ABSTRACT

Title of Document: THE ABUNDANCE AND DISTRIBUTION OF TRANSPARENT EXOPOLYMER PARTICLES IN THE TURBIDITY MAXIMUM REGION OF CHESAPEAKE BAY

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Transparent exopolymer particle (TEP) concentrations were measured in the turbidity maximum (ETM) region of Chesapeake Bay during eight research cruises over a two-year period. TEP concentrations ranged from <100 to >2500 μg XG eq l^{-1} and accounted for an estimated average of 31% ± 14 of POC. Spatially averaged TEP and chl-a concentrations were positively correlated over the two-year period, although these parameters were rarely correlated within cruises. Peak TEP concentrations were often separated from chl a maxima, suggesting that formation and concentration processes are more responsible for TEP concentrations than the proximity to precursor source material. Significant correlations between TEP and phaeophytin, POC, DOC, TSS and level of stratification were observed during some sampling periods. Settling tube experiments revealed a positive correlation between TEP

concentration and the fraction of settling particulate matter. A hypothetical model for TEP formation and concentration in estuaries is proposed.

THE ABUNDANCE AND DISTRIBUTION OF TRANSPARENT EXOPOLYMER PARTICLES IN THE TURBIDITY MAXIMUM REGION OF CHESAPEAKE BAY

By

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Introduction:

The estuarine turbidity maximum (ETM) of Chesapeake Bay is a region of high turbidity caused by the entrainment of tidally resuspended sediment. Located near the limit of salt intrusion in the upper Chesapeake Bay, it is created by tidal asymmetries brought about by the effect of gravitational circulation on tidal flows (Sanford et al. 2001). ETMs are common features of estuaries, having been observed and studied in the San Francisco Bay, Delaware and Chesapeake Bays, the Hudson River, Columbia River, Elbe River, Seine River, Tamar River, and Gironde River estuaries. The ETM is often a productive region of the estuary; in Chesapeake Bay it is host to high concentrations of the larval stages of white perch (*Morone americana*) and striped bass (*Morone saxatilis*), both of which are important economically and culturally to the Chesapeake Bay community (North & Houde 2006). The ETM represents an ideal nursery habitat for these species because of the high concentration of mesozoplankton prey, including the copepod *Eurytemora affinis* (Roman et al. 2001, Roman et al. 2005), and because the high turbidity in the region may offer a refuge from visual predators.

BITMAX II was a multi-disciplinary project conceived to determine the mechanisms by which the Chesapeake Bay ETM supports high secondary production. We hypothesized that microbial processes are partially responsible for the maintenance of the ETM and the presence of nutritious particulate material suitable for supporting large mesozooplankton communities. Sticky, biogenic transparent exopolymer particles could influence particle aggregation and sinking velocities, therefore affecting the efficiency of the ETM particle trap. The nutritional state of

particles within the ETM could be affected by microbial communities, either by the nutritional qualities of the biomass of particle-attached microbes themselves, or by the enzymatic reworking of organic compounds within non-living particulate matter.

To test these hypotheses, the concentrations of TEP and particulate carbohydrates and lipids were measured in the ETM region of Chesapeake Bay over two years of sampling (8 cruises). TEP was chosen because of its likely importance in particle aggregation, while carbohydrates and lipids were measured to characterize the POM pool and investigate the relative nutritional quality of ETM particles.

Chapter 1: The abundance and distribution of transparent exopolymer particles in the turbidity maximum region of Chesapeake Bay

Abstract

Transparent exopolymer particles (TEP) are formed from the coagulation of acidic polysaccharides in marine and freshwater environments, and are thought to enhance particle aggregation in the water column. Particle aggregation is an important process for the formation of estuarine turbidity maxima regions, which serve as critical nursery grounds for many fish species. We measured TEP concentrations in the turbidity maximum region of Chesapeake Bay during eight field campaigns over a two-year period. TEP ranged from <100 to >2500 μg XG eq l^{-1} and accounted for an

average of 31% ± 14% of POC. Spatially averaged TEP and chl a concentrations were positively correlated over the two-year period, although these parameters were rarely correlated on each sampling date (Spearman correlation, $p \geq .05$). Significant correlations between TEP and phaeophytin, POC, DOC, TSS and level of stratification were observed occasionally but no parameter was consistently correlated with TEP. Settling tube experiments revealed a positive correlation between TEP concentration and the fraction of settling particulate matter, suggesting that TEP is important for the formation of sinking aggregates in the Chesapeake Bay ETM region. High TEP concentrations were often spatially separated from chl a maxima that represent the likely source for TEP and TEP precursors, suggesting that formation and concentration processes are more important for the spatial distribution of TEP in the upper Chesapeake Bay than proximity to precursor source material. A hypothetical model for TEP formation and concentration in estuaries is proposed.

Introduction

Transparent exopolymer particles (TEP) are clear, gel-like particles composed of acidic polysaccharides that form a major component of marine snow and many other aggregates in aquatic environments (Alldredge et al. 1993, Passow and Alldredge 1995, Grossart et al. 1997). Both laboratory and field studies have demonstrated the importance of TEP for the aggregation and sinking of diatoms (Passow and Alldredge 1995, Passow et al. 2001), most likely by increasing the stickiness of particles (Engel 2000, Jackson 1995). Their ability to increase particle aggregation and sinking coupled with the high carbon content of TEP themselves

make them an important component of the oceanic carbon cycle. The C:N ratio of TEP is well above the Redfield ratio, making TEP a pathway for the flux of excess carbon to the deep ocean (Engel and Passow 2001, Engel 2004).

Few studies of TEP in estuaries have been published (Wurl and Holmes 2008, Wetz et al. 2009), despite the likely importance of TEP in estuarine environments. Studies in the coastal and open ocean have shown a general increase in TEP concentrations along a gradient from oligotrophic to more eutrophic environments (Passow 2002), a pattern which appears to extend into estuaries (Wurl and Holmes 2008, Wetz et al. 2009, Fig. 1 this study). Their influence on particle aggregation and sedimentation may have a profound effect on the fate of particulate organic matter in highly productive estuaries.

Transparent exopolymer particles can be formed via two processes: the direct release of TEP into the environment by organisms, and the coagulation of dissolved polysaccharides into TEP (Chin et al. 1998). Organisms known to release TEP directly include phytoplankton, bacteria and filter-feeding mollusks and ascidians (McKee et al. 2005, Heinonen et al. 2007), all of which are common in estuaries. In addition, dissolved polysaccharides (TEP "precursors") can be released by growing phytoplankton and bacteria, through "sloppy feeding" or grazing by zooplankton, and via cell lysis (Passow 2002, Verdugo et al. 2004). The abiotic coagulation of precursors into TEP is dependent on both physical processes that control the frequency of collisions between TEP precursors, and on the chemical environment, which influences the stickiness of the precursors. Of particular importance are the

presence of Ca^{++}, Mg^{++}, and H^{+} ions, which appear to stabilize TEP and have been shown to influence TEP formation in estuaries (Passow 2002, Wetz et al. 2009). Although the aforementioned studies (Wurl and Holmes 2008, Wetz et al. 2009) have increased our understanding of TEP in estuaries, there remains much to be learned about both the controls on TEP formation and the effects of TEP on the estuarine environment. This manuscript presents the first comprehensive study of TEP concentrations in a vertically stratified estuarine environment, collected over a 2-year period. We measured TEP to determine: (1) the presence of TEP, (2) the effect of TEP on particle aggregation, and (3) the possible mechanisms controlling the formation and distribution of TEP in the region.

Methods

Study site and sampling

The estuarine turbidity maximum (ETM) zone of Chesapeake Bay is a region of high turbidity caused by tidally resuspended sediment. Located in the upper Bay near the limit of salt intrusion, the ETM is created by tidal asymmetries brought about by the effect of gravitational circulation on tidal flows (Sanford et al. 2001). Samples were collected during 8 research cruises aboard the UNOLS vessel R/V *Hugh R. Sharp* in the ETM region of Chesapeake Bay (Fig. 2) in winter, early and late spring, and fall of 2007 and 2008 (Table 1). During each cruise at least two 5-station axial surveys through the ETM region were undertaken, with sampling at 3 depths per station (surface, mid-depth, and ~1 m above bottom). In addition, samples were collected at anchor stations upstream, within, and downstream of the ETM zone. Samples were collected with 10L plastic Niskin bottles attached to a rosette equipped

with a suite of sensors for measuring conductivity, temperature, depth (CTD), chlorophyll fluorescence, dissolved oxygen, and turbidity as optical backscatter. Water samples from each depth were collected in two Niskin bottles, combined in 20L plastic buckets equipped with sampling ports, and stirred with large stir-bars to keep particles suspended during subsampling.

TEP concentration measurements

Transparent exopolymer particles (TEP) were measured using the spectrophotometric method of Passow and Alldredge (1995). Samples were filtered in triplicate onto 0.40 μm pore-size, 47 mm diameter polycarbonate filters (Millipore). Sample volume was chosen carefully to avoid clogging the filter (range 20 to 200 ml), and low vacuum (< 15 cm Hg) was used to avoid destroying the delicate TEP. Particles retained on the filter were stained for ~2 s with 1 ml of a 0.02% (w/w) aqueous solution of Alcian Blue (8GX) and immediately rinsed with distilled water to remove unbound dye. Stained samples were stored at -20 °C until processed.

To dissolve TEP-bound Alcian Blue, the sample filters were soaked in 6 ml of an 80% sulfuric acid solution for 3 hours, and vortexed every hour. 300 μl of this solution was then loaded per well into a 96-well plate, and the absorbance read at 788 nm with a BioTek Synergy HT microplate reader. TEP was quantified using a standard curve prepared with Xanthan Gum (XG), and the resulting concentrations were expressed in units of XG equivalents l^{-1}.

DOC measurements

Dissolved organic carbon (DOC) measurements were performed on samples of filtrate from pre-ashed 25 mm GF/F (Wheaton) filters. DOC samples (20 ml) were stored at -20°C in polypropylene vials and analyzed by Horn Point Laboratory (HPL) analytical services using a Shimadzu TOC-5000 total organic carbon analyzer (Sugimura & Suzuki 1988).

TSS measurements

The concentration of total suspended solids (TSS) was determined from water samples filtered through pre-weighed 25 mm GF/F (Wheaton) filters. Duplicate sample filters were dried at 60°C for 48 h before being weighed with an Ohaus Adventurer microbalance.

POC measurements

Particulate organic carbon (POC) was measured from the material retained on the TSS filters. After drying and weighing, samples were fumed under concentrated (12 N) HCl overnight and dried for 24 hours at 60°C before being crimped into silver capsules. The samples were then analyzed at the University of California Davis Stable Isotope Facility using a PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK).

Chlorophyll a and phaeophytin a measurements

Chlorophyll a (chl a) and phaeophytin a (phe a) were measured using EPA method 445.0 (1997). Briefly, samples were collected by filtering water through 25

mm GF/F filters under low light conditions to minimize photodegradation of the pigments and stored at -20°C. The pigments were extracted with 90% acetone, and their concentrations measured fluorometrically. In addition, chl a fluorescence was sensed with a WET Labs ECO/AFL fluorometer attached to the CTD rosette.

Calculating degree of stratification

The degree of stratification of the water column was quantified by preparing vertical salinity profiles for each cast using data from the CTD. The profiles were smoothed via a 1.75 m moving average, and the salinity at the sample depth was subtracted from the salinity 1.5 m above the sample depth. The absolute value of the change in salinity divided by 1.5 m gives an approximation of ds/dz in units of salinity m^{-1}. Since the top of the Niskin bottles were roughly 1.5 m above the CTD sensor, this is equivalent to the salinity range sampled.

Settling tube sampling

To examine the settling characteristics of suspended material, a modified Owen-style settling tube was used to collect water samples during the anchor stations. The sampling apparatus consisted of a 20 l Niskin bottle attached to a frame. To sample, the tube was deployed from the A-frame over the stern of the ship. Vanes attached to the frame oriented the tube in a horizontal position into the water flow, allowing water and suspended particles to flow through the tube. When pneumatically tripped, the end caps closed and the bottle swung into a vertical position within the frame. Once on deck water samples were periodically drawn from a valve in the bottom of the bottle and analyzed for TSS. The apparatus was wrapped in a reflective Mylar blanket to minimize convection cells within the tube. The TSS

data was analyzed using a spreadsheet according to the procedure described by Owen (1976), giving the distribution of the settling velocities of particulate matter in the water column.

Results

Range of TEP concentrations

TEP concentrations in whole water samples ranged from <100 to >2500 μg XG eq l^{-1}, with average values ranging from 430 μg XG eq l^-1 in April 2008 to 1210 μg XG eq l^{-1} in February 2007. In 2007, TEP concentrations were highest in February (average 1210 μg XG eq l^{-1}) and declined steadily through October (Figure 3). In 2008, average TEP concentrations were more seasonally and spatially consistent, with average values ranging from 430 μg XG eq l^{-1} in April to 660 μg XG eq l^{-1} in May.

Correlation of TEP with POC, TSS, phe a, chl a, DOC and stratification

The concentration of TEP correlated positively with TSS and POC across all sampling dates (Fig. 4), but on some sampling dates these relationships were not significant. Spearman correlation analysis showed that TEP concentration was more strongly correlated with these and other environmental measurements in 2007 than in 2008 (Table 2). In 2007, TEP concentrations were positively correlated with TSS during the February, April, and May cruises. In addition, TEP was significantly correlated with phaeophytin, chl a, POC, and DOC concentrations, as well as degree of stratification in April and May, but not February (Spearman's correlation test, $p \leq$

.05, Table 2). In 2008 the only significant correlations were with TSS in January, DOC in April, and stratification in May (Table 2).

Relationship between TEP and chl a

Peak values of TEP concentration rarely overlapped with those of chl a during axial surveys. For example, the 23 Feb. 2007 axial survey revealed a strong chl a fluorescence maximum centered around river kilometer 45, while the highest TEP concentrations were observed at stations up- and down-estuary of this point (Fig. 5). However, patterns were observed in system-wide averages of TEP and chl a over the 2-year study period. There was a positive correlation between spatially-averaged TEP and chl a concentrations in samples with salinity > 7 (Spearman's rho=0.86, $p<0.02$), and 1< salinity <7 (Spearman's rho=0.77, $p<0.05$), while in freshwater (salinity <1) samples this pattern was less pronounced (Fig. 6; Spearman's rho=0.03, $p<0.96$).

Settling tube sampling

Separation of particles with the settling tube demonstrated high variability in the fraction of particles that settle faster than 0.06 mm s^{-1}, ranging from 0 to 90% of the suspended particle mass. We used this settling speed as a cutoff to define settling suspended solids because it approximates the minimum speed a resuspended ETM particle would need to reach the bottom during one tidal cycle. TEP measurements on whole-water samples collected concurrently with settling tube samples show that total TEP concentration correlated positively with the fraction of settling suspended solids (Fig. 7). ETM samples tended to have both higher TEP concentrations and

higher fractions of settling suspended solids than samples collected up- or down-estuary of the ETM.

Discussion

Comparison of TEP concentrations in upper Chesapeake Bay with other marine environments

TEP concentrations in the ETM region of Chesapeake Bay were persistently high compared to those observed in coastal and open-ocean environments (Fig. 1; Passow 2002, Ramaiah and Furuya 2002, Sugimoto et al. 2007, Engle 2004), and were similar to concentrations published in other estuarine studies (Wurl and Holmes 2008, Wetz et al. 2009). This is consistent with the observed trend of increasing TEP concentrations along productivity gradients (Passow 2002, Engel 2004), and likely reflects the eutrophic state of Chesapeake Bay (Kemp et al. 2005).

Seasonal patterns in TEP concentrations

Seasonal patterns in TEP concentrations differed dramatically between years. In 2007 the cruise-wide average TEP concentration decreased from 1215 μg XG eq l^{-1} during the February cruise to 550 μg XG eq l^{-1} during October. Since the residence time of water and particulate matter in the region is on the order of 1-2 weeks (Sanford pers. com.), it is unlikely that this was caused by the gradual dilution of TEP produced during February because any TEP present would have been removed from the system well before the next sampling cruise.

Of particular interest are the high TEP concentrations observed in freshwater samples collected in the upper portion of the ETM region in February 2007. During this cruise the average freshwater TEP concentration was 2 to 4 times higher than subsequent cruises (Fig. 3). It is worth noting that this cruise coincided with the breakup of a large ice cover in northern Chesapeake Bay. Water samples in the freshwater region featured large amounts of macroscopic filamentous algae colonies, which grew on the bottom and margins of the floating ice. We hypothesize that the melting and breakup of the ice cover caused these normally sessile colonies to enter the water column, where stress due to differing light regimes and osmotic pressure caused them to leak potential TEP precursors into the water column. The formation of TEP from macroalgae and macroalgal detritus has been demonstrated in both field and laboratory studies (Ramaiah et al. 2001, Thornton 2004).

POC content of TEP in Chesapeake Bay

TEP concentrations often made up a large fraction of the POC in the water column. The ratio of TEP to POC was highly variable, ranging from 0.07 to 1.42, with an average ratio of 0.58 ± 0.27 (Fig. 4). To determine if carbon in TEP represents a significant fraction of POC in the upper Chesapeake Bay we converted TEP concentration to carbon concentration using a conversion factor. Engel and Passow (2001) measured the carbon content of TEP produced from a variety of pure diatom cultures as well as a natural assemblage of diatoms, and found that the carbon content of TEP ranged from 0.53 to 0.88 μg C * μg XG eq.$^{-1}$, with an average value of 0.75 μg C * μg XG eq.$^{-1}$. We did not measure the carbon content of TEP in Chesapeake Bay, but it is clear that a significant portion of POC was in the form of

TEP. Using the lowest value reported by Engel and Passow (2001) as a conversion factor, we calculate that TEP derived carbon (TEP-C) comprises on average 31% ± 14 of the total measured POC in the upper Chesapeake Bay, and ranges as high as 75%. We consider this to be a conservative estimate of the importance of TEP as a component of POC. However, the smaller pore size of the filters used to measure TEP compared to those used to measure POC (0.4 μm Millipore and 0.7 μm GF/F, respectively) implies that some of the TEP in our samples is not captured as POC, which would cause these calculations to overestimate the portion of POC made up of TEP (Engel & Passow 2001, Passow & Alldredge 1995).

Effect of TEP on particle aggregation

Particle aggregation and sedimentation is an essential phenomenon for the formation of ETM, and our results show that the fraction of settling particles is positively correlated with the concentration of TEP (Fig. 7) suggesting that TEP increases the settling speeds of aggregates. This relationship is driven in part by the fact that total particle concentration and TEP concentration are higher in ETM samples than in freshwater and saltwater end-member samples. However, ETM samples clearly contained higher fractions of settling particles than the end member samples. Also, within each sample type (fresh, salt, ETM) there was a positive trend between TEP concentration and fraction of settling particulate matter. End-member samples exhibited low TSS concentrations overall, and were collected high above the bottom to reduce the amount of resuspended sediments in the samples. This suggests that TEP are in fact promoting the settling of suspended material throughout the system, most likely by increasing particle aggregation.

TEP is formed by flocculation of colloidal precursors into particles, which can then aggregate with mineral particles, phytoplankton and bacterial cells, and particulate detritus forming marine snow, lake snow, etc. This effect of TEP on particle aggregation is well-studied (Engel 2004, Logan et al. 1995, Passow and Alldredge 1994), in general increasing aggregation by increasing the stickiness of particles. In one field study, TEP was found to be positively correlated with aggregate size in the bottom water of the Mecklenburg Bight, where, similar to the Chesapeake Bay ETM, much of the TSS is resuspended sediment (Jahmlich et al. 1998). Using a settling tube sampler similar to that used in our study, Sanford et al. (2001) showed that large aggregates in the Chesapeake Bay ETM sank faster than their component silt and clay particles. This suggests that, in the Chesapeake Bay ETM, TEP promotes the coagulation of fine particulate material into large aggregates with sinking velocities high enough for them to become trapped in the ETM region. Ballast-free, "pure" TEP are less dense than water, with an estimated density between 0.70 to 0.84 g cm^{-3} (Azetsu-Scott & Passow, 2004). In laboratory experiments, TEP have been shown to decrease the settling velocity of diatom aggregates by decreasing the excess density of aggregates (Engel & Schartau 1999), and can scavenge and induce an upward flux of particles (Azetsu-Scott & Passow, 2004). However, un-laden TEP are unlikely to exist in the ETM due to high concentrations suspended particulate matter.

Factors affecting TEP concentration

Results of the Spearman correlation analysis revealed significant correlations between TEP and phaeophytin, chlorophyll-a, POC, DOC and TSS concentrations, as

well as degree of stratification, in 2007 (Table 2). However, these correlations were not observed in February 2007 (with the exception of DOC), or in 2008 (with the exception of POC), suggesting there are seasonal and inter-annual differences in the factors that control TEP concentrations.

Since the most likely source for TEP and TEP precursors is growing and senescing phytoplankton (Passow et al. 2001, Passow 2002), we expected a positive correlation between TEP concentration and chlorophyll. While we observed this correlation in April and May 2007, and for the year 2007 as a whole, the lack of a clear relationship during the other cruises and 2008 was puzzling (Table 2). By averaging all the TEP and chlorophyll-a measurements from each cruise (Fig. 6), a picture of the relationship between TEP and chlorophyll-a concentrations takes shape. There is a positive correlation between the cruise-averaged TEP and chl a concentration (Spearman rho=0.71, $p<0.05$), suggesting that primary production is a first-order predictor of average TEP concentrations on a seasonal timescale over broad spatial scales, but that chl a alone is not sufficient to explain the spatial and temporal heterogeneities observed during each cruise.

While TEP is often directly correlated with chl a concentrations (Passow & Alldredge 1995, Ramaiah & Furuya 2002, Wurl & Holmes 2008, Ortega-Retuerta et al. 2009), other studies have shown temporal or spatial disconnects between TEP and chl-a (Schuster & Herndl 1995, Garcia et al. 2002, Corzo et al. 2005) that resulted in weak or no correlations between the two measurements. For example, Corzo et al. (2005) found an inverse relationship between TEP and chl a concentrations in certain areas of the Bransfield Strait, Antarctica, likely due to a time lag between peak

biomass and peak TEP production within a phytoplankton bloom. This is similar to the findings of Garcia et al. (2002) in the Gulf of Cadiz, where TEP and chl a maxima were spatially distinct. TEP production by phytoplankton is highly variable, and is influenced by a variety of factors including species composition, growth phase, nutrient levels, and turbulence (Passow 2002, Ramaiah & Furuya 2002, Beauvais et al. 2006) that could lead to maximum TEP production becoming decoupled from maximum chl a concentrations.

Bacterial processes also influence TEP concentrations, either by producing TEP or TEP precursors themselves (Passow 2002 Sugimoto et al. 2007), stimulating TEP production by phytoplankton (Grossart & Simon 2007), or by degrading TEP or consuming TEP precursors (Grossart & Simon 2007). The interplay of these mechanisms by which bacteria regulate TEP concentrations are complex, often species-specific (Grossart et al. 2006), and difficult to predict *in situ*. We observed highly variable levels of bacterial production over the course of the study (data not shown) in both the particle-attached and free-living communities, but no relationships were found between bacterial production and TEP concentration. It is possible that much of the variability in TEP concentrations observed is due to the complicated nature of the relationship between bacteria and TEP.

Stratification has not been widely studied as a control on TEP formation or concentration, likely because there have been few studies of TEP in highly stratified systems. Corzo et al. (2005) reported horizontal differences in TEP concentrations due to the presence of a slope front in the Bransfield Straight, Antarctica. In this region they reported relatively high TEP and chl a concentrations in the upper layer

brought about by increased thermohaline stratification. In addition, the importance of stratification for the concentration of mucilage in the Adriatic Sea is well known (Alldredge & Crocker 1995, Precali et al. 2005). However, these mucilage events are unique to a few specific locations (Leppard 1995) and the spectacular size (up to meters long) and concentration of mucilaginous aggregates during these events distinguishes them from the majority of TEP studies (Precali et al. 2005). We believe our study to be the first to quantify stratification and directly correlate it with TEP in a system without conspicuous mucilage events.

TEP concentration was significantly correlated with degree of stratification in April and May 2007, May 2008, and 2007 as a whole (Table 2). Several mechanisms exist by which stratification could influence TEP concentrations in the Chesapeake Bay ETM region. Sinking TEP particles could accumulate on the pycnocline when they reach a water density at which they become neutrally buoyant. This same mechanism is responsible for the formation of mucilaginous "false bottoms" in the Adriatic Sea (Alldredge & Crocker 1995, Precali et al. 2005). In the ETM region vertical stratification was frequently high, at times greater than 2 $\Delta S\ m^{-1}$, which is the stratification level associated with "false bottom" formation in the Adriatic (Precali et al. 2005). Alternately, stratification could enhance the formation of TEP. Since the Mg^{2+} and Ca^{2+} cations necessary for the coagulation of TEP from dissolved or colloidal precursors are two orders of magnitude greater in seawater than in freshwater discharged from the Susquehanna River (USGS site number 01578310 http://nwis.waterdata.usgs.gov/usa/nwis/qwdata, Bianchi 2007), the concentrations of these cations should be conservative with salinity. A positive correlation observed

between TEP concentration and salinity in the Neuse River Estuary was attributed to Mg^{2+} and Ca^{2+} availability (Wetz et al. 2009). Thus the interface between low and high salinity waters could be a hotspot of TEP formation, provided that TEP formation is limited in low-salinity waters by low concentrations of Mg^{2+} and Ca^{2+} cations.

Model of the formation and distribution of TEP

Based on the observed relationships between TEP concentration and chl a, stratification, and TSS we can propose a theoretical model to explain the distribution of TEP in the upper Chesapeake Bay. The observed relationship between average TEP and chl a concentrations in the fresh and high-salinity samples suggests that photoautotrophic production is the main source for TEP and TEP precursors, but due to differences in the timing of peak biomass and peak TEP production, high chl a concentrations are not always associated with peaks in TEP concentration. In addition, the abiotic coagulation of TEP from dissolved organic matter is dependent on chemical conditions (Mg^{2+} and Ca^{2+} concentration, pH) that change across salinity gradients, making the pycnocline a likely hotspot of abiotic TEP production. Furthermore, changes in water density associated with the pycnocline will allow TEP and TEP-containing aggregates to accumulate in zones where they become neutrally buoyant. The high degree of stratification often associated with the pycnocline combined with the effects of estuarine circulation in the region could further distribute TEP away from their source; vertical movements of TEP of only a fraction of a meter due to sinking or turbulent mixing could result in the particles being advected in opposite directions. These processes, coupled with the particle-trapping

behavior of the ETM region (Sanford et al. 2001) result in TEP concentrations becoming further decoupled from their phytoplankton sources.

Conclusions

TEP concentrations in the Chesapeake Bay ETM were persistently high in 2007 and 2008, although different seasonal patterns were observed between these years. Average concentrations were among the highest reported for any system, and were similar to concentrations reported for other estuaries. TEP make up a significant fraction of the POC in the ETM, and so are likely to be an important part of detrital food webs that support the high secondary production typical of ETM regions. Although direct correlations between TEP and chl a concentration were not always observed, average region-wide TEP and chl a concentrations were positively correlated, suggesting that phytoplankton are the ultimate source of TEP or TEP precursors. Additional factors, such as degree of stratification, that could affect formation and concentration processes likely play a more important role in determining local TEP concentrations than mere proximity to TEP or TEP precursor sources. In addition, the presence of TEP particles likely enhances the entrainment of particulate matter in the region by increasing aggregate size and sinking velocity (Geyer 1993, Sanford et al. 2001), making them important for the formation of this feature. Since the ETM zones of other estuaries (Winkler et al. 2003) are also known to be nursery areas for ecologically and economically important species, further studies into the role of TEP in the maintenance and productivity of these regions will be beneficial to the understanding of the ecology of these organisms.

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Tables

Year	Winter	Early Spring	Late Spring	Fall
2007	Feb. 23-26	Apr. 9-15	May 8-30	Oct. 2-8
2008	Jan. 23-26	Apr. 17-23	May 16-22	Oct. 3-9

Table 1.1: List of cruise dates.

Cruise		Pha	Chl a	POC	DOC	TSS	Strat
Feb 07	Spearman	.041	-.099	.112	-.005	.379	-.339
	Sign.	.830	.603	.557	.977	**.039**	.083
	N	30	30	30	30	30	27
Apr 07	Spearman	**.603**	**.346**	**.550**	**.281**	**.576**	**.392**
	Sign.	**<.0001**	**.014**	**<.0001**	**.045**	**<.0001**	**.010**
	N	**50**	**50**	**51**	**51**	**51**	**42**
May 07	Spearman	**.743**	**.415**	**.786**	**.657**	**.829**	**.559**
	Sign.	**<.0001**	**.001**	**<.0001**	**<.0001**	**<.0001**	**.0001**
	N	**63**	**63**	**63**	**63**	**63**	**41**
Jan 08	Spearman	.365	-.336	**.671**	-.134	**.779**	-.352
	Sign.	.181	.221	**.006**	.634	**.001**	.318
	N	15	15	15	15	15	10
Apr. 08	Spearman	.352	-.442	-.105	**.549**	.149	NA
	Sign.	.198	.099	.708	**.034**	.611	NA
	N	15	15	15	**15**	15	NA
May 08	Spearman	.089	-.096	.365	NA	.022	**.850**
	Sign.	.752	.694	.124	NA	.926	**.0005**
	N	15	19	19	NA	19	**12**
Oct. 08	Spearman	-.078	.075	.189	.005	.133	.413
	Sign.	.781	.790	.388	.981	.545	.235
	N	15	15	23	24	.23	10
2007	Spearman	**.476**	**.223**	**.646**	**.275**	**.724**	**.309**
	Sign.	**<.0001**	**.007**	**<.0001**	**.001**	**<.0001**	**.001**
	N	**143**	**143**	**144**	**144**	**144**	**110**
2008	Spearman	.285	-.243	**.351**	.184	.275	.201
	Sign.	.058	.093	**.013**	.331	.056	.370
	N	45	49	**49**	30	49	22

Table 1.2: Results of Spearman correlation analysis between TEP and phaeophytin, chlorophyll a, POC, DOC, TSS and degree of stratification. The Spearman rho, significance, and N are calculated for each parameter for data from each individual cruise and for all data from 2007 and 2008. Correlations with a significance level ≥ 0.05 are bolded.

Figures

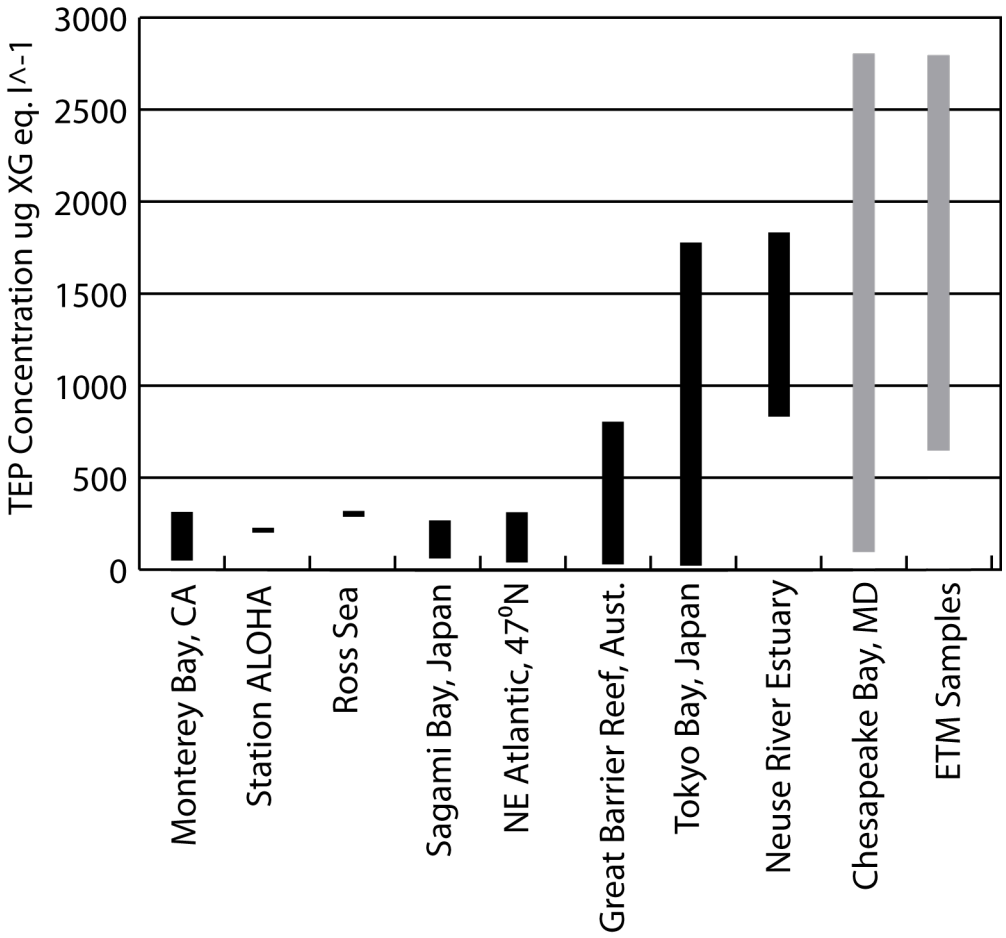

Figure 1.1: Summary of the range of TEP concentrations observed by other investigators in a variety of marine systems. Shaded bars represent the ranges observed in this study.

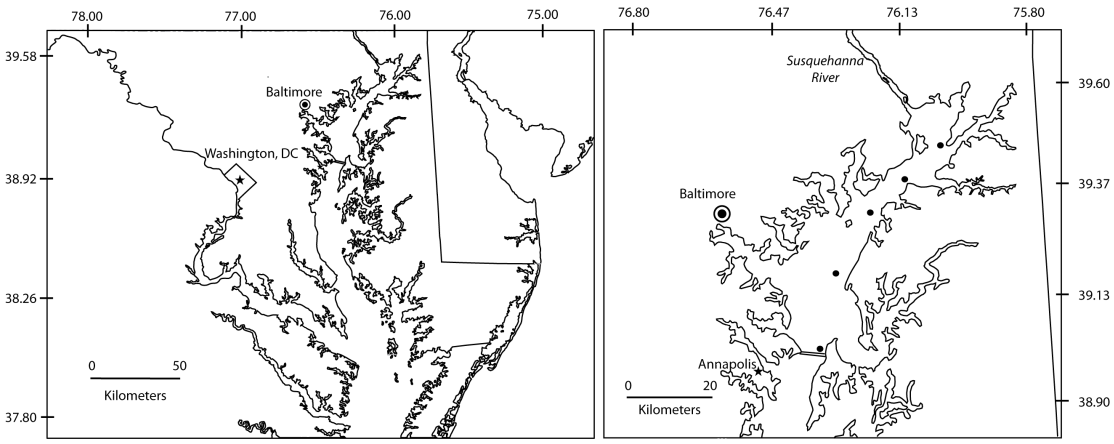

Figure 1.2: Map of Chesapeake Bay, with a detailed view of the turbidity maximum region. The locations of stations sampled during axial surveys are marked. During April 2007 the middle 3 stations were sampled roughly 5.5 km down-estuary of the locations shown here.

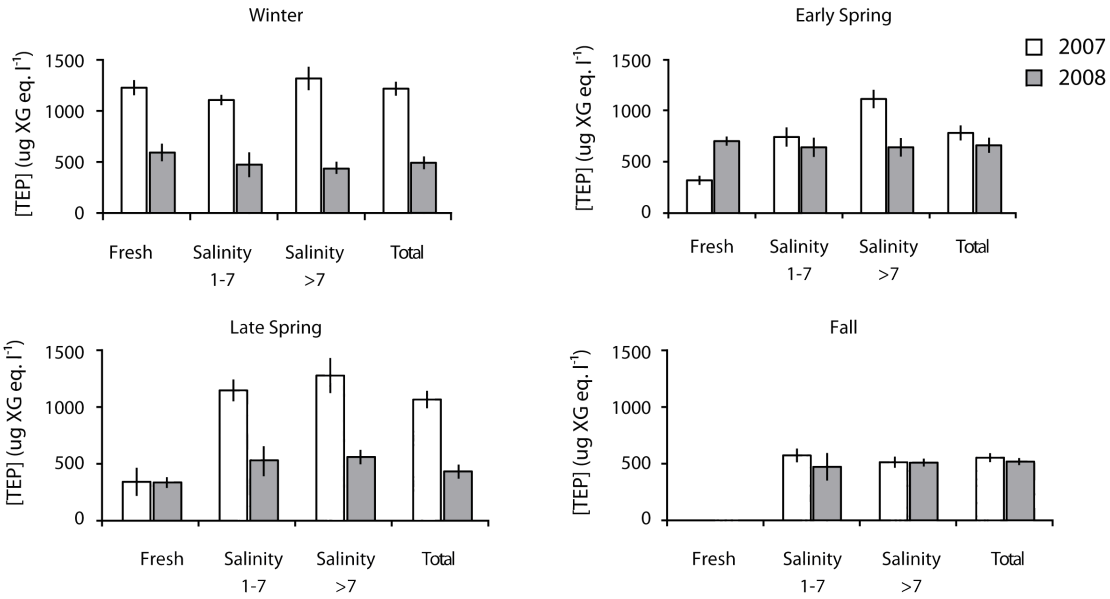

Figure 1.3: Average TEP concentrations observed during 2007 and 2008, for each cruise, ± SE. Averages are given for freshwater (salinity < 1), mid-salinity (1 < salinity < 7) and high-salinity (salinity > 7) samples, and for all samples within each cruise. Low river flow prevented collection of fresh water samples during fall cruises.

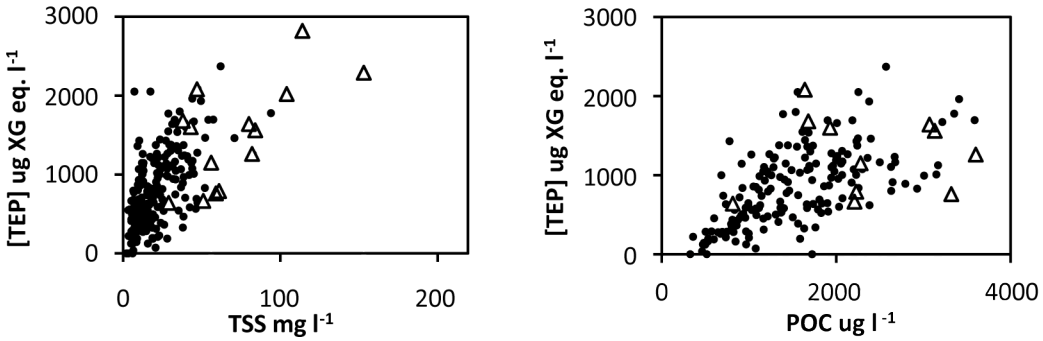

Figure 1.4: TEP concentrations versus TSS and POC concentrations for samples from all cruises. Open triangles denote samples taken during ETM events.

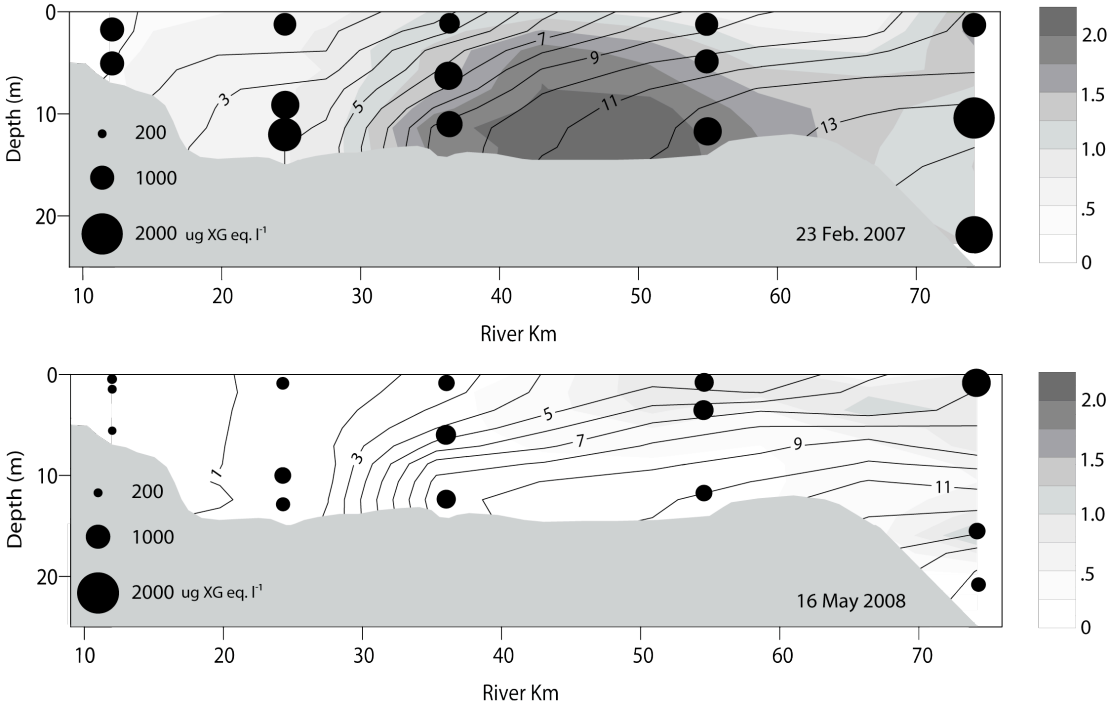

Figure 1.5: The distribution of TEP during selected axial surveys through the ETM. TEP concentration is represented by scaled bubbles, contours show salinity and shading denotes chl a fluorescence. TEP concentration is in units of μg XG eq. l^{-1}. Depth is in meters; distances from the mouth of the Susquehanna River are given in kilometers.

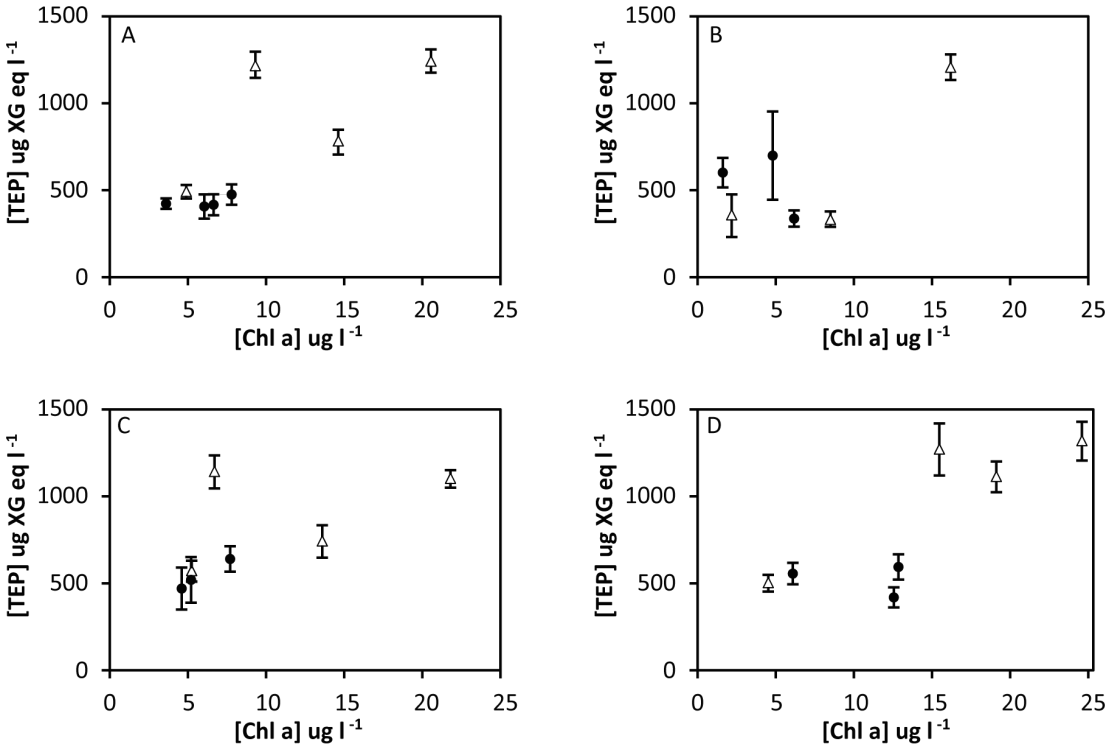

Figure 1.6: The average TEP concentration ± standard error for each cruise versus the average chl a concentration for each cruise of (A) all samples in each cruise, (B) samples with salinity < 1, (C) samples with 1< salinity <7, (D) samples with salinity > 7. TEP concentration is in units of μg XG eq. 1^{-1}. Triangles denote 2007 cruises, circles denote 2008 cruises.

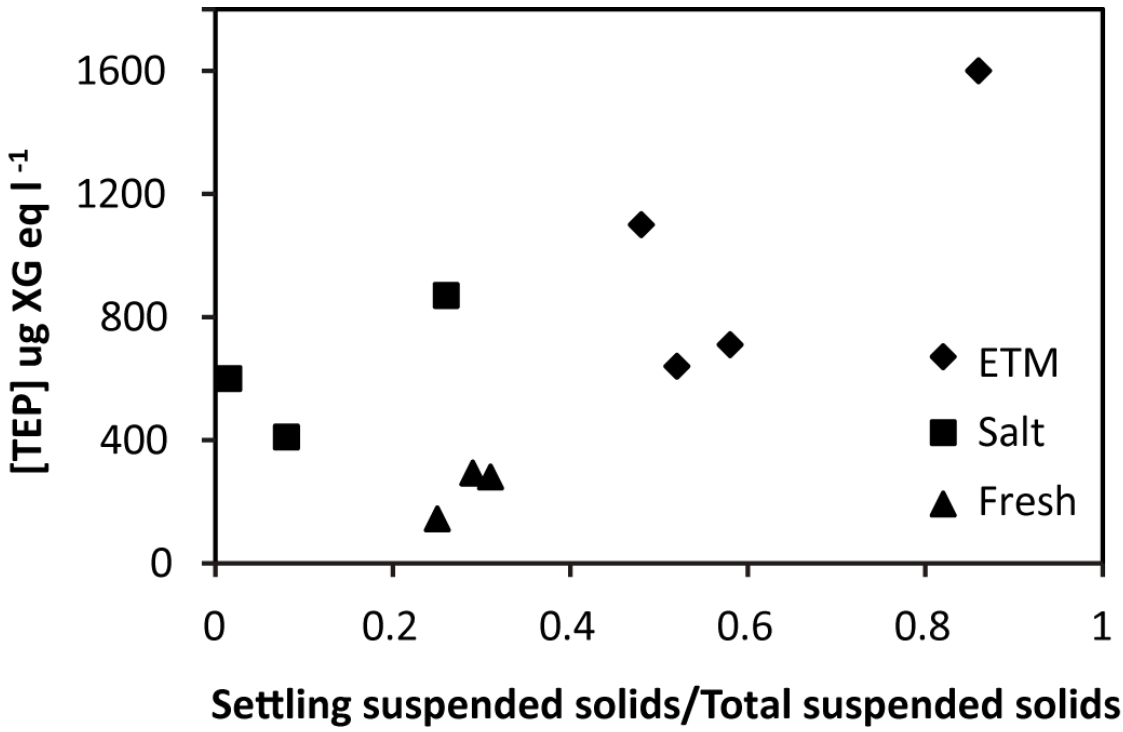

Figure 1.7: TEP concentration versus the ratio of settling suspended solids to total suspended solids in settling tube samples. Samples are labeled as coming from either freshwater or saltwater end member stations, or from ETM events.

Appendix 1: Methods

TEP

Transparent exopolymer particles (TEP) were measured using the spectrophotometric method of Passow and Alldredge (1995). Triplicate samples were filtered through 0.40 μm pore-size, 47 mm diameter polycarbonate filters (Millipore). Sample volume was chosen carefully to avoid clogging the filter, and low vacuum (< 15 cm Hg) used to avoid destroying the delicate TEP. Typical sample volumes ranged from 50 to 200 ml, depending on turbidity. Particles retained on the filter were stained for ~2 s with 1 ml of a 0.02% (w/w) aqueous solution of Alcian Blue (8GX) (Acros, cat. # 400460250) and immediately rinsed with distilled water to remove unbound dye. Stained samples were stored at -20 °C until processed.

To dissolve TEP-bound Alcian Blue, the sample filters were soaked in 6 ml of an 80% (w/w) sulfuric acid solution for 3 hours, and vortexed every hour. 300 μl of this solution was then loaded per well into a 96-well plate, and the absorbance read at 788 nm in a plate-reading spectrophotometer. TEP was quantified using a standard curve prepared with Xanthan Gum (XG), and the resulting concentrations were expressed in units of XG equivalents l^-1.

There is considerable variation in the quality of Alcian Blue dye powder between suppliers and batches. The continuous absorption spectrum of the dye in 80% w/w sulfuric acid should yield a sharp double peak just below 790 nm, with a maximum absorption around 788 nm. Inferior quality Alcian Blue will show a broader single peak at a shorter wavelength (around 744 nm). In this study a second batch of dye was purchased from a different vendor (Acros) when the first batch proved inferior (Sigma). This second batch displayed the characteristic absorption spectrum shown in figure 1.

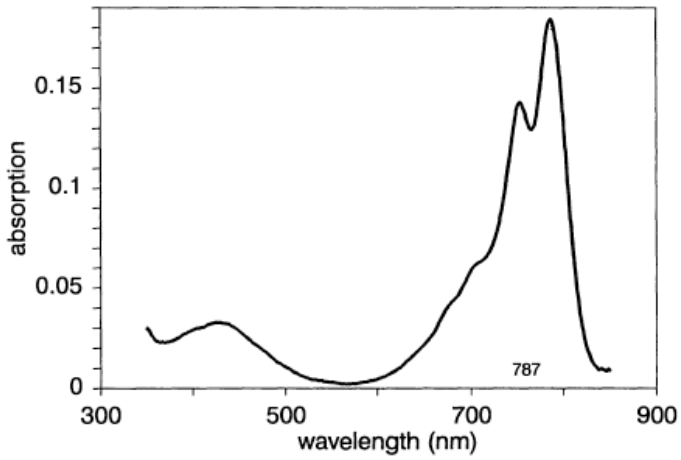

Fig. 1. Absorption spectrum of alcian blue in 80% sulfuric acid. From Passow and Alldredge 1995.

Due to the variability inherent in Alcian Blue dye powder purchased from any supplier, the exact concentration of sulfuric acid to be used in the assay should be determined experimentally for each batch of dye powder. 100 μl of staining solution was added to a range of sulfuric acid concentrations, from 75-85% w/w. The continuous absorption of Alcian Blue in each concentration was measured in a spectrophotometer, and the concentration yielding the tallest peak at 788 nm was used in the assay. In this study the solution used had a density of 1.74 g ml^-1.

Lipids

Lipid samples were processed according to a procedure based on that proposed by Inouye and Lotufo (2006).

Extraction: Samples were collected on pre-combusted (450°C, 3 h) 47 mm GF/F filters (Whatman) and stored in 7 ml glass scintillation vials at -20°C. To extract lipids from the samples 4 ml of a 1:1 dichloromethane/methanol solution was added to each vial. The filters were prodded with a stainless steel hypodermic needle to ensure they were completely submerged in the solvent solution. The vials were then capped with Teflon-coated screw caps and placed in an ultrasonic bath (Branson 2510) for 20 min. Vials were checked halfway through sonication to ensure the filters were submerged in solvent and the caps remained firmly in place.

After sonication the vials were centrifuged at 3000 rpm (Sorvall Legend RT, approx. 2000 rcf) for 5 minutes, allowing 2 layers to form. .50 ml of the bottom (non-polar) phase was transferred to a new pre-combusted 7 ml vial, and these vials were placed in a vacuum evaporator (Eppendorf Vacufuge) until dry.

Assay: Once the solvent had completely evaporated, 100 μl of concentrated sulfuric acid was added to each vial, the vials were capped tightly with Teflon-lined tops and placed in a boiling water bath for 10 minutes. The samples were then removed from the water bath, cooled to room temp on the lab bench, and 2.4 ml of vanillin reagent was added. The vials were capped tightly, vortexed, and incubated at room temp for 5 min. 200 μl from each tube was loaded into a clear-bottomed 96-well plate and its absorbance at 490 nm read in a plate-reading spectrophotometer (Bio Tek Synergy HT).

An 8-point standard curve (0-100 μg cholesterol) was prepared for each sample run. Aliquots of a cholesterol/dichloromethane solution (100 μg l^{-1}) were added to 7 ml vials and processed alongside the samples starting from the evaporation step.

Only pesticide residue grade solvents were used (Acros). Vanillin reagent was prepared by dissolving 600 mg vanillin (Acros) in a solution of 100 ml of hot DI water and 400 ml of 85% phosphoric acid (Fisher Scientific certified ACS grade). All glassware was combusted at 500°C for at least 2.5 hours in a muffle furnace prior to use.

Carbohydrates

Measuring carbohydrates involved two steps: an acid hydrolysis step to hydrolize polysaccharides into their component monosaccharides and reduce them to alditols, and a colorimetric assay step to quantify the reduced carbohydrate monomers.

The hydrolysis and reduction of carbohydrates was carried out using the procedure of Pakulski and Benner (1992), with slight modifications to compensate for our lower sample volume. This involves the use of concentrated (12 M) sulfuric acid and potassium borohydride to hydrolyze and reduce carbohydrates to alditols. This method was chosen over others that use hydrochloric acid solutions as a hydrolyzing agent because of its ability to thoroughly hydrolyze high molecular weight carbohydrates without reducing yields (Pakulski and Benner 1992).

Whole or filtered (0.7 μm glass fiber filter) sample water (4 ml) was aliquoted into triplicate 7-ml glass scintillation vials. The vials were placed in a vacuum

evaporator (Eppendorf Vacufuge) at 45°C until dry. 250 μl of 12 M H_2SO_4 was then added to each vial, the vials were tightly capped with Teflon-lined tops and left to incubate at room temperature for 2 hours. Each vial then received 2.25 ml of DI H_2O (Milli-Q), was recapped and suspended in a boiling water bath for 3 hours.

Following this incubation the samples were allowed to cool to room temperature. A 1.25 ml aliquot of each hydrosylate was then neutralized with 1.25 ml of 2 N NaOH in a new 7-ml vial. The pH of the neutralized hydrosylate should be close to 10, indicated by the formation of a white precipitate. Additional NaOH solution was occasionally necessary to bring about precipitate formation. In these instances the additional volume was noted to allow the calculation of the initial concentration of carbohydrates.

The neutralized hydrosylate was then reduced by adding 62.5 μl of 10% (w/w) of ice-cold freshly prepared KBH_4 and incubating for 4 hours in the dark at room temperature. 62.5 μl of 2 N HCl was then added to terminate the reduction reaction, at which point any remaining precipitate disappeared and the pH was ~2.5. The evolving hydrogen gas was dissipated by vortexing the samples several times over ~15 minutes, at which point the samples were ready to be assayed or frozen for storage.

The colorimetric assay of Myklestad et al. (1997) was used to quantify the concentration of carbohydrates. This method uses the reduced monosaccharides prepared above to reduce Fe^{3+} to Fe^{2+}. The concentration of Fe^{2+} produced by this reaction is then determined by its reaction with 2,4,6,-tripyridyl-*s*-triazine (TPTZ), which produces a violet condensation product. This method was chosen over the

more widely-used MBTH method of Johnson and Sieburth (1977) because it offers comparable precision but is less laborious and less prone to procedural errors. The method employs three reagents:

Reagent A: 400 mg NaOH, 20 g Na_2CO_3, and 230 mg $K_3[Fe(CN)_6]$ per liter of solution

Reagent B: 164 g anhydrous sodium acetate, 42 g citric acid, 300 g acetic acid and 324 mg of anhydrous $FeCl_3$ per liter. Reagent may be used up to 48 hours after $FeCl_3$ is added.

Reagent C: 0.78 mg TPTZ (Sigma) per milliliter in 3 M acetic acid. Reagent may be used up to 1 week.

One ml of reduced hydrosylate (prepared as above) was added to 1 ml of Reagent A in a 7-ml glass vial and incubated in a boiling water bath for 10 min. Each sample then had 1 ml each of Reagents B and C added and immediately vortexed. After 30 minutes a 300 μl aliquot from each sample was loaded into a 96-well plate and its absorbance read at 595 nm in a plate-reading spectrophotometer (Bio Tek Synergy HT).

Carbohydrates were quantified using a standard curve of d-glucose, prepared and processed parallel to each sample run, starting at the beginning of the acid hydrolysis step. All glassware used was acid-washed and combusted in a muffle furnace at 500°C for at least 2.5 hours.

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Appendix 2: Additional data

Data table

The following data table contains the following: Water sample number, station name, date, river km (distance from Susquehanna River mouth in km), dissolved oxygen (mg l^{-1}), pressure (db), temperature (degrees C), salinity, ammonium concentration (μM), inorganic phosphorus concentration (μM), total dissolved nitrogen concentration (μM), total dissolved phosphorus concentration (μM), dissolved organic carbon (mg l^{-1}), total suspended solids (mg l^{-1}), particulate organic carbon (μg l^{-1}), particulate organic nitrogen (μg l^{-1}), total particulate phosphorus (μg l^{-1}), inorganic particulate phosphorus (μg l^{-1}), TEP (XG eq l^{-1}), dissolved carbohydrates (μg l^{-1}), particulate carbohydrates (μg l^{-1}), particulate lipids (μg l^{-1}), chlorophyll a (μg l^{-1}), phaeophytin (μg l^{-1}), total bacterial production (μg C l^{-1} h^{-1}), and free-living (< 3.0 μm) bacterial production ((μg C l^{-1} h^{-1}).

WS#	station	mon	day	yr	Rkm	DOmgl	press	temp	salinity	NH4	SRP	TDN	TDP
1	AS03	Feb	23	2007	74.16	10.308	1.722	1.28	10.41	0.384	0.040	40.2	0.24
2	AS03	Feb	23	2007	74.16	9.080	11.651	1.79	11.99	0.546	0.080	35.6	0.26
3	AS03	Feb	23	2007	74.16	7.869	19.879	2.47	14.14	3.619	0.070	31.2	0.29
4	AS06	Feb	23	2007	54.66	10.569	1.739	0.33	7.47	0.708	0.090	51.2	0.22
5	AS06	Feb	23	2007	54.63	10.565	7.939	0.31	7.47	0.465	0.070	50.2	0.23
6	AS06	Feb	23	2007	54.60	9.435	10.401	1.27	10.38	0.384	0.040	47	0.36
7	AS09	Feb	23	2007	35.71	12.839	1.763	0.17	2.62	1.354	0.211	82.7	0.31
8	AS09	Feb	23	2007	35.81	18.880	8.313	0.16	4.01	1.435	0.100	81.4	0.18
9	AS09	Feb	23	2007	35.86	8.331	11.686	0.22	5.96	0.708	0.140	71.9	0.2
10	AS11	Feb	23	2007	24.67	13.111	1.953	0.18	1.17	0.869	0.130	113	0.18
11	AS11	Feb	23	2007	24.66	17.379	6.322	0.18	1.32	0.950	0.120	114	0.18
12	AS11	Feb	23	2007	24.65	9.795	12.612	0.14	1.26	1.112	0.130	102	0.24
13	AS13	Feb	23	2007	12.01	10.486	1.605	1.93	0.43	0.627	0.130	147	0.21
14	AS13	Feb	23	2007	12.01	10.488	3.525	1.93	0.43	0.869	0.171	148	0.21
15	AS13	Feb	23	2007	11.97	10.443	4.676	2.11	0.39	0.546	0.211	140	0.26
16		Feb	24	2007	30.96	10.852	1.722	0.07	1.29	0.384	0.110	115	0.19
17		Feb	24	2007	30.95	10.820	6.139	-0.02	1.54	0.061	0.100	108	0.12
18		Feb	24	2007	30.95	10.759	10.366	0.10	1.94	0.384	0.070	109	0.16
23	AS13	Feb	26	2007	11.97	10.586	1.420	0.82	0.90	0.869	0.161	140	0.18
24	AS13	Feb	26	2007	11.97	10.591	3.384	0.82	0.93	0.627	0.100	136	0.16
25	AS13	Feb	26	2007	11.96	10.585	5.699	0.81	0.95	0.788	0.110	135	0.18
26	AS11	Feb	26	2007	24.54	10.752	1.418	0.43	1.33	3.780	0.050	117	0.14
27	AS11	Feb	26	2007	24.52	10.680	10.870	0.28	3.29	0.142	0.151	91.5	0.14
28	AS11	Feb	26	2007	24.49	10.670	13.853	0.29	3.38	0.222	0.080	92.6	0.15
29	AS09	Feb	26	2007	36.45	10.593	1.266	0.32	4.38	-0.020	0.050	74.8	0.18
30	AS09	Feb	26	2007	36.41	10.213	7.065	0.59	6.69	0.142	0.050	47.9	0.2
31	AS09	Feb	26	2007	36.37	9.192	11.553	1.29	10.12	0.384	0.090	57.7	0.18
32	AS06	Feb	26	2007	54.44	10.323	1.510	1.12	9.39	0.384	0.070	40.1	0.29
33	AS06	Feb	26	2007	54.47	9.610	4.658	1.54	10.18	-0.020	0.080	34.2	0.24
34	AS06	Feb	26	2007	54.51	8.458	11.635	2.05	12.44	0.222	0.060	34.5	0.28
35	AS03	Feb	26	2007	74.16	10.269	1.640	1.95	11.14	0.869	0.070	30.6	0.3
36	AS03	Feb	26	2007	74.16	8.622	11.987	2.06	13.45	2.001	0.080	27.4	0.29
37	AS03	Feb	26	2007	74.16	8.008	22.373	2.38	14.90	2.163	0.060	27.5	0.29
59		Apr	11	2007	65.54	4.034	8.958	6.80	15.18	10.163	0.000	37.4	0.5

60		Apr	11	2007	65.54	8.819	1.870	7.94	7.31	6.409	n.d.	50.1	0.4
61	AS05	Apr	12	2007	61.03	8.718	1.460	7.75	5.58	4.504	0.038	69.5	0.31
62	AS05	Apr	12	2007	61.01	5.545	6.557	7.27	8.95	5.543	0.715	64.6	0.34
63	AS05	Apr	12	2007	60.99	3.478	10.776	6.65	14.48	11.317	n.d.	44.5	0.35
64	AS07	Apr	12	2007	48.29	8.193	1.374	7.71	4.42	9.470	0.114	74	1.06
65	AS07	Apr	12	2007	48.28	3.875	7.490	6.84	11.02	14.089	0.057	65.9	0.425
66	AS07	Apr	12	2007	48.24	2.775	12.387	6.56	13.78	15.590	0.086	58.5	0.38
67	AS09	Apr	12	2007	35.68	8.944	1.385	7.80	0.47	5.312	0.343	90	0.71
68	AS09	Apr	12	2007	35.68	5.855	7.407	7.28	6.53	11.953	0.286	80.7	0.63
69	AS09	Apr	12	2007	35.72	3.349	12.211	6.80	11.39	15.590	0.258	73.3	0.53
70	AS11	Apr	12	2007	24.35	8.631	1.250	7.55	1.06	7.045	0.429	93.3	0.56
71	AS11	Apr	12	2007	24.36	8.242	7.172	7.52	1.66	7.622	0.391	92.7	0.6
72	AS11	Apr	12	2007	24.40	6.620	12.341	7.41	4.46	8.546	0.391	90.9	0.77
73	AS13	Apr	12	2007	11.65	6.489	3.717	7.80	0.10	2.887	0.286	101	0.42
74	AS13	Apr	12	2007	11.66	6.461	3.515	7.88	0.10	2.829	0.219	102	0.42
75	AS13	Apr	12	2007	11.66	9.414	5.441	7.88	0.10	2.829	0.258	98.75	0.44
76		Apr	13	2007	33.63	8.198	3.105	7.90	2.22	8.084	0.353	88.2	0.61
77		Apr	13	2007	33.63	7.422	5.805	7.75	3.37	10.567	0.334	84	0.57
78		Apr	13	2007	33.63	5.908	8.062	7.43	6.03	14.089	0.296	78.4	0.52
79		Apr	13	2007	33.64	4.700	9.895	7.16	8.46	11.548	0.353	83.4	0.53
80		Apr	13	2007	33.85	8.621	2.965	7.89	1.36	6.640	0.401	93	0.51
81		Apr	13	2007	33.81	7.744	6.950	7.79	2.45	8.430	0.267	89.5	0.52
82		Apr	13	2007	33.75	7.478	8.115	7.72	3.04	11.144	0.315	87.2	0.54
83		Apr	13	2007	33.70	5.723	10.274	7.41	5.77	9.412	0.343	87.75	0.53
84		Apr	13	2007	33.64	8.448	4.106	8.30	2.08	13.281	0.372	86.8	0.56
85		Apr	13	2007	33.66	8.225	7.353	8.16	2.26	9.816	0.343	85.6	0.53
86		Apr	13	2007	33.68	6.601	9.219	7.56	4.80	9.470	0.343	84.8	0.52
87		Apr	13	2007	33.72	4.070	10.753	7.02	9.93	14.378	0.315	77.8	0.57
88		Apr	14	2007	33.85	8.474	2.557	8.19	1.92	9.008	0.248	88.1	0.58
89		Apr	14	2007	33.80	6.822	5.463	7.66	4.52	12.184	0.286	82.6	0.6
90		Apr	14	2007	33.76	5.923	7.695	7.45	5.89	14.493	0.315	80.1	0.61
91		Apr	14	2007	33.71	3.900	10.939	7.00	10.21	14.031	0.305	79.1	0.65
92		Apr	14	2007	33.43	8.128	1.469	8.18	2.16	8.661	0.448	96	0.67
93		Apr	14	2007	33.47	7.487	8.771	7.90	3.19	12.876	0.687	86.4	0.96
94		Apr	14	2007	33.52	5.107	11.150	7.34	8.03	10.740	0.391	88.3	0.56
95	AS03	Apr	15	2007	74.16	8.633	1.453	8.56	7.05	2.252	n.d.	62.4	0.49
96	AS03	Apr	15	2007	74.16	4.004	9.831	7.72	12.25	10.682	0.000	52.1	0.46
97	AS03	Apr	15	2007	74.16	3.278	22.647	7.87	16.77	14.955	0.010	41.8	0.4
98	AS05	Apr	15	2007	61.12	8.586	1.614	8.47	5.69	3.176	0.124	70.6	0.36
99	AS05	Apr	15	2007	61.11	4.872	7.859	7.63	9.66	10.336	0.038	61.7	0.33
100	AS05	Apr	15	2007	61.07	2.790	10.354	7.16	14.48	16.399	0.010	46.9	0.38
101	AS08	Apr	15	2007	41.84	7.863	1.252	8.35	3.41	10.798	0.410	84.3	0.66
102	AS08	Apr	15	2007	41.82	5.143	8.136	7.71	7.97	15.417	0.153	72	0.53
103	AS08	Apr	15	2007	41.80	3.812	12.379	7.31	9.99	17.149	0.210	70.55	0.77
104	AS10	Apr	15	2007	30.57	8.486	1.389	8.46	1.14	6.294	0.410	93	0.61
105	AS10	Apr	15	2007	30.51	8.457	7.854	8.44	1.33	7.160	0.391	91.5	0.6
106	AS10	Apr	15	2007	30.44	8.173	11.506	8.37	1.94	6.929	0.382	93.7	0.57
107	AS13	Apr	15	2007	12.25	8.990	1.502	9.11	0.10	1.559	0.219	98.2	1.09
108	AS13	Apr	15	2007	12.17	8.952	3.514	9.13	0.10	1.444	0.191	98.6	0.35
109	AS13	Apr	15	2007	12.05	8.988	5.561	9.15	0.10	1.386	0.134	100	0.35
110	AS07									3.291	0.324	105	0.55
111	AS07									13.338	0.134	79.5	1.16
112	AS09									1.039	0.248	88.5	0.36
113	AS09									15.359	0.363	92.4	0.635
114	AS10									1.963	0.305	90.9	0.56
115	AS10									2.136	0.286	90.1	0.44
116	AS12									1.790	0.210	86.7	0.36
117	AS12									2.310	0.267	86.5	0.95
118	AS07									5.255	0.277	92.1	0.51
119	AS07									13.512	0.029	63.2	0.56
120	AS10									4.331	0.477	87.75	0.665
121	AS10									10.509	0.343	78.5	0.65
122	AS11									1.963	0.305	90.4	0.51
123	AS11									3.638	0.296	83.3	0.53
124	AS14A									3.291	0.095	79.8	0.35
125	AS14A									3.234	0.143	78	0.39
126	AS03	May	8	2007	74.16	7.905	1.424	13.69	6.74	2.945	n.d.	49.2	0.3
127	AS03	May	8	2007	74.16	2.178	10.021	10.95	15.79	12.934	n.d.	34.8	0.48
128	AS03	May	8	2007	74.16	1.664	23.023	10.62	18.75	12.530	0.029	29.1	0.69
129	AS06	May	8	2007	54.76	7.371	1.654	14.86	3.13	3.465	n.d.	59.9	0.24
130	AS06	May	8	2007	54.72	3.232	5.707	11.83	12.31	7.218	n.d.	42.25	0.35
131	AS06	May	8	2007	54.69	1.975	12.244	10.80	15.61	11.260	0.000	39.4	0.32

132	AS09	May	8	2007	35.69	7.628	1.550	16.30	0.61	3.234	0.229	66.2	0.37
133	AS09	May	8	2007	35.72	3.461	9.176	12.21	10.94	14.436	0.010	48.1	0.39
134	AS09	May	8	2007	35.78	2.423	13.894	11.29	13.75	12.184	0.086	42.3	0.51
135	AS11	May	8	2007	24.00	7.396	1.481	16.37	0.78	4.100	0.258	72.4	0.45
136	AS11	May	8	2007	24.04	5.089	10.740	14.54	4.49	10.625	0.076	60	1.48
137	AS11	May	8	2007	24.09	4.022	15.159	13.07	7.97	10.163	0.134	59.8	0.41
138	AS13	May	8	2007	11.71	7.905	1.580	16.33	0.10	3.869	0.200	78.6	0.52
139	AS13	May	8	2007	11.73	7.917	4.209	15.98	0.10	4.100	0.143	75.6	0.38
140	AS13	May	8	2007	11.76	7.901	6.409	15.97	0.10	4.504	0.172	74.2	0.39
141		May	9	2007	11.89	7.750	1.463	17.65	0.10	4.042	0.143	58.8	0.39
142		May	9	2007	11.89	7.610	3.333	17.48	0.10	4.215	0.153	53.7	0.32
143		May	9	2007	11.89	7.619	5.128	17.48	0.10	4.100	0.114	69.6	0.39
144	AS11	May	9	2007	23.75	7.712	1.436	16.74	0.15	4.331	0.181	75.6	0.36
145	AS11	May	9	2007	23.72	7.430	5.502	16.66	0.41	5.312	0.200	71.5	0.4
146	AS11	May	9	2007	23.68	6.356	10.134	15.85	2.47	4.966	0.191	69.3	0.38
147	AS09	May	9	2007	36.31	7.433	1.424	16.95	0.84	4.215	0.105	69.5	0.3
148	AS09	May	9	2007	36.30	5.307	5.984	14.54	5.42	8.142	0.067	61.9	0.34
149	AS09	May	9	2007	36.26	3.005	11.533	12.26	11.33	10.336	0.057	56.7	0.375
150	AS07	May	9	2007	47.98	7.266	1.494	15.27	3.91	2.541	n.d.	59.8	0.26
151	AS07	May	9	2007	47.98	3.136	5.364	12.39	10.92	8.430	0.019	49.8	0.42
152	AS07	May	9	2007	47.98	2.235	11.430	11.45	13.50	9.643	0.048	46.6	0.41
153	AS05	May	9	2007	60.89	6.909	1.504	14.29	6.73	3.234	0.019	49.7	0.29
154	AS05	May	9	2007	60.91	3.260	6.627	11.94	12.25	8.026	n.d.	43.8	0.33
155	AS05	May	9	2007	60.92	2.038	10.712	11.11	14.59	11.144	0.019	42.3	0.32
156	AS09	May	10	2007	36.08	7.482	1.449	17.05	2.11	6.756	0.124	70.6	0.28
157	AS09	May	10	2007	36.06	4.369	4.834	13.93	7.52	9.296	0.010	57.3	0.34
158	AS09	May	10	2007	36.04	2.618	10.981	12.28	11.34	10.682	0.086	55.7	0.44
159	AS09	May	10	2007	35.92	8.030	1.294	17.35	1.42	2.598	0.143	70.2	0.25
160	AS09	May	10	2007	35.94	6.239	6.346	15.60	4.51	7.218	0.057	63.2	0.34
161	AS09	May	10	2007	35.96	3.818	12.182	13.30	8.93	7.449	0.076	63.6	0.33
162	AS09	May	10	2007	36.27	8.433	1.432	18.05	1.74	2.194	0.048	68.9	0.23
163	AS09	May	10	2007	36.31	3.705	8.189	13.47	8.71	10.163	n/a	56.1	0.41
164	AS09	May	10	2007	36.39	2.680	12.117	12.40	11.07	10.220	0.010	54.9	0.3
165	AS09	May	10	2007	35.91	7.980	1.529	17.50	2.56	3.753	0.038	63.9	0.25
166	AS09	May	10	2007	35.93	3.971	6.019	13.84	8.03	10.971	0.010	54.1	0.34
167	AS09	May	10	2007	35.95	2.584	12.727	12.39	11.15	9.989	0.048	52.9	0.41
168	AS09	May	10	2007	36.21	8.237	1.424	17.72	2.40	1.963	0.095	66.7	0.3
169	AS09	May	10	2007	36.17	5.860	5.809	15.58	4.73	8.719	0.067	59.9	0.36
170	AS09	May	10	2007	36.12	3.266	11.874	13.14	9.46	9.527	0.105	57	0.42
171	AS09	May	11	2007	36.19	9.143	1.480	18.40	2.65	1.386	0.019	67.8	0.27
172	AS09	May	11	2007	36.15	5.812	5.756	16.03	4.65	5.081	0.029	65.3	0.3
173	AS09	May	11	2007	36.09	3.467	10.834	13.94	8.20	9.932	0.076	61.3	0.39
174	AS09	May	12	2007	33.36	8.108	1.156	18.76	1.65	1.213	0.067	66.9	0.23
175	AS09	May	12	2007	33.36	7.009	6.915	17.60	2.88	2.887	0.029	66.4	0.24
176	AS09	May	12	2007	33.35	6.772	10.417	17.49	3.03	2.310	0.038	66.5	0.44
177	AS09	May	12	2007	33.31	8.699	1.481	19.64	2.32	2.021	0.048	64.9	0.27
178	AS09	May	12	2007	33.32	6.742	6.433	17.52	3.25	4.446	n.d.	63.9	0.32
179	AS09	May	12	2007	33.33	5.146	10.446	15.88	5.67	4.793	0.143	65.4	0.51
180	AS13	May	13	2007	12.01	7.197	1.658	21.86	0.09	5.659	0.229	70.8	0.49
181	AS03	May	13	2007	65.76	8.989	1.340	17.44	6.06	0.982	n.d.	49.8	0.33
182	AS03	May	13	2007	65.76	2.921	5.776	13.20	12.18	9.816	n.d.	46.9	0.33
183	AS03	May	13	2007	65.76	0.668	11.716	11.23	17.40	15.013	n.d.	39.2	0.38
184	AS03	May	14	2007	74.16	6.110	1.595	15.29	8.86	5.832	0.057	46.6	0.35
185	AS03	May	14	2007	74.16	2.102	7.029	12.91	13.86	12.645	n.d.	41.3	0.42
186	AS03	May	14	2007	74.16	0.608	20.628	11.25	18.70	15.590	n.d.	35.6	0.4
187	AS06	May	14	2007	54.23	7.993	1.598	16.89	5.33	4.562	0.401	48.6	0.3
188	AS06	May	14	2007	54.19	2.921	6.672	13.90	10.70	11.086	0.010	46.2	0.33
189	AS06	May	14	2007	54.15	1.267	11.614	12.17	14.40	12.415	0.019	44.3	0.36
190	AS09	May	14	2007	36.24	1.638	1.530	16.07	8.76	3.522	0.067	59	0.25
191	AS09	May	14	2007	36.15	1.551	6.763	14.48	8.82	7.102	0.012	56.6	0.27
192	AS09	May	14	2007	36.04	2.614	11.844	13.85	9.70	7.622	n.d.	56.5	0.3
193	AS11	May	14	2007	24.18	7.772	1.517	19.99	0.45	4.562	0.181	67.15	0.36
194	AS11	May	14	2007	24.17	7.727	7.676	19.84	0.56	2.252	0.134	67.2	0.43
195	AS11	May	14	2007	24.19	7.431	13.860	19.31	0.93	2.425	0.153	67.7	0.35
196	AS13	May	14	2007	12.03	7.328	1.599	20.66	0.10	4.562	0.238	66.7	0.43
197	AS13	May	14	2007	12.02	7.339	2.881	20.56	0.10	4.504	0.229	67.7	0.42
198	AS13	May	14	2007	11.99	7.331	5.141	20.48	0.10	4.562	0.229	67.6	0.54
199	AS07									3.465	n.d.	65	0.23
200	AS07									11.779	0.000	46.25	0.475
201	AS10									3.003	0.448	70.3	0.62
202	AS10									5.139	0.277	65.7	0.59
203	AS11									2.194	0.410	76.5	0.74

204	AS11										3.811	0.410	70.3	0.6
205	AS14A										6.987	0.238	80.9	0.51
206	AS14A										6.525	0.210	76.1	0.43
207	AS08										2.483	n.d.	73.2	0.26
208	AS08										7.506	0.013	43.7	0.6
209	AS10										2.656	0.071	62.9	0.3
210	AS10										4.850	0.023	56.2	0.31
211	AS11										2.425	0.100	63.3	0.38
212	AS11										3.291	0.071	60	0.31
215	AS03	Oct	2	2007	74.16	5.520	1.482	22.75	15.89	2.962	0.591	23.1	1.45	
216	AS03	Oct	2	2007	74.16	3.236	12.265	23.67	17.34	0.107	0.831	31	1.76	
217	AS03	Oct	2	2007	74.16	1.701	21.180	24.09	18.23	n.d.	0.773	29.4	1.53	
218	AS06	Oct	2	2007	54.53	6.186	1.455	22.26	13.35	0.892	1.129	23.2	1.86	
219	AS06	Oct	2	2007	54.55	5.929	5.989	22.45	13.83	1.249	1.149	23.2	1.87	
220	AS06	Oct	2	2007	54.56	4.702	12.201	22.97	15.01	2.249	1.408	23	2.125	
221	AS09	Oct	2	2007	35.74	6.794	1.363	21.90	8.12	0.750	0.995	34.8	1.52	
222	AS09	Oct	2	2007	35.80	6.493	6.955	22.01	8.94	0.892	0.937	36	1.56	
223	AS09	Oct	2	2007	35.88	5.550	13.251	22.49	11.66	1.178	1.101	29.6	1.71	
224	AS11	Oct	2	2007	24.31	7.293	1.458	22.03	6.25	0.393	0.706	48.8	1.2	
225	AS11	Oct	2	2007	24.32	6.732	7.973	22.14	7.68	0.607	0.773	40.4	1.36	
226	AS11	Oct	2	2007	24.31	6.956	15.247	21.95	7.77	0.321	0.716	37	1.18	
227	AS13	Oct	2	2007	11.84	7.185	1.445	22.21	4.52	1.678	0.677	48	1.15	
228	AS13	Oct	2	2007	11.85	6.983	3.520	22.13	4.80	1.678	0.677	46.5	1.08	
229	AS13	Oct	2	2007	11.88	6.896	6.074	22.10	4.92	1.749	0.629	48.6	0.99	
230		Oct	3	2007	33.03	7.069	1.614	22.16	8.13	0.535	0.831	35.8	1.43	
231		Oct	3	2007	33.01	6.748	5.477	22.33	8.67	0.607	0.898	34.7	1.42	
232		Oct	3	2007	33.02	5.789	10.796	22.37	11.00	0.750	0.937	34.7	1.48	
233		Oct	4	2007	39.64	6.789	1.397	22.48	9.53	0.678	0.927	31.8	1.48	
234		Oct	4	2007	39.64	5.772	6.594	22.44	11.79	1.178	1.129	29.8	1.81	
235		Oct	4	2007	39.64	5.472	12.286	22.47	13.42	1.321	1.101	29	1.65	
236										0.393	0.167	92	0.33	
237		Oct	4	2007	12.00	7.353	1.555	22.06	2.40	2.748	0.379	54.5	0.77	
238		Oct	4	2007	65.76	8.669	1.482	23.23	13.36	2.249	0.639	21.6	1.53	
239		Oct	4	2007	65.76	5.155	4.976	23.18	15.99	0.107	0.610	21.3	1.29	
241	AS13	Oct	5	2007	12.14	7.081	1.375	22.61	4.90	0.821	0.639	45.8	1.02	
242	AS13	Oct	5	2007	12.13	7.026	3.860	22.61	5.13	0.607	0.562	45.6	1.06	
243	AS13	Oct	5	2007	12.11	6.957	6.175	22.60	5.25	0.750	0.543	45.9	0.98	
244	AS11	Oct	5	2007	24.37	7.324	1.255	22.63	6.76	0.107	0.562	37.4	1.09	
245	AS11	Oct	5	2007	24.38	7.255	7.116	22.63	6.82	0.107	0.658	38.3	1.15	
246	AS11	Oct	5	2007	24.39	6.482	14.170	22.67	8.05	0.178	0.764	35.1	1.24	
247	AS09	Oct	5	2007	36.57	6.868	1.363	22.63	8.45	0.107	0.812	34.1	1.41	
248	AS09	Oct	5	2007	36.53	6.304	6.234	22.71	9.62	0.750	0.995	31.9	1.61	
249	AS09	Oct	5	2007	36.50	5.172	10.860	22.71	12.62	0.321	0.937	32.7	1.55	
250	AS07	Oct	5	2007	48.03	6.063	1.538	23.09	13.03	0.607	0.908	19.5	1.595	
251	AS07	Oct	5	2007	48.03	5.902	6.741	23.25	14.49	0.607	0.879	19.7	1.58	
252	AS07	Oct	5	2007	48.03	5.553	11.966	23.29	14.90	0.678	0.773	20.5	1.57	
253	AS05	Oct	5	2007	60.94	7.876	1.550	23.22	13.72	0.178	0.754	19	1.47	
254	AS05	Oct	5	2007	60.95	2.791	5.835	23.29	16.43	1.749	1.110	27.3	1.81	
255	AS05	Oct	5	2007	60.96	2.137	11.103	23.43	17.09	1.535	1.014	25.8	1.57	
256		Oct	6	2007	40.01	6.348	1.362	22.82	10.34	0.750	1.043	28.9	1.71	
257		Oct	6	2007	40.00	5.577	5.260	23.18	13.06	1.035	0.850	23.2	1.65	
258		Oct	6	2007	39.99	5.316	10.206	23.30	14.28	1.106	0.985	24.8	1.65	
259		Oct	6	2007	40.25	6.239	1.345	22.88	10.73	0.393	0.975	28.6	1.59	
260		Oct	6	2007	40.21	6.026	5.571	22.97	11.24	0.892	0.995	26.4	1.665	
261		Oct	6	2007	40.17	5.160	10.615	23.24	13.98	1.035	1.033	26.3	1.69	
262		Oct	6	2007	39.09	6.453	1.604	22.89	9.39	0.535	0.898	27.2	1.53	
263		Oct	6	2007	39.07	5.562	6.134	22.91	11.17	1.249	1.062	27.8	1.72	
264		Oct	6	2007	39.05	5.110	11.319	23.17	13.69	1.106	1.081	28.1	1.7	
265		Oct	6	2007	39.07	6.815	1.427	23.15	9.41	0.393	0.918	30.4	1.42	
266		Oct	6	2007	39.09	5.406	6.507	23.14	12.73	1.463	1.043	25.2	1.62	
267		Oct	6	2007	39.11	5.163	12.009	23.31	14.14	1.321	0.947	25.6	1.65	
268		Oct	6	2007	39.87	6.390	1.353	23.22	11.26	0.750	0.995	25.7	1.63	
269		Oct	6	2007	39.88	5.631	5.410	23.34	13.56	0.821	0.975	24.1	1.61	
270		Oct	6	2007	39.90	5.598	10.988	23.47	14.43	1.106	0.908	22.3	1.545	
271		Oct	7	2007	35.36	6.964	1.491	23.40	8.85	0.178	0.879	34.7	1.44	
272		Oct	7	2007	35.37	6.074	6.440	23.13	9.58	0.607	0.966	31.6	1.51	
273		Oct	7	2007	35.39	5.378	11.618	23.23	11.68	0.678	1.004	31.6	1.56	
274	AS03	Oct	8	2007	74.16	6.350	1.437	23.52	14.52	0.000	0.610	24.4	1.27	
275	AS03	Oct	8	2007	74.16	3.381	9.967	23.67	17.00	0.000	0.677	26.3	1.31	
276	AS03	Oct	8	2007	74.16	0.584	20.901	23.64	20.55	0.000	0.754	32.2	1.27	
277	AS06	Oct	8	2007	54.53	6.185	1.236	23.52	14.42	0.000	0.802	21	1.42	
278	AS06	Oct	8	2007	54.55	4.701	6.092	23.46	15.02	0.000	0.956	23.2	1.63	

279	AS06	Oct	8	2007	54.56	2.622	11.285	23.38	15.87	0.321	1.206	25.1	1.81
280	AS09	Oct	8	2007	36.15	5.798	1.381	23.40	10.57	0.678	1.052	30.9	1.65
281	AS09	Oct	8	2007	36.13	5.453	5.923	23.41	11.36	0.678	1.033	31.2	1.62
282	AS09	Oct	8	2007	36.09	4.904	11.829	23.51	13.37	0.821	0.956	27.4	1.65
283	AS11	Oct	8	2007	24.07	7.438	1.155	23.33	6.11	0.000	0.610	40.4	1.07
284	AS11	Oct	8	2007	24.08	6.205	9.875	23.16	7.73	0.000	0.696	39.6	1.2
285	AS11	Oct	8	2007	24.09	6.058	13.245	23.18	7.99	0.000	0.735	38.4	1.2
286	AS13	Oct	8	2007	12.07	7.160	1.357	23.43	4.12	0.321	0.504	46.9	0.89
287	AS13	Oct	8	2007	12.07	6.991	3.247	23.32	4.29	0.250	0.485	47.2	0.89
288	AS13	Oct	8	2007	12.07	6.586	5.638	23.19	4.82	0.535	0.514	47	0.93
309		Jan	24	2008	25.45	12.832	9.567	2.22	1.82	2.820	0.341	81.5	0.46
319		Jan	25	2008	12.10	9.104	1.630	1.15	0.08	0.821	0.292	89.85	0.41
320		Jan	26	2008	65.50	4.946	6.531	5.44	17.42	3.105	0.013	36.6	0.375
321	AS03	Jan	26	2008	54.49	7.998	1.328	1.74	7.65	2.820	0.052	52.1	0.25
322	AS03	Jan	26	2008	54.51	6.814	5.199	3.39	11.88	3.034	0.716	34.2	0.33
323	AS03	Jan	26	2008	54.59	4.840	9.525	5.45	17.52	3.034	0.042	23.9	0.39
324	AS06	Jan	26	2008	35.94	8.478	1.270	1.40	2.95	4.390	0.177	60.2	0.36
325	AS06	Jan	26	2008	35.98	7.659	5.787	2.23	5.57	3.890	0.033	39.5	0.34
326	AS06	Jan	26	2008	36.09	6.089	11.971	3.99	12.20	4.390	0.052	35.05	0.325
327	AS09	Jan	26	2008	24.02	8.869	1.424	0.99	0.69	3.890	0.283	76	0.5
328	AS09	Jan	26	2008	24.04	8.347	9.951	1.80	2.60	4.818	0.215	65.5	0.47
329	AS09	Jan	26	2008	24.12	8.056	13.895	2.12	3.88	5.604	0.139	53.7	0.42
330	AS11	Jan	26	2008	12.22	8.936	1.446	1.06	0.08	2.748	0.369	80.5	0.49
331	AS11	Jan	26	2008	12.22	9.472	3.277	1.03	0.08	3.962	0.312	74.9	0.49
332	AS11	Jan	26	2008	12.24	13.724	4.887	1.04	0.11	3.462	0.331	77	0.49
333	AS13									0.964	0.273	92.3	0.39
334	AS13									1.463	0.302	91.8	0.44
335	AS13									1.249	0.283	90.15	0.4
336	AS03	Apr	17	2008	74.16	9.984	1.603	11.57	4.86	9.950	0.047	54.6	0.35
337	AS03	Apr	17	2008	74.16	6.591	7.189	10.24	10.10	11.699	0.000	47.9	0.32
338	AS03	Apr	17	2008	74.16	5.863	21.369	10.42	15.74	9.613	0.000	31.7	0.35
339	AS06	Apr	17	2008	54.74	10.149	1.525	12.11	5.35	5.576	0.000	55	0.2
340	AS06	Apr	17	2008	54.71	6.455	4.799	10.30	8.22	12.439	0.047	54.3	0.3
341	AS06	Apr	17	2008	54.67	3.754	11.455	9.55	11.54	20.245	0.237	51.4	0.56
342	AS09	Apr	17	2008	36.04	9.129	1.685	11.88	1.84	11.497	0.427	63.9	1.52
343	AS09	Apr	17	2008	35.98	6.676	7.231	10.83	5.27	17.352	0.474	60.8	0.73
344	AS09	Apr	17	2008	35.94	4.492	12.476	9.86	9.20	17.352	0.427	60.3	0.73
345	AS11	Apr	17	2008	24.32	10.439	1.865	12.99	0.13	2.817	0.237	71	0.5
346	AS11	Apr	17	2008	24.27	10.323	7.082	12.21	0.12	2.884	0.285	68.85	0.56
347	AS11	Apr	17	2008	24.22	10.298	13.010	12.18	0.12	3.019	0.332	72.1	0.52
348	AS13	Apr	17	2008	11.97	11.135	1.956	14.58	0.09	0.260	0.000	68.9	0.2
349	AS13	Apr	17	2008	11.95	11.149	3.175	14.58	0.09	0.596	0.000	65.3	0.19
350	AS13	Apr	17	2008	11.91	11.140	5.006	14.54	0.09	1.000	0.000	66.7	0.19
412	AS03	May	16	2008	74.16	11.584	1.463	16.25	6.58	0.932	0.095	40.1	0.5
413	AS03	May	16	2008	74.16	1.754	14.806	14.30	12.97	11.094	0.000	33.7	0.39
414	AS03	May	16	2008	74.16	0.219	20.884	13.90	15.32	11.161	0.000	31.5	0.37
415	AS06	May	16	2008	54.64	9.959	1.663	16.59	4.74	0.731	0.000	48.5	0.26
416	AS06	May	16	2008	54.63	9.218	6.565	15.77	7.51	2.346	0.000	39.1	0.29
417	AS06	May	16	2008	54.64	3.130	11.947	14.29	10.77	9.008	0.000	38.25	0.33
418	AS09	May	16	2008	36.10	7.974	1.472	16.46	2.69	7.393	0.237	68.4	0.56
419	AS09	May	16	2008	36.05	6.136	6.819	15.56	5.28	10.017	0.142	58.3	0.47
420	AS09	May	16	2008	36.00	3.438	12.833	14.38	9.36	11.632	0.142	48.3	0.44
421	AS11	May	16	2008	24.27	9.260	1.536	17.36	1.07	3.557	0.237	75.8	0.53
422	AS11	May	16	2008	24.27	8.866	9.981	16.96	1.35	4.499	0.285	79.8	0.6
423	AS11	May	16	2008	24.27	8.608	14.208	16.88	1.42	3.893	0.285	78.9	0.58
424	AS13	May	16	2008	12.11	9.277	1.554	18.01	0.37	2.413	0.047	73.5	0.3
425	AS13	May	16	2008	12.07	9.279	3.570	18.03	0.37	2.480	0.000	74.8	0.3
426	AS13	May	16	2008	12.00	9.264	5.362	18.02	0.38	2.817	0.095	76.9	0.29
461		May	21	2008	33.04	8.543	9.755	16.22	0.43	5.172	0.474	83.3	0.76
462		May	21	2008	12.17	9.705	1.483	15.46	0.10	1.673	0.142	88.8	0.4
463	AS03	May	22	2008	74.16	10.128	1.508	15.66	5.42	0.663	0.000	37.5	0.3
464	AS03	May	22	2008	74.16	1.319	5.762	15.28	10.94	13.785	0.000	36	0.44
465	AS03	May	22	2008	74.16	0.157	17.457	14.59	13.67	17.284	0.047	32.4	0.48
466	AS06	May	22	2008	54.58	8.830	1.575	16.00	1.72	5.710	0.142	61.2	0.43
467	AS06	May	22	2008	54.61	8.537	5.816	16.07	3.19	3.355	0.000	53.75	0.3
468	AS06	May	22	2008	54.74	3.232	12.102	15.44	8.80	7.729	0.000	38.4	0.37
469	AS09	May	22	2008	36.06	8.604	1.553	16.22	0.44	5.710	0.474	83.7	0.74
470	AS09	May	22	2008	36.08	8.280	7.865	16.24	0.66	6.720	0.474	75.8	0.75
486	AS03									2.072	0.438	26.8	1.08
487	AS03									3.011	0.389	24.6	0.87
488	AS03									7.155	0.409	25.4	0.88
489	AS06									0.899	1.149	32.4	1.64

490	AS06										1.447	1.168	31.4	1.62	
491	AS06										1.838	1.178	30.1	1.64	
492	AS09										2.150	1.428	42.5	1.835	
493	AS09										1.759	1.380	42.8	1.79	
494	AS09										1.838	1.370	41	1.74	
495	AS11										2.307	1.351	51.5	1.7	
496	AS11										2.385	1.313	49.9	1.72	
497	AS11										2.150	1.332	50	1.73	
498	AS13										3.558	1.159	66.5	1.3	
499	AS13										3.167	1.120	66.5	1.51	
500	AS13										2.932	1.149	67.8	1.525	
509											3.558	1.024	67.8	1.25	
510											3.011	0.976	70.2	1.32	
511											2.854	0.918	66.5	1.195	
512											3.167	1.024	64.2	1.39	
513											3.089	1.130	63.25	1.51	
514											3.011	1.178	61.3	1.53	
515											2.072	1.130	62.4	1.45	
516											2.229	1.063	58.3	1.61	
517											2.072	1.216	53.4	1.59	

WS#	DOC	TSS	POC	PON	TPP	IPP	TEP	CARB DIS	CARB PART	LIPID	CHLA	PHYTIN	BP	BP_FL
1	2.564	52.0	2927.8	422.12	55.26	27.25	830			246	28.65	11.54	0.321	0.115
2	2.634	38.0	2792.7	404.82	49.12	26.66	890			212	39.22	5.05	0.333	0.153
3	2.738	43.5	2676.8	407.55	60.80	36.24	1160			171	32.38	8.92	0.425	0.144
4	2.551	44.0	3409.0	431.21	83.86	42.83	1960			202	33.34	4.92	0.093	0.116
5	2.424	45.0	3216.7	411.19	79.37	44.63	1670			299	32.24	7.16	0.211	0.054
6	2.874	57.3	3587.4	484.41	86.48	46.05	1700			398	38.27	4.33	0.405	0.099
7	2.152	33.0	2499.9	192.48	56.31	35.94	1160			153	15.57	4.40	0.204	0.111
8	1.950	45.0	3148.2	364.49	71.28	45.52	1010			183	18.62	8.03	0.159	0.087
9	2.756	42.0	3007.8	315.11	80.86	51.51	990			229	24.81	7.34	0.220	0.150
10	1.359	26.0	1946.0	161.21	52.41	31.75	1100			99	11.02	4.37	0.411	0.113
11	1.449	23.5	1642.3	150.24	50.76	29.20	1440			99	10.25	4.60	0.278	0.085
12	1.445	27.5	1695.0	160.30	56.61	33.24	1080			98	10.21	4.30	0.396	0.058
13	1.153	26.5	1642.3	154.81	54.81	33.54	1220			76	7.70	5.76	0.834	0.188
14	1.230	41.5	1998.5	196.87	66.19	38.93	1190			90	7.72	6.78	0.725	0.119
15	1.265	34.5	1683.3	151.15	56.01	32.35	1540			67	7.48	6.46	0.402	0.151
16	1.404	16.5	1163.7	134.90	38.74	24.16				50	9.49	3.82	0.620	
17	1.498	16.3	1310.5	133.77	39.53	23.96				89	9.21	4.40	0.542	
18	1.450	18.0	1279.3	117.29	39.53	23.36				56	12.78	4.43	0.544	0.320
23	1.370	12.5	1163.9	111.80	35.94	21.56	1050	900	1120	95	24.46	6.01	0.499	0.360
24	1.304	12.5	1026.8	90.84	37.14	23.36	1260	1110	1370	81	25.06	8.93	0.535	0.126
25	1.260	13.0	1206.9	95.32	38.34	22.16	1050	990	1090	85	27.10	10.83	0.494	0.131
26	1.375	10.0	1181.5	139.27	34.74	20.37	930	980	1450	83	29.52	1.94	0.446	0.182
27	1.713	31.5	1964.3	217.53	58.70	31.15	1120	1030	1270	109	35.50	1.72	0.349	0.141
28	1.734	35.0	2067.8	248.67	59.90	35.34	1310	980	1130		42.53	6.85	0.358	0.105
29	1.490	11.0	1860.8	239.98	43.13	21.56	860	1000	1170	155	31.23	1.27	0.359	0.141
30	2.190	27.5	2274.6	340.61	47.92	26.95	1140			215	44.32	6.34	0.524	0.185
31	2.094	28.0	2200.8	328.31	43.13	22.76	1070	1040	1470	183	34.72	1.84	0.423	0.187
32	2.216	22.0	2023.5	279.08	31.15	14.38	950	1060	1390	157	16.74	1.90	0.343	0.199
33	2.357	22.0	2067.8	316.73	34.14	20.37	1000	1060	1410	253	15.82	6.53	0.382	0.174
34	2.477	24.0	2628.5	400.65	41.33	26.36	1100	1090	1520	234	17.40	5.31	0.422	0.146
35	2.623	33.5	1979.1	263.16	29.05	20.07	1050	1020	1500	152	10.60	4.00	0.341	0.105
36	2.538	49.5	2377.9	316.00	43.13	30.55	1930	1110	1340	203	12.37	4.26	0.405	0.101
37	2.634	39.0	2008.7	279.81	50.91	35.34	1660	1210	1480		12.03	3.53	0.415	0.084
59	2.900	9.4	1918.4	335.36	41.35	29.09	870				25.04	6.49	0.713	0.224
60	2.574	7.2	2382.2	363.55			620						1.071	
61	2.608	12.0	1421.0	231.42			1150				19.64	5.14	0.846	0.281
62	2.367	9.2	1550.5	244.82			1360				18.41	7.11	0.758	0.236
63	2.964	13.0	1768.5	273.76			1150				18.53	14.60	0.867	0.199
64	2.384	17.4	1557.4	229.09			2050				17.65	8.75	0.639	0.106
65	2.525	32.8	2185.7	307.29			1690				14.55	13.97	0.758	0.234
66	2.570	27.2	2232.3	282.37			1430				11.24	18.77	0.789	0.309
67	1.800	19.8	915.9	92.25			1140				2.35	3.07	0.292	0.111
68	2.116	30.4	1446.0	179.55			1380				5.92	10.53	0.485	0.076

69	2.410	43.4	2056.1	250.08			1150				7.51	17.31	0.656	0.155
70	1.710	27.8	1120.5	115.97			990			107	2.75	4.89	0.366	0.134
71	1.803	37.8	1679.8	144.53			1680			84	3.27	6.89	0.364	0.185
72	1.872	47.4	1635.3	164.47			2080			133	3.11	9.04	0.406	0.110
73	1.450	6.2	529.5	51.75			160			27	1.25	2.29	0.582	0.178
74	1.500	7.0	674.5	59.89			260			40	1.48	2.50	0.452	0.257
75	1.534	6.8	570.3	55.58			290			43	1.45	2.05	0.545	0.358
76	2.052	20.9	925.3	108.80			840			68	4.31	4.04	0.454	0.104
77	2.130	23.2	1256.1	152.07			1000			100	4.16	8.62	0.674	0.217
78	2.304	34.0	1668.6	207.55			1360			114	6.37	12.50	0.633	0.339
79	2.040	28.8	1390.2	166.62			1770			146	5.03	9.52	0.480	0.203
80	1.721	15.1	704.7	81.32			740			76	2.16	3.27	0.393	0.032
81	1.739	25.0	1112.6	118.12			820			140	2.88	5.99	0.384	0.082
82	2.004	36.0	1535.2	168.24			1800			188	3.94	10.46	0.283	0.033
83	1.912	28.4	1356.7	139.68			980			176	3.43	8.76	0.556	0.136
84	1.883	21.6	1051.0	112.04			860			175	3.78	5.68	0.343	0.082
85	1.862	29.4	1345.5	141.84			1380			159	4.41	6.01	0.413	0.075
86	1.877	28.2	1233.7	141.84			1270			185	3.87	6.87	0.314	0.088
87	2.250	56.4	2276.3	286.67			1150			334	5.72	16.02	0.528	0.105
88	1.712	17.4	891.7	104.76			720				3.25	5.56	0.339	0.115
89	2.090	21.6	1222.5	148.84			1020			199	4.60	7.88	0.497	0.150
90	2.251	33.4	1724.2	202.71			940			244	5.60	12.39	0.488	0.149
91	2.287	36.8	1668.6	201.63			1070			275	5.57	12.88	0.465	0.181
92	2.038	42.4	1666.0	166.97			580			182	3.45	8.36	0.282	0.105
93	2.165	94.0	3353.0	362.50			1780			463	5.90	19.48	0.629	0.115
94	2.321	70.8	2397.0	244.16			1460			263	4.91	14.91	0.412	0.098
95	2.640	2.1	1723.7	264.62				1340	1900	367	21.67	6.50	1.157	0.613
96	2.916	7.2	2254.3	386.15			2050	1290	1140	462	25.18	8.04	1.135	0.311
97	2.870	10.2	1735.3	259.23			640			575	16.46	10.00	0.735	0.250
98	2.654	7.2	1633.0	261.79			330	1280	1740	304	29.73	8.03	0.417	0.322
99	2.690	12.8	1446.0	344.25			910	1310	1680	441	19.29	12.38	0.882	0.429
100	2.837	40.8	2670.3	381.74			1230	1180	1610	570	16.20	22.05	0.828	0.332
101	2.009	46.2	1790.7	190.08			570	1240	1530	241	5.70	10.70	0.309	0.155
102	2.429	82.5	3595.5	390.22			1260	1230	1720	485	9.78	24.55	0.664	0.278
103	2.560	114.3	4299.4	462.86			2820	1120	1310	445	9.93	33.13	0.799	0.339
104	1.639	38.4	1501.8	143.69			470	1150	1360	187	2.79	6.66	0.346	0.126
105	2.187	54.2	1901.4	172.36			1690	1090	1490	225	3.09	8.58	0.370	0.119
106	1.860	47.2	1945.7	171.14			1280			180	2.83	7.87	0.274	0.169
107	1.486	16.1	794.9	71.49			380	1080	900	145	3.32	2.76	0.254	0.241
108	1.505	15.8	967.2	80.49			120	1060	900		3.43	3.15	0.375	0.342
109	1.450	14.0	858.0	76.70			360			122	3.40	2.40	0.428	0.366
110	3.271	18.3	1284.8	112.48			1210			87				
111	2.330	22.8	1583.7	196.21			1030			129				
112	1.691	25.7	1358.0	128.39			670			62				
113	2.269	104.3	4326.3	450.88			2020			265				
114	1.807	10.3	776.5	99.40			1430			85				
115	1.816	22.2	1217.9	116.81			790			693				
116	1.884	7.8	600.5	73.21			450			65				
117	2.080	11.6	910.3	94.99			490			54				
118	5.149	10.6	1172.5	164.41						129	10.79	2.08		
119	6.994	61.3	3992.0	501.70						234	15.33	5.03		
120	2.312	16.8	1106.9	123.03						87	2.89	2.67		
121	2.897	136.3	4992.0	476.92						337	4.61	13.22		
122	2.078	14.0	1178.2	144.66						89	11.91	-		
123	1.920	27.7	1685.5	160.03						90	6.56	-		
124	5.154	4.3	642.1	79.34						82	3.82	8.21		
125	1.856	18.4	1012.9	99.77						91	2.80	9.37		
126	2.557	8.2	1858.9	276.33	34.45	22.07				215	24.81	6.04	1.603	0.606
127	3.182	13.3	3021.5	442.03	48.73	35.06				304	41.43	15.97	1.716	0.474
128	2.773	16.9	2901.8	384.92	50.86	39.01				381	36.06	17.74	1.134	0.456
129	2.191	9.8	1442.1	228.43	37.25	28.03				145	24.43	4.43	0.626	0.257
130	3.007	12.9	2519.0	422.52	55.07	43.22				253	35.95	12.43	0.960	0.347
131	2.858	18.5	1980.8	295.32	47.59	35.44				235	20.05	12.17	0.607	0.525
132	1.748	12.9	1020.2	138.04	30.80	18.95				87	9.22	5.37	0.508	0.115
133	2.712	44.0	2299.5	299.25	74.71	48.73	1080			192	10.35	13.60	0.992	0.312
134	2.583	153.0	5443.6	601.13	191.95	117.51	2290			332	15.08	30.57	1.339	0.234
135	1.735	8.2	997.0	130.32	30.19	15.76	260			58	4.97	3.65	0.470	0.195
136	2.185	79.6	3066.3	309.76	97.87	59.44	1640			184	7.69	11.91	0.544	0.238
137	2.414	84.4	3126.6	308.40	109.13	69.22	1560			203	7.88	15.25	0.604	0.244
138	1.534	11.1	817.1	93.75	22.56	10.51	290			55	4.33	6.53	1.096	0.502
139	1.560	13.0	822.2	99.77	25.60	12.63	280			68	4.53	7.29	1.232	0.504
140	1.655	11.2	746.1	90.31	24.38	11.32	290			48	4.19	6.81	0.946	0.198

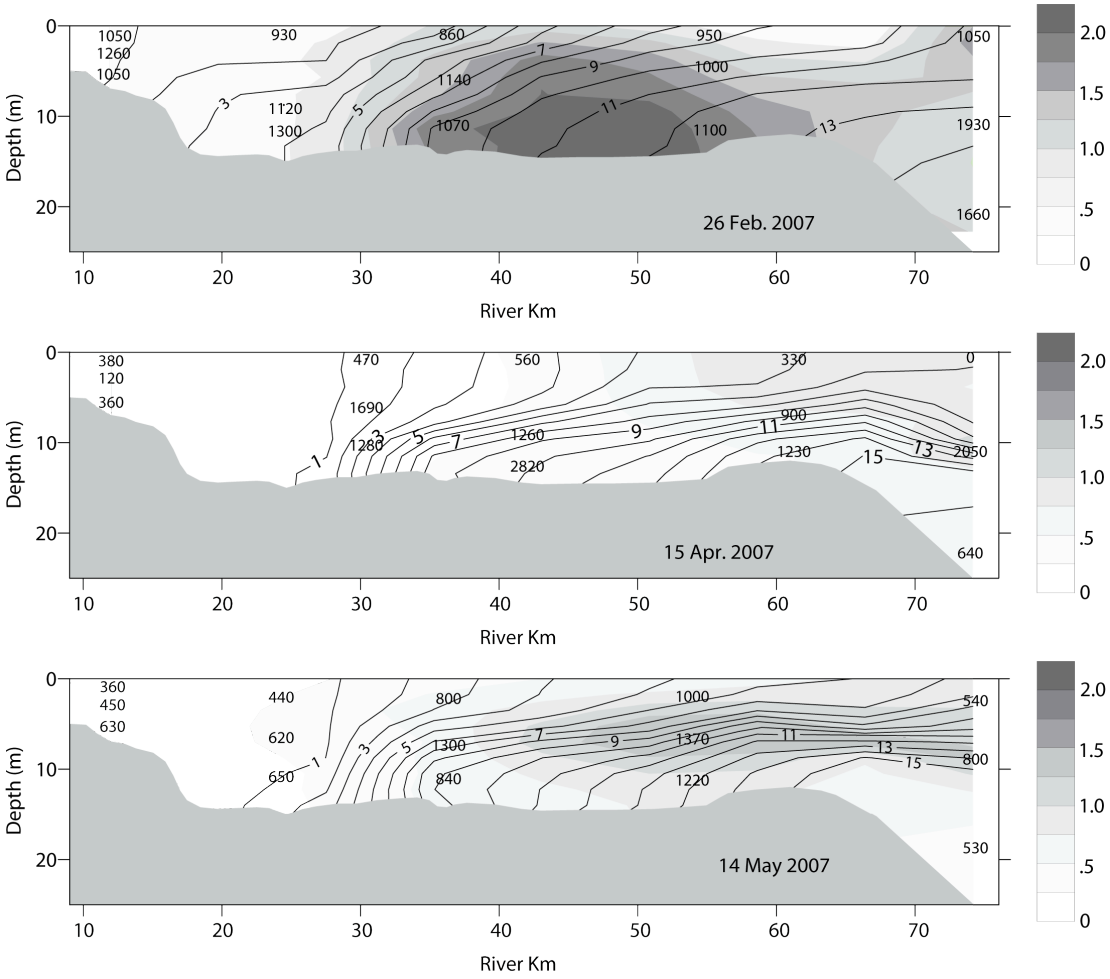
141	1.569	5.1	471.4	65.80			130	670	510	29	1.97	4.83	1.465	0.857
142	1.724	6.6	484.7	60.89			140	720	560	29	2.34	6.80	1.418	1.055
143	1.583	6.5	462.1	62.59			40	740	500	27	2.06	6.10	1.177	0.952
144	1.768	6.1	498.5	72.89			120	750	510	41	3.44	3.57	1.030	0.780
145	1.864	12.6	710.5	92.27			270	740	490	53	3.59	4.89	0.846	0.515
146	1.750	8.9	597.4	75.79			190	760	520	41	3.57	3.34	0.825	0.674
147	2.092	7.6	734.4	119.55			210	790	690	65	6.76	3.08	0.777	0.379
148	1.828	19.0	1084.8	163.18			500	780	630	86	6.97	7.07	0.938	0.549
149	2.646	13.8	1400.5	223.19			580	930	650	118	7.83	8.09	1.331	0.577
150	2.317	7.5	1761.7	287.18			340	890	570	190	21.37	6.45	1.423	0.965
151	2.701	21.0	2176.8	345.46			910	830	680	154	18.21	12.30	1.006	0.640
152	3.005	21.5	2131.0	333.16			1260	850	530	161	17.52	10.14	1.151	0.695
153	2.547	8.1	1827.9	296.46			520	890	670	162	22.62	7.08	1.016	0.691
154	2.860	10.1	2213.9	360.03			650	880	690	197	22.00	9.78	1.053	0.692
155	2.822	11.9	2071.7	338.43			710	900	780	175	18.84	13.09	1.314	0.755
156	2.153	8.5	806.4	134.96			320			82	9.84	5.16	0.643	0.339
157	2.461	23.7	1487.8	223.88			1060			110	11.11	6.98	1.159	0.403
158	2.442	39.0	2012.3	278.99			1240			179	11.27	12.30	1.125	0.564
159	1.893	7.6	935.7	138.73			510			106	10.10	4.04	0.718	0.519
160	2.191	15.5	1079.0	156.99			850			105	7.25	5.65	0.937	0.617
161	2.212	17.0	1248.1	174.65			830			99	7.85	6.28	0.643	0.461
162	2.088	8.2	957.3	134.33			460			102	10.29	2.50	0.897	0.201
163	2.456	44.2	2071.7	269.53			1170			171	7.27	12.69	1.100	0.651
164	2.474	52.2	2249.4	276.36			1470			218	10.67	12.98	1.438	0.561
165	2.110	13.1	1114.7	157.62			590			112	10.17	5.07	1.078	0.268
166	2.529	27.8	1691.0	250.63			1120			164	11.33	10.84	1.405	0.804
167	2.493	38.5	1943.2	257.34			970			178	12.12	10.66	1.672	1.016
168	1.983	8.8	1079.0	142.82			580			99	10.77	5.62	0.807	0.264
169	2.316	28.7	1612.9	210.21			1550			142	9.51	10.10	0.964	0.608
170	2.337	37.4	2000.5	252.94			1240			130	10.31	10.63	1.120	0.562
171	2.256	8.8	1214.5	158.88			480			86	13.46	4.68	0.792	0.329
172	2.220	17.2	1296.1	194.54			1220			97	10.18	7.59	0.798	0.306
173	2.434	62.0	2571.4	297.61			2370			186	11.92	17.80	1.085	0.597
174	1.861	11.6	1164.6	169.60			450			60	13.53	5.58	0.504	0.275
175	2.049	38.4	1733.2	198.41			1370			130	9.72	10.98	0.592	0.395
176	2.157	43.3	1931.9	225.29	58.18	34.46	1600			122	10.81	8.95	0.472	0.154
177	2.180	22.0	1361.1	182.33			590			131	14.10	10.92	0.744	0.260
178	2.179	31.9	1407.3	177.92			940			126	10.48	9.60	0.603	0.273
179	2.292	31.4	1281.0	176.58	52.22	32.73	1100			101	10.71	8.56	0.768	0.413
180	1.611	8.5	482.3	59.77	16.69	8.56	140				2.40	3.54	0.696	0.252
181	2.412	9.1	1898.9	212.19			650			177	17.69	5.31	1.550	0.194
182	2.683	11.8	2646.8	344.56			910			202	37.56	6.41	1.771	1.115
183	2.732	9.7	2032.7	285.54	34.26	26.97	600				23.07	6.63	0.947	0.645
184	2.675	7.5	1908.3	259.45			540			177	29.83	9.79	1.651	1.198
185	2.941	9.4	2630.6	355.70			800			195	32.75	13.39	1.853	1.244
186	2.885	7.3	1372.0	200.36			530			135	12.14	6.47	1.419	0.850
187	2.602	12.4	2228.7	313.28			1000			156	36.52	5.81	1.486	0.615
188	3.006	20.8	2241.7	309.91			1370			170	26.33	12.92	1.748	0.947
189	2.523	22.5	2359.7	330.93			1220			171	26.36	9.78	1.687	0.716
190	2.145	20.0	1461.6	209.15			800			113	20.48	5.41	1.305	0.418
191	2.358	30.3	1702.6	237.88			1300			136	16.53	9.98	1.361	0.518
192	2.520	36.9	2256.7	278.84			840			145	19.83	14.33	1.402	0.618
193	1.819	15.4	809.8	108.17			440			62	8.07	6.68	0.679	0.145
194	1.812	16.7	992.3	113.48			620			63	8.46	6.84	0.896	0.130
195	1.889	19.4	992.4	117.97			650			70	7.48	5.00	0.822	0.254
196	1.637	17.4	801.0	86.48			360			48	29.83	3.93	0.591	0.154
197	1.657	20.4	893.1	95.50			460			63	32.75	4.76	0.852	0.318
198	1.651	12.8	734.9	74.43			630			52	12.14	4.28	0.687	0.166
199	2.502	9.3	1366.8	182.49			530				17.02	4.69		
200	24.972	22.1	3167.9	425.60			1130				21.84	7.40		
201	1.831	12.1	683.0	85.34			1000				2.22	2.61		
202	2.028	23.6	1143.6	171.57			740				4.68	4.84		
203	1.999	14.3	834.6	104.34			560				4.31	2.89		
204	1.886	29.3	1172.6	149.70			1100				3.88	3.70		
205	2.068	3.5	358.7	41.49			220				0.93	1.89		
206	1.971	7.2	532.3	61.51			200				1.24	3.84		
207	2.710	6.8	1430.9	211.44			770				12.68	4.64		
208	2.939	59.2	3320.3	423.79			760				8.26	10.31		
209	2.542	7.3	869.7	111.96			430				4.34	3.37		
210	3.210	39.7	1932.7	237.31			1600				6.32	7.36		
211	2.078	11.9	799.4	105.87			310				4.47	4.57		
212	2.090	15.0	928.2	123.23			480				3.38	3.69		

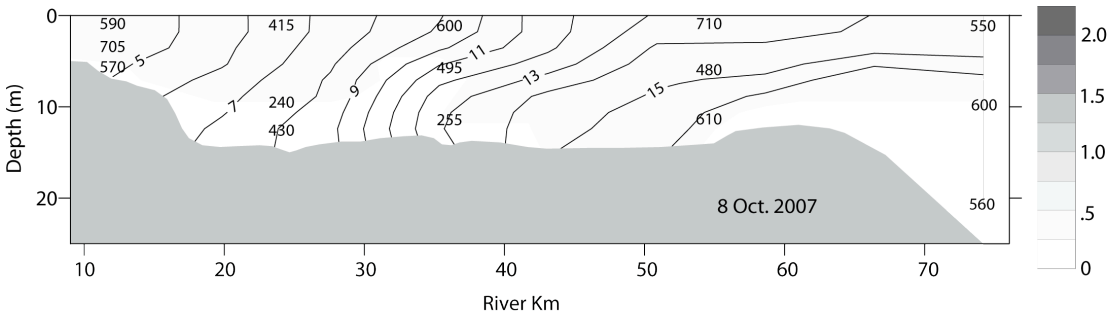
215	3.198	3.5	573.8	104.45	23.76	16.24	630	760		7.00	8.06	1.779	0.440
216	3.148	2.7	579.1	82.05	21.70	13.55	710	520		4.14	6.10	1.045	0.430
217	2.903	7.3	539.5	72.28	21.80	13.03	690	490		2.96	5.29	0.658	0.399
218	3.060	11.3	714.4	124.25	38.52	21.28	720	480		6.34	5.78	1.529	0.510
219	3.007	17.0	902.5	137.73	39.29	24.87	710	500		5.05	7.81	0.854	0.049
220	2.899	39.0	1189.8	180.45	56.75	34.00	740	610		6.10	15.02	1.171	0.571
221	2.899	22.3	708.8	93.14	31.94	19.40	750	560		2.50	4.38	0.372	
222	3.109	25.0	910.9	86.61	50.42	22.36	820	580		2.40	5.00	0.768	
223	3.056	45.0	1215.1	148.81	57.63	36.94	810	530	145	2.75	8.25	0.587	
224	3.435	10.0	770.7	107.12	26.61	16.58	790	550	63	6.94	4.18		
225	3.006	20.7	759.5	92.61	35.55	20.50	760	560	46	3.66	3.87		
226	3.080	30.0	1113.9	124.26	45.56	29.57	780	580	68	4.30	5.68		
227	2.807	25.3	787.6	108.70	37.90	24.94	620	540	53	4.06	5.25		
228	2.751	29.0	970.2	104.05	43.05	25.50	610	510	79	3.64	5.25		
229	2.925	20.0	860.1	95.73	34.74	19.07	590	530	58	5.34	4.43		
230	2.899	13.5	599.1	76.58					46	3.11	3.03		
231	2.802	17.3	725.7	78.09					39	3.18	3.93		
232	3.252	25.0	1113.9	138.91	42.68	24.81			70	3.29	6.32		
233	2.954	9.3	552.7	69.06					46	3.83	3.16		
234	2.798	13.0	1341.5	194.46					50	3.14	4.06	0.556	
235	2.980	39.7	742.6	80.46	56.21	35.83			98	3.88	8.40	0.620	0.395
236	2.375	7.7	525.6	91.85	17.52	9.80			45	4.92	7.23		1.003
237	2.720	7.3	483.6	87.12	18.48	12.08			46	5.10	3.52	0.720	0.230
238	3.203	5.7	974.8	192.48					123	13.59	10.74	2.212	0.740
239	3.360	4.5	380.9	75.50					56	6.15	8.30	1.742	1.193
241	2.903	14.0	591.1	100.12					52	4.15	3.81	1.777	1.085
242	2.839	15.0	621.6	102.46					53	4.04	4.07	0.927	0.844
243	2.850	11.7	610.4	97.52					63	3.79	4.32	0.780	0.671
244	2.916	9.3	688.6	130.51					52	9.14	3.55	1.277	1.503
245	3.022	9.0	512.5	93.36					72	4.99	3.38	1.188	1.111
246	3.002	9.8	529.3	83.85					48	3.88	3.06	0.965	0.957
247	3.000	5.5	520.9	101.68					49	5.29	2.50	0.709	0.935
248	3.021	10.8	571.3	85.80					55	2.83	3.27	0.746	0.753
249	3.084	9.8	541.9	98.40					52	5.37	3.02	0.843	0.605
250	3.136	10.8	731.8	123.65					69	7.43	5.96	2.169	1.270
251	3.029	11.3	823.5	118.40					86	7.19	7.67	2.133	1.059
252	3.027	14.3	870.4	135.05						7.64	7.53	1.891	1.235
253	3.289	4.8	714.2	126.95					59	11.02	7.02	2.330	1.301
254	2.927	4.0	433.6	71.32						2.20	5.90	1.029	0.944
255	2.989	4.3	522.7	69.05					66	4.17	6.58	1.306	0.740
256	2.996	5.8	581.9	94.67					76	4.79	3.88	2.320	0.983
257	3.155	5.5	586.8	106.24					72	5.39	4.81	1.887	0.674
258	3.187	7.3	652.8	102.94					71	5.85	4.75	1.503	1.100
259	2.915	5.0	511.9	81.45					47			0.780	0.566
260	3.045	4.5	520.7	78.69					57			1.469	0.866
261	3.100	11.5	657.2	93.21					59			1.270	0.950
262	2.886	7.7	700.1	105.90					82			0.819	0.500
263	3.141	8.7	552.2	68.81					50			1.087	1.811
264	3.010	10.3	579.9	73.97					34			0.859	0.726
265	2.898	11.0	554.0	84.29					39	3.93	3.22	1.009	0.921
266	3.242	25.3	1156.4	136.52					42	4.39	7.91	1.268	0.981
267	2.911	20.0	1002.3	134.73					53	4.14	6.40	1.186	1.049
268	3.154	11.7	770.7	100.50					43			1.852	0.971
269	3.338	16.5	997.5	145.38					42			1.773	1.151
270	2.993	21.5	909.6	124.45					43			1.658	1.114
271	2.912	8.5	683.5	108.99					51	7.48	3.79	1.211	0.487
272	3.045	18.5	709.8	93.21					36	2.81	4.69	1.084	0.680
273	2.977	27.3	1185.4	137.74					43	3.41	6.28	1.169	0.839
274	2.889	3.4	407.8	80.38			550		34	4.03	4.79	1.594	0.938
275	2.851	3.8	358.1	63.68			600		29	2.46	4.32	1.064	1.132
276	2.918	4.3	362.3	52.06			560		33	0.81	2.69	0.556	0.603
277	3.115	3.8	527.4	100.43			710		74	6.79	6.66	2.152	1.003
278	2.955	6.0	559.0	99.50			480		77	5.34	6.93	1.692	0.979
279	3.157	10.0	602.6	95.34			610		91	4.11	6.27	1.721	0.747
280	3.168	9.2	590.0	87.07			600		53	3.17	3.31	1.337	0.751
281	3.108	11.5	537.1	75.43			500		44	2.74	4.22	1.150	0.747
282	2.758	11.0	589.5	85.38			260		50	3.87	4.80	0.876	0.638
283	2.734	6.8	615.7	95.16			420		63	7.31	3.13	1.021	0.723
284	2.790	11.8	545.9	78.32			240		52	3.60	3.22	1.060	0.648
285	2.918	12.5	702.8	107.28			430		71	7.45	4.07	0.964	0.832
286	2.622	7.3	611.3	96.24			590		62	5.95	4.26	0.703	0.459
287	2.560	11.3	593.9	92.44			710		54	5.22	4.17	0.558	0.570

288	2.710	7.8	689.7	109.63			570			58	4.93	3.74	0.442	0.329
309	1.965	47.3	1836.5	166.96			640				1.92	10.65	0.548	0.268
319	1.753	14.8	695.0	74.76			280				2.44	5.55	0.254	0.171
320	2.689	8.0	1337.7	196.94			410				18.78	9.70	0.483	0.265
321	1.859	5.3	645.0	103.03			280	660	720		5.89	3.48	0.315	0.216
322	2.509	8.6	1307.2	219.39			500	720	690		17.76	9.57	0.490	0.228
323	2.754	15.3	1662.8	255.80			630	810	640		25.04	14.04	0.490	0.241
324	2.277	8.3	846.1	124.14			160	780	630		8.44	3.48	0.164	0.111
325	2.545	18.7	1586.0	238.59			200	750	700		16.47	9.28	0.456	0.213
326	2.522	24.0	1562.7	217.56			390	770	730		14.18	10.76	0.391	0.171
327	2.039	15.0	1032.3	90.88			560	740	700		1.62	2.76	0.121	0.112
328	2.127	22.7	961.7	122.60			590	630	710		3.46	4.79	0.182	0.184
329	2.470	33.2	1563.8	189.69			750	780	750		6.72	8.26	0.297	0.241
330	1.812	25.5	1128.3	109.01			620	670	710		1.57	5.92	0.210	0.134
331	1.970	61.0	2231.4	219.53			790	560	750		2.72	10.63	0.171	0.147
332	1.959	46.7	1807.9	202.98			690	570	770		2.00	7.72	0.152	0.191
333	1.686	21.0	1168.6	104.93			310	530	690		1.60	4.68	0.238	0.223
334	1.615	22.0	999.3	115.27			210	500	680		1.59	5.53	0.238	0.188
335	1.610	20.7	1077.0	105.07				510	700		1.56	4.88	0.209	0.144
336	2.294	6.3	679.3	122.85	30.92	21.07	330				10.33	5.42	0.796	0.275
337	2.706	5.5	605.7	128.33	26.82	20.38	550				8.95	5.94	0.883	0.512
338	3.791	6.5	719.0	96.84	25.06	19.00	330				6.99	7.19	0.785	0.339
339	2.150	7.8	750.8	132.90	30.12	19.92	300				10.47	5.52	1.126	0.496
340	2.222	11.0	632.1	97.04	29.89	20.38	640				7.42	6.53	0.755	0.458
341	2.456	14.8	660.3	84.11	30.77	18.73	590				2.61	6.92	0.673	0.320
342	1.911	25.7	674.0	77.60	36.58	21.66	590				1.50	3.68	0.353	0.060
343	2.204	27.7	950.6	111.23	42.82	25.44	870				1.61	4.77	0.362	0.089
344	2.159	33.0	853.7	66.33	47.36	26.96	700				1.91	5.64	0.412	0.074
345	1.852	29.7	930.9	88.20	46.29	26.77	290				2.73	5.43	0.470	0.287
346	1.437	52.5	1562.8	180.13	69.21	43.14	420				2.65	7.75	0.379	0.191
347	1.471	58.0	1387.2	140.03	75.57	46.28	520				3.27	7.70	0.578	0.244
348	1.425	20.6	730.2	114.45	32.01	17.10	290				7.06	2.04	1.014	0.847
349	1.459	20.3	674.1	93.62	34.49	18.93	270				6.75	3.88	0.939	0.634
350	1.420	19.7	798.6	78.48	30.35	16.34	200				6.33	3.79	1.030	0.668
412		10.0	1843.3	240.85	35.18	25.60	1070	780	610		34.14	-	1.187	0.132
413		10.0	1963.9	221.57	48.67	36.01	530	890	570		30.24	-	1.463	0.490
414		7.1	1235.8	120.56	32.95	25.41	420	860	430		10.87	2.62	2.069	1.103
415		7.3	1147.9	117.22	28.30	18.18	630	790	510		21.09	-	1.458	0.570
416		7.7	867.5	84.71	23.70	15.32	670	840	540		11.17	-	1.195	0.608
417		15.7	780.0	70.25	26.97	18.69	550	1070	590		3.68	1.99	1.050	0.610
418		13.3	56.4	8.75	25.95	16.24	470	890	580		3.06	3.08	0.358	0.178
419		25.0	709.1	41.33	31.78	19.30	680	790	580		3.53	2.26	0.375	0.282
420		29.2	814.5	75.21	40.44	23.69	640	830	600		2.13	5.69	0.514	0.336
421		15.3	645.8	77.62	25.64	15.01	320	750	490		5.79	4.30	0.348	0.295
422		25.8	858.8	98.61	34.54	21.09	540	680	460		4.80	4.96	0.636	0.266
423		26.2	947.0	93.15	38.43	22.98	360	710	480		5.41	4.51	0.590	0.219
424		23.0	779.6	83.75	35.97	20.94	230	540	450		8.49	4.44	0.666	0.272
425		28.1	1064.5	130.72	40.91	25.22	190	530	440		8.10	4.24	0.792	0.402
426		18.8	812.4	81.68	30.89	17.79	180	530	440		6.98	7.58	0.690	0.416
461		39.5	1922.6	131.69			710				2.74	10.30		
462		11.3	760.8	65.77			290				4.92	10.64		
463		6.8	1152.3	180.41			680				20.22	10.29		
464		5.2	1212.9	203.26			670				10.97	5.26		
465		4.2	571.7	86.30			560				2.40	3.21		
466		10.0	1010.3	147.73			690				18.20	4.19		
467		12.8	1985.1	362.08			910				51.02	0.67		
468		12.7	905.1	137.27			1120				8.15	6.25		
469		31.3	981.3	69.81			1640				2.72	5.94		
470		34.0	1290.5	98.26			1650				2.07	5.97		
486	2.853	7.2	885.5	139.86	25.44	11.64	410				8.94	6.63		
487	2.821	8.0	697.8	118.62	22.45	10.72	480				6.79	6.18		
488	2.849	8.2	623.3	87.64	18.85	9.42	530				3.40	4.61		
489	2.783	7.5	638.7	92.96	20.77	9.88	470				5.16	3.59		
490	2.949	14.8	771.8	94.16	26.67	14.17	430				4.21	5.43		
491	2.827	19.0	909.1	102.24	30.91	17.26	740				4.38	6.83		
492	2.638	18.5	776.1	75.03	27.44	16.24	330				1.83	2.80		
493	2.985	35.3	1467.5	133.02	44.04	27.48	540				1.85	5.21		
494	2.798	51.3	2211.1	182.23	62.04	39.03	670				1.75	7.95		
495	2.570	18.3	913.1	84.41	24.60	15.17	430				1.59	2.94		
496	2.710	38.0	1575.9	138.24	50.84	33.05	330				1.61	6.21		
497	2.806						550				1.82	4.99		
498	2.490	19.0	938.6	86.93	25.67	18.62	710				2.71	3.09		

499	2.745	17.0	935.0	86.01	25.44	19.82	790	2.86	3.06
500	2.688	15.3	740.9	76.46	21.76	13.17	790	2.44	2.69
509	2.644	5.3	585.5	70.77			410		
510	2.556	6.5	559.4	69.41			800		
511	2.543	7.0	510.7	58.41			500		
512	2.713	5.8	484.9	66.90			490		
513	2.803	8.3	572.1	69.89			350		
514	2.699	9.3	545.6	60.23			470		
515	2.700	7.5	472.8	50.09			340		
516	2.598	10.8	584.8	57.16			400		
517	2.630	11.8	615.7	57.90			450		

Additional axial survey plots




Depth (m)
River Km
8 Oct. 2007
590
705
570
415
240
430
600
495
255
710
480
610
550
600
560
23 Jan. 2008
620
790
690
560
590
750
160
200
390
280
500
630
17 Apr. 2008
290
265
200
290
415
520
585
865
700
300
635
590
330
555
330
16 May 2008
230
190
180
320
540
360
470
680
640
630
670
550
1070
520
420
3 Oct. 2008
705
785
425
330
550
325
540
665
470
430
740
415
480
530

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