# Fine scale patterns of water quality in three regions of Maryland's Coastal Bays: assessing nitrogen source in relation to land use.

**Data Report**

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## Summary

Intensive sampling of the Maryland Coastal Bays in May and July of 2007 served to further assess spatial patterns in nutrients, responses of biological indicators, seasons, land use, and nutrient cycling. Studies conducted in 2004 and 2006 had pinpointed the regions of St. Martin River and Johnsons Bay as areas of degraded water quality, high turbidity, increasing total nitrogen and phosphorus concentrations, high natural isotope abundance ($\delta^{15}N$), and low dissolved oxygen. Therefore the current study sought to ascertain whether the land use composition in each of these particular bays could explain some of the trends observed in water quality. The Sinepuxent Bay was also examined, as a comparatively less impacted "control" site to compare the other two bays. The abundance of crop agriculture and development of the St. Martin River watershed indicates terrestrial sources of poor water quality, especially in upstream reaches, but no such land use connection has been reported for the region of Johnsons Bay. The difference between these two coastal bays may be their flushing and nutrient cycling abilities, in conjunction with adjacent land use.

### Degraded water quality continues to be an important issue in the Maryland Coastal Bays

Total nitrogen and phosphorus concentrations remain above water quality standards. Spatial patterns indicate land use as a primary source of inputs to each bay. Decreased water clarity and low dissolved oxygen, as a result of increased organic matter, threatens seagrasses, fish, and benthic biota

### Drought lessens nutrient inputs from run-off but concentrations remain high

In comparison to the 2006 study that measured an influx of nutrients as a result of a massive rainfall event, nutrient concentrations from May to July in 2007 did not experience such an

increase. Lack of rainfall during this period resulted in less runoff and subsequent nutrient inputs, though concentrations were still high.

**High water temperature and organic nutrients increase bacteria and virus abundance**

Bacteria and viruses thrive under warm conditions with plenty of organic matter. The high organic content of dissolved and total nutrients was consistent with their abundances.

**Residence time influences dilution or aggregation of nutrients**

Johnsons Bay exhibits less than half the loading of St. Martin River but displays similar concentrations of N and P. Its long residence time and lack of linear flushing allows for nutrients to accumulate and cycle within the system.

**St. Martin River displays high upstream inputs**

Upstream reaches of both prongs of the river have high concentrations of nutrients. This pattern decreases downstream with tidal influence.

**Sinepuxent also shows indications of anthropogenic inputs**

The northernmost site closest to the Ocean City inlet consistently displays decreased water quality and clarity, when compared to sites farther away.

**Oysters indicate substantial time integration of changes in nitrogen concentration**

All tissues of deployed oyster bioindicators had increased $\delta^{15}N$, which corresponded to patterns in water quality and $\delta^{15}N$ of suspended particulate organic matter.

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## Introduction

Maintaining ecosystem health in coastal systems by effective management practices requires an understanding of broad and small scale patterns of nutrient inputs, cycling, and uptake. As development increases along the coast of Maryland, knowledge of the processes of nutrient source, delivery, and influence upon coastal bays in particular can aid in the preservation of these systems. A summary of ten years worth of data within the Maryland Coastal Bays has indicated that nutrient concentrations which had been decreasing now have begun to increase (Wazniak et al. 2007). These analyses indicate that system-wide changes are occurring, and spatially explicit assessments can help to address the cause of such water quality patterns.

Both land use and flushing rates/residence times vary among the individual bays, possibly having significant impacts on nutrient inputs and subsequent cycling. Residence times estimates range from and average of 63 days in Johnsons Bay to 12 in St. Martin River, to less than 10 in Sinepuxent Bay (Lung 1994). The unique water quality signature and its relation to the watershed of each bay can indicate specific problems and target areas for nutrient reduction strategies. The 2004 integrated study (funded by MDCBP) showed four regions of major concern; St. Martin River, Public Landing, Johnsons Bay, and Southern Chincoteague Bay (Wazniak et al 2004). Each location exhibited elevated total nutrient concentrations and also high $\delta^{15}N$, which has been successful in the indication of processed nitrogen and potential wastewater input (Costanzo et al. 2001, Jones et al. 2004) Water quality in these regions was below threshold values for seagrasses, fisheries, and other aquatic life in 2004 and again in 2006 (Wazniak et al. 2004, Fertig et al. 2006). High turbidity, low dissolved oxygen, and high total nitrogen and phosphorus concentrations created habitat conditions that were far less than optimal.

Spatial patterns in nutrient species may indicate predominant inputs and their location in each system. Inorganic pools of nitrogen (N) and phosphorus (P) from runoff, nutrient cycling, fertilizers, and groundwater sources are the preferred species for phytoplankton uptake, while organic nutrients may indicate wastewater, animal manure, and autochthonous breakdown of biota (Jordan et al. 1997, Glibert and Capone 1993). Although elevated total N and P concentrations measured in previous studies may indicate that eutrophication is occurring in the Maryland Coastal Bays, these shallow lagoons may differ in their nutrient composition, which can be indicative of either specific inputs or cycling. Processes such as preferential nutrient species uptake by phytoplankton, benthic denitrification, and bacterial cycling can serve as nutrient sinks, sources, and indicators in different locations.

Different watershed land uses can contribute to significantly different nitrogen and phosphorus loads in each of the Coastal Bays, therefore affecting the nutrient budget (Pionke et al. 2000, Beaulac and Reckhow 1982). Half to two thirds of the nutrient inputs to the whole Coastal Bays system are estimated to have come from agriculture (Bohlen et al. 1997). However, St. Martins River and Johnsons Bay have both exhibited degraded water quality, even though agriculture and forest are their respective dominant land covers. Characterizing and quantifying nutrient loading from each system's land use may be useful means by which to compare the bays, in addition to their flushing and nutrient cycling attributes.

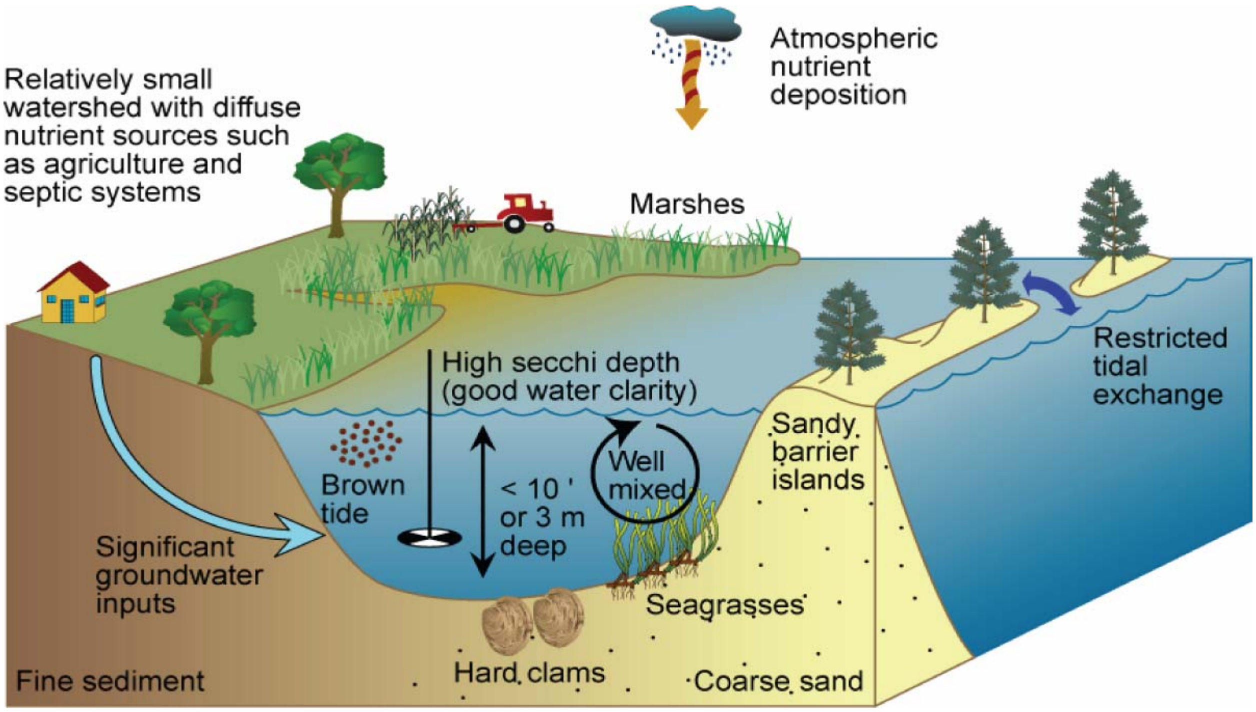



**Figure 1**: Conceptual diagram showing the key physical and biological processes within the Maryland Coastal Bays (after Wazniak *et al*., 2004)

The deployment of oysters as a time-integrated bioindicator in 2006 was successful in revealing direct nutrient inputs to Johnsons Bay and distinct seasonality in the nutrient status of St. Martin River (Fertig et al. 2006). The eastern oyster, *Crassostrea virginica*, has the potential to integrate $\delta^{15}N$ over long periods of time through its ability to turn over nitrogen at different rates in different tissues. By measuring the $\delta^{15}N$ in the muscle, gills, and mantle of the oyster, short (1-2 weeks), medium (2-4 weeks) and long (> 3 months) histories of water filtering can be revealed (Moore 2003). This analysis, in combination with the measured concentrations of water column nutrients, may provide powerful insight into the system's nitrogen inputs and cycling.

This study focused on the regions of St. Martin River, Johnsons Bay, and Sinepuxent Bay, and sought to integrate physical (temperature, salinity, Secchi depth, and dissolved oxygen), chemical (total N, total P, inorganic N and P, $\delta^{15}N$), and biological (chlorophyll *a*, phytoplankton, bacteria, oysters) parameters to address the current condition and spatial patterns of each bay. Estimates of land use composition and nutrient loading of each watershed helped in the analysis of the linkage between N and P forms and possible input sources. Nutrient cycling by bacteria and uptake by phytoplankton indicated impact of nutrient concentration and type within the bays. In addition, the analysis of oyster tissue was compared to that of 2006 to address differences in conditions and corresponding bay nutrients.

## Methodology

*Study Region*

The Maryland Coastal Bays comprise a series of shallow lagoons behind Fenwick and Assateague Islands. On two sampling occasions, May and July 2007, a water quality assessment was made of both St Martins River and Johnsons Bay, as well as three sites in Sinepuxent Bay. The same sites used in the 2006 study (Fertig et al., 2006) were sampled in St Martins River (21) and Johnsons Bay (28) (Figure x). An additional six sites were added to St Martins River, one further upstream on the Single Landing Prong and the others by the dam on the Bishopville Prong to assess inputs from watershed land use. Site locations were generated randomly using ArcView software, with the number of samples based on variability in spatial data collected in a previous survey (Jones *et al*., 2004) and where possible match the sites used in the 2006 survey (Fertig et al., 2006). Within Johnsons Bay, five sites were chosen for more intensive sampling in which all water quality measurements were made in triplicate, and additional measures of phytoplankton and bacteria were collected.  Six intensive sampling sites were also chosen from those in St. Martin River, and all three sites in Sinepuxent were sampled in this manner.

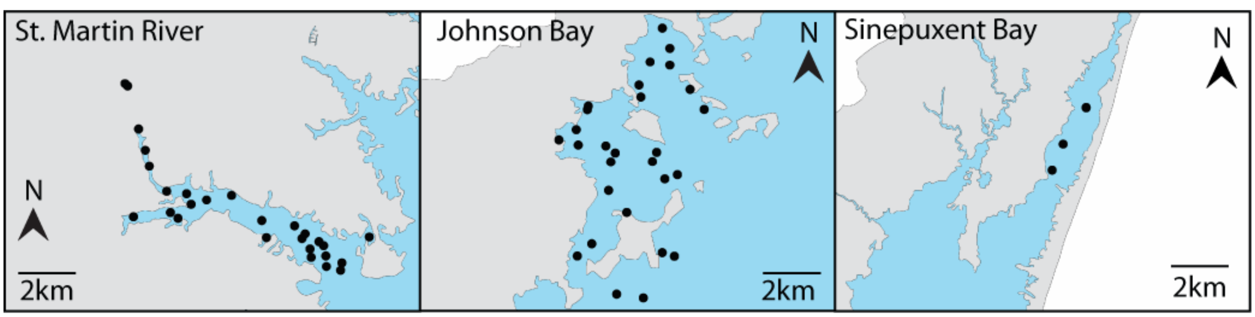



Figure 2. Sampling sites used in 2007 Survey.

*Water quality sampling*

Salinity, pH, temperature and dissolved oxygen (DO) were measured with a YSI water quality probe. Secchi depth was determined by lowering a 20 cm diameter Secchi disk through the water column until it was no longer possible to distinguish between the black and white quadrants.

*Water column nutrients*

Total nitrogen and total phosphorus were determined by collecting water samples in pre-rinsed containers, placed on ice and returned to the laboratory where they were frozen for subsequent analysis in accordance with the methods of Clesceri *et al.* (1989). Concentrations of dissolved nitrogen and phosphorus ($NO_x$, urea, $PO_4$) were measured at each study site by filtering 20mL of water through a GF/F filter, storing on ice and freezing at -20°C before analysis in accordance with the methods of Clesceri *et al.* (1989). At intensive sites, dissolved nitrogen species ($NO_2$ and $NO_3$) were also analyzed.

*Chlorophyll* a

Chlorophyll *a* concentrations were used as an indicator of phytoplankton biomass. At each site, Chlorophyll *a* concentration was determined by filtering a known volume of water through a Whatman GF/F filter which was immediately frozen. In the laboratory, the filter was ground in acetone to extract chlorophyll *a*, spectral extinction coefficients were determined on a fluorometer (Arar 1997).

*Stable isotope technique*

Nitrogen (N) occurs in two naturally stable forms, $^{15}N$ and $^{14}N$, with the predominant form being $^{14}N$ (99.6%). The various sources of nitrogen often have distinguishable $^{15}N$ to $^{14}N$ ratios, thereby making it possible to identify the source of the nutrients (Heaton, 1986). Stable isotope ratios of nitrogen ($\delta^{15}N$) have been used widely in marine systems as tracers of discharged nitrogen from point and diffuse sources, including sewage effluent (Rau *et al.*, 1981; Heaton, 1986; Wada., 1980; Van Dover *et al.*, 1992; Macko & Ostrom, 1994; Cifuentes *et al.*, 1996; McClelland & Valiela, 1998). Plant $\delta^{15}N$ signatures have been used to identify nitrogen sources available for plant uptake (Heaton, 1986). Elevated $\delta^{15}N$ signatures in seagrass, mangroves and macroalgae have been attributed to plant assimilation of N from treated sewage effluent (Wada, 1980; Grice *et al.*, 1996; Udy & Dennison, 1997; Abal *et al.*, 1998, Carruthers et al., 2005). The elevated $\delta^{15}N$ signature subsequent to treatment of the sewage effluent is a result of isotopic fractionation during ammonia volatilization, nitrification and denitrification (McClelland & Valiela, 1998).

Samples were collected by filtering a known volume of water through a Whatman GF/F filter which was immediately frozen. Filters were pressed into tin capsules and sent to University California, Davis for stable isotope analysis.

*Oyster stable isotope analysis*

Oysters were sourced from the Maryland Coastal Bays, near Ocean Pines, on St Martins River. These clutch-less (not set on shell) oysters, less than one year old, were initially grown as part of the Maryland Coastal Bays Oyster Gardening Program. Five oysters were placed in cages made from ¾" mesh, anchored by 3 bricks and suspended by surface buoys. Oysters were selected to be deployed on the 30$^{th}$ and 31$^{st}$ of May in St Martins River, Johnson Bay, and Sinepuxent Bay. Oyster cages were collected from Johnson Bay and St Martins in July. Samples were kept on ice until frozen at the laboratory until dissection. Shell length was measured and then mantle, gills, and adductor muscle were dissected out. Tissues were oven dried at 60°C for 48 hrs or until thoroughly dry and then ground with mortar and pestle. 1 mg subsamples were packed in tin capsules and sent to University California, Davis for stable isotope analysis. Samples were oxidized in a CN Biological Sample Converter. The resultant $N_2$ was analyzed by a continuous flow isotope ratio mass spectrometer. Total %N was determined, and the ratio of $^{15}N$ to $^{14}N$ was expressed as the relative difference between the sample and a standard ($N_2$ in air) using the following equation (Peterson & Fry, 1987):

$\delta^{15}N = (^{15}N/^{14}N \text{ (sample)} / {}^{15}N/^{14}N \text{ (standard)} - 1) \times 1000$ (‰).

*Denitrification*

Stable nitrogen isotope values have been known to be influenced in other studies in part by microbial processing. Denitrification, a common multi-step microbial process removes biologically available nitrogen from the environment. A preliminary indirect assessment of the presence or absence of this process and spatial and temporal patterns of relative rates was conducted using acetylene inhibition techniques on a slurry of the top 1 cm of sediment.

Measurements of nitrous oxide ($N_2O$), an intermediate byproduct, were made after 24 hrs using an electron capture detector attached to a gas chromatograph. To assess potential denitrification, 100 µM nitrate was added to the slurry to stimulate this process and measurements were made after an additional 24 hrs.

*Calculating Water Quality Index (WQI)*

A water quality index was calculated for each region using the methods of Wazniak et al. (2007) (Table 1). Two metrics were included in the current analysis, temperature and nitrogen isotope ratio of deployed macroalgae. Recent research is indicating that extended periods of warm water (>30 °C) may result in loss of seagrass due to reduction in oxygen concentrations in the vicinity of the apical meristem (Ken Moore and Jens Borum personal communications).

| **Management Objective** | **Water Quality Indicator** | **Reference Value** |
|---|---|---|
| Maintain suitable fisheries habitat | Dissolved oxygen | DO > 5 mg $L^{-1}$ |
| Maintain seagrass | Chlorophyll *a* | Chl *a* < 15 µg $L^{-1}$ |
| Maintain seagrass | Total phosphorus | TP < 1.2 µM |
| Maintain seagrass | Total nitrogen | TN < 46 µM |
| Maintain seagrass | Water temperature | Temp<30 °C |
| Reduce sewage/septic inputs | Delta $^{15}N$ ($\delta^{15}N$) | $\delta^{15}N$ < 7 ‰ |

**Table 1.** Table of management objectives for the Maryland Coastal Bays together with water quality indicators and reference values to determine the status of the objectives (Wazniak *et al.*, in press).

*Spatial analysis*

Measurements of physical parameters and water quality indicators were mapped using ESRI ArcMap. The NAD 1983 UTM Zone 18N Projected Coordinate System was selected to plot the data. Interpolation of the data was conducted by kriging, using the Spatial Analyst package and the advanced parameters from the semivariogram created by the Geostatistical Analyst. To determine the validity of kriged interpolations, the Cross Validation plot in the Geostatistical Analyst was employed. The resulting regression plot was analyzed with SAS 8.2 to determine if the slope significantly differed from zero, and thus had some measure of autocorrelation between the interpolated krig and original input data. Insignificant krigs were presented site by site without interpolation.

### *Bacterial and Virus counts*

Bacterial abundance were determined at each site by the Sybr Green method, which also allowed for counting of virus like particles (VLPs) (Hewson et al. 2001). Duplicate seawater samples were collected at 6 sites from the St. Martins River, 5 sites from Johnson's Bay and 3 sites from Sinepuxent Bay once a month during the months of May and July. Surface samples were collected using 60 mL syringes and 50 mL samples were dispensed into sterile 60 mL nalgene bottles and immediately fixed with 1 mL 1% formalin. The samples were then placed in the dark until being returned to the lab where they were placed in 4 C.

Bacteria and Viruses were enumerated using epi-flourescent microscopy according (Patel et. al. in 2007. A Nikon Eclipse E800 microscope fitted with a TE-FM epi-flourescence attachment was utilized for counting the bacteria and VLP. The filters were placed under blue light excitation at 100x oil immersion magnification. Ten fields for both viruses and bacteria were counted on each filter using a grid to count 20-120 VLP and bacteria per field. These numbers were then calculated to give bacteria and VLP estimates using the equation:
Number of each organism counted per small 1/100 square* 100 * Grid reticle scaling factor (RSF: 13529.710, for our microscope) * 5 (for dilution) / 2 mL (volume).

### ***Statistical Analysis:***

Analysis of these experiments utilized SAS and Microsoft Excel 2003 in order to determine statistical significance and correlations.

*Phytoplankton production*

Chlorophyll measurements were taken to determine phytoplankton biomass, and primary production will be based on $^{14}CO_2$ incorporation over a 3-4 h period near midday on samples returned to the lab (Parsons et al 1984; O'Donohue and Dennison, 1997).

*Calculation of N and P loads related to land use*

Assessment of Land Use: Using the available land cover inventories (Maryland Department of Planning) for these two basins in years 1973, 1997, 2000 and 2002, we estimated annual N and P loading using land use area yield coefficients (kg N or P ha-1 y-1 associated with each land use). This simple, empirical approach is based on published syntheses of literature values of nutrient yields from small watersheds (e.g., Beaulac and Reckow 1982) and has been used to estimate nutrient inputs to other coastal environments (e.g., Johnes 1996, Bilen and Garnier 1997). While there are limitations to this approach (e.g., no seasonal resolution of inputs, no spatial interactions within a basin), this simple, GIS-based approach provides economical estimates of changes in annual inputs when land use changes are happening on interannual time scales.

## Findings

| Parameter | Region | | | | | |
|---|---|---|---|---|---|---|
| | St. Martin River | | Johnson Bay | | Sinepuxent Bay | |
| | *May* | *July* | *May* | *July* | *May* | *July* |
| Secchi Depth | 0.66 (0.04, 25) | 0.36 (0.03, 25) | 0.29 (0.01, 28) | 0.42 (0.01, 28) | 1.02 (0.39, 3) | 0.48 (0.11, 3) |
| Surface Salinity | 21.07 (1.14, 24) | 25.86 (1.33, 25) | 26.38 (0.06, 28) | 32.10 (0.07, 27) | 27.27 (0.09, 3) | 31.17 (0.13, 3) |
| Surface Temperature | 25.32 (0.42, 24) | 29.67 (0.19, 25) | 23.89 (0.20, 28) | 27.73 (0.31, 27) | 25.07 (0.03, 3) | 27.53 (0.61, 3) |
| Bottom Dissolved Oxygen | 2.46 (0.16, 24) | 4.46 (0.35, 25) | 2.94 (0.09, 27) | 4.75 (0.17, 28) | 3.29 (0.08, 3) | 4.66 (0.29, 3) |
| Bottom DO % Saturation | 32.59 (2.12, 24) | 63.59 (4.81, 25) | 35.68 (1.60, 27) | 72.21 (2.99, 28) | 41.63 (0.87, 3) | 71.70 (5.99, 3) |
| TSS | 28.79 (2.91, 6) | 58.42 (21.80, 6) | 35.73 (5.49, 5) | 51.48 (5.00, 5) | 34.71 (4.07, 3) | 40.55 (5.80, 3) |
| VSS | 7.69 (0.86, 6) | 22.44 (5.16, 6) | 6.59 (0.14, 5) | 15.18 (0.65, 5) | 7.28 (0.90, 3) | 13.94 (1.84, 3) |
| TN | 58.36 (5.71, 25) | 86.68 (5.20, 25) | 60.39 (1.39, 28) | 53.67 (2.46, 28) | 50.28 (1.13, 3) | 65.51 (6.99, 3) |
| TP | 2.42 (0.27, 25) | 4.34 (0.50, 25) | 3.53 (0.06, 28) | 2.84 (0.12, 28) | 3.04 (0.02, 3) | 3.12 (0.43, 3) |
| NH4 | 1.84 (1.08, 25) | 1.49 (0.29, 24) | 0.47 (0.11, 28) | 2.13 (0.20, 28) | 0.32 (0.02, 3) | 1.90 (0.26, 3) |
| Nox | 2.13 (1.28, 25) | 0.38 (0.02, 25) | 0.21 (0.02, 28) | 0.36 (0.03, 28) | 0.17 (0.03, 3) | 0.53 (0.03, 3) |
| NO3 | 4.14 (3.99, 6) | 0.26 (0.05, 6) | 0.10 (0.03, 5) | 0.14 (0.05, 5) | | |
| NO2 | 0.45 (0.31, 6) | 0.13 (0.01, 6) | 0.14 (0.02, 5) | 0.18 (0.01, 5) | | |
| PO4 | 0.24 (0.05, 25) | 0.52 (0.16, 25) | 0.27 (0.03, 28) | 1.22 (0.08, 27) | 0.18 (0.04, 3) | 0.83 (0.09, 3) |
| CHL | 12.98 (1.05, 22) | 34.02 (2.69, 24) | 27.82 (1.21, 28) | 17.66 (1.92, 26) | 29.61 (2.60, 3) | 25.18 (4.99, 3) |
| PHAEO | 6.25 (1.19, 24) | 8.40 (1.00, 24) | 5.43 (1.80, 28) | 9.87 (2.70, 20) | 3.14 (1.12, 3) | 12.31 (1.75, 3) |
| Bacteria | 1.8E+7 (2.5E+6, 6) | 4.5E+7 (8.7E+6, 6) | 1.2E+7 (1.5E+6, 5) | 1.1E+7 (9.6E+5, 5) | 5.8E+6 (3.6E+6, 2) | 1.0E+7 (0, 1) |
| Viruses | 1.7E+8 (2.2E+7, 6) | 2.1E+8 (1.5E+7, 6) | 1.6E+8 (1.9E+7, 5) | 1.4E+8 (1.3E+7, 5) | 1.2E+8 (6.2E+6, 2) | 9.9E+7 (0, 1) |
| SPOM del N | | 11.25 (0.50, 25) | | 14.54 (0.77, 28) | | 13.24 (1.59, 3) |
| Oyster Mantle del N | | 8.58 (0.15, 13) | | 9.09 (0.10, 16) | | 9.09 (0.00, 1) |
| Oyster Gill del N | | 8.75 (0.19, 13) | | 9.18 (0.10, 16) | | 9.32 (0.00, 1) |
| Oyster Muscle del N | | 9.69 (0.11, 13) | | 9.86 (0.10, 16) | | 9.86 (0.00, 1) |
| Measured Denitrification (ppm $N_20$ $g^{-1}$ $h^{-1}$) | 0.09 (0.05, 18) | 0.13 (0.08, 18) | 0.06 (0.02, 18) | 0.20 (0.10, 9) | 0.01 (0.01, 10) | 0.06 (0.05, 9) |
| Potential Denitrification (ppm $N_20$ $g^{-1}$ $h^{-1}$) | 0.63 (0.09, 15) | 0.62 (0.26, 18) | 0.09 (0.03, 9) | 0.36 (0.11, 9) | 0.16 (0.02, 9) | 0.09 (0.06, 9) |

Table 2. Summary of measurements made in Maryland's Coastal Bays. All values are reported as mean (standard error, number of samples).

*Temperature*

May temperatures ranged between 22-26 degrees C throughout the three bays and were constant at the surface and bottom, indicating that these shallow estuaries are well-mixed. Average temperatures increased to 27-29 degrees C in July. The shallower upstream reaches of St. Martin River were warmer than other areas. Johnsons Bay was the warmest closest to the land and coolest in the southern bay outside of Mills Island, where there was probably more exchange with the ocean. Sinepuxent sites also warmed in July.

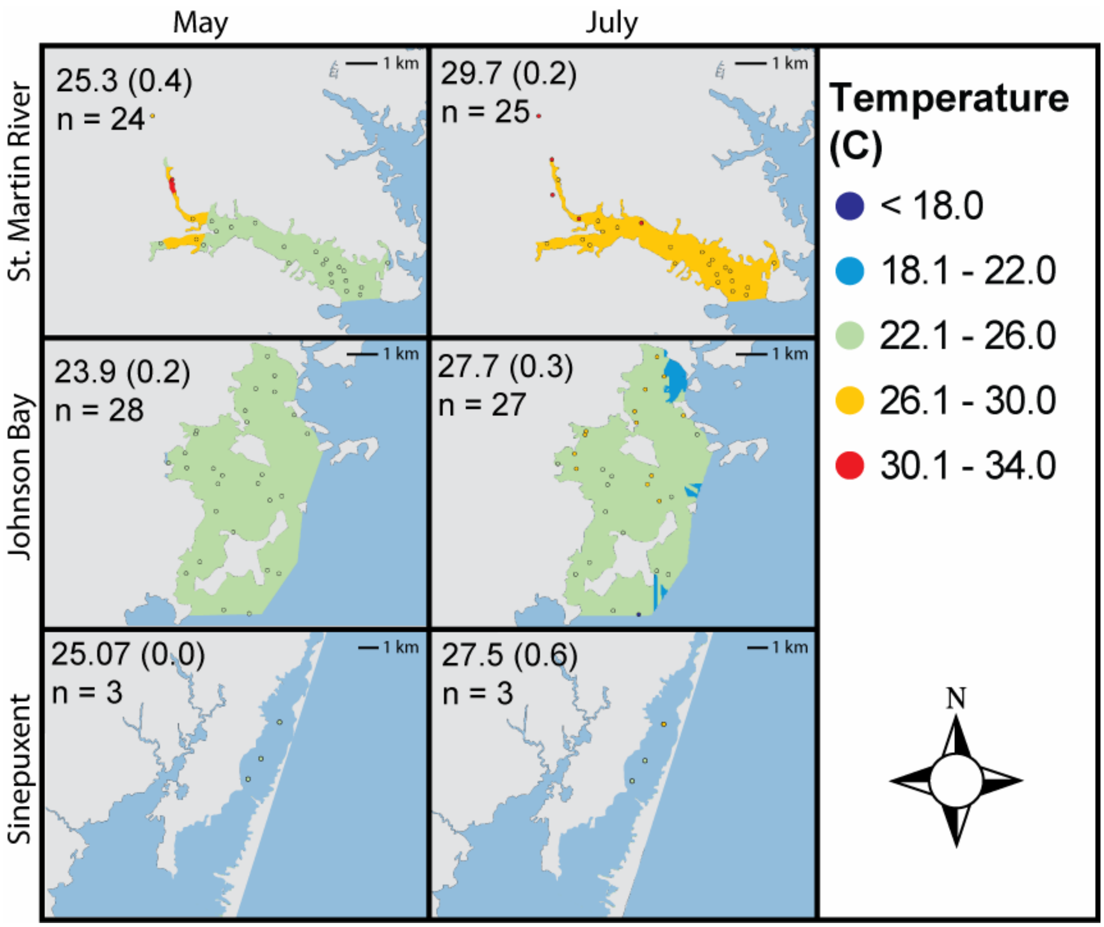



Figure 3. Spatial variation of surface temperature

*Surface salinity*

Overall salinity increased from May to July (24.11± 0.61 to 29.21± 0.73), most likely due to a lack of rain over this time period. Upstream reaches of St. Martin River were the freshest of the May sampling sites. Johnsons Bay was homogeneous and Sinepuxent had the highest salinity, most likely due to its proximity to the inlet at Ocean City and subsequent flushing with the Ocean. In July there was a gradient of increasing salinity from the prongs to the mouth of St. Martin River as well, and the mouth sites exhibited salinities 30-33. This pattern displayed a salt intrusion upstream in the river. Johnsons Bay and Sinepuxent became increasingly more saline than they had been in May, though they were still homogeneous throughout.

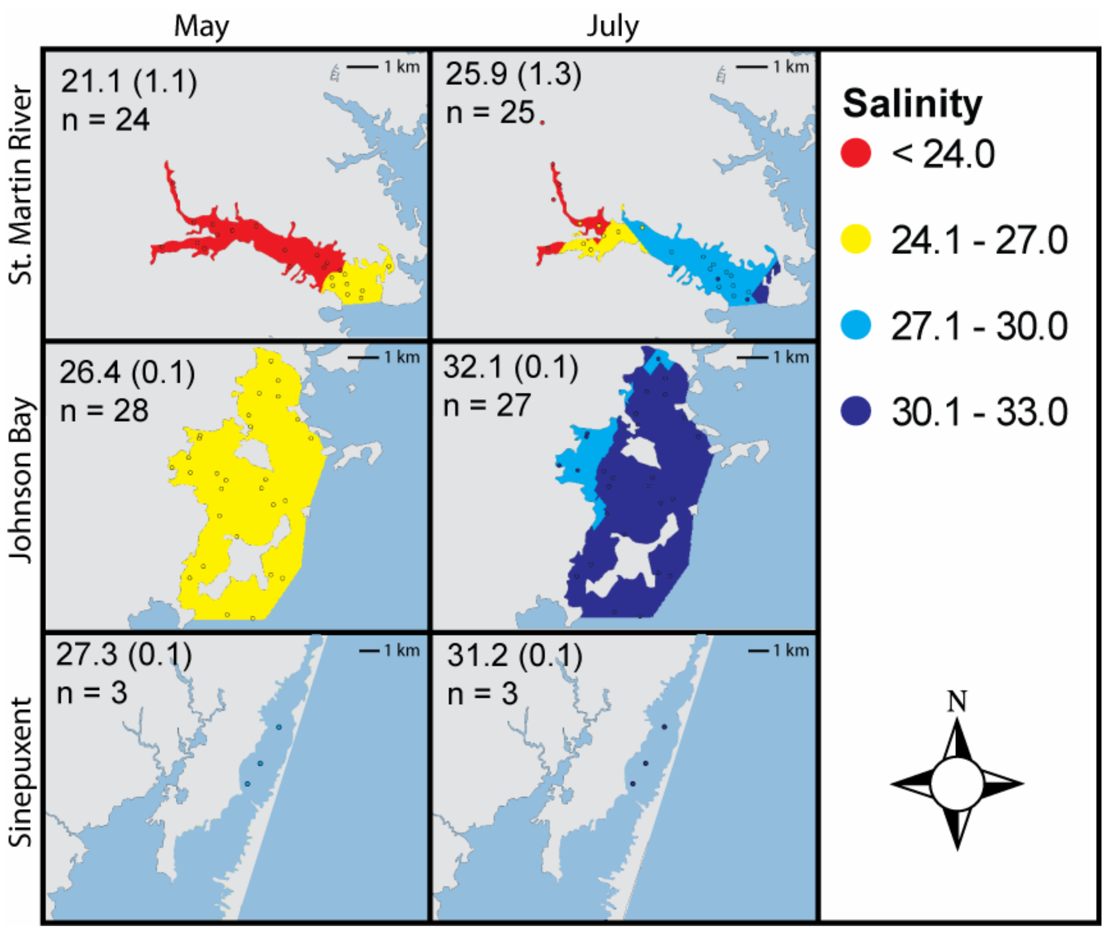



Figure 4. Spatial variation of surface salinity

*Bottom Dissolved Oxygen*

Dissolved oxygen increased from May to July in all three bays. St. Martin River (2.46± 0.16 to 4.46± 0.35mgL$^{-1}$), Johnsons Bay (2.94 ±0.09 to 4.75± 0.17 mgL$^{-1}$), and Sinepuxent (3.29± 0.08 to 4.66± 0.29 mgL$^{-1}$) were not significantly different in either month. Dissolved oxygen throughout St. Martin River was extremely low in May. In Johnsons Bay, southern sites were slightly higher than other sites in the bay but were still below an acceptable threshold. Sinepuxent had the highest levels of the three bays but was still below threshold values. This pattern, along with other parameters, suggests that even this bay is heavily impacted by anthropogenic activities, despite its location closer to the inlet and its higher salinity and rate of exchange. However, the fact that all three bays showed improvement in dissolved oxygen levels from May to July was not consistent with nutrient increases and Secchi depth. St. Martin showed a gradient from poor dissolved oxygen in both prongs to a better level at their confluence and the highest levels at the mouth. Johnsons Bay exhibited fair oxygen levels; however there was a small area of low dissolved oxygen in the southern part of Johnsons Bay. There was a slight gradient spreading northeast from this region, away from the mainland, suggesting spatial differences between the southern sub-bay of Johnsons Bay and the northern Brockatonorton Bay. It is possible that the timing of sampling for each bay during each month, especially when conducted at noon, could have influenced such low values.

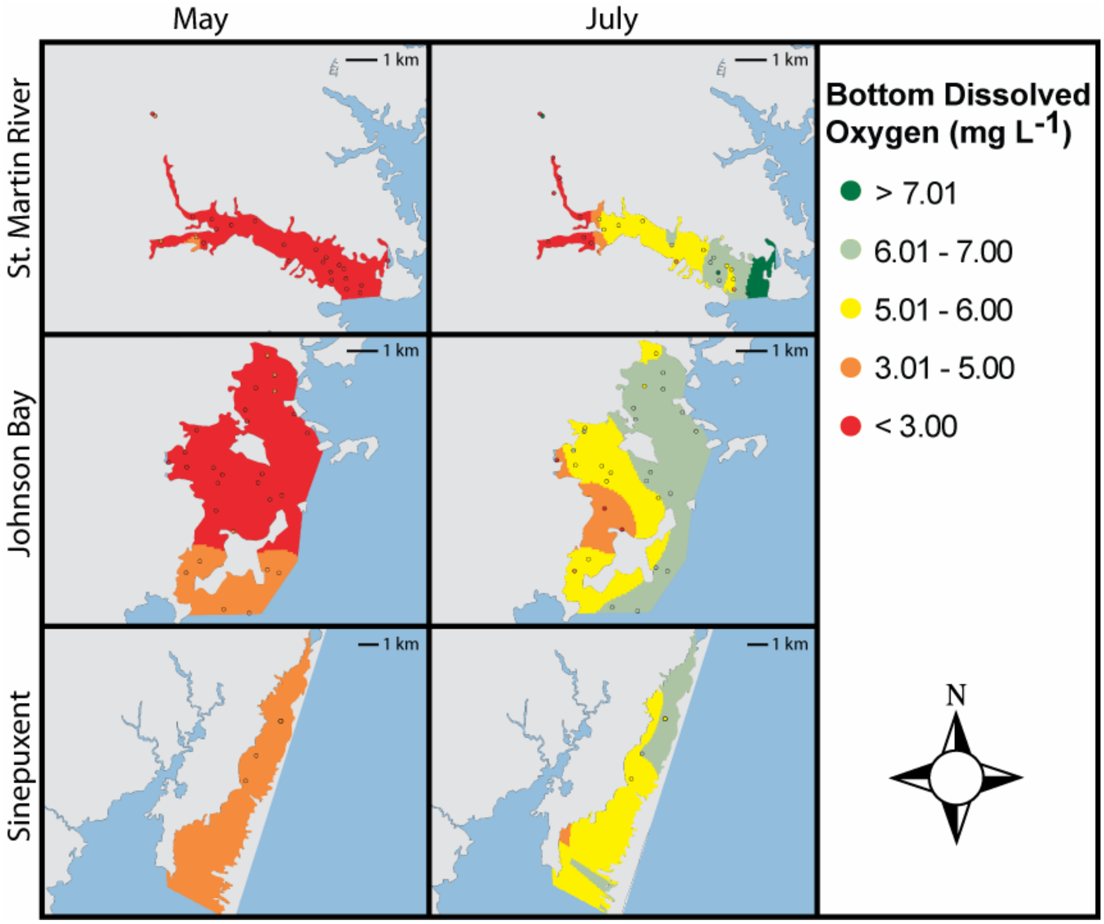



Figure 5. Spatial variation of bottom dissolved oxygen

*Secchi depth*

In May, stations ranged from 0.2-1.5m, and Sinepuxent (1.02 ±0.39m) was clearer than both St. Martin (0.66± 0.04m) and Johnsons Bay (0.29±0.01m). Johnsons Bay was mostly homogeneous throughout, while St. Martin exhibited a gradient of increasing clarity downstream. It is possible that the Secchi depth of St. Martin River is a function of proximity to inputs and saltwater flushing. In July, Secchi depth decreased at most sites and even reached 0 at the dam sites of St. Martin River. All three bays displayed poor water clarity, which was consistent with the 2004 and 2006 reports.

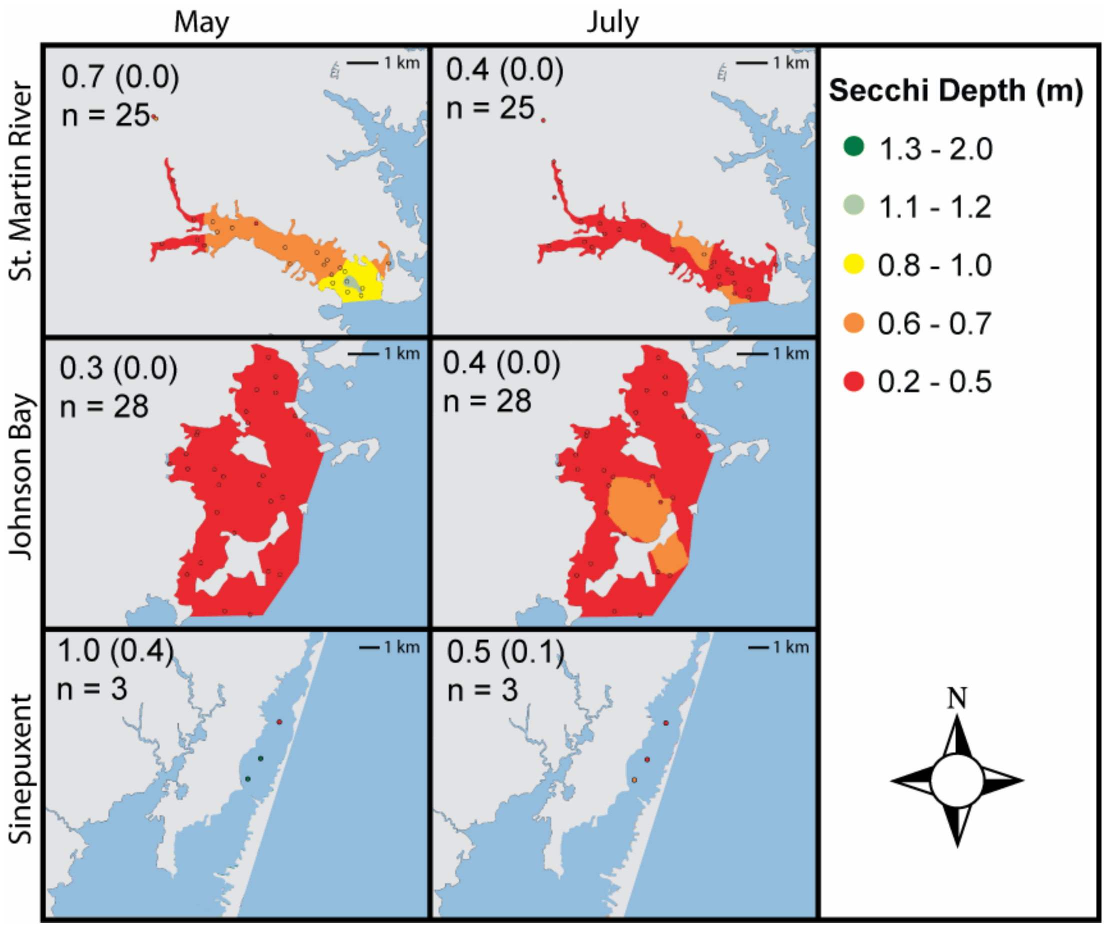



Figure 6. Spatial variation of Secchi depth

*Nutrient loading and land use calculations*

St. Martin River has the largest watershed land area (11361.3 ha) and land:water ratio (13.7) while Sinepuxent has the smallest watershed area (3058.1 ha) and smallest ratio (1.2). St. Martin River's predominant land use is crop agriculture (46.5%), followed by forest (29%) and urban development (16%), with few wetlands (5.5%) (Figure 7). In contrast, Johnsons Bay is predominantly natural forest or wetlands (37.4 and 29.1% respectively) and crop agriculture (30.1%). Urban development makes up only 2.2% of land use. Although the land draining into Sinepuxent is mainly forest and wetland (43.2 and 23.3%), it is 22.1% developed, which can be seen on the barrier island in the location of the Ocean City beach town. Nitrogen loading to each bay reflects these corresponding dominant land uses, with St. Martin River almost an order or magnitude greater than Johnsons Bay, and Johnsons Bay an order of magnitude greater than

Sinepuxent (Table XX). Phosphorus loads also reflect this same pattern. When normalized by water area, nitrogen loading to St. Martin River is amplified by its small water area, demonstrating greater impact than Johnsons Bay and Sinepuxent. The greater water areas have a diluting effect on both N and P loads, suggesting that the land use in St. Martin River. However, comparative residence times of each bay may also change the impact of nutrient loading to the systems, especially since Johnsons Bay has the longest residence time of 63 days, while St. Martin is only 12 and Sinepuxent is less than 10 (Lung 1994).

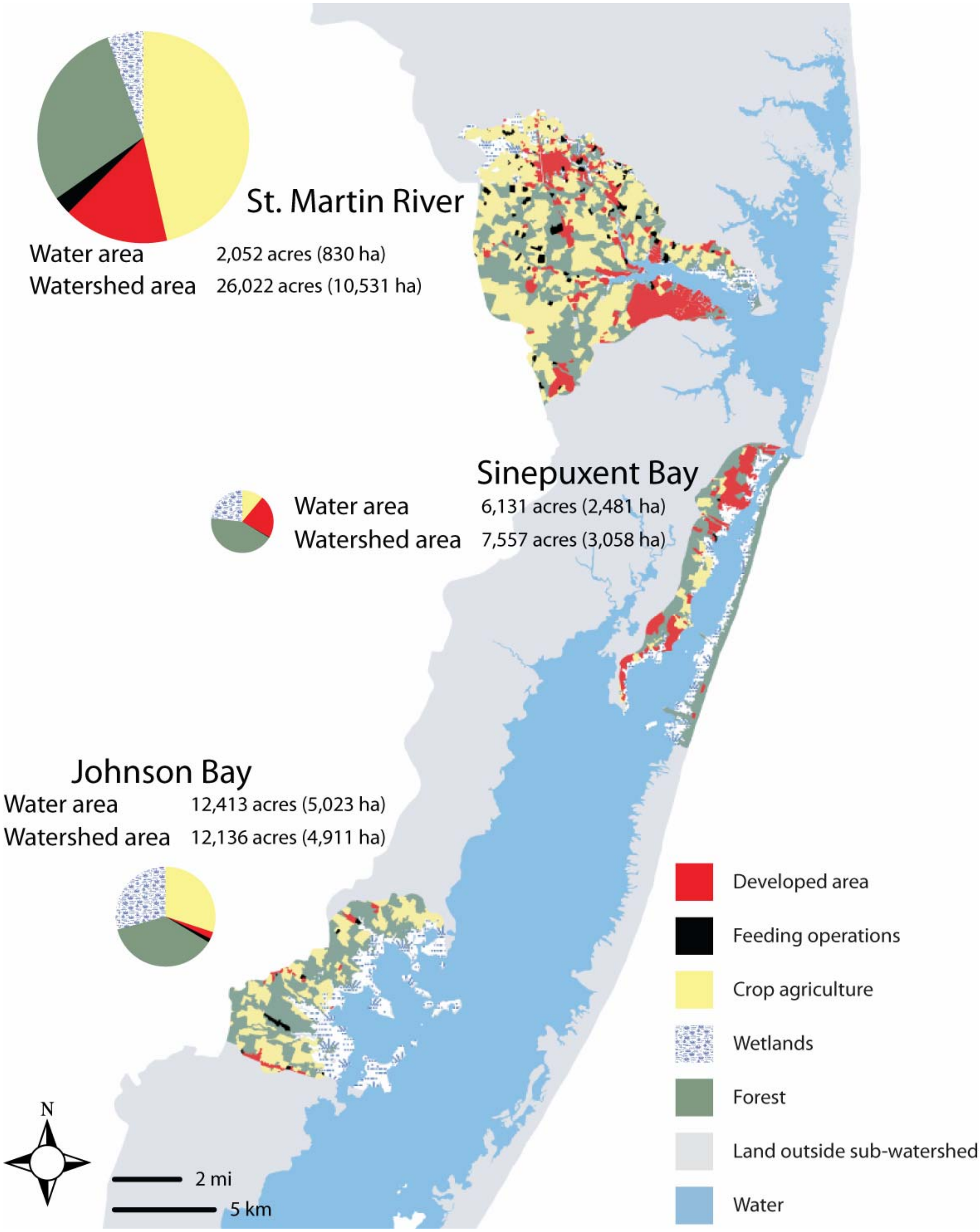



Figure 7: Map of land use. Pie charts display percentage and are scaled relative to the size of Sinepuxent watershed.

*Water column total nitrogen*

During both May and July, all three bays were above the threshold of 46 µM. Average TN increased from May to July in St. Martin River (58.36 ±5.71 to 86.68 ±5.20 µM) and Sinepuxent (50.28 ±1.13 to 65.51 ±6.99 µM) but decreased in Johnsons Bay (60.39 ±1.39 to 53.67 ±2.46 µM). In May, St. Martin River exhibited a downstream gradient of decreasing total nitrogen (TN). In the Bishopsville Prong, TN peaked at 117 µM at the site just above the dam and 109 µM just below the dam, while the Single Landing Prong peaked at 175.6 µM towards the confluence of the two prongs. At the mouth of the river, TN decreased to 29.7 µM. In May, both Johnsons Bay and Sinepuxent had homogeneous distributions, but in July, Johnsons Bay was higher in he middle region and the southern region, where it peaked at 77 µM. Surprisingly, the TN of Sinepuxent was the highest at the site closest to the Ocean City inlet, contrary to a higher flushing rate.

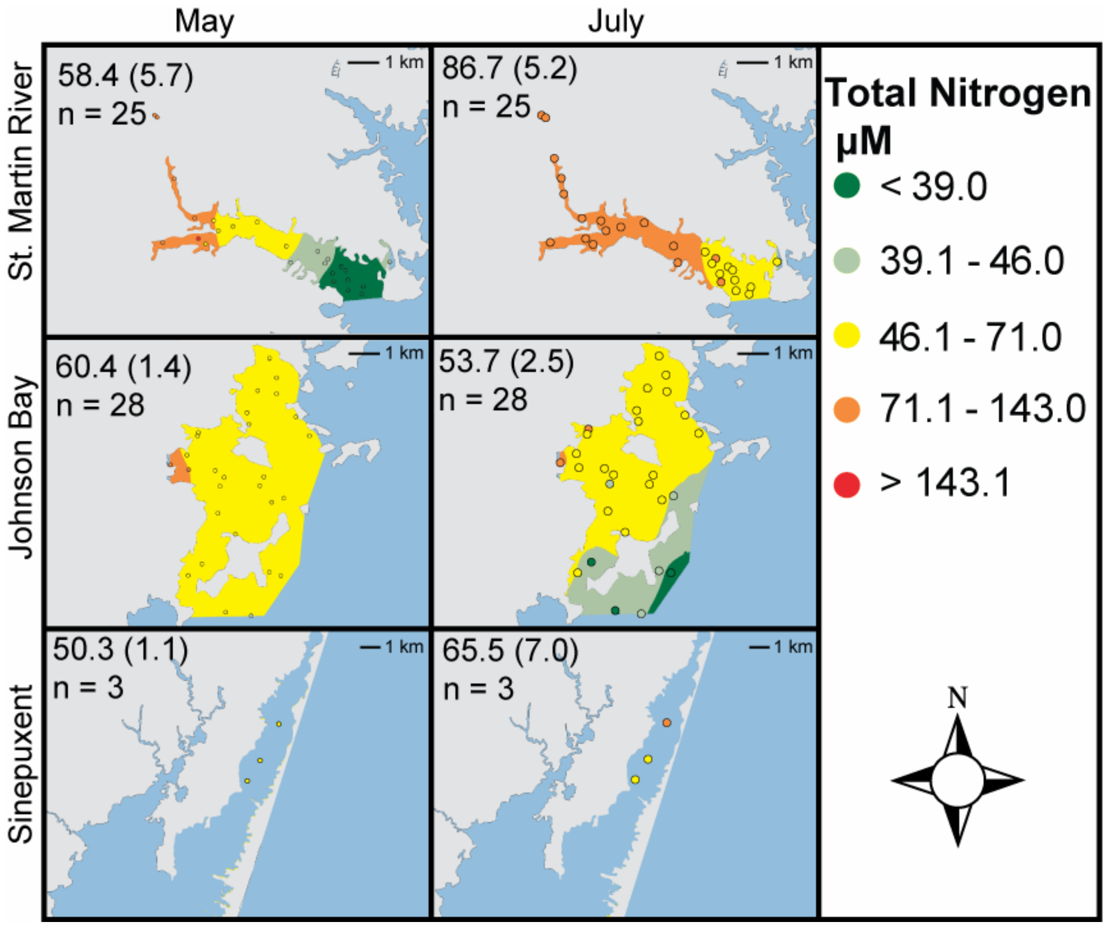



Figure 8. Spatial variation of water column total nitrogen

*Water column nitrogen species*

Organic nitrogen was the dominant form in both May and July in all sites, but trends in inorganic species in each bay were different. In May, St. Martin had the highest mean $NH_4$ of the three bays (1.84 ±1.08 µM) but dropped in July (1.49 ± 0.29 µM). Johnsons Bay $NH_4$ quadrupled from May to July (0.47 ± 0.11 µM to 2.13 ± 0.20 µM) and Sinepuxent also increased (0.32± 0.02 to 1.90± 0.26µM). NOx concentrations of both Johnsons Bay and Sinepuxent also increased in July, contributing to a greater portion of the N-pool. NOx dropped from May to July in St. Martin River, though total nitrogen increased. The trends of St. Martins and Johnsons Bay were opposite that of total nitrogen from May to July.

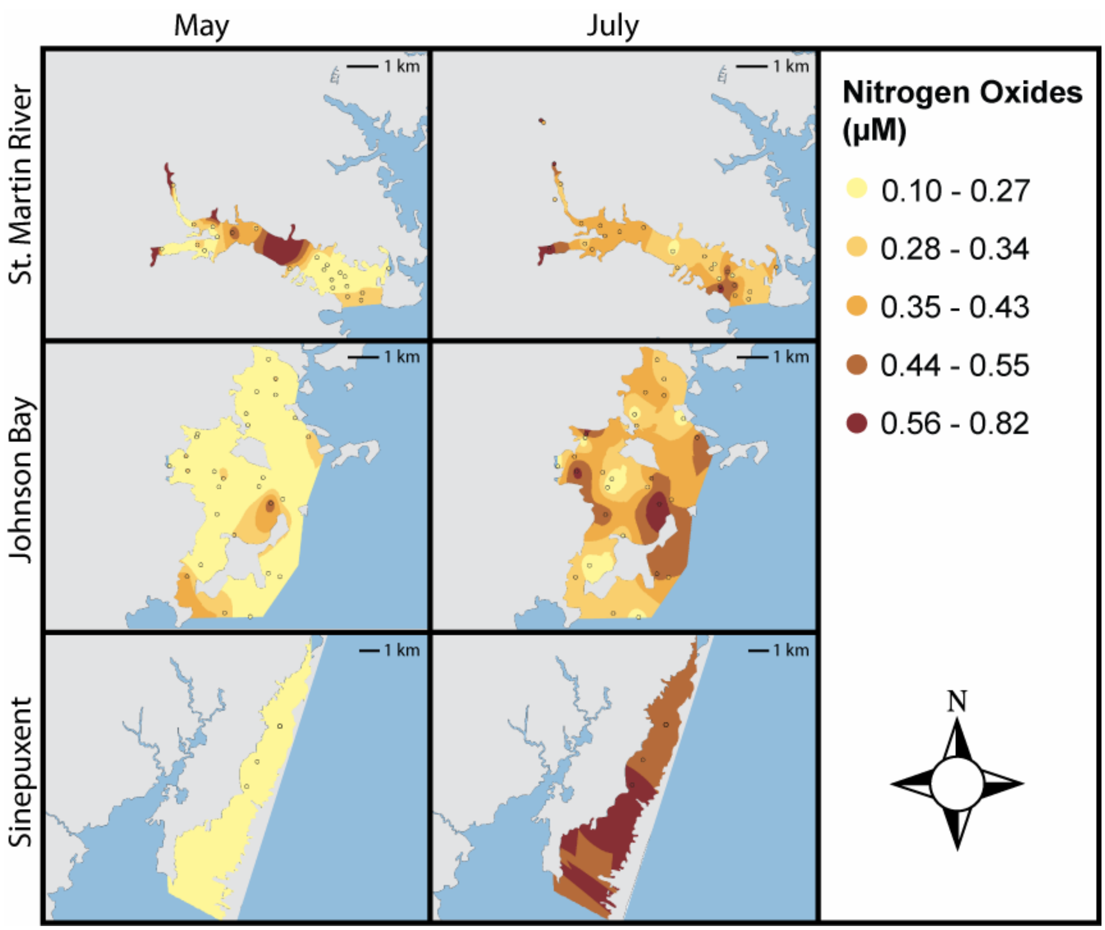



Figure 9. Spatial variation of nitrogen oxides

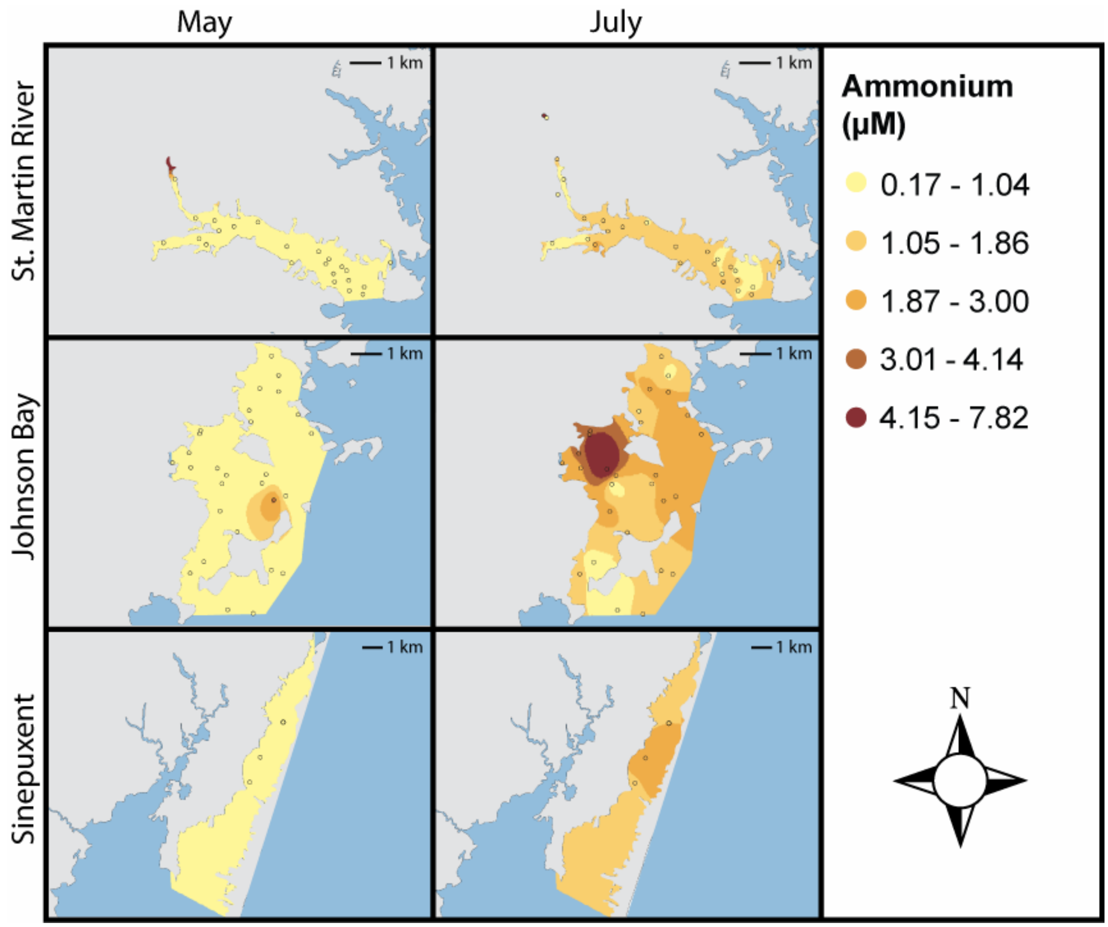



Figure 10. Spatial variation of ammonium

*Water column total phosphorus*

All bays were above the threshold value for water column total phosphorus (TP) of 1.2µM in both May and July, though St. Martin River showed a marked increase (2.42± 0.27µM to 4.34± 0.50µM ) compared with the two other bays that decreased slightly or remained constant. In May there was a gradient of decreasing TP from source to mouth in St. Martins. High levels of phosphorus were prevalent in both the Single Landing and Bishopsville upstream prongs in May 2007, suggesting terrestrial inputs from these regions. The northern region of Johnsons Bay, Brockatonorton Bay, increased from May to July 2007. The highest July levels were located close to land, especially in southern Johnsons Bay near Scarboro Creek. Sinepuxent's site closest to the inlet also increased in TP from May to July, despite higher flushing.

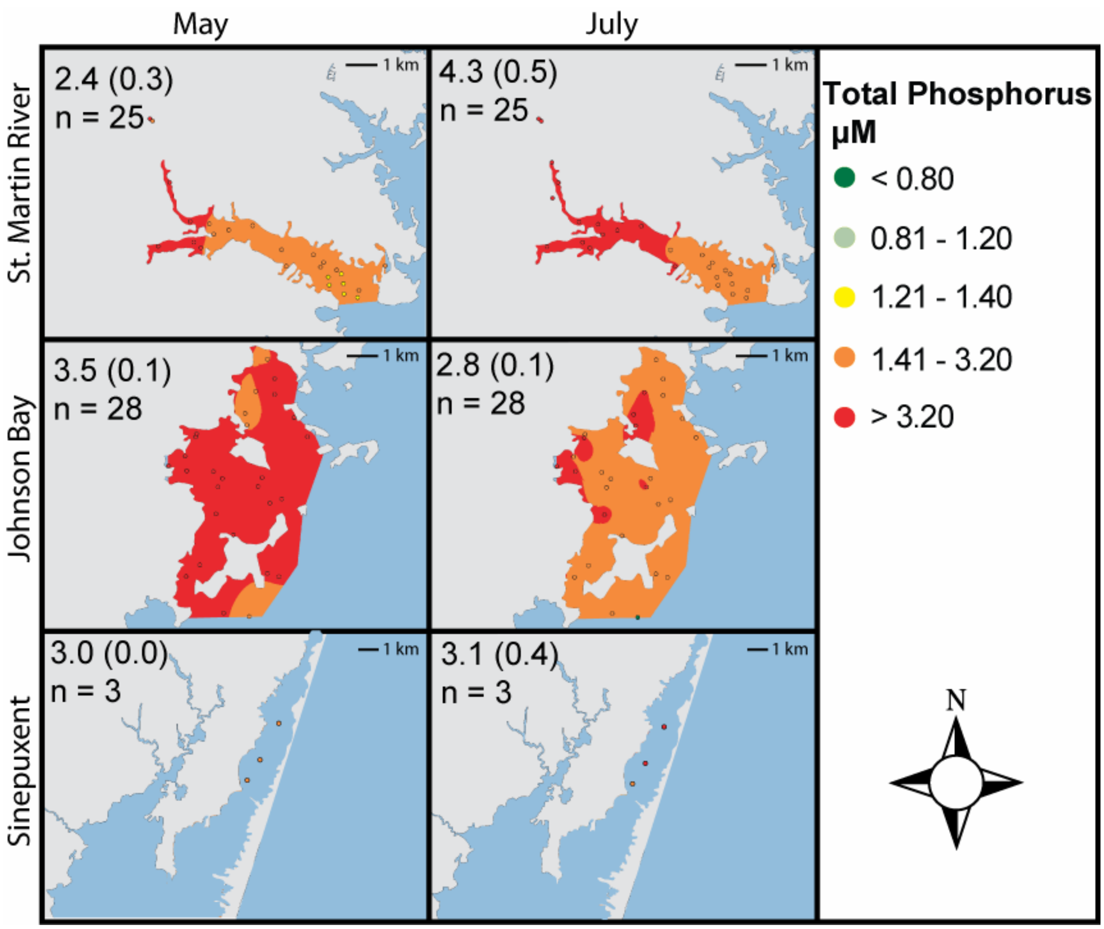



Figure 11. Spatial variation of total phosphorus

*Water column phosphorus species*

$PO_4$ concentrations increased from May to July in all three bays, though organic forms dominated in both May and July. However, Johnsons Bay had the highest concentrations in July (1.22± 0.08µM), though its total phosphorus decreased.

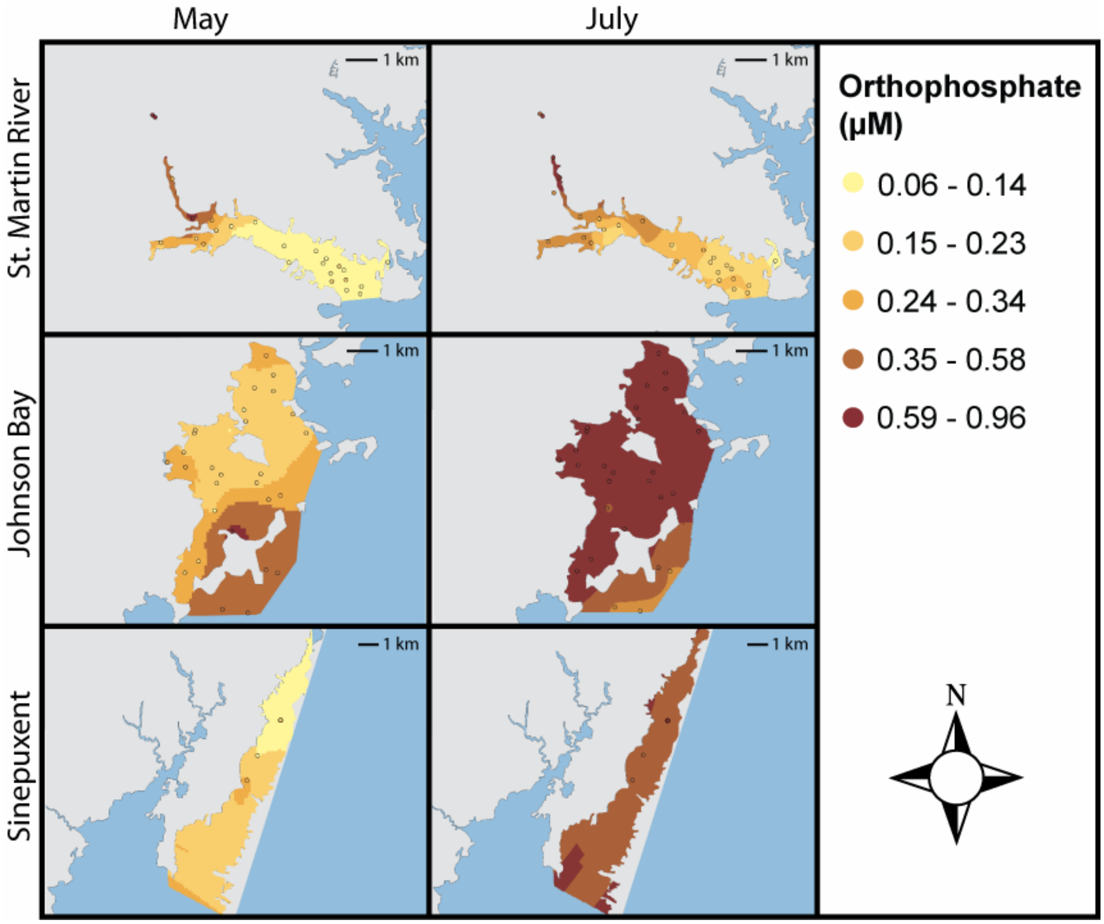



Figure 12. Spatial variation of orthophosphate

*Water column chlorophyll a*

Chlorophyll concentrations displayed similar trends as TN and TP from May to July, indicating an increase in St. Martin River (12.98± 1.05μgL$^{-1}$ to 34.02± 2.69μgL$^{-1}$ ) but a decrease in Johnsons Bay (27.82± 1.21μgL$^{-1}$ to 17.66± 1.92μgL$^{-1}$ ). Chlorophyll exhibited a gradient throughout the mainstem St. Martin River in May. The Bishopsville Prong had lower concentrations than the Shingle Landing Prong. In July, there was a chlorophyll maximum at the confluence of the two prongs, suggesting a bloom. Johnsons Bay displayed similar spatial patterns in both months and was highest in the southern region. Sinepuxent had high concentrations in both May and July (29.61± 2.60μgL$^{-1}$ and 25.18± 4.99μgL$^{-1}$), especially in the site towards the inlet. Phaeopigment concentration, a record of degraded chlorophyll *a*, increased at all three bays from May to July, consistent with increased turbidity and decreased Secchi depth.

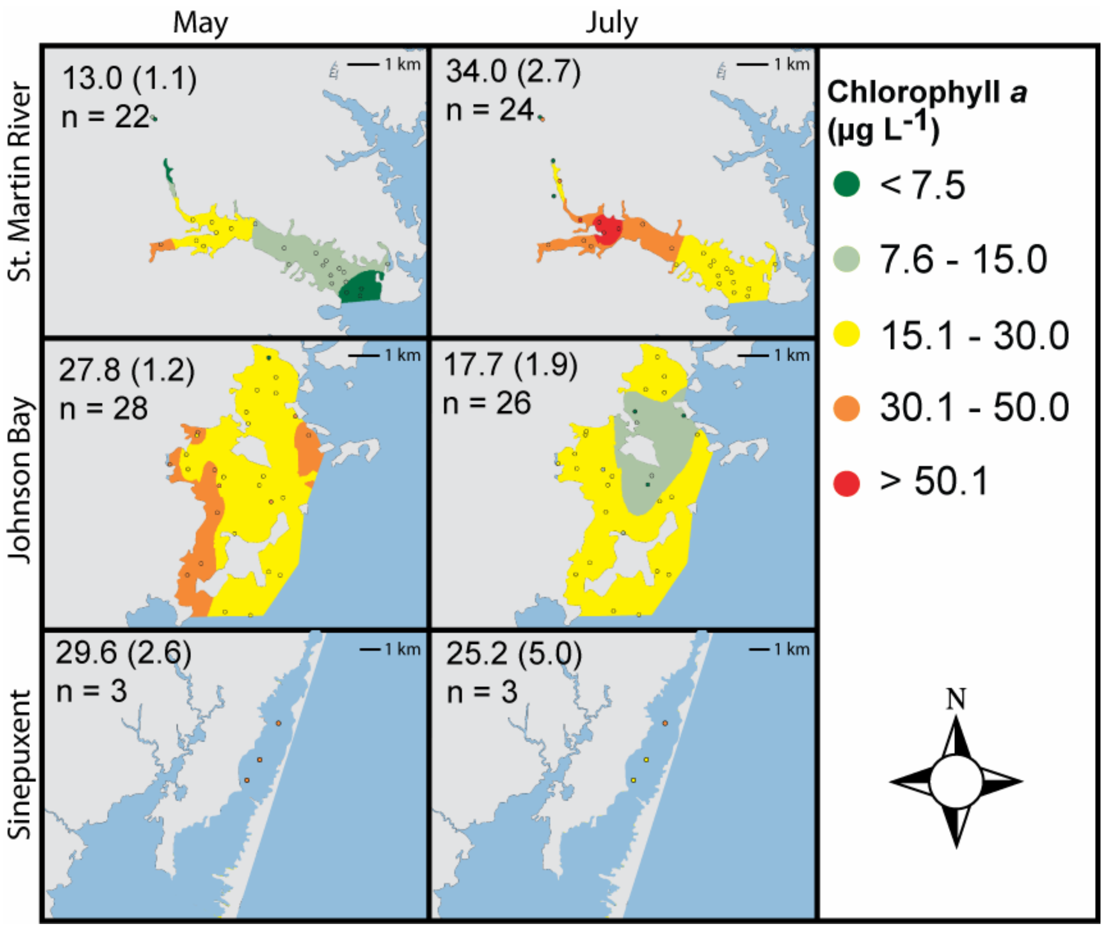



Figure 13. Spatial variation of chlorophyll *a*

*Total suspended solids and volatile suspended solids*

Mean total suspended solids (TSS) increased from May to July (32.54± 2.46 to 52.11± 9.26mgL$^{-1}$), which was consistent with a decrease in mean Secchi depth. Volatile suspended solids, indicating organic material, also increased and nearly doubled in all bays from May to July. St.

Martin River had the highest mean concentration of both TSS and VSS, which is consistent with its nutrient concentrations and organic components.

*Bacteria and viruses*

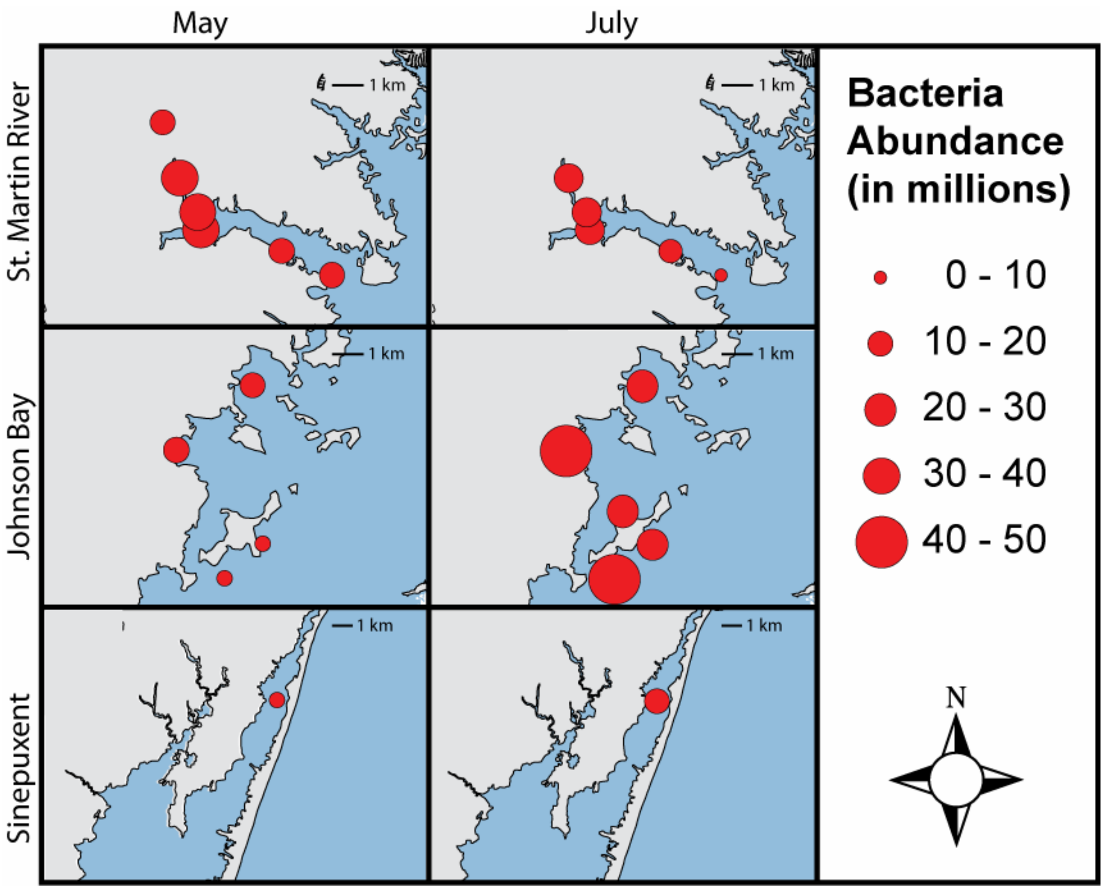



Figure 14. Spatial variations of bacterial abundance

Bacteria concentrations ranged from $10^6$ to $10^7$ $ml^{-1}$ during sampling periods in May and July. Viruses ranged from $10^7$ to $10^8$ $ml^{-1}$ over the same time period. These numbers are similar to or greater than other coastal eutrophic systems. Bacteria and virus abundance was significantly greater in St. Martin River than Sinepuxent Bay in May and from both Sinepuxent and Johnsons

Bay in July. St. Martin River also significantly increased in bacteria and virus abundance from May to July ($1.77x10^7 \pm 2.45\ x10^6$to $4.45\ x10^7 \pm 8.70\ x10^6$ bacteria and $1.7x\ x10^8 \pm 2.19x10^7$to $2.12x\ x10^8 \pm 1.48x10^6$viruses). These results are consistent with increased organic nutrient concentrations from May to July, indicative of the enhanced microbial loop and recycling occurring in the Coastal Bays.

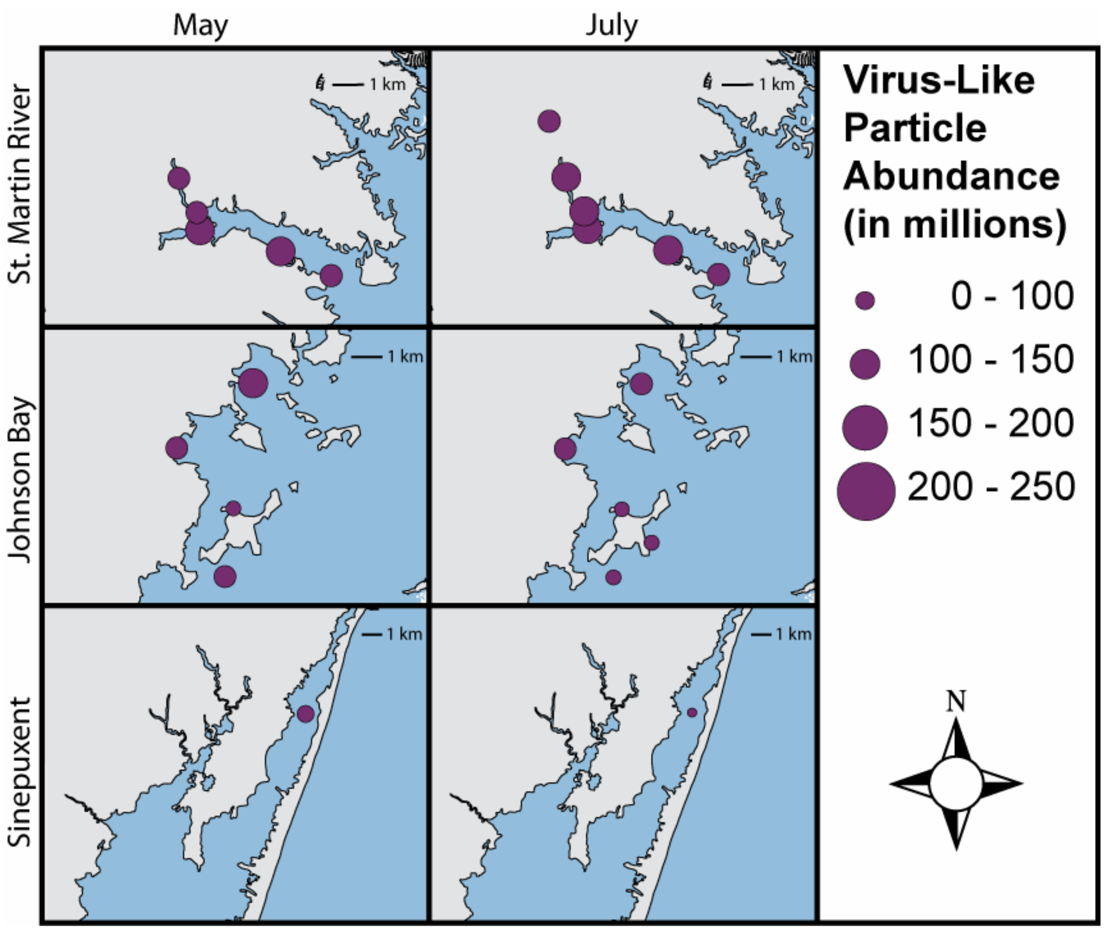



Figure 15. Spatial variations of virus-like particles

*Water quality index*

In May, the water quality index of St. Martin River improved downstream, but both Sinepuxent and Johnsons Bay were severely degraded (WQI 0.0-0.2). In July, all of St. Martin had an extremely low water quality, due to its increased nutrient concentrations and chlorophyll. Johnsons Bay ranged from 0.0 to 0.4 and exhibited improvement away from the coastline, but Sinepuxent's index did not improve in July.

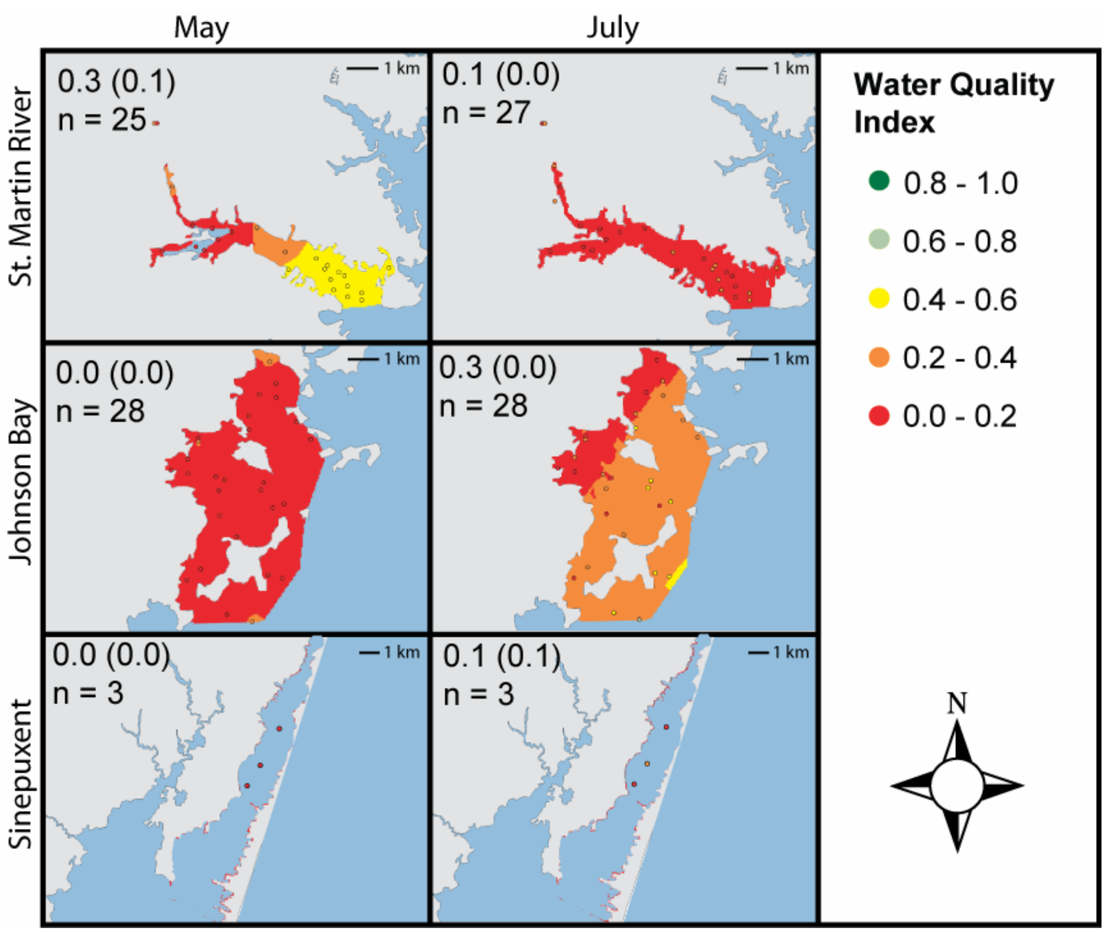



Figure 16. Spatial variation of Water Quality Index

*Suspended particulate matter $\delta^{15}N$*

Suspended particulate matter, including plankton, was collected on filter papers and analyzed for $\delta^{15}N$. This analysis provides a 'snapshot' of the ambient stable nitrogen isotope conditions and is generally more variable than larger primary producers or consumers. The range of suspended particulate matter in July 2007 (8.71‰ – 27.24‰) was similar to that for macroalgae (*Gracilaria* sp.) deployed in these coastal bays in June 2004 (8.94‰ – 26.39‰, see Jones et al. 2004). Mean suspended particulate matter $\delta^{15}$N values for July 2007 were 13.00 ± 0.45. The values were highest in Johnson Bay (14.54 ± 0.77) and lowest in St. Martin River (11.25 ± 0.50).

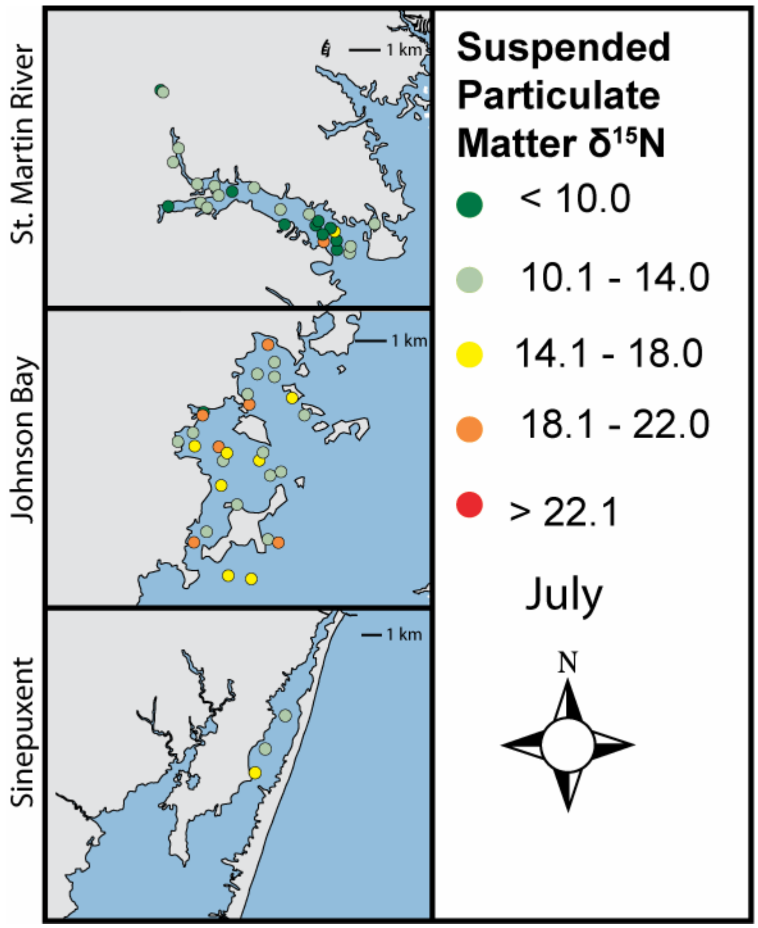



Figure 17. Spatial variation of suspended particulate matter $\delta^{15}$N

*Oyster tissues $\delta^{15}N$*

Oyster $\delta^{15}$N data is only available for July, after the oysters had time to incorporate nitrogen during the summer. In general, oyster tissue $\delta^{15}$N was within the range associated with wastewater effluent and manures, indicated that these sources of nitrogen are biologically incorporated. Overall there was little variability. The mantle tissues, which integrate nitrogen over the shortest time period, had $\delta^{15}N$ values of 8.98 ± 0.08 ‰. Gills, a medium-term temporal integrator, had $\delta^{15}N$ values of 9.32 ± 0.09 ‰. Muscle tissues, the slowest integrator, had $\delta^{15}N$ values of 9.90 ± 0.06 ‰. The values were highest in Johnson Bay and Sinepuxent Bay.

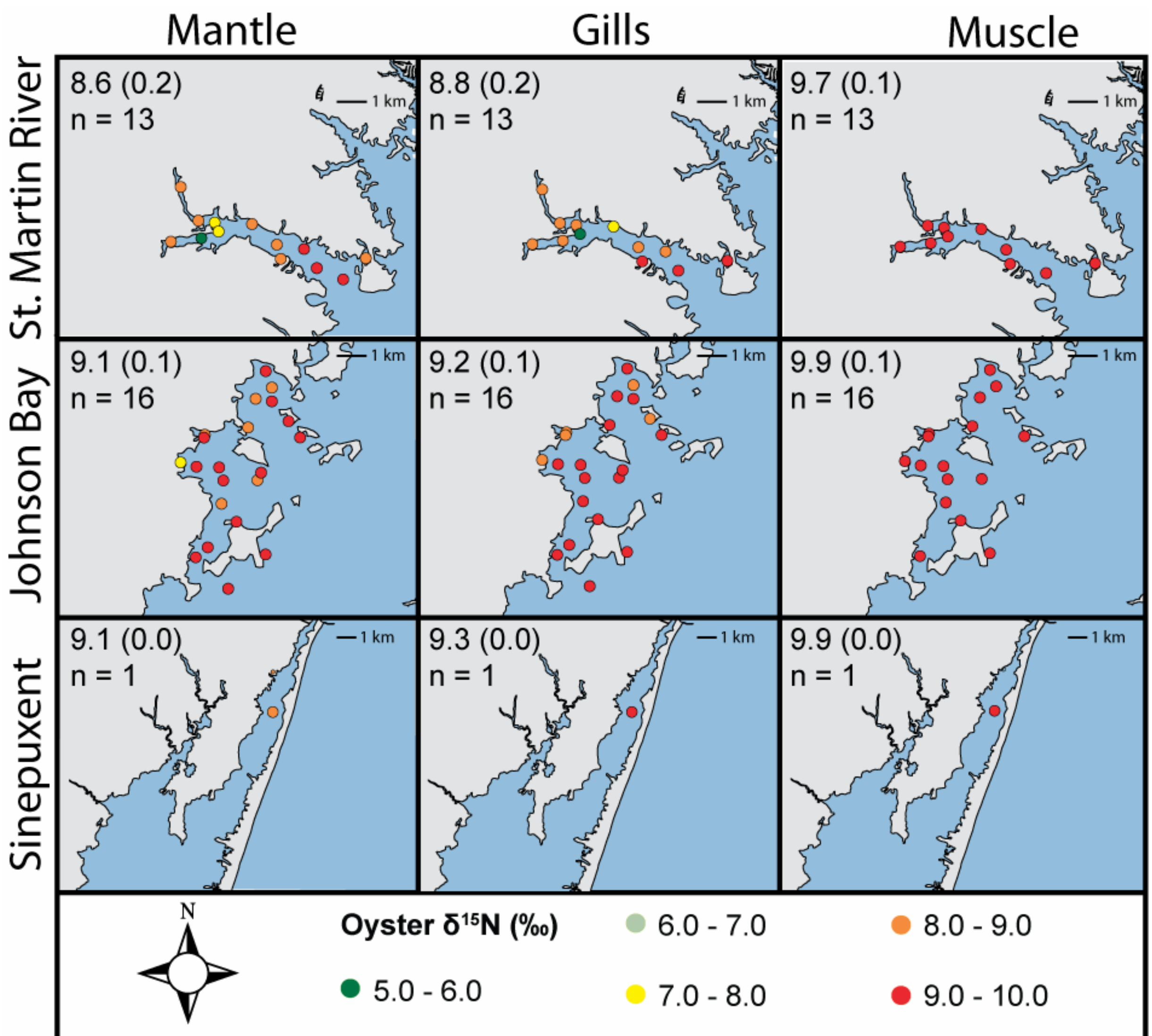


Figure 18. Spatial variation of $\delta^{15}N$ in oyster tissues

*Denitrification*

In all cases, potential denitrification was greater after spiking the slurries with nitrate than was the initially measured denitrification. Usually, variability was high relative to observations.

Overall across all three regions, denitrification was greater in July than in May. This pattern was found for both measured values (0.06 ± 0.02 ppm $N_2O$ $g^{-1}$ $h^{-1}$ in May and 0.13 ± 0.05 ppm $N_2O$ $g^{-1}$ $h^{-1}$ in July) and potential values (0.36 ± 0.06 ppm $N_2O$ $g^{-1}$ $h^{-1}$ in May and 0.42 ± 0.12 ppm $N_2O$ $g^{-1}$ $h^{-1}$ in July). Comparisons between regions can be found in Figure x. St. Martin River had both the greatest measured and potential denitrification in May (0.09 ± 0.05 ppm $N_2O$ $g^{-1}$ $h^{-1}$ measured, and 0.63 ± 0.09 ppm $N_2O$ $g^{-1}$ $h^{-1}$ potential). In July, Johnson Bay had the greatest measured denitrification (0.20 ± 0.10 ppm $N_2O$ $g^{-1}$ $h^{-1}$) while St. Martin River had the greatest potential denitrification (0.62 ± 0.26 ppm $N_2O$ $g^{-1}$ $h^{-1}$). Sinepuxent Bay had the least measured and potential denitrification in July (0.06 ± 0.05 ppm $N_2O$ $g^{-1}$ $h^{-1}$ measured, 0.09 ±0.06 ppm $N_2O$ $g^{-1}$ $h^{-1}$ potential) and also had the lowest measured denitrification (0.01 ± 0.01 ppm $N_2O$ $g^{-1}$ $h^{-1}$) in May, while Johnson Bay had the lowest potential denitrification (0.09 ± 0.03 ppm $N_2O$ $g^{-1}$ $h^{-1}$) in May.

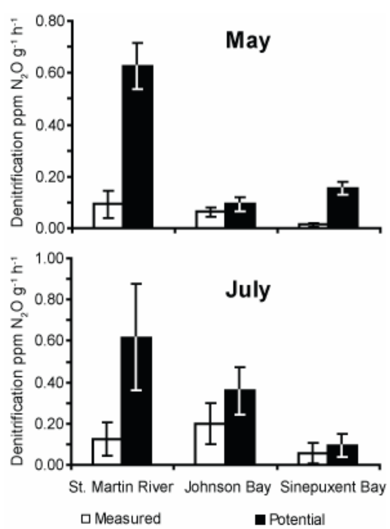



Figure 19. Comparing measured and potential denitrification across regions and months

Within bays, spatial patterns were only sometimes found along the transects, likely influenced by high variability (Figure x). In St. Martin River during May, potential denitrification decreased downstream. Note that the first two bars represent sites that are respectively located immediately above and below the dam along the Bishopsville prong and the remaining three bars represent a transect down the length of the river. Though there was a general decrease in potential denitrification heading downstream St. Martin River in July, the pattern is not as distinct. Johnson Bay does not follow a clear spatial pattern in May, but potential denitrification increases heading offshore in July. No clear spatial patterns were observed for either measured or potential denitrification in either May or July at Sinepuxent Bay.

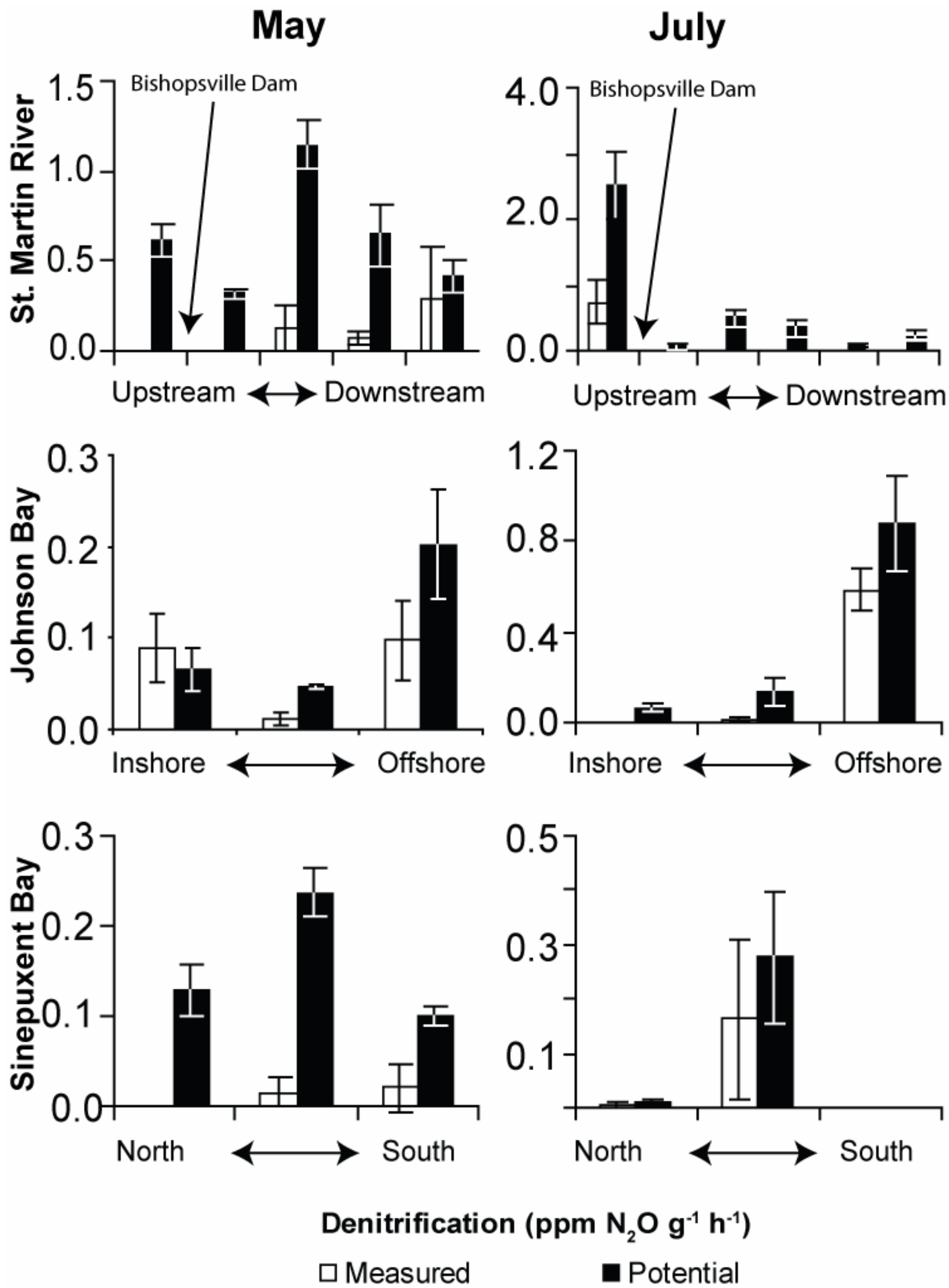



Figure 20. Spatial patterns of denitrification within regions

**Summary Conceptual Diagrams***:*

The watershed of St. Martins River comprises many different land uses, with crop agriculture being dominant. Upstream nutrient sources, stretching into Delaware, contribute to overall nutrient loading. The town of Bishopville, as well as the canal community of Ocean Pines, are directly adjacent to the river and may also affect its water quality. Development and agriculture along both the Bishopsville Prong and the Birch, Middle, and Church Branches leads to high nitrogen (N) and phosphorus (P) inputs and effects downstream water quality and clarity.  Little to no wetland cover along the edges of the river allows runoff to enter without the possibility of filtration.  From May to July, higher salinity water reached farther upstream, and water temperature increased.  Bacteria also increased from May to July. Secchi depth decreased, indicating increased turbidity.  Low dissolved oxygen is also a problem in this region, but this measure actually improved from May to July.

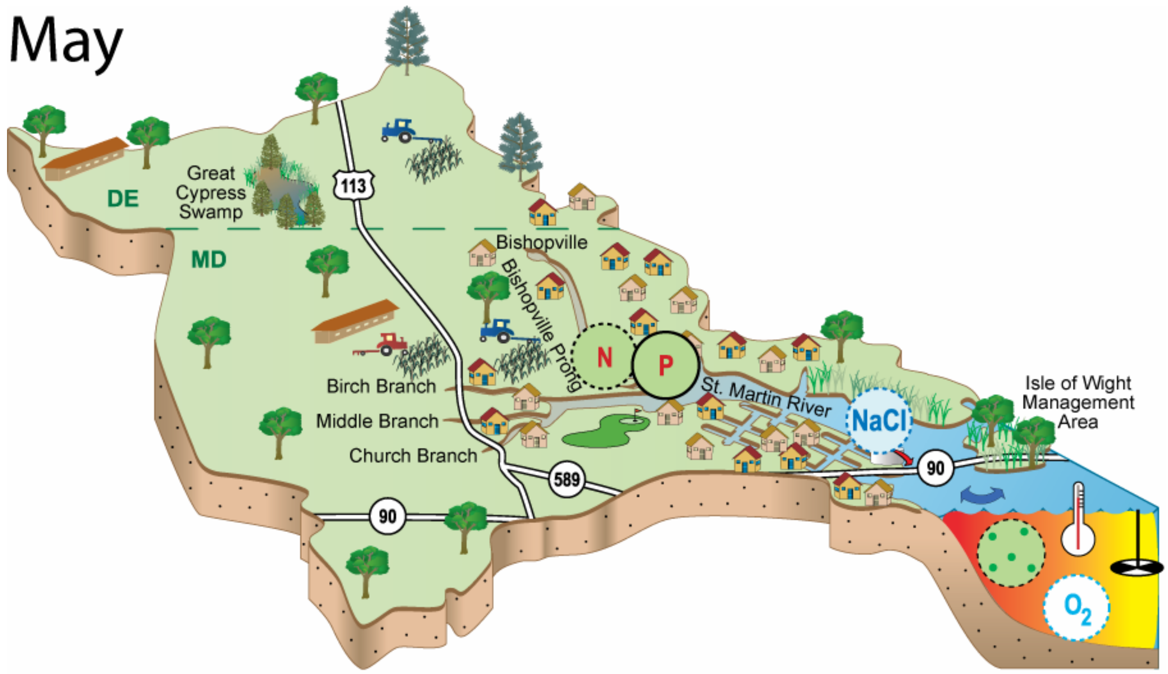




Figure 21 Summary conceptual diagrams of St. Martin River

In Johnsons Bay, development is low, but agricultural land use is high and spread throughout the watershed. Due to its low flushing rate and shallow depth, Johnsons Bay experiences high water column nitrogen and phosphorus concentrations, resulting from a combination of terrestrial loading and cycling within the bay. Bacteria abundance remained high throughout both months, and temperature increased. However, dissolved oxygen levels, though still low, increased from May to July, though Secchi depth increased. Abundant wetlands along the edges of the watershed protect and filter some of the nutrients from the landscape. Nutrient loading may be especially critical in this bay because of its structure and physical characteristics.

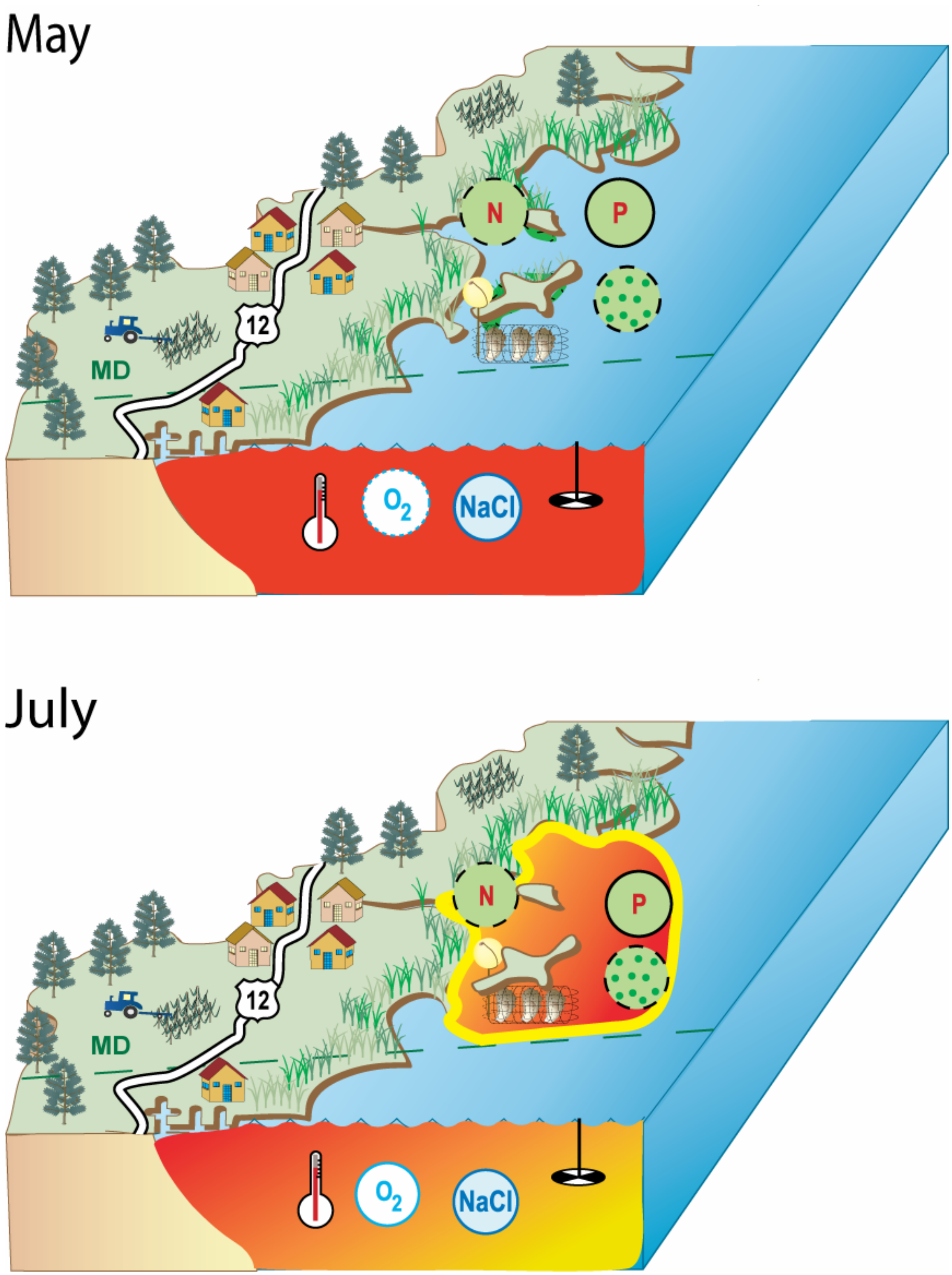
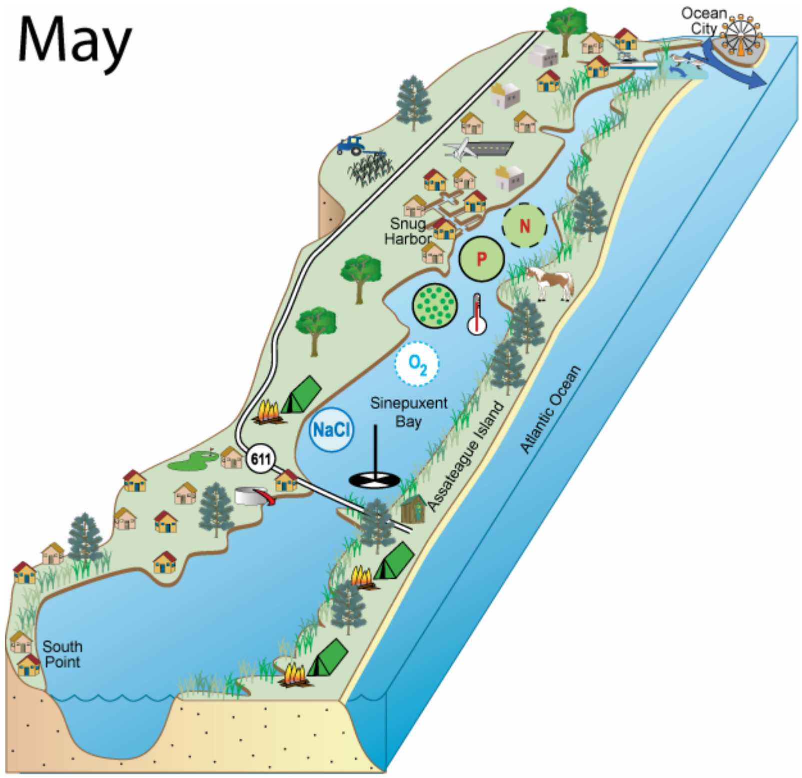



Figure 22. Summary conceptual diagrams of Johnson Bay

Sinepuxent Bay, due to its location near the Ocean City inlet, experiences a higher rate of flushing than the other two bays. Though the pristine surrounding landscape seems like an adequate location by which to compare the other two bays, this bay also is affected by anthropogenic inputs. Relative to its land area, Sinepuxent has a large percentage of development. . Inputs of both N and P from the land most likely result from urbanization in the northern regions of the watershed. Trends from May to July indicated an increase in water temperature as well as bacterial abundance. Secchi depth improved, possibly as a result of a lack of rain and little runoff.



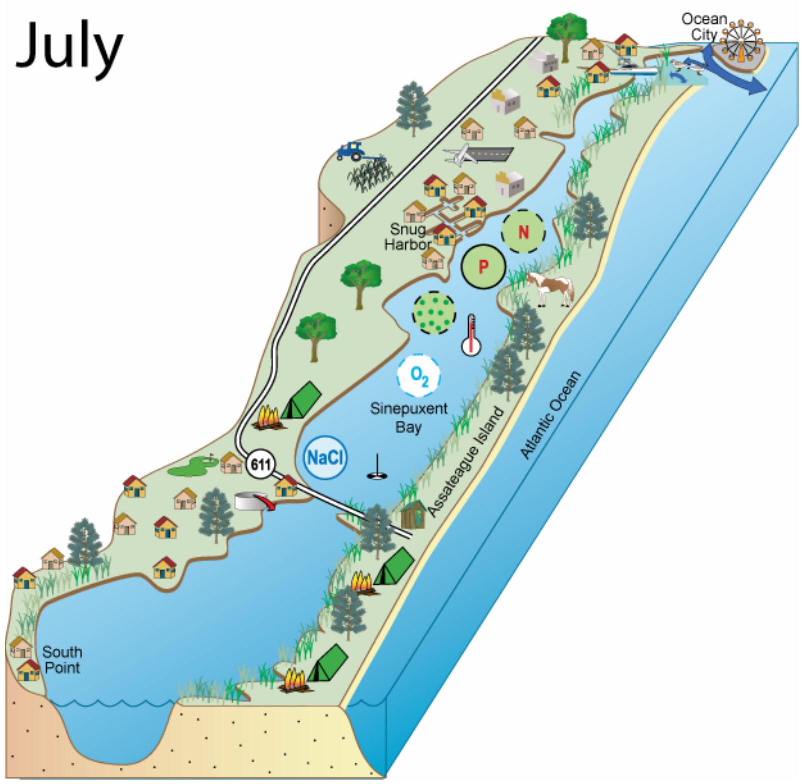




Figure 23. Summary Conceptual diagrams of Sinepuxent Bay

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# Appendix 1 – May 2007 Survey Data

Appendix 1 - May 2007 Survey Data

| | | | | | Surface | | | | Bottom | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Lat | Long | Depth (m) | Secchi (m) | Temp (deg C) | Salinity | DO (mg/L) | DO % | Temp (deg C) | Salinity | DO (mg/L) | DO % | $NH_4$ (0□) | $NO_x$ (0□) | Tot N (0M) | $PO_4$ (0g/L) | Tot P (0M) | Chl-*a* (0g/L) | phaeo (0g/L) |
| SM1 | 38.412 | -75.174 | 1.1 | 0.6 | 24.8 | 22.5 | 2.68 | 34.5 | 25.5 | 14.1 | 2.26 | 29.5 | 0.24 | 0.26 | 65.6 | 0.28 | 2.99 | 18.56 | 9.98 |
| SM2 | 38.394 | -75.131 | 1.6 | 0.9 | 25.0 | 24.3 | 2.54 | 32.3 | 24.7 | 14.0 | 2.23 | 28.8 | 0.24 | 0.26 | 35.9 | 0.16 | 1.31 | 9.59 | 0.98 |
| SM3 | 38.406 | -75.177 | 0.9 | 0.5 | 24.9 | 19.6 | 3.45 | 43.4 | 25.3 | 20.3 | 2.68 | 38.9 | 0.30 | 0.25 | 68.1 | 0.26 | 3.27 | 17.13 | 10.19 |
| SM4 | 38.405 | -75.148 | 1.3 | 0.6 | 23.8 | 21.9 | 2.64 | 32.6 | 25.1 | 24.0 | 1.92 | 24.3 | 0.74 | 1.02 | 50.0 | 0.13 | 2.11 | 11.54 | 5.83 |
| SM5 | 38.400 | -75.147 | 2.1 | 0.6 | 25.7 | 22.9 | 2.23 | 30.8 | 25.0 | 24.3 | 1.82 | 24.2 | 0.25 | 0.27 | 43.7 | 0.14 | 1.76 | 12.54 | 3.73 |
| SM6 | 38.413 | -75.181 | 0.5 | 0.4 | 28.9 | 16.7 | 8.16 | 113.1 | 28.3 | 19.2 | 1.56 | 27.7 | 0.53 | 0.30 | 87.5 | 0.93 | 4.34 | 26.30 | 10.53 |
| SM7 | 38.399 | -75.129 | 1.6 | 0.7 | 23.9 | 23.9 | 2.82 | 34.8 | 23.9 | 24.4 | 2.34 | 30.3 | 0.20 | 0.23 | 37.1 | 0.18 | 1.45 | 10.97 | 2.89 |
| SM9 | 38.401 | -75.133 | 1.6 | 0.7 | 24.0 | 23.5 | 2.73 | 33.8 | 24.3 | 24.9 | 1.84 | 26.3 | 0.28 | 0.26 | 41.1 | 0.12 | 1.54 | 13.26 | -0.29 |
| SM10 | 38.407 | -75.180 | 0.8 | 0.4 | 28.3 | 18.6 | 4.55 | 61.0 | 27.5 | 19.4 | 4.88 | 64.4 | 0.25 | 0.30 | 81.9 | 0.14 | 4.09 | 20.28 | 15.67 |
| SM11 | 38.400 | -75.111 | 0.6 | 0.6 | 24.2 | 24.6 | 2.56 | 31.7 | 24.2 | 24.6 | 2.58 | 31.9 | 0.22 | 0.26 | 42.5 | 0.11 | 1.42 | 9.61 | 2.01 |
| SM12 | 38.391 | -75.121 | 1.8 | 1.0 | 24.6 | 25.5 | 2.28 | 28.3 | 24.0 | 25.8 | 2.15 | 27.2 | 0.21 | 0.27 | 34.0 | 0.08 | 1.29 | 7.44 | 2.00 |
| SM13 | 38.411 | -75.167 | 1.8 | 0.6 | 24.5 | 20.6 | 2.61 | 32.3 | 25.5 | 16.8 | 2.04 | 25.8 | 0.72 | 0.47 | 56.8 | 0.13 | 2.51 | 18.13 | 8.98 |
| SM14 | 38.392 | -75.126 | 1.5 | 0.9 | 25.3 | 24.4 | 2.72 | 35.0 | 25.2 | 24.5 | 2.73 | 34.6 | 1.03 | 0.31 | 34.2 | 0.11 | 1.29 | 7.39 | 1.58 |
| SM15 | 38.400 | -75.134 | 1.7 | 0.7 | 24.1 | 23.6 | 2.81 | 34.7 | 24.5 | 25.1 | 2.21 | 27.0 | 0.21 | 0.21 | 40.7 | 0.06 | 1.51 | 11.97 | 3.28 |
| SM16 | 38.403 | -75.137 | 1.6 | 0.6 | 24.1 | 23.4 | 2.59 | 32.4 | 24.4 | 14.0 | 2.12 | 29.3 | 0.17 | 0.20 | 41.0 | 0.08 | 1.61 | 10.91 | 1.97 |
| SM17 | 38.395 | -75.126 | 1.3 | 1.1 | 24.3 | 24.7 | 2.63 | 32.2 | 24.2 | 25.3 | 2.29 | 28.7 | 0.23 | 0.21 | 32.7 | 0.15 | 1.21 | 8.53 | 0.92 |
| SM18 | 38.393 | -75.121 | 1.8 | 1.0 | 24.4 | 25.5 | 2.39 | 30.4 | 24.1 | 25.5 | 2.09 | 26.2 | 0.28 | 0.28 | 29.7 | 0.10 | 1.52 | 6.63 | 1.48 |
| SM19 | 38.412 | -75.158 | 1.2 | 0.5 | 23.6 | 21.5 | 2.64 | 32.9 | 25.4 | 22.9 | 2.10 | 26.9 | 0.25 | 0.32 | 54.6 | 0.14 | 2.54 | 14.26 | 7.04 |
| SM20 | 38.398 | -75.127 | 1.6 | 0.9 | 24.0 | 24.5 | 2.63 | 32.6 | 24.1 | 25.0 | 2.26 | 28.3 | 0.31 | 0.24 | 35.6 | 0.09 | 1.34 | 10.55 | 1.66 |
| SMS28 | 38.397 | -75.132 | 1.8 | 0.7 | 24.5 | 24.3 | 2.89 | 36.1 | 24.6 | 25.2 | 2.18 | 34.8 | 0.19 | 0.23 | 36.8 | 0.10 | 1.34 | 11.04 | 1.81 |
| SM31 | 38.409 | -75.172 | 1.0 | 0.6 | 24.3 | 19.9 | 2.77 | 35.8 | 25.5 | 20.9 | 2.34 | 29.3 | 0.24 | 0.25 | 61.6 | 0.17 | 2.84 | 18.13 | 8.80 |
| SM71 | 38.442 | -75.194 | 0.7 | 0.5 | 29.8 | 0.0 | 5.54 | 77.2 | 21.7 | 0.0 | 2.53 | 32.3 | 13.63 | 26.10 | 117.3 | 0.96 | 3.25 | 10.82 | 22.54 |
| SM72 | 38.442 | -75.193 | 0.7 | 0.7 | nd | nd | nd | nd | 26.3 | 11.6 | 4.41 | 60.9 | 24.30 | 20.20 | 109.0 | 0.92 | 2.92 | nd | 11.47 |
| SM73 | 38.406 | -75.192 | 0.4 | 0.3 | 25.4 | 17.7 | 3.48 | 44.2 | 25.3 | 17.8 | 3.50 | 44.6 | 0.29 | 0.23 | 96.7 | 0.17 | 4.73 | nd | 14.99 |
| SM74 | 38.424 | -75.188 | 0.5 | 0.3 | 31.2 | 11.6 | 0.12 | 2.5 | nd | nd | nd | nd | 0.66 | 0.29 | 125.0 | 0.32 | 6.43 | nd | nd |
| JB1 | 38.067 | -75.332 | 1.4 | 0.3 | 23.1 | 26.4 | 2.68 | 32.6 | 23.0 | 26.5 | 2.66 | 7.8 | 0.24 | 0.10 | 55.0 | 0.15 | 3.65 | 27.59 | 4.59 |
| JB2 | 38.042 | -75.359 | 0.4 | 0.3 | 24.8 | 26.8 | 3.55 | 44.7 | 24.8 | 26.8 | 3.58 | 45.2 | 0.54 | 0.37 | 62.1 | 0.22 | 4.12 | 32.89 | 7.57 |
| JB3 | 38.042 | -75.325 | 1.5 | 0.3 | 24.7 | 26.7 | 3.72 | 47.2 | 24.6 | 26.7 | 3.74 | 47.0 | 0.28 | 0.12 | 49.1 | 0.49 | 3.26 | 21.00 | 3.58 |
| JB4 | 38.071 | -75.348 | 1.1 | 0.3 | 23.0 | 26.3 | 2.59 | 31.5 | 23.0 | 26.3 | 2.59 | 37.5 | 0.42 | 0.25 | 64.8 | 0.17 | 4.00 | 34.75 | 4.45 |
| JB5 | 38.081 | -75.354 | 0.7 | 0.3 | 22.8 | 26.5 | nd | nd | 22.8 | 26.4 | nd | nd | 0.29 | 0.11 | 63.1 | 0.15 | 3.62 | 29.88 | 1.77 |
| JB6 | 38.060 | -75.347 | 1.2 | 0.3 | 23.1 | 26.3 | 2.72 | 33.2 | 23.0 | 26.3 | 2.67 | 32.6 | 0.23 | 0.10 | 69.3 | 0.12 | 4.00 | 37.47 | 4.42 |
| JB7 | 38.086 | -75.319 | 0.8 | 0.3 | 22.8 | 26.2 | 2.86 | 34.6 | 22.8 | 26.2 | 2.89 | 34.9 | 0.25 | 0.11 | 55.7 | 0.18 | 3.35 | 30.31 | 1.18 |
| JB8 | 38.088 | -75.336 | 1.0 | 0.3 | 23.7 | 26.1 | 2.78 | 34.1 | 23.3 | 26.1 | 2.80 | 34.2 | 0.45 | 0.23 | 58.8 | 0.13 | 3.04 | 24.86 | 2.49 |
| JB9 | 38.070 | -75.345 | 1.1 | 0.3 | 23.0 | 26.6 | 2.66 | 32.5 | 23.0 | 26.6 | 2.64 | 32.1 | 0.60 | 0.30 | 61.9 | 0.15 | 3.41 | 23.43 | 3.59 |
| JB10 | 38.094 | -75.332 | 1.0 | 0.3 | 25.5 | 26.0 | 3.04 | 38.5 | 25.4 | 26.0 | 2.99 | 38.1 | 0.40 | 0.19 | 63.2 | 0.22 | 3.19 | 27.40 | 3.20 |
| JB11 | 38.069 | -75.331 | 1.2 | 0.3 | 22.9 | 26.4 | 2.65 | 32.2 | 22.8 | 26.4 | 2.62 | 31.8 | 0.29 | 0.18 | 59.4 | 0.18 | 3.55 | 24.29 | 4.35 |
| JB12 | 38.084 | -75.336 | 0.5 | 0.4 | 23.0 | 26.2 | 2.82 | 34.2 | 23.0 | 26.2 | 2.80 | 34.0 | 0.32 | 0.13 | 57.6 | 0.15 | 3.16 | 24.00 | 2.79 |
| JB13 | 38.073 | -75.364 | 0.5 | 0.2 | 24.8 | 25.9 | 2.85 | 35.5 | 24.7 | 25.9 | 2.84 | 35.6 | 0.52 | 0.16 | 79.1 | 0.29 | 3.93 | 34.13 | 6.86 |
| JB14 | 38.093 | -75.326 | 0.8 | 0.3 | 25.5 | 26.2 | 3.59 | 45.7 | 25.5 | 26.2 | 3.60 | 45.8 | 0.31 | 0.23 | 59.4 | 0.18 | 3.36 | 26.58 | 4.03 |
| JB15 | 38.054 | -75.341 | 0.9 | 0.4 | 23.8 | 26.8 | 3.20 | 39.0 | 23.7 | 26.8 | 3.18 | 39.1 | 0.56 | 0.29 | 58.2 | 0.89 | 3.44 | 16.46 | 1.61 |
| JB16 | 38.067 | -75.347 | 1.1 | 0.3 | 23.1 | 26.5 | 2.63 | 32.1 | 23.1 | 26.5 | 2.56 | 31.5 | 0.37 | 0.13 | 59.8 | 0.15 | 3.50 | 31.02 | 3.03 |
| JB17 | 38.045 | -75.354 | 0.5 | 0.3 | 24.8 | 26.7 | 3.13 | 46.7 | 24.7 | 26.7 | 3.69 | 46.2 | 0.27 | 0.13 | 68.0 | 0.21 | 3.92 | 36.04 | 6.40 |
| JB18 | 38.030 | -75.336 | 1.8 | 0.3 | 24.4 | 26.8 | 3.67 | 46.8 | 24.2 | 26.8 | 3.64 | 45.2 | 0.27 | 0.12 | 45.3 | 0.43 | 2.88 | 24.00 | 5.11 |
| JB20 | 38.103 | -75.328 | 0.6 | 0.2 | 26.0 | 25.8 | 3.17 | 41.0 | 26.0 | 25.8 | 3.16 | 40.5 | 0.33 | 0.12 | 65.2 | 0.30 | 3.18 | 6.14 | 53.06 |
| JB21 | 38.032 | -75.345 | 1.5 | 0.3 | 24.5 | 26.9 | 3.22 | 40.3 | 24.4 | 26.9 | 3.19 | 39.8 | 0.58 | 0.34 | 49.5 | 0.58 | 3.30 | 28.92 | 2.56 |
| JB22 | 38.097 | -75.326 | 1.3 | 0.3 | 25.3 | 26.0 | 3.41 | 43.2 | 25.3 | 26.0 | 3.29 | 41.6 | 0.33 | 0.28 | 61.2 | 0.18 | 3.34 | 29.88 | 4.62 |
| JB23 | 38.043 | -75.330 | 1.4 | 0.3 | 24.9 | 26.8 | 3.49 | 44.1 | 24.7 | 26.8 | 3.46 | 43.7 | 0.30 | 0.21 | 50.1 | 0.50 | 3.26 | 28.30 | 5.68 |
| JB24 | 38.062 | -75.328 | 1.4 | 0.4 | 23.2 | 26.5 | 2.74 | 33.4 | 23.1 | 26.5 | 2.64 | 32.1 | 3.27 | 0.51 | 56.5 | 0.32 | 3.68 | 31.74 | 3.46 |
| JB25 | 38.081 | -75.314 | 0.9 | 0.3 | 22.9 | 26.3 | 2.82 | 34.2 | 22.9 | 26.3 | 2.81 | 34.0 | 0.37 | 0.29 | 55.6 | 0.23 | 3.46 | 32.17 | -0.87 |
| JB26 | 38.076 | -75.358 | 0.9 | 0.4 | 22.6 | 26.1 | 2.41 | 29.3 | 22.7 | 26.4 | 2.00 | 23.7 | 0.37 | 0.27 | 68.1 | 0.20 | 3.92 | 27.87 | 3.48 |
| JB27 | 38.063 | -75.324 | 1.5 | 0.4 | 23.2 | 26.4 | 2.70 | 33.1 | 23.2 | 26.4 | 2.70 | 32.8 | 0.30 | 0.22 | 57.6 | 0.27 | 3.57 | 29.59 | 4.30 |
| JB28 | 38.082 | -75.354 | 0.8 | 0.3 | 22.8 | 26.4 | 2.31 | 28.1 | 22.8 | 26.4 | 2.11 | 26.2 | 0.36 | 0.19 | 65.8 | 0.16 | 3.91 | 33.75 | 3.00 |
| JBS30 | 38.072 | -75.358 | 1.5 | 0.2 | 24.6 | 26.1 | 2.81 | 24.8 | 23.6 | 26.3 | 2.46 | 30.2 | 0.49 | 0.27 | 71.7 | 0.34 | 3.89 | 24.58 | 1.82 |
| SPX1 | 38.277 | -75.146 | 2.5 | 0.3 | 25.1 | 27.4 | 3.46 | 43.3 | 24.9 | 27.5 | 3.38 | 42.4 | 0.34 | 0.22 | 49.2 | 0.15 | 3.06 | 24.91 | 5.33 |
| SPX2 | 38.261 | -75.143 | 1.5 | 1.5 | 25.1 | 27.1 | 3.38 | 42.6 | 24.9 | 27.1 | 3.36 | 42.6 | 0.34 | 0.18 | 49.1 | 0.13 | 3.01 | 30.02 | 2.40 |
| SPX3 | 38.250 | -75.149 | 1.3 | 1.3 | 25.0 | 27.3 | 3.16 | 40.0 | 24.5 | 27.3 | 3.14 | 39.9 | 0.29 | 0.11 | 52.5 | 0.26 | 3.06 | 33.89 | 1.67 |

# Appendix 2 – July 2007 Survey Data

Appendix 2 - July 2007 Survey Data

| Site | Lat | Long | Depth (m) | Secchi (m) | Surface Temp (deg C) | Salinity | DO (mg/L) | DO % | Bottom Temp (deg C) | Salinity | DO (mg/L) | DO % | $NH_4$ ( gM) | $NO_x$ ( gM) | Tot N ( M) | $PO_4$ ( gM) | Tot P ( M) | Chl-a ( g/L) | phaeo ( g/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SM1 | 38.412 | -75.174 | 1.4 | 0.3 | 29.7 | 25.1 | 4.54 | 69.0 | 29.7 | 25.6 | 4.54 | 67.1 | 1.72 | 0.36 | 77.4 | 0.82 | 5.12 | 55.09 | 9.90 |
| SM2 | 38.394 | -75.131 | 1.8 | 0.5 | 29.7 | 29.0 | 6.83 | 116.7 | 28.9 | 29.4 | 5.32 | 81.3 | 1.91 | 0.60 | 73.8 | 0.23 | 2.64 | 26.30 | 6.38 |
| SM3 | 38.406 | -75.177 | 0.9 | 0.3 | 29.2 | 25.3 | 4.09 | 62.9 | 28.5 | 25.1 | 2.29 | 32.8 | 2.13 | 0.38 | 111.0 | 0.35 | 4.94 | 45.35 | 12.01 |
| SM4 | 38.405 | -75.148 | 1.7 | 0.5 | 29.3 | 28.4 | 5.86 | 93.1 | 29.2 | 28.3 | 5.94 | 87.0 | 1.60 | 0.25 | 75.5 | 0.22 | 2.93 | 33.03 | 5.59 |
| SM5 | 38.400 | -75.147 | 1.5 | 0.3 | 29.4 | 27.8 | 5.48 | 93.1 | 28.2 | 28.1 | 3.14 | 47.9 | 1.16 | 0.33 | 78.6 | 0.25 | 3.31 | 27.54 | 5.43 |
| SM6 | 38.413 | -75.181 | 0.9 | 0.2 | 30.1 | 25.6 | 4.67 | 87.2 | 29.9 | 24.8 | 1.94 | 31.5 | 1.51 | 0.37 | 126.7 | 0.42 | 6.44 | 53.47 | 4.67 |
| SM7 | 38.399 | -75.129 | 0.8 | 0.4 | 29.2 | 29.4 | 6.31 | 98.9 | 28.6 | 29.3 | 4.34 | 66.2 | 1.75 | 0.55 | 63.4 | 0.18 | 2.21 | 20.85 | 6.09 |
| SM9 | 38.401 | -75.133 | 0.9 | 0.4 | 29.4 | 28.8 | 6.46 | 106.5 | 29.0 | 29.1 | 5.63 | 86.1 | 0.68 | 0.26 | 71.6 | 0.15 | 2.81 | 27.73 | 3.68 |
| SM10 | 38.407 | -75.180 | 1.1 | 0.3 | 28.9 | 24.9 | 3.85 | 60.1 | 28.4 | 25.0 | 2.97 | 43.4 | 0.90 | 0.30 | 116.3 | 0.40 | 5.62 | 42.15 | 12.17 |
| SM11 | 38.400 | -75.111 | 0.5 | 0.5 | 30.0 | 30.4 | 7.06 | 111.8 | 30.4 | 30.6 | 7.09 | #### | 1.445 | 0.37 | 61.6 | 0.13 | 2.01 | 18.85 | 5.49 |
| SM12 | 38.391 | -75.121 | 1.9 | 0.5 | 29.1 | 30.4 | 6.84 | 109.3 | 28.6 | 29.7 | 6.30 | 85.3 | 1.28 | 0.33 | 68.6 | 0.23 | 2.41 | 18.85 | 6.20 |
| SM13 | 38.411 | -75.167 | 1.3 | 0.3 | 29.7 | 26.5 | 6.17 | 103.1 | 29.4 | 26.6 | 4.97 | 83.7 | 1.86 | 0.35 | 97.0 | 0.22 | 4.52 | 51.65 | 18.93 |
| SM14 | 38.392 | -75.126 | 1.8 | 0.5 | 29.5 | 29.3 | 6.35 | 95.7 | 28.5 | 29.6 | 3.93 | 57.7 | 0.78 | 0.35 | 65.7 | 0.21 | 2.86 | 26.54 | 4.45 |
| SM15 | 38.400 | -75.134 | 1.8 | 0.5 | 29.3 | 29.1 | 6.52 | 107.1 | 28.9 | 29.2 | 5.63 | 81.3 | 1.24 | 0.32 | 67.0 | 0.18 | 2.53 | 22.72 | 5.11 |
| SM16 | 38.403 | -75.137 | 1.8 | 0.6 | 29.2 | 28.6 | 6.34 | 101.1 | 28.7 | 28.9 | 4.30 | 79.3 | 1.51 | 0.34 | 69.3 | 0.25 | 2.95 | 17.99 | 5.08 |
| SM17 | 38.395 | -75.126 | 2.0 | 0.5 | 29.1 | 29.3 | 6.77 | 90.0 | 28.6 | 29.3 | 4.17 | 48.4 | 1.44 | 0.53 | 59.0 | 0.28 | 2.38 | 24.58 | 5.91 |
| SM18 | 38.393 | -75.121 | 1.4 | 0.3 | 29.2 | 29.5 | 7.44 | 117.3 | 28.6 | 29.7 | 7.19 | 86.2 | 0.82 | 0.28 | 64.5 | 0.23 | 2.38 | 24.29 | 3.46 |
| SM19 | 38.412 | -75.158 | 1.1 | 0.4 | 30.1 | 27.0 | 6.22 | 99.1 | 29.3 | 27.1 | 4.80 | 75.6 | 0.98 | 0.37 | 99.6 | 0.49 | 4.57 | 47.40 | 12.97 |
| SM20 | 38.398 | -75.127 | 1.8 | 0.5 | 29.1 | 29.4 | 6.35 | 94.1 | 28.8 | 29.4 | 4.81 | 59.0 | 0.38 | 0.26 | 59.7 | 0.17 | 2.23 | 22.57 | 6.20 |
| SMS28 | 38.397 | -75.132 | 1.8 | 0.4 | 29.3 | 30.1 | 6.87 | 107.2 | 29.0 | 29.3 | 6.39 | 84.4 | 0.90 | 0.27 | 64.6 | 0.23 | 2.37 | 25.87 | 7.51 |
| SM31 | 38.409 | -75.172 | 0.6 | 0.2 | 29.6 | 26.1 | 5.46 | 84.0 | 29.6 | 26.1 | 4.73 | 73.1 | 1.28 | 0.41 | 111.0 | 0.23 | 5.16 | 58.14 | 16.49 |
| SM71 | 38.442 | -75.194 | 0.3 | 0.0 | 31.4 | 0.1 | 0.82 | 12.2 | 31.6 | 0.1 | 1.40 | 20.0 | 7.82 | 0.66 | 87.1 | 0.93 | 6.97 | nd | nd |
| SM72 | 38.442 | -75.193 | 0.2 | 0.2 | 33.4 | 12.1 | 6.77 | 105.6 | 33.4 | 12.4 | 6.32 | 62.1 | 0.55 | 0.36 | 123.0 | 3.81 | 10.80 | 32.60 | 3.87 |
| SM73 | 38.406 | -75.192 | 0.5 | 0.3 | 29.0 | 23.1 | 2.77 | 42.5 | 29.7 | 22.6 | 1.02 | 11.7 | 0.90 | 0.60 | 140.0 | 0.51 | 7.85 | 46.93 | 18.54 |
| SM74 | 38.424 | -75.188 | 0.7 | 0.2 | 29.9 | 21.2 | 2.77 | 40.9 | 29.1 | 23.8 | 2.32 | 35.3 | 0.59 | 0.31 | 135.0 | 1.91 | 10.47 | 46.07 | 13.49 |
| *SM75 | 38.430 | -75.190 | 0.3 | 0.2 | 30.1 | 18.7 | 3.42 | 52.0 | 30.0 | 20.5 | 2.01 | 28.0 | 1.26 | 0.57 | 127.0 | 3.04 | 10.00 | 0.08 | 0.00 |
| *SM76 | 38.420 | -75.190 | 1.2 | 0.3 | 30.3 | 22.7 | 4.18 | 74.0 | 29.2 | 23.6 | 1.90 | 36.9 | 0.47 | 0.30 | 123.0 | 0.57 | 8.11 | 0.10 | 0.00 |
| JB1 | 38.067 | -75.332 | 1.6 | 0.5 | 28.1 | 32.1 | 6.41 | 87.9 | 28.0 | 32.1 | 5.70 | 89.2 | 1.45 | 0.32 | 55.5 | 0.98 | 3.26 | 0.08 | 0.00 |
| JB2 | 38.042 | -75.359 | 0.8 | 0.4 | 27.0 | 31.8 | 5.21 | 74.2 | 27.0 | 31.8 | 3.97 | 71.9 | 1.29 | 0.33 | 46.5 | 1.31 | 3.15 | 21.14 | 9.79 |
| JB3 | 38.042 | -75.325 | 2.0 | 0.5 | 27.4 | 32.2 | 5.61 | 84.7 | 27.4 | 32.1 | 5.54 | 84.0 | 1.25 | 0.43 | 33.4 | 0.53 | 1.93 | 25.58 | 1.32 |
| JB4 | 38.071 | -75.348 | 1.3 | 0.4 | 27.0 | 32.1 | 4.16 | 62.0 | 27.0 | 32.1 | 4.18 | 62.6 | 7.35 | 0.33 | 50.8 | 1.30 | 2.98 | 13.26 | 6.65 |
| JB5 | 38.081 | -75.354 | 0.9 | 0.3 | 29.0 | 32.4 | 5.33 | 81.4 | 29.5 | 32.4 | 5.03 | 73.8 | 4.14 | 0.19 | 50.3 | 1.54 | 3.85 | 20.42 | 13.63 |
| JB6 | 38.060 | -75.347 | 1.4 | 0.5 | 27.1 | 31.9 | 4.65 | 69.7 | 27.1 | 31.9 | 2.64 | 54.5 | 2.43 | 0.51 | 54.6 | 0.92 | 3.39 | 20.71 | 7.54 |
| JB7 | 38.086 | -75.319 | 1.0 | 0.4 | 28.7 | 32.4 | 5.28 | 80.5 | 28.8 | nd | 5.24 | 80.4 | 2.41 | 0.21 | 51.8 | 1.20 | 3.12 | nd | nd |
| JB8 | 38.088 | -75.336 | 1.4 | 0.4 | 28.8 | 32.2 | 5.70 | 90.7 | 28.9 | 32.1 | 5.38 | 84.5 | 1.04 | 0.21 | 61.1 | 1.47 | 3.28 | nd | nd |
| JB9 | 38.070 | -75.345 | 1.4 | 0.5 | 26.7 | 32.2 | 4.89 | 69.4 | 26.8 | 32.1 | 4.28 | 73.2 | 2.20 | 0.22 | 51.8 | 1.08 | 2.98 | 19.28 | 1.51 |
| JB10 | 38.094 | -75.332 | 1.4 | 0.4 | 28.7 | 32.1 | 5.12 | 80.5 | 28.6 | 32.0 | 4.95 | 73.8 | 2.17 | 0.38 | 63.8 | 1.44 | 3.25 | 19.99 | 6.69 |
| JB11 | 38.069 | -75.331 | 1.5 | 0.5 | 28.1 | 32.1 | 5.27 | 81.1 | 28.1 | 32.1 | 5.40 | 77.8 | 2.64 | 0.44 | 50.7 | 1.13 | 3.03 | 14.55 | 7.53 |
| JB12 | 38.084 | -75.336 | 0.9 | 0.4 | 29.1 | 32.2 | 5.34 | 81.8 | 29.2 | nd | 5.26 | 82.4 | 1.27 | 0.34 | 57.5 | 1.65 | 3.41 | 13.83 | 8.52 |
| JB13 | 38.073 | -75.364 | 0.9 | 0.4 | 26.6 | 30.9 | 3.42 | 57.1 | 26.7 | 31.9 | 2.46 | 47.3 | 1.95 | 0.20 | 77.9 | 1.60 | 4.05 | 23.48 | 11.29 |
| JB14 | 38.093 | -75.326 | 0.9 | 0.4 | nd | 32.2 | 6.24 | 88.0 | 28.5 | 32.2 | 5.14 | 83.8 | 2.14 | 0.38 | 60.4 | 1.28 | 2.89 | 22.14 | 4.48 |
| JB15 | 38.054 | -75.341 | 1.7 | 0.5 | 27.1 | 32.1 | 4.67 | 70.0 | 27.0 | 32.0 | 2.85 | 42.5 | 1.65 | 0.26 | 53.6 | 1.12 | 2.76 | 13.21 | 6.00 |
| JB16 | 38.067 | -75.347 | 1.4 | 0.5 | 27.1 | 32.1 | 4.74 | 70.6 | 27.1 | 32.1 | 4.56 | 64.3 | 0.46 | 0.22 | 44.2 | 1.17 | 2.75 | 17.27 | 6.25 |
| JB17 | 38.045 | -75.354 | 1.4 | 0.4 | 27.2 | 31.8 | 4.69 | 70.5 | 27.1 | 31.9 | 4.66 | 70.8 | 0.62 | 0.21 | 38.6 | 1.37 | 2.37 | 24.72 | -2.11 |
| JB18 | 38.030 | -75.336 | 1.9 | 0.4 | 22.6 | 32.0 | 5.73 | 86.5 | 27.3 | 32.1 | 5.53 | 82.9 | 1.27 | 0.24 | 39.8 | 0.49 | 1.54 | -15.25 | 58.43 |
| JB20 | 38.103 | -75.328 | 1.0 | 0.4 | 28.8 | 32.2 | 4.94 | 82.2 | 28.8 | 32.2 | 4.89 | 67.8 | 1.48 | 0.33 | 69.1 | 1.355 | 2.44 | 19.25 | 9.27 |
| JB21 | 38.032 | -75.345 | 2.0 | 0.4 | 27.2 | 32.0 | 6.90 | 84.2 | 27.2 | 32.0 | 5.25 | 79.6 | 0.81 | 0.31 | 38.2 | 0.52 | 1.97 | 17.84 | 4.62 |
| JB22 | 38.097 | -75.326 | 0.9 | 0.4 | 28.4 | 32.2 | 5.39 | 84.7 | 28.4 | 32.0 | 5.12 | 71.0 | 0.68 | 0.30 | 66.0 | 1.33 | 3.06 | 18.13 | 9.51 |
| JB23 | 38.043 | -75.330 | 1.4 | 0.5 | 27.6 | 32.1 | 5.82 | 83.7 | 27.4 | 32.1 | 5.03 | 79.7 | 1.10 | 0.46 | 44.1 | 0.92 | 2.32 | 19.71 | 4.66 |
| JB24 | 38.062 | -75.328 | 1.8 | 0.5 | 28.1 | 32.0 | 5.41 | 88.1 | 27.9 | 32.1 | 4.57 | 70.1 | 2.44 | 0.82 | 48.2 | 1.15 | 2.48 | 18.13 | 6.66 |
| JB25 | 38.081 | -75.314 | 1.0 | 0.4 | 28.0 | 32.2 | 5.36 | 83.5 | 28.1 | 32.2 | 5.07 | 82.3 | 2.23 | 0.46 | 48.1 | 1.65 | 2.37 | 19.56 | 11.08 |
| JB26 | 38.076 | -75.358 | 1.3 | 0.3 | 28.9 | nd | 7.01 | 93.3 | 28.9 | 32.4 | 5.10 | 78.7 | 3.61 | 0.38 | 64.2 | 1.34 | 3.11 | 26.28 | 13.80 |
| JB27 | 38.063 | -75.324 | 1.8 | 0.5 | 27.8 | 32.1 | 6.68 | 93.8 | 27.8 | 32.1 | 5.58 | 88.5 | 3.00 | 0.38 | 43.7 | 1.07 | 2.30 | 18.70 | 6.22 |
| JB28 | 38.082 | -75.354 | 0.9 | 0.4 | 29.2 | 32.4 | 5.40 | 85.0 | 29.3 | 32.1 | 4.80 | 34.6 | 3.81 | 0.61 | 71.8 | 2.00 | 2.31 | 25.69 | 14.48 |
| JBS30 | 38.072 | -75.358 | 1.0 | 0.3 | 28.5 | 32.6 | 5.13 | 78.7 | 28.8 | 32.2 | 4.82 | 69.9 | 2.72 | 0.62 | 67.2 | 1.45 | 3.25 | 21.57 | 8.48 |
| SPX1 | 38.277 | -75.146 | 1.3 | 0.4 | 28.6 | 30.9 | 5.39 | 83.9 | 28.5 | 30.9 | 4.49 | 73.1 | 1.56 | 0.50 | 75.3 | 1.01 | 3.80 | 33.46 | 10.39 |
| SPX2 | 38.261 | -75.143 | 1.7 | 0.4 | 27.5 | 31.3 | 7.15 | 86.3 | 27.4 | 31.2 | 5.23 | 81.3 | 2.42 | 0.50 | 69.3 | 0.76 | 3.23 | 25.87 | 15.81 |
| SPX3 | 38.250 | -75.149 | 1.8 | 0.7 | 26.5 | 31.3 | 5.29 | 80.4 | 26.4 | 31.4 | 4.25 | 60.7 | 1.73 | 0.60 | 52.0 | 0.73 | 2.33 | 16.22 | 10.73 |

# Appendix 3 – July 2007 Stable Isotope Data

Appendix 3 - July 2007 Isotopes

| | | | | *Crassostrea* | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mantle | | | | | | | Gill | | | | | | | Muscle | | | | | | |
| | | | SPOM | | | | | | | molar | | | | | | | molar | | | | | | | molar |
| Site | Lat | Long | 015N | 0g N | 015N | 0g C | 013C | %N | %C | C:N | 0g N | 015N | 0g C | 013C | %N | %C | C:N | 0g N | 015N | 0g C | 013C | %N | %C | C:N |
| SM1 | 38.412 | -75.174 | 13.2 | 89.2 | 8.0 | 500.6 | -23.6 | 2.1 | 11.9 | 6.5 | 88.7 | 8.5 | 420.1 | -23.1 | 0.7 | 3.2 | 5.5 | 139.6 | 9.2 | 502.0 | -21.9 | 2.5 | 9.1 | 4.2 |
| SM2 | 38.394 | -75.131 | 19.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM3 | 38.406 | -75.177 | 13.3 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM4 | 38.405 | -75.148 | 10.3 | 92.7 | 8.4 | 420.3 | -23.1 | 2.3 | 10.5 | 5.3 | 85.2 | 8.7 | 363.4 | -23.2 | 0.8 | 3.5 | 5.0 | 107.8 | 9.5 | 371.3 | -22.2 | 2.2 | 7.5 | 4.0 |
| SM5 | 38.400 | -75.147 | 9.2 | 72.4 | 8.9 | 344.5 | -23.5 | 1.8 | 8.5 | 5.6 | 58.1 | 9.3 | 252.7 | -23.0 | 0.6 | 2.7 | 5.1 | 118.8 | 9.9 | 415.2 | -22.2 | 2.3 | 8.2 | 4.1 |
| SM6 | 38.413 | -75.181 | 10.2 | 90.4 | 8.5 | 421.8 | -22.8 | 2.2 | 10.1 | 5.4 | 109.8 | 8.7 | 493.0 | -22.8 | 1.1 | 4.8 | 5.2 | 119.3 | 9.6 | 426.6 | -22.0 | 2.3 | 8.1 | 4.2 |
| SM7 | 38.399 | -75.129 | 9.7 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM9 | 38.401 | -75.133 | 9.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM10 | 38.407 | -75.180 | 11.0 | 92.7 | 7.9 | 453.3 | -23.4 | 2.2 | 10.7 | 5.7 | 107.3 | 8.3 | 498.3 | -23.1 | 1.0 | 4.5 | 5.4 | 132.5 | 9.4 | 481.7 | -22.4 | 2.4 | 8.9 | 4.2 |
| SM11 | 38.400 | -75.111 | 11.8 | 78.9 | 8.9 | 354.1 | -22.6 | 1.9 | 8.6 | 5.2 | 79.4 | 9.1 | 338.2 | -22.5 | 0.7 | 2.9 | 5.0 | 130.2 | 9.7 | 458.1 | -21.6 | 2.6 | 9.2 | 4.1 |
| SM12 | 38.391 | -75.121 | 10.1 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM13 | 38.411 | -75.167 | 9.2 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM14 | 38.392 | -75.126 | 9.1 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM15 | 38.400 | -75.134 | 9.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM16 | 38.403 | -75.137 | 14.0 | 77.0 | 9.0 | 374.5 | -23.5 | 1.9 | 9.2 | 5.7 | 88.1 | 9.0 | 391.9 | -23.4 | 0.6 | 2.8 | 5.2 | 149.4 | 10.3 | 521.8 | -22.1 | 2.9 | 10.1 | 4.1 |
| SM17 | 38.395 | -75.126 | 9.8 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM18 | 38.393 | -75.121 | 10.7 | 68.3 | 9.7 | 333.4 | -23.5 | 1.7 | 8.1 | 5.7 | 69.5 | 10.4 | 322.4 | -23.1 | 0.6 | 3.0 | 5.4 | 148.1 | 10.3 | 525.3 | -22.5 | 2.7 | 9.7 | 4.1 |
| SM19 | 38.412 | -75.158 | 10.5 | 99.1 | 8.4 | nd | nd | nd | nd | nd | 106.9 | 7.9 | 483.9 | -23.2 | 1.0 | 4.6 | 5.3 | 124.5 | 9.4 | 454.9 | -21.9 | 2.4 | 8.6 | 4.3 |
| SM20 | 38.398 | -75.127 | 16.7 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SMS28 | 38.397 | -75.132 | 9.4 | 128.5 | 9.2 | 557.2 | -23.5 | 3.2 | 13.9 | 5.1 | 101.4 | 9.1 | 433.3 | -23.4 | 1.1 | 4.6 | 5.0 | 178.4 | 9.8 | 612.1 | -22.6 | 3.6 | 12.3 | 4.0 |
| SM31 | 38.409 | -75.172 | 10.5 | 73.2 | 7.9 | 419.2 | -24.2 | 1.7 | 10.0 | 6.7 | 86.6 | 7.8 | 406.0 | -23.7 | 0.8 | 3.9 | 5.5 | 132.5 | 9.7 | 475.4 | -22.4 | 2.4 | 8.7 | 4.2 |
| SM71 | 38.442 | -75.194 | 9.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM72 | 38.442 | -75.193 | 12.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SM73 | 38.406 | -75.192 | 9.9 | 81.1 | 8.4 | 478.5 | -23.3 | 1.9 | 11.2 | 6.9 | 82.3 | 8.8 | 421.8 | -22.9 | 0.8 | 3.1 | 6.0 | 121.8 | 9.1 | 447.3 | -21.6 | 2.0 | 7.5 | 4.3 |
| SM74 | 38.424 | -75.188 | 12.9 | 64.3 | 8.2 | 323.9 | -24.4 | 1.6 | 7.9 | 5.9 | 88.5 | 8.0 | 413.3 | -24.2 | 0.7 | 3.2 | 5.4 | 123.3 | 10.1 | 436.0 | -22.9 | 2.3 | 8.0 | 4.1 |
| *SM75 | 38.430 | -75.190 | 27.2 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| *SM76 | 38.420 | -75.190 | 11.9 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB1 | 38.067 | -75.332 | 12.8 | 95.6 | 9.0 | 454.9 | -22.7 | 2.4 | 11.3 | 5.6 | 73.0 | 9.0 | 319.2 | -22.6 | 0.6 | 2.5 | 5.1 | 138.9 | 9.4 | 480.1 | -21.9 | 2.7 | 9.4 | 4.0 |
| JB2 | 38.042 | -75.359 | 15.3 | 170.4 | 9.5 | 738.9 | -22.2 | 4.2 | 18.3 | 5.1 | 75.9 | 9.6 | 327.1 | -21.5 | 0.5 | 2.1 | 5.0 | 112.3 | 10.0 | 387.8 | -21.4 | 2.2 | 7.7 | 4.0 |
| JB3 | 38.042 | -75.325 | 11.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB4 | 38.071 | -75.348 | 14.0 | 78.8 | 9.3 | 361.9 | -22.6 | 1.9 | 8.9 | 5.4 | 97.9 | 9.5 | 432.9 | -22.5 | 0.7 | 3.1 | 5.2 | 130.8 | 9.5 | 454.9 | -22.1 | 2.5 | 8.8 | 4.1 |
| JB5 | 38.081 | -75.354 | 20.5 | 73.6 | 9.1 | 335.0 | -22.8 | 1.8 | 8.1 | 5.3 | 176.1 | 8.2 | 834.1 | -22.4 | 0.9 | 4.1 | 5.5 | 208.6 | 9.4 | 743.6 | -22.7 | 3.8 | 13.5 | 4.2 |
| JB6 | 38.060 | -75.347 | 12.6 | 78.9 | 8.9 | 358.5 | -22.3 | 1.9 | 8.5 | 5.3 | 104.8 | 9.0 | 442.3 | -22.2 | 0.8 | 3.5 | 4.9 | 135.4 | 9.3 | 488.0 | -22.0 | 2.8 | 9.9 | 4.2 |
| JB7 | 38.086 | -75.319 | 15.7 | 62.5 | 9.1 | 314.5 | -23.2 | 1.5 | 7.6 | 5.9 | 75.9 | 8.9 | 338.2 | -22.7 | 0.5 | 2.1 | 5.2 | 142.3 | 10.1 | 502.1 | -21.9 | 2.7 | 9.7 | 4.1 |
| JB8 | 38.088 | -75.336 | 18.9 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB9 | 38.070 | -75.345 | 10.7 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB10 | 38.094 | -75.332 | 21.1 | 75.1 | 8.8 | 351.2 | -23.6 | 1.9 | 8.7 | 5.5 | 110.6 | 9.1 | 475.4 | -22.8 | 0.5 | 2.3 | 5.0 | 78.8 | 9.4 | 271.7 | -22.1 | 1.6 | 5.4 | 4.0 |
| JB11 | 38.069 | -75.331 | 15.3 | 85.7 | 9.5 | 406.1 | -22.2 | 2.1 | 10.0 | 5.5 | 92.4 | 9.6 | 395.1 | -22.2 | 0.6 | 2.6 | 5.0 | 119.9 | 10.3 | 418.7 | -21.2 | 2.4 | 8.4 | 4.1 |
| JB12 | 38.084 | -75.336 | 19.5 | 63.7 | 8.8 | 314.5 | -23.0 | 1.5 | 7.5 | 5.8 | 89.2 | 9.2 | 398.2 | -22.7 | 0.5 | 2.0 | 5.2 | 96.9 | 9.3 | 350.3 | -21.9 | 1.9 | 6.7 | 4.2 |
| JB13 | 38.073 | -75.364 | 18.8 | 87.2 | 8.0 | 382.3 | -22.9 | 2.1 | 9.2 | 5.1 | 85.2 | 8.2 | 371.3 | -22.7 | 0.5 | 2.0 | 5.1 | 162.4 | 9.7 | 577.6 | -22.3 | 3.2 | 11.4 | 4.1 |
| JB14 | 38.093 | -75.326 | 16.8 | 53.4 | 9.6 | 355.5 | -24.6 | 1.3 | 8.8 | 7.8 | 90.4 | 9.5 | 423.4 | -22.7 | 0.5 | 2.5 | 5.5 | 94.3 | 10.6 | 327.3 | -21.9 | 1.7 | 6.0 | 4.0 |
| JB15 | 38.054 | -75.341 | 20.5 | 66.6 | 9.2 | 290.7 | -22.1 | 1.6 | 7.2 | 5.1 | 86.6 | 9.3 | 371.3 | -22.1 | 0.4 | 1.8 | 5.0 | 123.3 | 9.9 | 427.9 | -22.2 | 2.5 | 8.6 | 4.0 |
| JB16 | 38.067 | -75.347 | 12.1 | 100.7 | 9.2 | 438.8 | -22.4 | 2.4 | 10.6 | 5.1 | 79.9 | 9.3 | 342.9 | -22.2 | 0.7 | 2.8 | 5.0 | 100.1 | 9.9 | 354.8 | -21.9 | 2.0 | 7.1 | 4.1 |
| JB17 | 38.045 | -75.354 | 12.6 | 63.1 | 9.4 | 279.7 | -21.6 | 1.5 | 6.8 | 5.2 | 68.3 | 9.4 | 293.9 | -21.5 | 0.5 | 2.3 | 5.0 | 156.7 | 10.2 | 554.0 | -21.4 | 3.1 | 11.0 | 4.1 |
| JB18 | 38.030 | -75.336 | 10.2 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB20 | 38.103 | -75.328 | 17.7 | 104.8 | 9.2 | 459.6 | -22.9 | 2.6 | 11.4 | 5.1 | 122.2 | 9.2 | 516.3 | -22.6 | 0.7 | 2.9 | 4.9 | 197.8 | 9.7 | 685.7 | -21.8 | 4.0 | 13.9 | 4.0 |
| JB21 | 38.032 | -75.345 | 8.7 | 85.7 | 9.6 | 443.9 | -21.7 | 2.0 | 10.5 | 6.0 | 85.2 | 9.9 | 388.7 | -20.7 | 1.0 | 4.5 | 5.3 | 44.4 | 10.5 | 160.7 | -20.4 | 0.8 | 3.0 | 4.2 |
| JB22 | 38.097 | -75.326 | 13.5 | 97.3 | 8.9 | 436.0 | -22.6 | 2.4 | 10.9 | 5.2 | 88.6 | 8.8 | 407.6 | -22.5 | 0.7 | 3.0 | 5.4 | 169.3 | 9.6 | 580.7 | -21.9 | 3.2 | 10.8 | 4.0 |
| JB23 | 38.043 | -75.330 | 14.5 | 95.0 | 9.1 | 426.6 | -22.0 | 2.3 | 10.5 | 5.2 | 92.7 | 9.2 | 414.1 | -21.7 | 0.6 | 2.9 | 5.2 | 111.7 | 9.4 | 389.6 | -21.3 | 2.1 | 7.5 | 4.1 |
| JB24 | 38.062 | -75.328 | 14.4 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB25 | 38.081 | -75.314 | 11.3 | 66.6 | 9.1 | 303.4 | -22.6 | 1.6 | 7.4 | 5.3 | 94.9 | 9.0 | 413.3 | -22.6 | 0.8 | 3.6 | 5.1 | 135.0 | 9.8 | 473.2 | -21.9 | 2.7 | 9.3 | 4.1 |
| JB26 | 38.076 | -75.358 | 13.1 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB27 | 38.063 | -75.324 | 11.4 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| JB28 | 38.082 | -75.354 | 12.2 | 79.5 | 8.7 | 340.1 | -22.8 | 1.9 | 8.3 | 5.0 | 60.8 | 8.8 | 259.1 | -22.3 | 0.5 | 2.1 | 5.0 | 160.1 | 9.8 | 565.0 | -21.6 | 3.2 | 11.4 | 4.1 |
| JBS30 | 38.072 | -75.358 | 11.8 | 81.5 | 9.0 | 343.8 | -22.8 | 2.0 | 8.5 | 4.9 | 132.5 | 9.2 | 583.9 | -22.8 | 1.1 | 5.0 | 5.1 | 118.7 | 9.6 | 409.2 | -22.2 | 2.3 | 8.0 | 4.0 |
| SPX1 | 38.277 | -75.146 | 11.6 | 70.7 | 9.0 | 311.3 | -22.8 | 1.7 | 7.4 | 5.1 | 75.3 | 9.3 | 311.3 | -22.6 | 0.7 | 2.7 | 4.8 | 134.5 | 9.9 | 482.0 | -22.3 | 2.8 | 10.0 | 4.2 |
| SPX2 | 38.261 | -75.143 | 11.7 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| SPX3 | 38.250 | -75.149 | 16.4 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |

# Appendix 4 – May 2007 Intensive Measurements

Appendix 4 - May 2007 Intensive Data

| Site | Lat | Long | $NH_4$ (0M) | $NO_x$ (0M) | $NO_3$ (0M) | $NO_2$ (0M) | Tot N (0M) | $PO_4$ (0M) | Tot P (0M) | Chl-*a* (0g/L) | phaeo (0g/L) | TSS (mg/L) | VSS (mg/L) | Bacteria | VLPs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JB10 | 38.094 | -75.332 | 0.33 | 0.16 | 0.08 | 0.08 | 59.4 | 0.19 | 3.18 | 27.87 | 2.06 | 40.82 | 6.75 | 15,852,310 | 220,196,030 |
| JB10 | 38.094 | -75.332 | 0.37 | 0.10 | 0.02 | 0.08 | 64.9 | 0.30 | 3.24 | 27.87 | 3.66 | 30.33 | 3.90 | 14,341,493 | 195,053,319 |
| JB10 | 38.094 | -75.332 | 0.49 | 0.31 | 0.21 | 0.10 | 65.2 | 0.18 | 3.14 | 26.44 | 3.87 | 100.60 | 9.30 | nd | nd |
| JB13 | 38.073 | -75.364 | 0.80 | 0.14 | 0.07 | 0.07 | 79.7 | 0.24 | 3.95 | 35.61 | 7.36 | 30.61 | 5.50 | 14,995,429 | 175,886,230 |
| JB13 | 38.073 | -75.364 | 0.38 | 0.22 | 0.14 | 0.08 | 78.7 | 0.18 | 3.93 | 33.46 | 6.24 | 20.41 | 6.60 | 16,754,291 | 213,769,418 |
| JB13 | 38.073 | -75.364 | 0.37 | 0.12 | 0.04 | 0.08 | 79.0 | 0.44 | 3.92 | 33.32 | 6.97 | 40.44 | 8.20 | nd | nd |
| JB15 | 38.054 | -75.341 | 0.54 | 0.29 | 0.12 | 0.17 | 57.2 | 0.85 | 3.37 | 8.37 | 0.98 | 20.12 | 5.65 | 8,839,411 | 150,518,024 |
| JB15 | 38.054 | -75.341 | 0.52 | 0.28 | 0.10 | 0.18 | 58.9 | 0.85 | 3.45 | 33.89 | 2.98 | 30.15 | 5.85 | 8,929,609 | 143,076,683 |
| JB15 | 38.054 | -75.341 | 0.63 | 0.30 | 0.11 | 0.19 | 58.4 | 0.97 | 3.51 | 7.13 | 0.87 | 30.46 | 6.70 | nd | nd |
| JB21 | 38.032 | -75.345 | 0.25 | 0.12 | 0.05 | 0.07 | 48.3 | 0.70 | 3.33 | 26.01 | 4.11 | 20.12 | 7.25 | 11,703,199 | 184,342,299 |
| JB21 | 38.032 | -75.345 | 0.24 | 0.13 | 0.04 | 0.09 | 53.6 | 0.51 | 3.28 | 33.32 | 1.28 | 30.06 | 6.85 | 7,576,638 | 147,473,839 |
| JB21 | 38.032 | -75.345 | 1.24 | 0.78 | 0.71 | 0.07 | 46.6 | 0.52 | 3.28 | 27.44 | 2.30 | 40.40 | 6.50 | nd | nd |
| JB23 | 38.043 | -75.330 | 0.33 | 0.35 | 0.28 | 0.07 | 50.2 | 0.50 | 3.28 | 26.73 | 7.56 | 30.33 | 6.55 | 11,522,803 | 101,472,825 |
| JB23 | 38.043 | -75.330 | 0.28 | 0.15 | 0.09 | 0.06 | 50.0 | 0.51 | 3.29 | 29.45 | 4.68 | 30.46 | 7.00 | 8,343,321 | 96,399,184 |
| JB23 | 38.043 | -75.330 | 0.29 | 0.13 | 0.07 | 0.06 | 50.2 | 0.50 | 3.22 | 28.73 | 4.78 | 40.61 | 6.20 | nd | nd |
| SM5 | 38.400 | -75.147 | 0.31 | 0.30 | 0.18 | 0.12 | 44.5 | 0.10 | 1.81 | 14.41 | 3.64 | 30.46 | 9.35 | 15,266,023 | 228,990,342 |
| SM5 | 38.400 | -75.147 | 0.23 | 0.25 | 0.11 | 0.14 | 42.9 | 0.22 | 1.67 | 12.26 | 3.59 | 10.11 | 7.00 | 13,980,700 | 179,268,658 |
| SM5 | 38.400 | -75.147 | 0.20 | 0.26 | 0.11 | 0.15 | 43.8 | 0.10 | 1.80 | 10.97 | 3.95 | nd | 7.05 | nd | nd |
| SM6 | 38.413 | -75.181 | 0.44 | 0.26 | 0.07 | 0.19 | 87.8 | 0.85 | 4.35 | 31.88 | 13.23 | 30.46 | nd | nd | 163,033,006 |
| SM6 | 38.413 | -75.181 | 0.62 | 0.34 | 0.12 | 0.22 | 86.7 | 1.03 | 4.31 | 13.83 | 5.32 | 40.61 | 5.90 | 20,542,610 | 184,680,542 |
| SM6 | 38.413 | -75.181 | 0.53 | 0.31 | 0.07 | 0.24 | 87.9 | 0.91 | 4.35 | 33.17 | 13.04 | 30.77 | 5.90 | nd | nd |
| SM10 | 38.407 | -75.180 | 0.27 | 0.30 | 0.16 | 0.14 | 81.9 | 0.12 | 4.06 | 22.86 | 15.59 | 10.15 | 5.55 | 21,410,766 | 214,107,661 |
| SM10 | 38.407 | -75.180 | 0.24 | 0.30 | 0.17 | 0.13 | 81.8 | 0.15 | 4.12 | 17.13 | 16.95 | 20.41 | 6.20 | nd | nd |
| SM10 | 38.407 | -75.180 | nd | nd | nd | nd | nd | nd | nd | 20.85 | 14.46 | 30.61 | 6.30 | nd | nd |
| SM14 | 38.392 | -75.126 | 2.43 | 0.43 | 0.30 | 0.13 | 33.6 | 0.15 | 1.28 | 9.78 | 1.56 | 42.30 | 6.80 | 10,169,832 | 156,606,393 |
| SM14 | 38.392 | -75.126 | 0.44 | 0.28 | 0.15 | 0.13 | 34.4 | 0.11 | 1.32 | 7.93 | 2.15 | 40.20 | 6.70 | 13,935,601 | 172,842,045 |
| SM14 | 38.392 | -75.126 | 0.21 | 0.23 | nd | nd | 34.5 | 0.08 | 1.27 | 4.45 | 1.05 | 30.80 | 6.50 | nd | nd |
| SM71 | 38.442 | -75.194 | 13.80 | 28.40 | 26.19 | 2.21 | 117.0 | 1.24 | 3.22 | 11.25 | 24.73 | 10.11 | 7.90 | nd | nd |
| SM71 | 38.442 | -75.194 | 14.60 | 29.70 | 27.47 | 2.23 | 118.0 | 0.64 | 3.31 | 12.69 | 22.04 | 50.00 | 8.60 | nd | nd |
| SM71 | 38.442 | -75.194 | 12.50 | 20.20 | 18.66 | 1.54 | 117.0 | 0.99 | 3.21 | 8.53 | 20.85 | nd | nd | nd | nd |
| SM 74 | 38.424 | -75.188 | 0.53 | 0.24 | 0.13 | 0.11 | 122.0 | 0.29 | 6.52 | nd | nd | 20.30 | 15.10 | 26,315,286 | 197,533,766 |
| SM 74 | 38.424 | -75.188 | 0.82 | 0.37 | 0.26 | 0.11 | 123.0 | 0.24 | 6.26 | nd | nd | 50.25 | 10.05 | nd | nd |
| SM 74 | 38.424 | -75.188 | 0.64 | 0.27 | 0.16 | 0.11 | 130.0 | 0.44 | 6.51 | nd | nd | 20.30 | 9.45 | nd | nd |
| SPX1 | 38.277 | -75.146 | 0.31 | 0.21 | nd | nd | 48.6 | 0.24 | 3.20 | 48.93 | 10.60 | 30.06 | 8.05 | 8,704,113 | 128,532,245 |
| SPX1 | 38.277 | -75.146 | 0.40 | 0.29 | nd | nd | 49.9 | 0.15 | 3.01 | -0.22 | 0.57 | 20.18 | 4.65 | 10,057,084 | 101,134,582 |
| SPX1 | 38.277 | -75.146 | 0.32 | 0.15 | nd | nd | 49.1 | 0.06 | 2.97 | 26.01 | 4.82 | 30.06 | 5.70 | nd | nd |
| SPX2 | 38.261 | -75.143 | 0.40 | 0.27 | nd | nd | 48.9 | 0.13 | 3.03 | 29.59 | 2.70 | 50.30 | 11.20 | 2,215,490 | 127,179,274 |
| SPX2 | 38.261 | -75.143 | 0.33 | 0.14 | nd | nd | 48.9 | 0.13 | 2.99 | 29.16 | 3.65 | 40.82 | 8.65 | nd | nd |
| SPX2 | 38.261 | -75.143 | 0.28 | 0.12 | nd | nd | 49.5 | 0.13 | 3.02 | 31.31 | 0.86 | 20.20 | 7.30 | nd | nd |
| SPX3 | 38.250 | -75.149 | 0.28 | 0.11 | nd | nd | 52.1 | 0.28 | 3.16 | 29.31 | 2.57 | 40.24 | 6.70 | nd | nd |
| SPX3 | 38.250 | -75.149 | 0.26 | 0.10 | nd | nd | 52.9 | 0.21 | 3.08 | 31.31 | 5.13 | 30.18 | 5.85 | nd | nd |
| SPX3 | 38.250 | -75.149 | 0.32 | 0.11 | nd | nd | 52.6 | 0.30 | 2.94 | 41.05 | -2.68 | 50.35 | 7.45 | nd | nd |

# Appendix 5 – July 2007 Intensive Measurements

**Appendix 5 - July 2007 Intensive Data**

| Site | Lat | Long | $NH_4$ (µM) | $NO_x$ (µM) | $NO_3$ (µM) | $NO_2$ (µM) | Tot N (µM) | $PO_4$ (µM) | Tot P (µM) | Chl-*a* (µg/L) | phaeo (µg/L) | TSS (mg/L) | VSS (mg/L) | Bacteria | VLPs | SPOM $\delta^{15}N$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JB10 | 38.094 | -75.332 | 1.77 | 0.38 | 0.22 | 0.16 | 61.4 | 1.15 | 3.26 | 17.84 | 8.13 | 67.20 | 14.97 | 10,823,768 | 173,518,531 | 12.0 |
| JB10 | 38.094 | -75.332 | 1.80 | 0.46 | 0.27 | 0.19 | 67.4 | 1.45 | 3.15 | 18.99 | 5.47 | 64.20 | 16.20 | 8,151,650 | 133,267,644 | 12.8 |
| JB10 | 38.094 | -75.332 | 2.94 | 0.31 | 0.15 | 0.16 | 62.5 | 1.71 | 3.33 | 23.15 | 6.48 | 70.23 | 13.60 | nd | nd | 13.0 |
| JB13 | 38.073 | -75.364 | 1.65 | 0.17 | 0.01 | 0.16 | 72.9 | 1.60 | 4.09 | 21.28 | 12.08 | 40.47 | 14.07 | 15,626,815 | 181,298,114 | 12.4 |
| JB13 | 38.073 | -75.364 | 1.51 | 0.21 | 0.05 | 0.16 | 80.4 | 1.44 | 4.24 | 23.15 | 10.92 | 30.47 | 11.27 | 13,157,643 | 192,460,125 | 10.5 |
| JB13 | 38.073 | -75.364 | 2.70 | 0.21 | 0.09 | 0.12 | 80.3 | 1.75 | 3.81 | 26.01 | 10.87 | 45.27 | 18.60 | nd | nd | 9.2 |
| JB15 | 38.054 | -75.341 | 2.21 | 0.21 | 0.07 | 0.14 | 58.6 | 1.04 | 2.73 | 13.98 | 5.30 | 43.23 | 16.97 | 8,816,861 | 136,988,314 | 15.3 |
| JB15 | 38.054 | -75.341 | 1.94 | 0.33 | 0.18 | 0.15 | 48.1 | 1.07 | 2.83 | 13.40 | 5.03 | 52.87 | 17.93 | 10,665,921 | 147,135,596 | 12.2 |
| JB15 | 38.054 | -75.341 | 0.81 | 0.23 | 0.08 | 0.15 | 54.1 | 1.25 | 2.72 | 12.26 | 7.68 | 47.17 | 14.67 | nd | nd | 11.8 |
| JB21 | 38.032 | -75.345 | 1.04 | 0.31 | 0.20 | 0.11 | 36.8 | 0.54 | 2.05 | 16.27 | 4.62 | 50.90 | 13.00 | 11,331,132 | 123,458,604 | 14.3 |
| JB21 | 38.032 | -75.345 | 0.54 | 0.37 | 0.26 | 0.11 | 36.5 | 0.46 | 1.95 | 17.84 | 2.97 | 67.53 | 19.63 | 9,809,040 | 113,987,807 | 15.1 |
| JB21 | 38.032 | -75.345 | 0.86 | 0.26 | 0.14 | 0.12 | 41.2 | 0.57 | 1.90 | 19.42 | 2.03 | 55.53 | 17.30 | nd | nd | 13.9 |
| JB23 | 38.043 | -75.330 | 1.06 | 0.22 | 0.09 | 0.13 | 41.5 | 0.95 | 2.71 | 23.15 | 0.78 | 48.13 | 13.63 | 9,200,203 | 118,046,720 | 10.7 |
| JB23 | 38.043 | -75.330 | 0.91 | 0.32 | 0.21 | 0.11 | 43.9 | 0.77 | 2.08 | 18.85 | 5.85 | 45.27 | 12.40 | nd | nd | 9.6 |
| JB23 | 38.043 | -75.330 | 1.34 | 0.83 | 0.68 | 0.15 | 46.8 | 1.04 | 2.16 | 17.13 | 7.34 | 43.73 | 13.40 | nd | nd | 10.7 |
| SM5 | 38.400 | -75.147 | 1.14 | 0.36 | 0.25 | 0.11 | 77.1 | 0.17 | 3.32 | 27.73 | 8.49 | 29.30 | 14.40 | 29,934,483 | 240,828,838 | 8.0 |
| SM5 | 38.400 | -75.147 | 0.94 | 0.36 | 0.22 | 0.14 | 77.8 | 0.24 | 3.21 | 37.04 | 0.92 | 26.50 | 13.23 | 32,606,601 | 227,975,614 | 9.5 |
| SM5 | 38.400 | -75.147 | 1.41 | 0.28 | 0.17 | 0.11 | 81.0 | 0.33 | 3.40 | 17.84 | 6.88 | 32.20 | 13.40 | nd | nd | 10.2 |
| SM6 | 38.413 | -75.181 | 1.33 | 0.32 | 0.21 | 0.11 | 131.0 | 0.36 | 6.45 | 52.08 | 5.17 | 37.08 | 15.68 | 42,753,884 | 222,563,730 | 13.7 |
| SM6 | 38.413 | -75.181 | 1.58 | 0.32 | 0.24 | 0.08 | 129.0 | 0.49 | 6.52 | 52.51 | 5.64 | 40.56 | 17.08 | 40,047,942 | 212,754,690 | 8.3 |
| SM6 | 38.413 | -75.181 | 1.62 | 0.48 | 0.38 | 0.10 | 120.0 | 0.42 | 6.36 | 55.81 | 3.21 | 48.80 | 21.44 | nd | nd | 8.4 |
| SM10 | 38.407 | -75.180 | 0.58 | 0.31 | 0.18 | 0.13 | 117.0 | 0.46 | 5.20 | 41.48 | 16.83 | 46.24 | 20.56 | 45,798,068 | 249,284,907 | 10.0 |
| SM10 | 38.407 | -75.180 | 1.02 | 0.31 | 0.21 | 0.10 | 117.0 | 0.42 | 5.64 | 35.32 | -4.88 | 50.95 | 23.95 | 51,277,601 | 227,975,614 | 14.5 |
| SM10 | 38.407 | -75.180 | 1.09 | 0.29 | 0.21 | 0.08 | 115.0 | 0.32 | 6.01 | 49.65 | 24.56 | 46.25 | 20.60 | nd | nd | 8.7 |
| SM14 | 38.392 | -75.126 | 0.64 | 0.29 | 0.19 | 0.10 | 67.6 | 0.23 | 2.98 | 26.87 | 3.81 | 34.68 | 17.60 | 20,362,214 | 166,415,433 | 8.5 |
| SM14 | 38.392 | -75.126 | 0.49 | 0.33 | 0.23 | 0.10 | 61.8 | 0.22 | 2.72 | 24.00 | 9.02 | 34.56 | 16.04 | 17,994,514 | 178,930,415 | 9.2 |
| SM14 | 38.392 | -75.126 | 1.20 | 0.42 | 0.32 | 0.10 | 67.6 | 0.18 | 2.88 | 28.73 | 0.51 | 38.64 | 18.16 | nd | nd | 9.7 |
| SM71 | 38.442 | -75.194 | 6.33 | 0.47 | 0.35 | 0.12 | 83.2 | 0.99 | 5.09 | nd | nd | 166.55 | 45.80 | 55,268,865 | 171,150,832 | 10.9 |
| SM71 | 38.442 | -75.194 | 6.82 | 0.61 | 0.35 | 0.26 | 81.0 | 0.91 | 5.43 | nd | nd | 176.10 | 51.80 | 109,252,408 | 142,400,198 | 8.8 |
| SM71 | 38.442 | -75.194 | 10.30 | 0.91 | 0.79 | 0.12 | 97.1 | 0.89 | 10.40 | nd | nd | 156.55 | 45.50 | nd | nd | 8.9 |
| SM74 | 38.424 | -75.188 | 0.42 | 0.31 | 0.18 | 0.13 | 132.0 | 1.87 | 10.60 | 33.60 | 18.50 | 22.48 | 13.64 | 33,012,492 | 248,270,179 | 10.8 |
| SM74 | 38.424 | -75.188 | 0.45 | 0.30 | 0.11 | 0.19 | 135.0 | 2.11 | 10.40 | 50.94 | 19.21 | 34.72 | 19.40 | 55,133,568 | 231,358,041 | 12.3 |
| SM74 | 38.424 | -75.188 | 0.90 | 0.32 | 0.15 | 0.17 | 138.0 | 1.74 | 10.40 | 53.66 | -2.89 | 29.44 | 15.60 | nd | nd | 15.6 |
| SPX1 | 38.277 | -75.146 | 1.97 | 0.48 | nd | nd | 77.4 | 1.34 | 3.75 | 36.61 | 7.57 | 45.00 | 15.37 | 10,981,615 | 106,884,709 | 12.3 |
| SPX1 | 38.277 | -75.146 | 1.64 | 0.64 | nd | nd | 73.8 | 0.96 | 3.76 | 27.30 | 15.49 | 55.83 | 18.67 | 9,538,446 | 91,663,785 | 11.6 |
| SPX1 | 38.277 | -75.146 | 1.08 | 0.37 | nd | nd | 74.7 | 0.72 | 3.90 | 36.47 | 8.12 | 48.00 | 16.13 | nd | nd | 10.8 |
| SPX2 | 38.261 | -75.143 | 1.91 | 0.35 | nd | nd | 63.7 | 0.76 | 3.22 | 23.86 | 19.01 | 49.77 | 18.43 | nd | nd | 13.0 |
| SPX2 | 38.261 | -75.143 | 2.68 | 0.49 | nd | nd | 68.9 | 0.68 | 3.35 | 28.16 | 12.70 | 37.57 | 13.27 | nd | nd | 11.0 |
| SPX2 | 38.261 | -75.143 | 2.66 | 0.67 | nd | nd | 75.2 | 0.84 | 3.13 | 25.58 | 15.74 | 39.53 | 12.17 | nd | nd | 11.2 |
| SPX3 | 38.250 | -75.149 | 2.36 | 1.10 | nd | nd | 53.9 | 0.93 | 2.19 | 14.41 | 10.04 | 29.13 | 9.87 | nd | nd | 12.5 |
| SPX3 | 38.250 | -75.149 | 1.42 | 0.37 | nd | nd | 53.6 | 0.69 | 2.29 | 17.27 | 9.99 | 31.87 | 10.07 | nd | nd | 13.3 |
| SPX3 | 38.250 | -75.149 | 1.41 | 0.34 | nd | nd | 48.4 | 0.58 | 2.50 | 16.98 | 12.17 | 28.23 | 11.47 | nd | nd | 23.4 |