	1	0.395	0.077	0.066	0.013	1.3770	0.1353	1.3098	0.2295	0.0226	0.2183
KC01	05/21/02	6	2	1.004	0.151	0.167	0.025	0.8706	0.1039	0.8190	0.1451	0.0173	0.1365
KC01	05/21/02	6	3	0.528	0.107	0.088	0.018	1.8679	0.2044	1.7661	0.3113	0.0341	0.2943
KC01	05/28/02	7	1	0.397	0.099	0.057	0.014	2.1241	0.1125	2.0680	0.3034	0.0161	0.2954

Table A-4 **Standard Mylar Strip Epiphyte accumulation rates for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD**

Filename: BPSMEPI2002
Revised: 11/7/02

Station	Date	Days *in situ*	Replicate No.	Observed Dry Wt. (mg cm^{-2})	Observed Org Wt. (mg cm^{-2})	Dry Wt. Accum Rate (mg cm^{-2} day^{-1})	Org Wt. Accum Rate (mg cm^{-2} day^{-1})	Epiphtyte Chlorophyll observed Total (µg cm^{-2})	Phaeo (µg cm^{-2})	Active (µg cm^{-2})	Epiphtyte Chlorophyll accum rate Total (µg cm^{-2} day^{-1})	Phaeo (µg cm^{-2} day^{-1})	Active (µg cm^{-2} day^{-1})
KC01	05/28/02	7	2	0.989	0.183	0.141	0.026	3.0000	NI	3.0126	0.4286	-0.0037	0.4304
KC01	05/28/02	7	3	0.933	0.178	0.133	0.025	5.8632	0.4545	5.6369	0.8376	0.0649	0.8053
KC01	06/12/02	8	1	4.216	0.806	0.527	0.101	11.6632	1.4500	10.9430	1.4579	0.1813	1.3679
KC01	06/12/02	8	2	3.395	0.729	0.424	0.091	10.7324	1.1461	10.1628	1.3415	0.1433	1.2703
KC01	06/12/02	8	3	3.503	0.760	0.438	0.095	16.0855	1.5688	15.3057	2.0107	0.1961	1.9132
KC01	07/16/02	7	1	0.527	0.101	0.075	0.014	0.2161	0.0942	0.1693	0.0309	0.0135	0.0242
KC01	07/16/02	7	2	0.124	0.039	0.018	0.006	0.2823	0.1197	0.2229	0.0403	0.0171	0.0318
KC01	07/16/02	7	3	0.566	0.112	0.081	0.016	0.4582	0.1525	0.3825	0.0655	0.0218	0.0546
KC01	07/22/02	6	1	0.229	0.080	0.038	0.013	0.5803	0.2072	0.4777	0.0967	0.0345	0.0796
KC01	07/22/02	6	2	0.272	0.083	0.045	0.014	0.4743	0.1863	0.3819	0.0791	0.0311	0.0637
KC01	07/22/02	6	3	0.216	0.086	0.036	0.014	YY	YY	YY	YY	YY	YY
KC01	07/30/02	8	1	0.273	0.102	0.034	0.013	0.6724	0.2711	0.5382	0.0840	0.0339	0.0673
KC01	07/30/02	8	2	0.405	0.123	0.051	0.015	0.5025	0.2446	0.3813	0.0628	0.0306	0.0477
KC01	07/30/02	8	3	0.350	0.109	0.044	0.014	0.8699	0.2747	0.7336	0.1087	0.0343	0.0917
KC01	08/13/02	7	2	0.078	0.047	0.011	0.007	0.1542	0.0259	0.1414	0.0220	0.0037	0.0202
KC01	08/19/02	6	1	0.781	0.136	0.130	0.023	YY	YY	YY	YY	YY	YY
KC01	08/19/02	6	2	0.539	0.136	0.090	0.023	0.2373	0.1253	0.1750	0.0396	0.0209	0.0292
KC01	08/27/02	8	1	0.605	0.163	0.076	0.020	0.5358	0.0746	0.4986	0.0670	0.0093	0.0623
KC01	09/17/02	7	1	0.153	0.062	0.022	0.009	0.3540	0.0767	0.3159	0.0506	0.0110	0.0451
KC01	09/17/02	7	2	0.089	0.048	0.013	0.007	0.2342	0.0462	0.2111	0.0335	0.0066	0.0302
KC01	09/17/02	7	3	0.120	0.058	0.017	0.008	0.4971	0.1032	0.4456	0.0710	0.0147	0.0637
KC01	09/23/02	6	1	0.132	0.050	0.022	0.008	0.7367	0.1707	0.6518	0.1228	0.0284	0.1086
KC01	09/23/02	6	2	0.047	0.039	0.008	0.006	0.4307	0.1228	0.3697	0.0718	0.0205	0.0616
KC01	09/23/02	6	3	0.213	0.074	0.036	0.012	1.4076	0.2105	1.3028	0.2346	0.0351	0.2171
KC01	10/01/02	8	1	0.267	0.116	0.033	0.015	1.2879	0.3043	1.1366	0.1610	0.0380	0.1421
KC01	10/01/02	8	2	0.089	0.070	0.011	0.009	0.7204	0.1846	0.6287	0.0901	0.0231	0.0786
KC01	10/01/02	8	3	0.155	0.097	0.019	0.012	1.1307	0.3049	0.9790	0.1413	0.0381	0.1224
PR05	05/21/02	6	1	0.415	0.064	0.069	0.011	0.8096	0.0415	0.7888	0.1349	0.0069	0.1315
PR05	05/21/02	6	2	0.417	0.062	0.069	0.010	0.9432	0.0752	0.9057	0.1572	0.0125	0.1509
PR05	05/21/02	6	3	0.378	0.070	0.063	0.012	0.6400	0.0440	0.6180	0.1067	0.0073	0.1030
PR05	05/28/02	7	1	0.659	0.140	0.094	0.020	3.6546	0.3337	3.4884	0.5221	0.0477	0.4983
PR05	05/28/02	7	2	0.664	0.119	0.095	0.017	3.6059	0.3261	3.4435	0.5151	0.0466	0.4919
PR05	05/28/02	7	3	0.398	0.078	0.057	0.011	0.9539	0.0722	0.9179	0.1363	0.0103	0.1311
PR05	06/12/02	8	1	7.303	1.051	0.913	0.131	24.3815	1.6136	23.5780	3.0477	0.2017	2.9473

Table A-4 **Standard Mylar Strip Epiphyte accumulation rates for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD**

Filename: BPSMEPI2002
Revised: 11/7/02

Station	Date	Days *in situ*	Replicate No.	Observed Dry Wt. (mg cm^{-2})	Observed Org Wt. (mg cm^{-2})	Dry Wt. Accum Rate (mg cm^{-2} day^{-1})	Org Wt. Accum Rate (mg cm^{-2} day^{-1})	Epiphyte Chlorophyll observed Total (µg cm^{-2})	Phaeo (µg cm^{-2})	Active (µg cm^{-2})	Epiphtyte Chlorophyll accum rate Total (µg cm^{-2} day^{-1})	Phaeo (µg cm^{-2} day^{-1})	Active (µg cm^{-2} day^{-1})
PR05	06/12/02	8	2	7.388	1.279	0.924	0.160	22.9638	1.8411	22.0477	2.8705	0.2301	2.7560
PR05	06/12/02	8	3	LL	LL	LL	LL	27.6378	1.9394	26.6721	3.4547	0.2424	3.3340
PR05	07/16/02	7	1	1.430	0.186	0.204	0.027	1.5049	0.3929	1.3101	0.2150	0.0561	0.1872
PR05	07/16/02	7	2	1.052	0.174	0.150	0.025	1.4860	0.3329	1.3208	0.2123	0.0476	0.1887
PR05	07/16/02	7	3	1.250	0.169	0.179	0.024	1.7438	0.3622	1.5641	0.2491	0.0517	0.2234
PR05	07/22/02	6	1	2.348	0.310	0.391	0.052	4.0176	0.2720	3.8821	0.6696	0.0453	0.6470
PR05	07/22/02	6	2	3.201	0.388	0.533	0.065	2.6209	0.3926	2.4259	0.4368	0.0654	0.4043
PR05	07/22/02	6	3	3.240	0.403	0.540	0.067	5.0423	0.4824	4.8025	0.8404	0.0804	0.8004
PR05	07/30/02	8	1	0.930	0.217	0.116	0.027	2.6349	0.4261	2.4234	0.3294	0.0533	0.3029
PR05	07/30/02	8	2	1.073	0.242	0.134	0.030	2.4515	0.3822	2.2618	0.3064	0.0478	0.2827
PR05	07/30/02	8	3	1.420	0.267	0.177	0.033	2.0934	0.3466	1.9214	0.2617	0.0433	0.2402
PR05	08/19/02	6	1	3.139	0.535	0.523	0.089	2.7685	0.5239	2.5077	0.4614	0.0873	0.4180
PR05	08/27/02	8	1	1.790	0.395	0.224	0.049	4.4917	0.9326	4.0275	0.5615	0.1166	0.5034
PR05	09/17/02	7	1	2.499	0.523	0.357	0.075	3.0568	0.4724	2.8216	0.4367	0.0675	0.4031
PR05	09/17/02	7	2	2.794	0.678	0.399	0.097	3.3430	0.6067	3.0410	0.4776	0.0867	0.4344
PR05	09/17/02	7	3	1.628	0.426	0.233	0.061	6.0058	1.0140	5.5011	0.8580	0.1449	0.7859
PR05	09/23/02	6	1	0.566	0.124	0.094	0.021	4.7233	0.8184	4.3160	0.7872	0.1364	0.7193
PR05	09/23/02	6	2	2.193	0.333	0.366	0.056	2.7418	0.2511	2.6167	0.4570	0.0419	0.4361
PR05	09/23/02	6	3	1.170	0.186	0.195	0.031	2.0259	0.2350	1.9088	0.3376	0.0392	0.3181
PR05	10/01/02	8	1	4.340	0.698	0.543	0.087	4.6973	0.6313	4.3831	0.5872	0.0789	0.5479
PR05	10/01/02	8	2	1.744	0.407	0.218	0.051	5.0835	0.7888	4.6908	0.6354	0.0986	0.5863
PR05	10/01/02	8	3	3.689	0.651	0.461	0.081	3.9431	0.6098	3.6394	0.4929	0.0762	0.4549

Table A-4.1 Complex Morphology Epiphyte accumulation rates for the US ARMY Adelphi Research Laboratory at Blossom Pt. MD

Filename: BPCMEPI2002
Revised: 12/19/02

Station	Date	Days In Situ	Replicate No.	Leaf area cm2	Sample Depth	Observed Dry Wt. (mg cm^{-2})	Observed Org Wt. (mg cm^{-2})	Dry Wt. Accum Rate (mg cm^{-2} day^{-1})	Org Wt. Accum Rate (mg cm^{-2} day^{-1})	Epiphyte Chlorophyll observed Total (ug cm^{-2})	Epiphyte Chlorophyll observed Phaeo (ug cm^{-2})	Epiphyte Chlorophyll observed Active (ug cm^{-2})	Epiphyte Chlorophyll accum rate Total (ug cm^{-2} day^{-1})	Epiphyte Chlorophyll accum rate Phaeo (ug cm^{-2} day^{-1})	Epiphyte Chlorophyll accum rate Active (ug cm^{-2} day^{-1})
BP03	08/27/02	8	1	36.46	Bottom	1.2685	0.4971	0.1586	0.0621	1.1664	0.5267	0.9043	0.1458	0.0658	0.1130
BP03	08/27/02	8	2	38.54	Bottom	0.7460	0.2595	0.0932	0.0324	0.8908	0.5188	0.6326	0.1113	0.0648	0.0791
BP03	08/27/02	8	1	17.32	Surface	0.8661	0.4330	0.1083	0.0541	1.0003	0.5065	0.7483	0.1250	0.0633	0.0935
BP03	08/27/02	8	2	19.90	Surface	0.7751	0.3982	0.0969	0.0498	0.7263	0.3194	0.5673	0.0908	0.0399	0.0709
KC01	08/27/02	8	1	37.38	Bottom	0.3344	0.2842	0.0418	0.0355	0.7309	0.2578	0.6026	0.0914	0.0322	0.0753
KC01	08/27/02	8	2	34.58	Bottom	0.1930	0.2046	0.0241	0.0256	0.5636	0.1758	0.4761	0.0704	0.0220	0.0595
KC01	08/27/02	8	1	22.46	Surface	0.6539	0.3200	0.0817	0.0400	0.6969	0.4185	0.4887	0.0871	0.0523	0.0611
KC01	08/27/02	8	2	16.02	Surface	0.7210	0.3901	0.0901	0.0488	0.7188	0.4106	0.5145	0.0899	0.0513	0.0643
PR05	08/27/02	8	1	34.92	Bottom	2.1299	0.4296	0.2662	0.0537	1.9256	0.9035	1.4760	0.2407	0.1129	0.1845
PR05	08/27/02	8	2	38.78	Bottom	1.2410	0.3384	0.1551	0.0423	1.2009	0.5631	0.9207	0.1501	0.0704	0.1151
PR05	08/27/02	8	1	19.86	Surface	2.4862	0.6923	0.3108	0.0865	4.3262	1.6868	3.4868	0.5408	0.2108	0.4359
PR05	08/27/02	8	2	18.36	Surface	4.9020	0.9191	0.6127	0.1149	6.6255	2.1259	5.5675	0.8282	0.2657	0.6959
BP0	09/17/02	7	1	38.40	Bottom	0.1628	0.0977	0.0233	0.0140	0.3423	0.0971	0.2938	0.0489	0.0139	0.0420
BP03L	09/17/02	7	1	29.76	Live Surface	1.0501	0.5250	0.1500	0.0750	1.3037	0.4604	1.0735	0.1862	0.0658	0.1534
BP03	09/17/02	7	1	18.00	Surface	0.1153	0.1736	0.0165	0.0248	0.4112	0.1514	0.3355	0.0587	0.0216	0.0479
KC01	09/17/02	7	1	36.16	Bottom	0.5012	0.3457	0.0716	0.0494	0.9628	0.2888	0.8184	0.1375	0.0413	0.1169
KC01L	09/17/02	7	1	37.20	Live Surface	0.4872	0.2352	0.0696	0.0336	0.7803	0.2848	0.6379	0.1115	0.0407	0.0911
KC01	09/17/02	7	1	19.66	Surface	0.3344	0.3662	0.0478	0.0523	0.5747	0.2068	0.4713	0.0821	0.0295	0.0673
PR05	09/17/02	7	1	35.46	Bottom	1.3924	0.4230	0.1989	0.0604	1.9273	0.4642	1.6952	0.2753	0.0663	0.2422
PR05	09/17/02	7	1	23.68	Surface	2.3226	0.7390	0.3318	0.1056	3.4592	0.7227	3.0978	0.4942	0.1032	0.4425
*BP03	08/27/02	8	1	64.52	Mid	0.2015	0.0930	0.0252	0.0116	0.3107	0.0763	0.2727	0.0388	0.0095	0.0341
*KC01	08/27/02	8	1	64.52	Mid	0.6045	0.1628	0.0756	0.0203	0.5358	0.0746	0.4986	0.0670	0.0093	0.0623
*PR05	08/27/02	8	1	64.52	Mid	1.7903	0.3953	0.2238	0.0494	4.4917	0.9326	4.0275	0.5615	0.1166	0.5034
*BP03	09/17/02	7	1	64.52	Mid	0.0775	0.0407	0.0111	0.0058	0.1499	0.0335	0.1331	0.0214	0.0048	0.0190
*BP03	09/17/02	7	2	64.52	Mid	0.0543	0.0388	0.0078	0.0055	0.1722	0.0425	0.1510	0.0246	0.0061	0.0216
*BP03	09/17/02	7	3	64.52	Mid	0.0194	0.0271	0.0028	0.0039	0.1576	0.0386	0.1384	0.0225	0.0055	0.0198
*KC01	09/17/02	7	1	64.52	Mid	0.1531	0.0620	0.0219	0.0089	0.3540	0.0767	0.3159	0.0506	0.0110	0.0451
*KC01	09/17/02	7	2	64.52	Mid	0.0891	0.0484	0.0127	0.0069	0.2342	0.0462	0.2111	0.0335	0.0066	0.0302
*KC01	09/17/02	7	3	64.52	Mid	0.1201	0.0581	0.0172	0.0083	0.4971	0.1032	0.4456	0.0710	0.0147	0.0637
*PR05	09/17/02	7	1	64.52	Mid	2.4994	0.5231	0.3571	0.0747	3.0568	0.4724	2.8216	0.4367	0.0675	0.4031
*PR05	09/17/02	7	2	64.52	Mid	2.7939	0.6781	0.3991	0.0969	3.3430	0.6067	3.0410	0.4776	0.0867	0.4344
*PR05	09/17/02	7	3	64.52	Mid	1.6275	0.4263	0.2325	0.0609	6.0058	1.0140	5.5011	0.8580	0.1449	0.7859

**These data are from Mylar Epiphyte Strips that served as controls during Complex Morphology deployments.*