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DEPARTMENT OF
NATURAL RESOURCES

2013 Masonville Cove – Patapsco River Shallow Water Monitoring Data Report

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Executive summary

Masonville Cove, a small inlet of the upper tidal Patapsco River, figures in local Baltimore lore as a natural respite from the rigors of early twentieth century city life. However, as the Patapsco River was heavily impacted by pollution from centuries of being a center of commerce and population, so too was Masonville Cove. In 2007, the Maryland Port Administration received a permit to build a dredged material containment facility at the Masonville Marine Terminal, adjacent to Masonville Cove. As part of the mitigation agreement for this project, the Maryland Department of Natural Resources (DNR) first deployed a continuous water quality monitor in the summer of 2009, ahead of the construction of the dredged material containment facility. Since 2009, DNR has continued to deploy a monitor during most of the year, although it has been removed in the winter to prevent icing damage. In continuation of this project, a water quality monitor was deployed in Masonville Cove in the early spring of 2013. The monitor was deployed off the Masonville Cove pier, approximately one-tenth of a mile west of previous years' deployment location. This change was made so that DNR field personnel will be able to access the site during winter months, which will allow the monitor to be deployed year-round. In previous years, the site was only accessible by boat so the monitor needed to be removed during the winter months when icing at the boat ramp precluded access.

In 2013, water quality conditions in Masonville Cove, as in the rest of the Chesapeake Bay watershed, were influenced by meteorological events. Heavy rains in early summer, as well as the remnants of Tropical Storm Karen in early October, led to large discharge events that affected salinity and turbidity, although turbidity readings were generally high throughout the year. Nutrients in the October storm runoff may also have been factors in the formation of an algal bloom of potentially harmful dinoflagellate species in early December. Furthermore, the rate of low dissolved oxygen conditions was slightly above the 5-year average in Masonville Cove. All 2013 continuous monitoring data, as well as data from previous years, are available on the DNR "Eyes on the Bay" website (www.eyesonthebay.net). Data from grab samples are available through the Chesapeake Bay Program's datahub (www.chesapeakebay.net/data).

Introduction

In 2007, the Maryland Port Administration (MPA) submitted plans to the United States Army Corps of Engineers (USACE) to construct a dredged material containment facility (DMCF) in the vicinity of the Masonville Marine Terminal (Figure 1). The terminal, located on the upper Patapsco River in Baltimore, is a major port for the automotive industry. The design for the DMCF uses sand and clay dikes to contain material dredged from the navigation channels in Baltimore Harbor. The same year, an environmental impact study submitted to USACE suggested mitigation for the project. Mitigation was deemed necessary as the DMCF was to fill 130 acres of tidal open water, cover ten acres of upland habitat, and disturb one acre of vegetated wetland and 0.38 acres of submerged aquatic vegetation (SAV).

In 2013, as continuation of the mitigation plan implemented in 2009, the Resource Assessment Service of the Maryland Department of Natural Resources (DNR) monitored water quality in Masonville Cove adjacent to the DMCF site. In late March, DNR deployed a continuous water quality monitor that collected data every 15 minutes on a suite of water quality parameters, including dissolved oxygen, salinity, temperature, turbidity, pH, and chlorophyll. Data from this monitor were telemetered to the DNR website "Eyes on the Bay" (www.eyesonthebay.net) and displayed in near real-time. DNR personnel visited the station every two to four weeks to replace the meters, and to collect water samples for analyses of total suspended solids, chlorophyll *a*, and phaeophytin concentrations. The continuous monitoring site at Masonville Cove was the only continuous monitoring station located in the upper Patapsco in 2013.

Description of continuous monitoring

On March 27th, 2013 a data collection device known as a sonde was attached to a piling on the Masonville Cove pier (39.2447°, -76.5972°) with its instrumentation deployed one meter below the water surface (see Figure 1 for station location). This location is approximately one-tenth of a mile west of previous years' deployment location (Figure 1). This change was made so that DNR field personnel will be able to access the site during winter months, which will allow the monitor to be deployed year-round. In previous years, the site was only accessible by boat so the monitor needed to be removed during the winter months when icing at the boat ramp precluded access. The data sonde deployed in Masonville Cove was a YSI™ 6600 V2 (Yellow Springs Instruments, Yellow Springs, OH), which housed several water quality sensors (Figure 2). The water quality indicator data collected by each sensor are explained in greater detail in the following section. The sonde collected a reading from each sensor simultaneously every 15 minutes for the duration of its deployment. These readings were stored in the sonde's data memory and sent, by attached cellular telemetry equipment, to DNR headquarters in Annapolis. There, the data were posted on DNR's "Eyes on the Bay" website (www.eyesonthebay.net) for easy public access. This website enables the public to access near real-time water quality data for numerous locations throughout Maryland. The data are called "near real-time" since there is a lag of approximately 30-minutes to one hour between the time that the sonde collects the data and the time that the data are posted on the website.

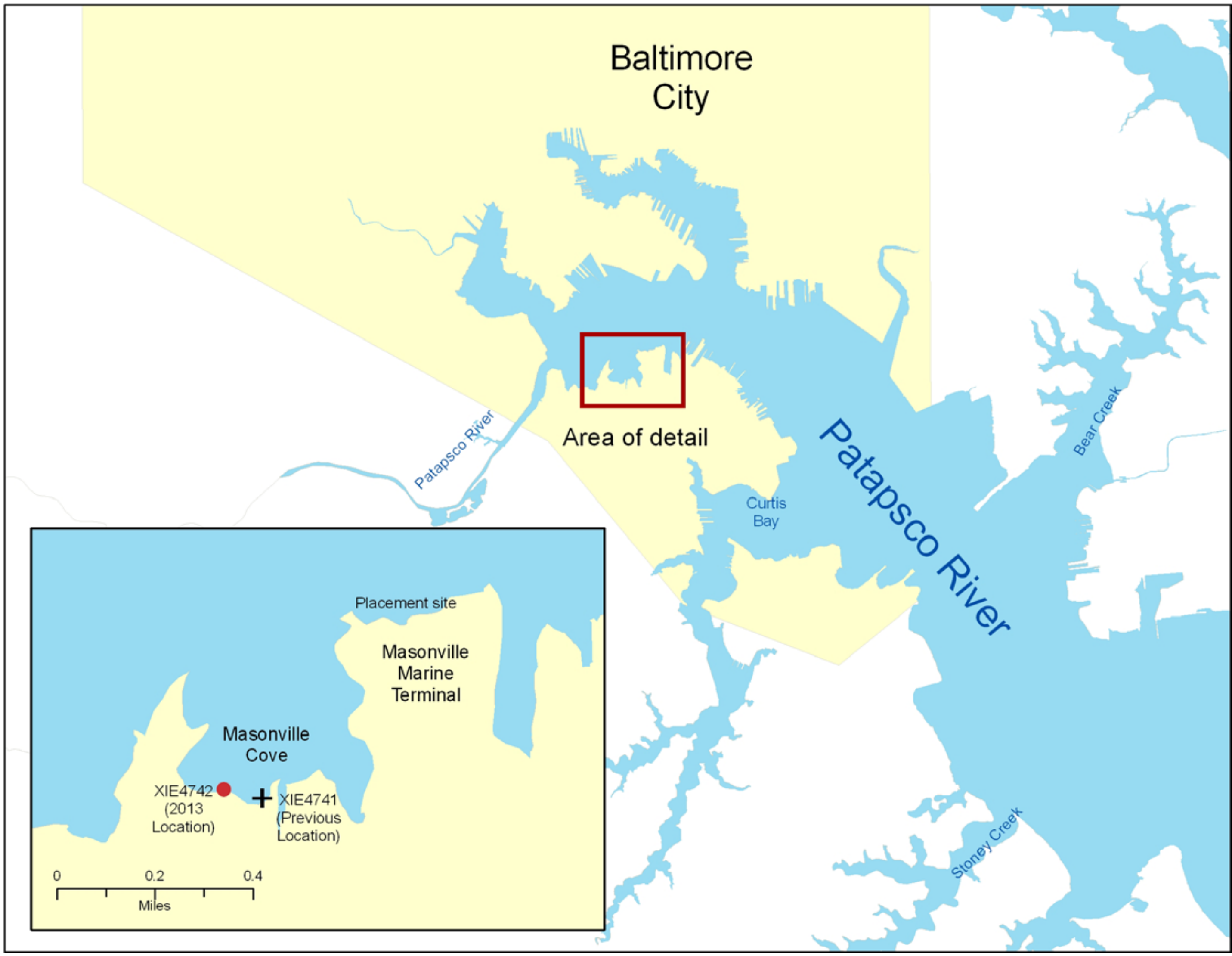

Figure 1. Map of the Patapsco River and Masonville Cove. The inset shows the 2013 continuous monitor location within the cove, the location of the monitor in previous years, and the approximate site for dredged material placement.

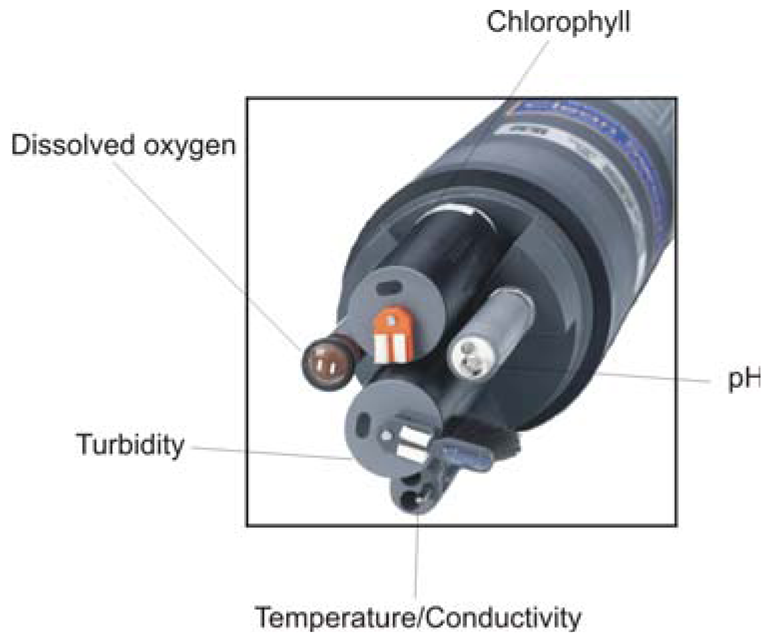

Figure 2. YSI 6600 continuous monitoring sonde showing individual sensors. Image courtesy of YSI, Inc.

Continuous monitoring parameters

The continuous monitors at Masonville Cove, like all continuous monitors in the DNR Shallow Water Monitoring Program, collected data on six water quality parameters:

1. Dissolved oxygen (DO): Fish and other aquatic life require DO to survive. Maryland state water quality criteria require a minimum DO concentration of 5 milligrams per liter (mg/L) (COMAR 1995). This threshold is necessary for the survival of many fish and shellfish species, including blue crabs (*Callinectes sapidus*) and striped bass (*Morone saxitilis*).
2. Salinity: Salinity, or salt concentration, in the Patapsco River comes from the Chesapeake Bay. Therefore, areas closer to the Bay have higher salinities, except perhaps during large freshwater releases from the Conowingo Dam on the Susquehanna River. During periods of low precipitation and river flow, salinity increases as salty water intrudes further up the river. During wetter periods, salinity decreases. Salinity also cycles in relation to tides, increasing during flood tides and decreasing during ebb tides. Salinity levels are important to aquatic organisms, as some organisms are adapted to live only in brackish or salt water, while others require fresh water.
3. Water temperature: Water temperature is another variable affecting suitability of waterways for aquatic organisms. Many aquatic organisms can tolerate gradual temperature changes associated with changing seasons, but sudden changes can cause stress. Higher water temperatures cause more dissolved oxygen to come out of solution and enter the air, decreasing the amount available to fish and other aquatic organisms.
4. pH: The acidity of water is indicated by pH. A neutral pH is 7; lower values indicate higher acidity, while higher numbers indicate more alkaline conditions. pH is affected by salinity (higher salinities tend to buffer pH in the 7-8 range) and algae blooms (large algae blooms can raise the pH over 8 in low salinity waters).

5. Turbidity: Turbidity is a measure of water clarity. Events that stir up sediment or cause runoff, such as storms, will increase turbidity. Dense algae blooms will also cause higher turbidities. Relatively clear water (low turbidity) is required for growth and survival of submerged aquatic vegetation (SAV).
6. Chlorophyll: Chlorophyll concentration is a surrogate measure of the amount of algae in the water. Chlorophyll is the main photopigment responsible for photosynthesis, the process by which sunlight is converted into food energy. Chlorophyll concentrations are calculated from fluorescence values collected by the sensors. One downside to this method is that certain species of phytoplankton, such as cyanobacteria or blue-green algae, fluoresce outside the detection range of the chlorophyll fluorescence sensor.

Calibration of continuous monitors and collection of laboratory water samples

Pigments and suspended solids data were obtained by DNR staff during deployment of continuous monitoring data sondes. Discrete whole water samples were collected to measure chlorophyll *a*, phaeophytin, and total suspended solids. Data sondes were removed and replaced with freshly calibrated instruments on a biweekly basis between March and October, and once a month in November and December. At the time of each instrument replacement, Secchi disk depth was recorded for use in water clarity determination.

Masonville Cove continuous monitor deployment

In 2013, the continuous monitor at Masonville Cove was deployed on March 27th and remained deployed for the remainder of the year, collecting 26,844 data records. Seventeen calibration samples were also collected and analyzed in 2013. Automated telemetry generally operated throughout the deployment of the surface sonde, but there were times when telemetry did not work properly, which led to gaps in near real-time web presentation of the data. Telemetry issues did not, however, impede the sonde from collecting data. The water quality monitor did not, however, collect data between April 14th and April 17th due to a power failure of the sonde. Probe malfunctions also resulted in invalid turbidity data between June 25th and July 1st, and no dissolved oxygen data collected between July 25th and August 14th.

A vandalism incident was reported by Maryland Environmental Service (MES) on September 3rd, in which the latches on the continuous monitoring telemetry unit were unhooked. However, the lock on the unit remained in place and no equipment was damaged, nor were data compromised.

2013 Precipitation and Discharge Events

Precipitation increases runoff into waterways, which can lead to a higher discharge of nutrients that fuel algal blooms, decrease water clarity, and suppress SAV growth. Although beyond the scope of sampling for this report, precipitation has also been tied to increased loads of contaminants from urban and industrial centers in and around Baltimore (Leffler and Greer 2001).

Monthly precipitation at Baltimore Washington International (BWI) Thurgood Marshall Airport was roughly equivalent to the 20-year average in 2013 (Figure 3), however 36% of the total annual precipitation fell in two months; June and October. An extended drought impacted Central Maryland in July, August, and September, and eight of the twelve months in 2013 were below normal for precipitation (Figure 3). The drought ended in October when the remnants of Tropical Storm Karen impacted the region on October 10th and 11th, and over 6-inches of rain fell at BWI Marshall Airport.

Daily mean discharge at the USGS gaging station in the Gwynns Falls reflected the pattern of precipitation seen in 2013 (Figure 4). Gage data indicate average flow levels in late winter and early spring, followed by a decrease in April and May as the region experienced dryer than normal conditions. Flows during June and July generally reflected the 47-year mean with several brief spikes associated with storm events that impacted the region. The low flows seen during August and September reflected the drought conditions during that time. Flows associated with Tropical Storm Karen in October were more than 50 times greater than the 47-year mean, reflecting high discharge levels into the Chesapeake Bay from this storm event. For the remainder of the year, flows were below average in November and above average in December

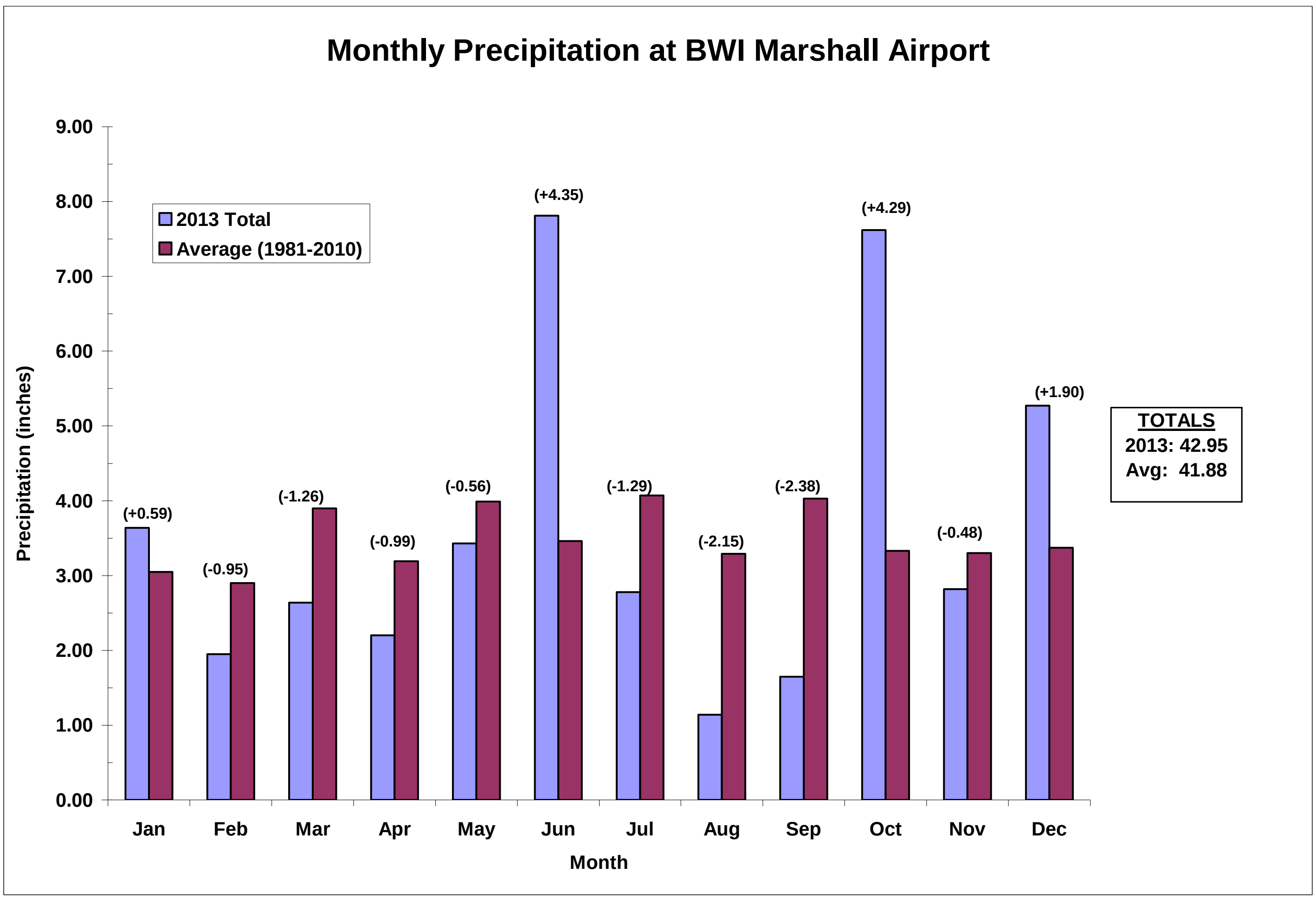

Figure 3. Total monthly precipitation at BWI Thurgood Marshall Airport compared to 20-year averages for 2013. Data source: National Oceanographic and Atmospheric Administration (http://www.erh.noaa.gov/lwx/climate/bwi/bwiprecip.txt).

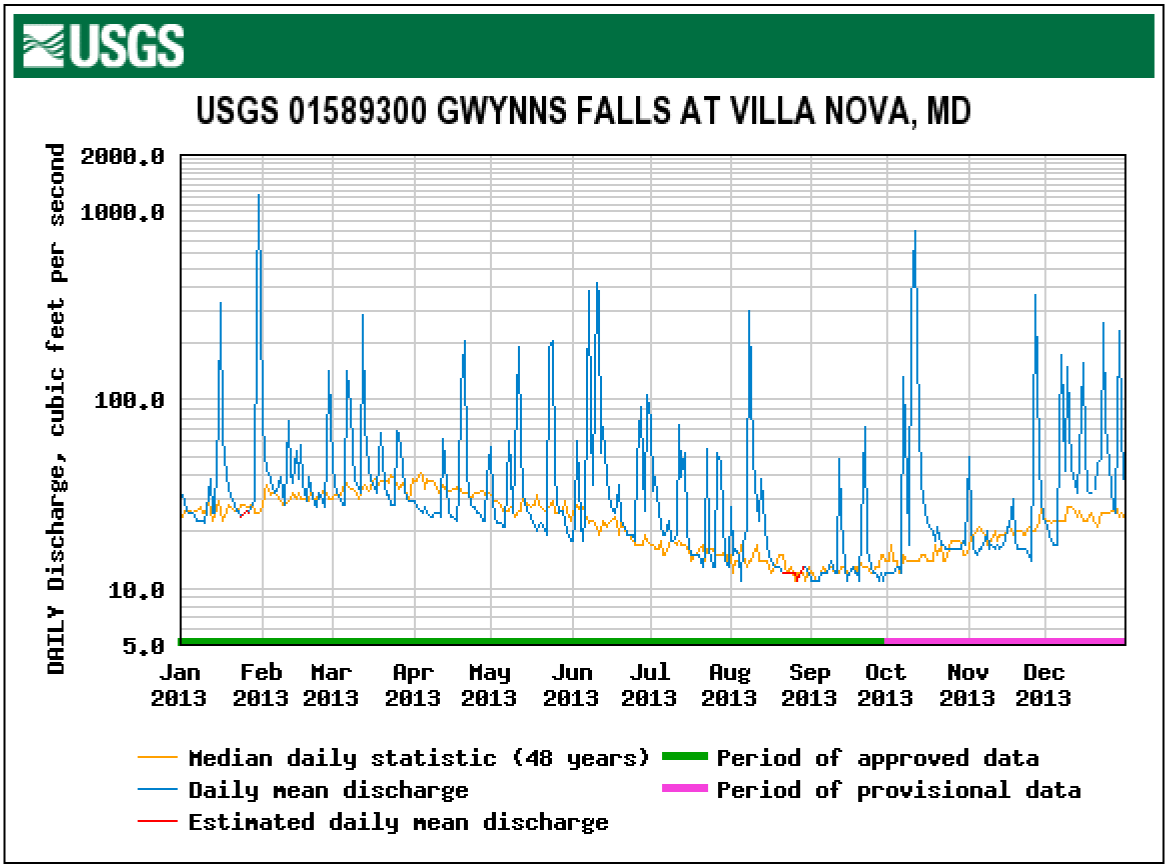

Figure 4. Daily discharge in cubic feet per second measured at a USGS gaging station west of Masonville Cove. The y-axis is in logarithmic scale. Graph courtesy of the United States Geological Survey (http://waterdata.usgs.gov/nwis/dv/?site_no=01589300).

2013 Continuous Monitoring Data

Water Temperature

Water temperature at Masonville Cove rose predictably as air temperatures increased during the summer months and peaked in July (Figure 5). Water temperature peaked at approximately 32°C (~89º F) on July 21st. Following the July peak, temperature gradually declined through the rest of the year. Variability in the plots in Figure 5 was most likely a result of diel variation in temperature (warming temperatures during the day and cooling temperatures during the night).

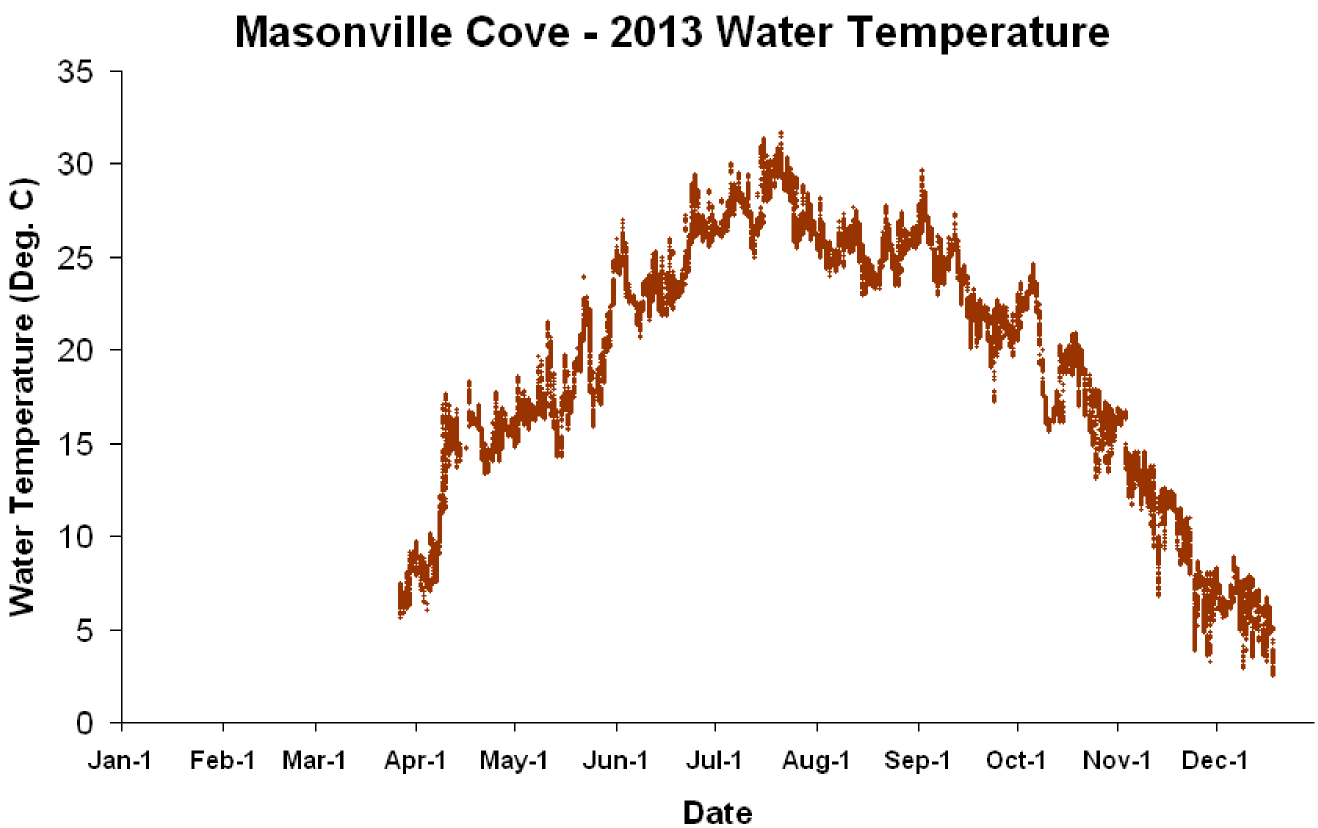

Figure 5. Water temperature at Masonville Cove Continuous Monitor during 2013.

Salinity

Salinity readings between June 11th and July 1st were censored out of the 2013 dataset because post-deployment equipment checks indicated an equipment malfunction may have led to inaccurate salinity values.

Salinity tends to vary with precipitation and stream flow. In 2013 (Figure 6), the highest salinity readings of the year in Masonville Cove occurred shortly after initial deployment in the spring when concentrations peaked at 13.62 parts per thousand (ppt) on March 30th. Salinity then decreased throughout the spring until mid-May, when it rose sharply following the dryer than normal conditions in April and May (Figure 3). Heavy rains in mid-June and early July led to a drop in salinity, before drought conditions caused salinity to rise to over 11 ppt in October. Tropical Storm Karen and the associated runoff impacted the region on October 10th and 11th, which led to a large influx of freshwater and runoff from land into the Patapsco River. As a result, salinity in Masonville Cove dropped from almost 8 parts per thousand (ppt) on October 10th to 0.49 ppt, the lowest reading of the year, on October 12th. Concentrations then rose to over 12 ppt for the much of the remainder of the year.

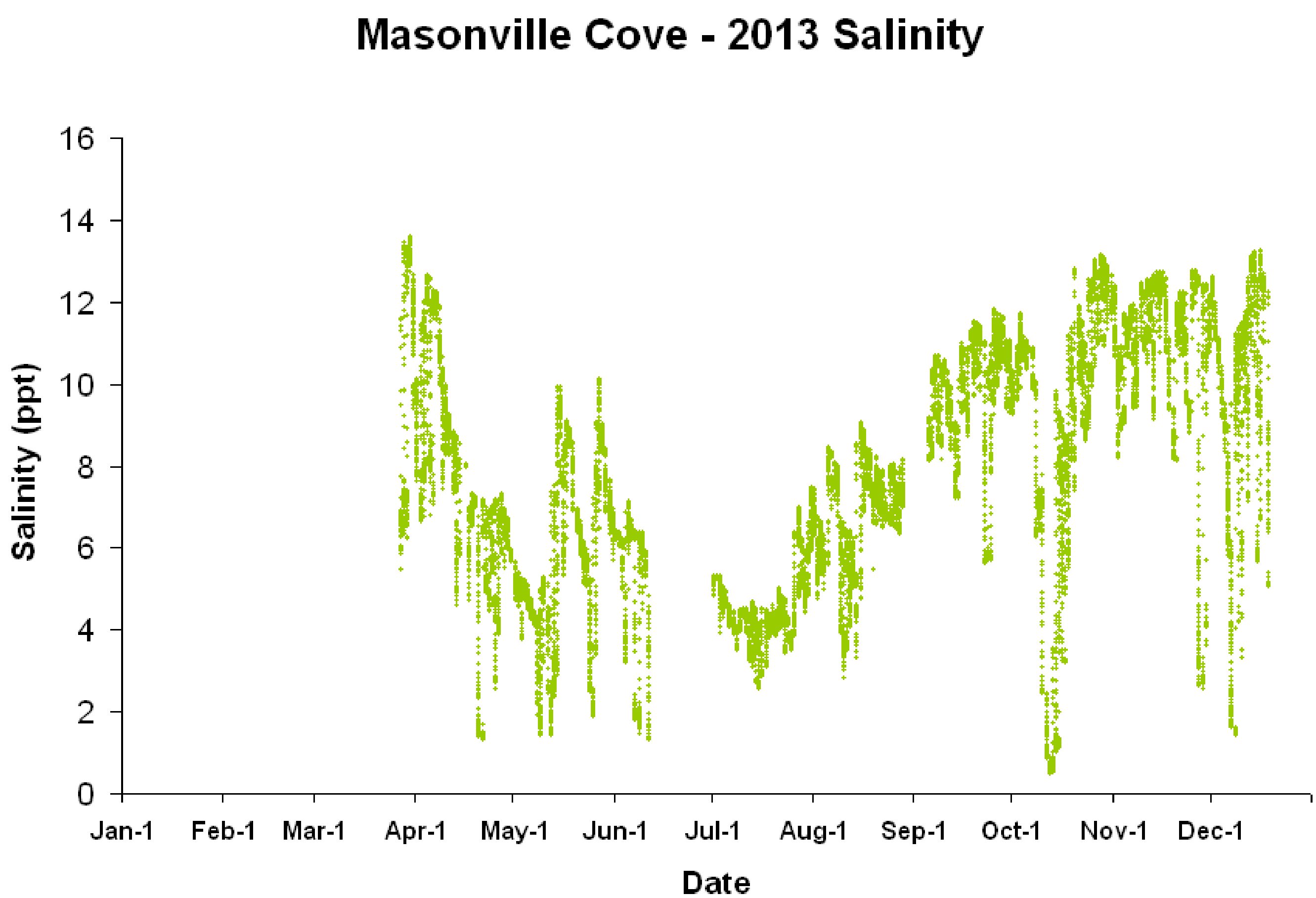

Figure 6. Salinity levels at Masonville Cove Continuous Monitor during 2013.

Dissolved Oxygen

No dissolved oxygen readings were collected between July 25th and August 14th due to equipment malfunction.

Dissolved oxygen values rose through the early spring of 2014 before exhibiting a general downward trend throughout the late spring and summer, before gradually increasing again in the fall (Figure 7). The summer decrease and fall increase were expected since warmer water carries less dissolved oxygen, while cooler water can hold more. DO also generally fluctuated on a daily (diel) basis, possibly due to photosynthetic activity and tidal influence.

A large number of DO readings throughout the year were below 5 milligrams per liter (mg/L), which can be detrimental to the survival of juvenile fish (US EPA, 2003). Most of these occurred in the summer between June and September and the water quality monitor recorded a low DO of 0.29 mg/L on September 5th. However, decreases in chlorophyll levels signal the death and decomposition of algal blooms and are often accompanied by a drop in dissolved oxygen levels. The decomposition process can consume significant amounts of dissolved oxygen in the water and can lead to conditions harmful to aquatic organisms. For example, decreases in dissolved oxygen levels to extremely low concentrations at the Masonville Cove water quality monitor coincided with drops in chlorophyll levels (Figure 8) on May 14th (1.49 mg/L), June 5th (1.54 mg/L), June 9th (1.57 mg/L), July 14th (1.52 mg/L), September 26th (1.11 mg/L), October 16th (0.76 mg/L), and October 30th (3.89 mg/L).

As part of the goal of the 1987 Chesapeake Bay Agreement, the signatories agreed "to provide for the restoration and protection of living resources, their habitats and ecological relationships." Further, the Chesapeake Executive Council (CEC) committed to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat protection programs." A document was produced by the Chesapeake Bay Program outlining dissolved oxygen thresholds for various living resources (Jordan et al. 1992). The State of Maryland adopted these dissolved oxygen thresholds as standards in 1995 (COMAR 1995). For shallow water habitats, the criteria are a 30-day average of 5 mg/L DO and an instantaneous minimum of 3.2 mg/L. Table 1 shows the percentage of time the Masonville Cove DO data fell below these criteria values between April and September, which is generally the time of year that DO values are the lowest due to warmer waters. 2013 DO failure rate decreased from 2012, but was slightly above the 5-year average (Table 1). These results are similar to those observed in the main stem of the Chesapeake Bay in 2013 (http://mddnr.chesapeakebay.net/eyesonthebay/documents/DeadZoneStatus_Summer2013.pdf).

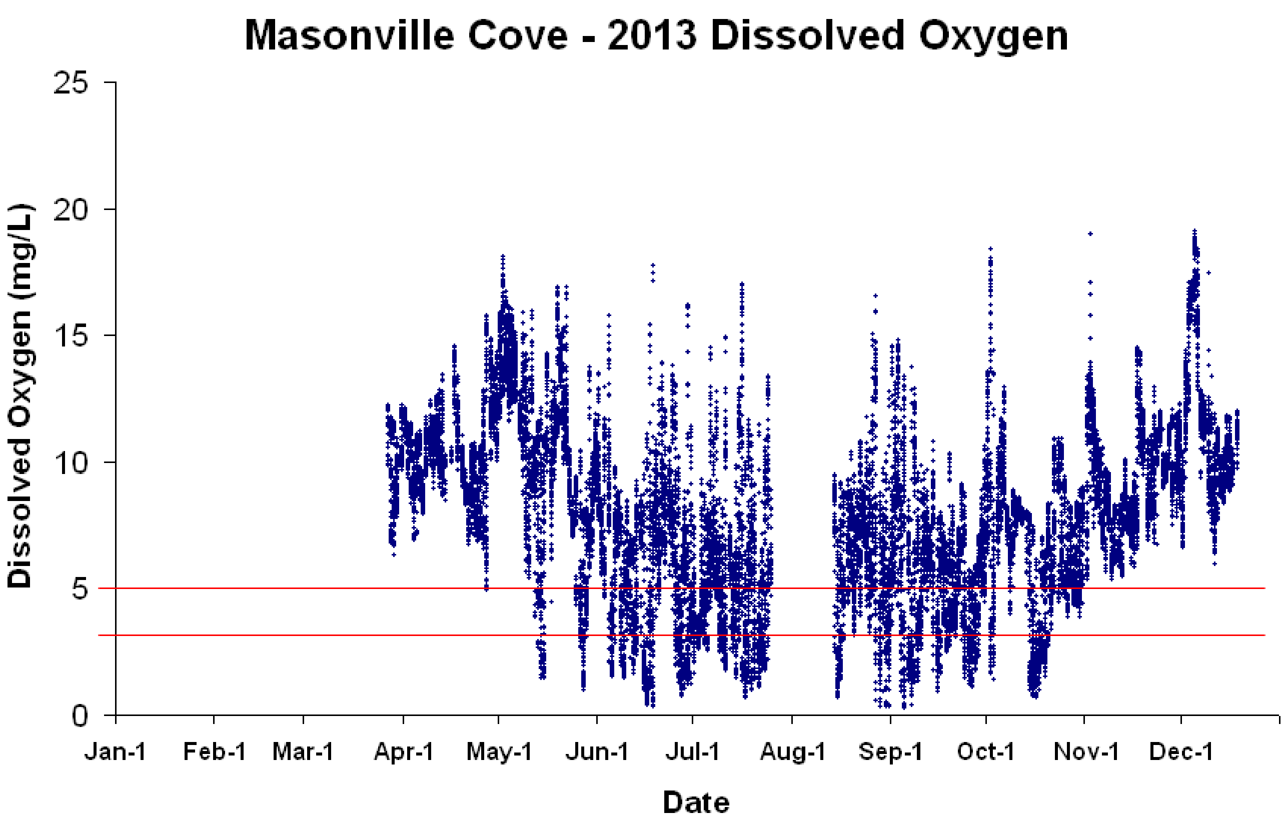

Figure 7. Dissolved oxygen levels at Masonville Cove Continuous Monitor during 2013. Gaps are where data were removed for quality assurance purposes. (*Red lines indicate 5 mg/L and 3.2 mg/L criteria.)*

Table 1. Dissolved oxygen criteria failure at Masonville Cove Continuous Monitor during March through October, 2010, and April through September, 2009, 2011, 2012, and 2013.

Continuous Monitor	2009	2010	2011	2012	**2013**
Surface					
Dissolved Oxygen less than 5 mg/L	28.29%	20.02%	14.32%	30.59%	**26.01%**
Dissolved Oxygen less than 3.2 mg/L	9.89%	8.61%	8.17%	14.20%	**11.73%**

Chlorophyll

Chlorophyll values tend to vary with, and are an indicator of, algal (phytoplankton) levels. Spikes above 15 micrograms per liter (µg/L) represent algal blooms that can negatively affect living resources. Chlorophyll concentrations greater than 50 µg/L represent significant algal blooms, and concentrations above 100 µg/L represent severe blooms. At Masonville Cove in 2013, chlorophyll values indicated significant or severe algal blooms in early to mid-May, early and mid- to late June, mid-July, early September, early October, and early December (Figure 8). Water samples collected in Masonville Cove on December 5th were also used to measure two species of dinoflagellate, *Prorocentrum minimum* (8.8 x 107 cells/L) and *Heterocapsa rotundata* (2.1 x 108 cells/L), at high concentrations. *Prorocentrum minimum* is a potentially toxic algal species and both of these dinoflagellate species, in sufficient concentrations, can cause water to become discolored a reddish-brown and form mahogany tides. The water quality monitor deployed during the December bloom measured a chlorophyll peak of 500 µg/L, the highest reading of 2013, on December 7th and pH levels, which can spike above 9 during an algal bloom, peaked above 10 on December 5th-6th (Figure 9). Sonde data indicate that the bloom subsided on December 8th. Additional information on this bloom, and all potential toxic algal blooms throughout Maryland's waterways can be found at DNR's Harmful Algal Bloom website (http://mddnr.chesapeakebay.net/eyesonthebay/habs.cfm).

As stated previously, chlorophyll readings of 15 µg/L and 50 µg/L indicate blooms with potential ecosystem effects and significant blooms, respectively. Table 2 lists the percentage of data readings that violated these thresholds for Masonville Cove during the portion of the 2013 deployment that coincided with SAV growing season (March – October). Algal blooms during this period may impede the ability of SAV to grow and reproduce. Over half of the chlorophyll measurements were greater than 15 µg/L and the violation rate for the 50 µg/L was approximately 10%, which was slightly less than the 2012 rate (Table 2).

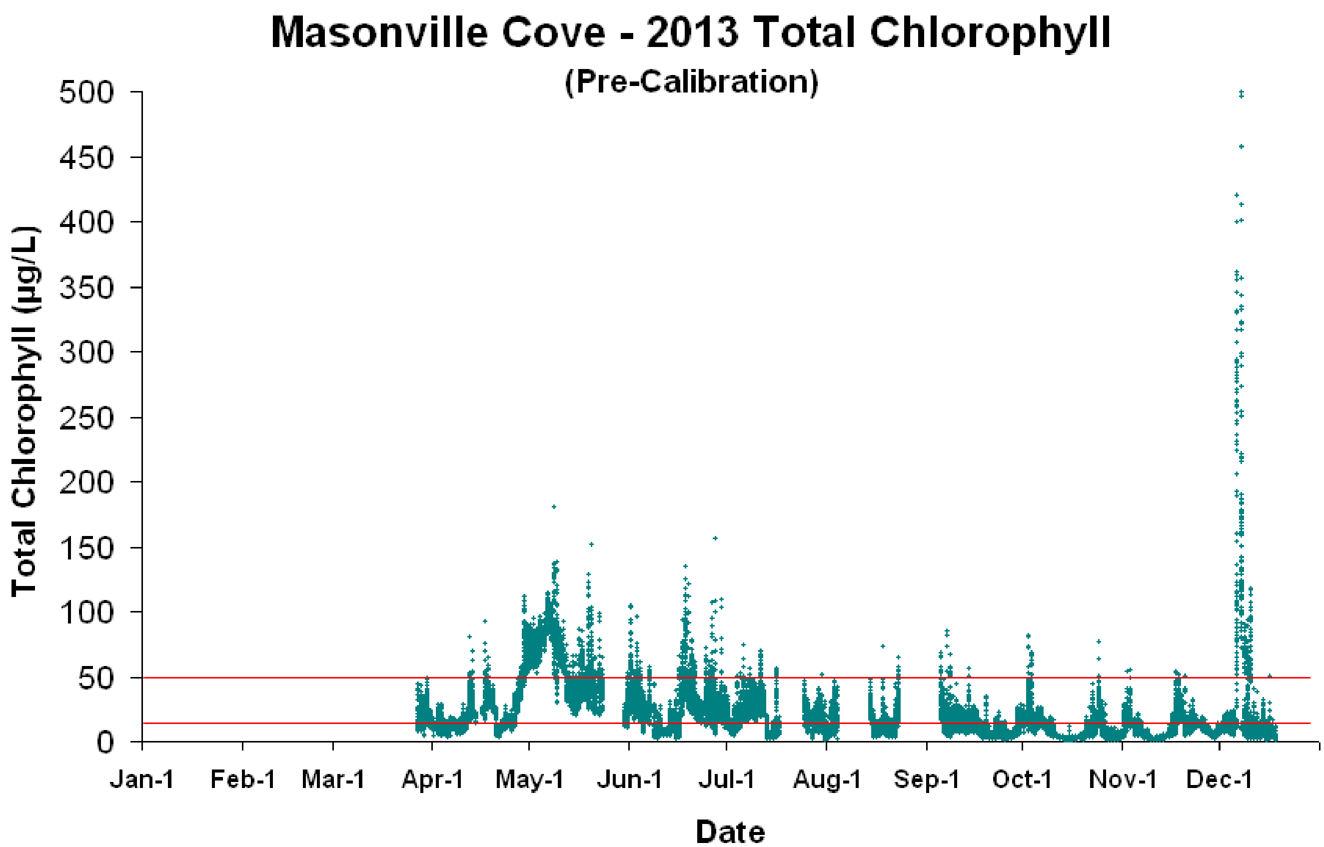

Figure 8. Total chlorophyll levels at Masonville Cove Continuous Monitor during 2013. Gaps are where data were removed for quality assurance purposes. *(Red lines indicate thresholds above which levels may have harmful effects on aquatic ecosystems---15mg/L-- or are considered significant blooms—50mg/L.)*

Table 2. Chlorophyll threshold failures at Masonville Cove Continuous Monitor during June through November, 2009, and March through October, 2010 to 2013.

Continuous Monitor	2009	2010	2011	2012	**2013**
Surface					
Readings greater than 15 µg/L	37.37%	58.99%	38.78%	55.63%	**52.12%**
Readings greater than 50 µg/L	3.28%	6.58%	0.87%	14.52%	**10.50%**

pH

pH readings tend to fluctuate between 7 and 9 in most Chesapeake Bay tidal waters, with spikes above 9 indicating potential algal blooms. High pH in the absence of high chlorophyll can also give some indication that a blue-green algal bloom may have occurred (the chlorophyll sensors on the continuous monitors deployed at Masonville Cove were not designed to detect the wavelengths emitted by cyanobacteria). At Masonville Cove in 2013, pH reached its maximum during the December algal bloom (Figure 9). pH peaked at 10.14 on December 5th, and an additional peak of 9.60 on May 6th coincided with a suspected early May bloom (Figure 8).

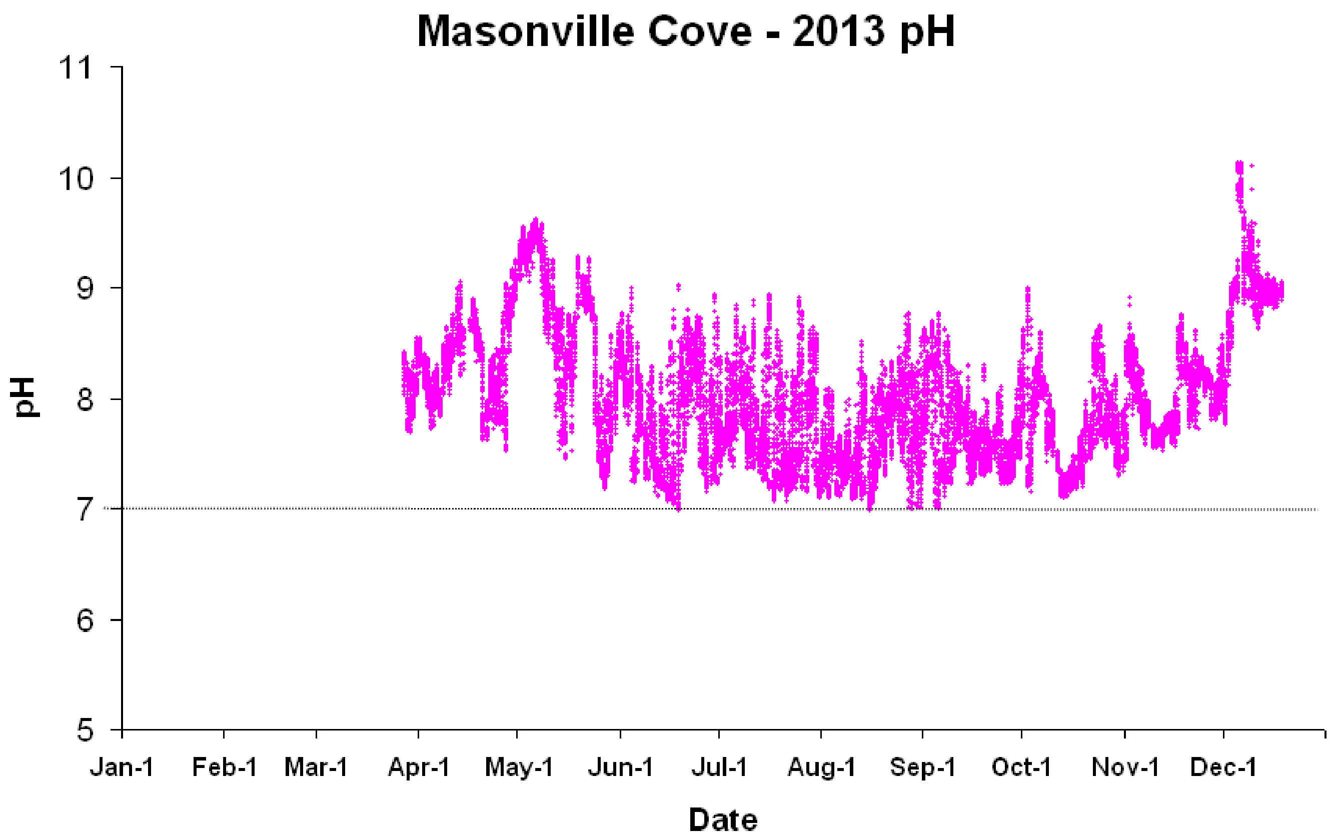

Figure 9. pH levels at Masonville Cove Continuous Monitor during 2013. Gaps are where data were removed for quality assurance purposes. *(Line indicates neutral pH.)*

Turbidity

Equipment malfunction resulted in inaccurate turbidity readings between May 31st and July 9th. These data were therefore censored out of the 2013 dataset.

Turbidity is quantified by measuring how much light is reflected from suspended particles in the water and is used to determine water clarity. Lower turbidity values indicate less reflection and, therefore, clearer water, while values above 7 Nephelometric Turbidity Units (NTU) are generally thought to be detrimental to SAV growth based on the effects of elevated turbidity in other systems (M. Trice, MD DNR, personal communication). During the year, there were only a few instances when turbidity levels spiked to above 100 NTU, however values were generally high throughout the year (Figure 10). Masonville Cove turbidity levels were greater than 7 NTU for almost half of all readings collected in 2013 (median value: 6.2 NTU).

Turbidity surpassed 100 NTU on two days in late May (May 25th: 108.5 NTU; May 28th: 117.9) following thunderstorms in the area. Levels again spiked from less than 3 NTU on October 9th, to 81.3 NTU on October 12th following Tropical Storm Karen and the associated discharge events (Figure 4). Algal blooms can also negatively impact water clarity and turbidity peaked at 28.8 NTU during the early December dinoflagellate bloom.

As stated previously, turbidity concentrations above 7 NTU are considered a threshold for detrimental effects on SAV. The water quality monitor at Masonville Cove was above this threshold for over half of the readings during the 2013 SAV growing season (March through October), which was slightly above the 5-year average (Table 3).

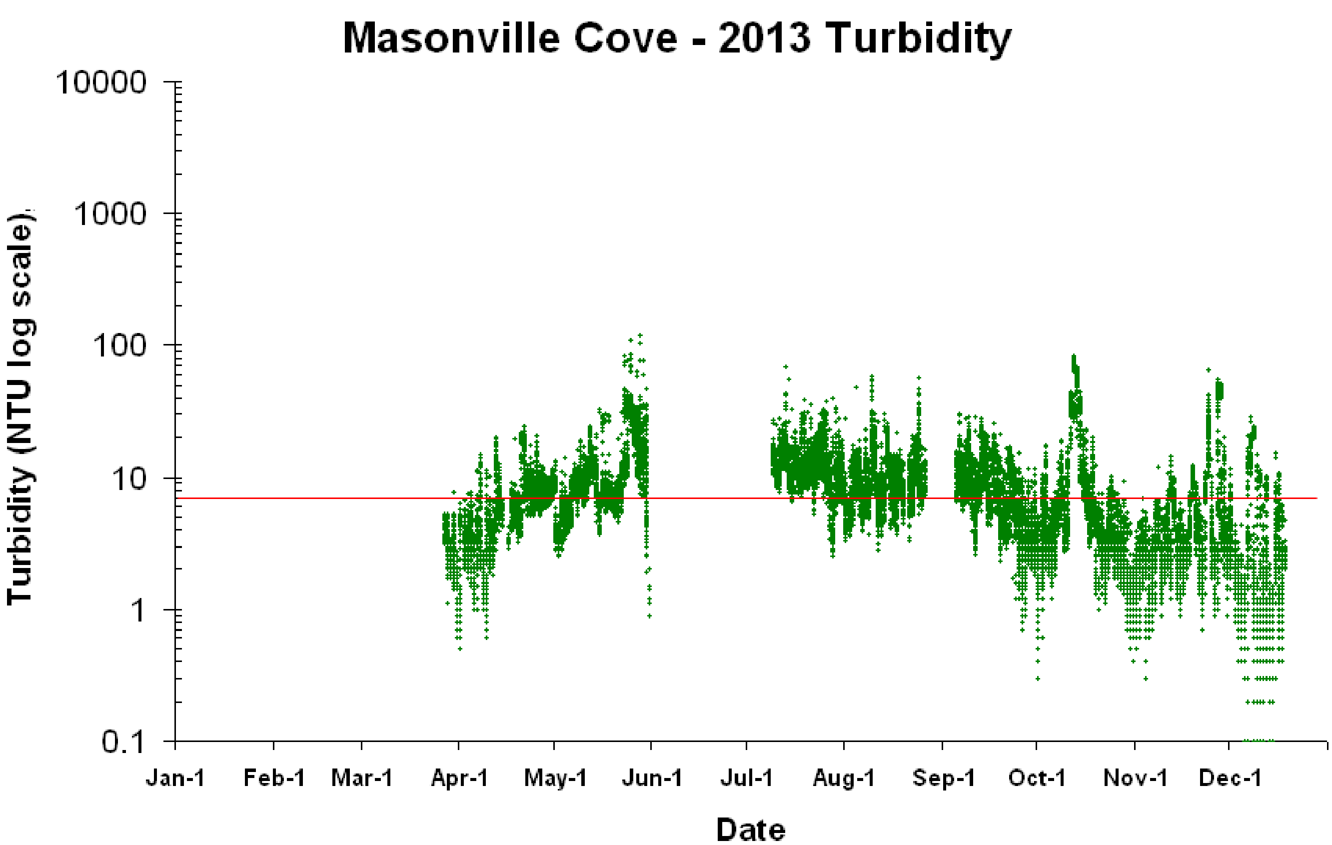

Figure 10. Turbidity levels at Masonville Cove Continuous Monitor during 2013. Gaps are where data were removed for quality assurance purposes. *(Red line indicates threshold above which levels are considered detrimental to bay grass growth.)*

Table 3. Turbidity threshold failures at Masonville Cove Continuous Monitor during June through September, 2009, and March through October, 2010 to 2013.

Continuous Monitor	2009	2010	2011	2012	**2013**
Surface					
Readings greater than 7 NTU	54.58%	60.09%	51.58%	35.0%	**53.91%**

Anti-virus software updated on internet kiosk at Masonville Cove Environmental Education Center

DNR personnel repaired an internet connection problem and updated anti-virus software installed on the interactive kiosk in the Masonville Cove Environmental Education Center (MCEEC) on September 13th, 2013. The kiosk allows MCEEC staff to display real time water quality data from Masonville Cove, and throughout the Chesapeake Bay, through DNR's "Eyes on the Bay" website (www.eyesonthebay.net). The kiosk features a touch-screen as well as a track ball for easy web navigation. The kiosk is protected by software that prevents users from navigating away from the "Eyes on the Bay" or MCEEC websites. MCEEC staff use the kiosk in their education programs, and it is available to MCEEC visitors. Anti-virus software installed on the kiosk is next scheduled to be updated in 2015.

Submerged Aquatic Vegetation (SAV) in the Patapsco River

SAV, or underwater grasses, are an important component of estuarine ecosystems. They provide habitat for juvenile fish and shellfish, supply food for waterfowl, oxygenate the water, and help stabilize bottom sediments. Since 1984, SAV within the Chesapeake Bay and associated tributaries has been assessed annually (with the exception of 1988) by the Virginia Institute of Marine Science (VIMS). Figure 11 shows total area and density of SAV within the Patapsco beginning in 1994 (the first year SAV was found in the river) through 2013.

Total area of SAV within the Patapsco River remains well below the restoration goal of 389 acres. 2005 was the single best year with 72% of the restoration goal achieved, including SAV beds within Masonville Cove. 2004 and 2005 were generally very good years for SAV throughout the Chesapeake Bay region and the increases in coverage have been attributed to an accompanying population explosion and range expansion of dark false mussels (*Mytilopsis leucophaeata*). These filter feeders may have increased water clarity and allowed SAV coverage to significantly expand (L. Karrh, MD DNR, personal communication). In 2006, the mussels died back, SAV beds disappeared in Masonville Cove, and total area of SAV within the Patapsco decreased 83%. In 2010, there was no SAV in the entire Patapsco River. As of 2013, there continued to be no SAV within Masonville Cove, as well as no SAV within the entire Patapsco River.

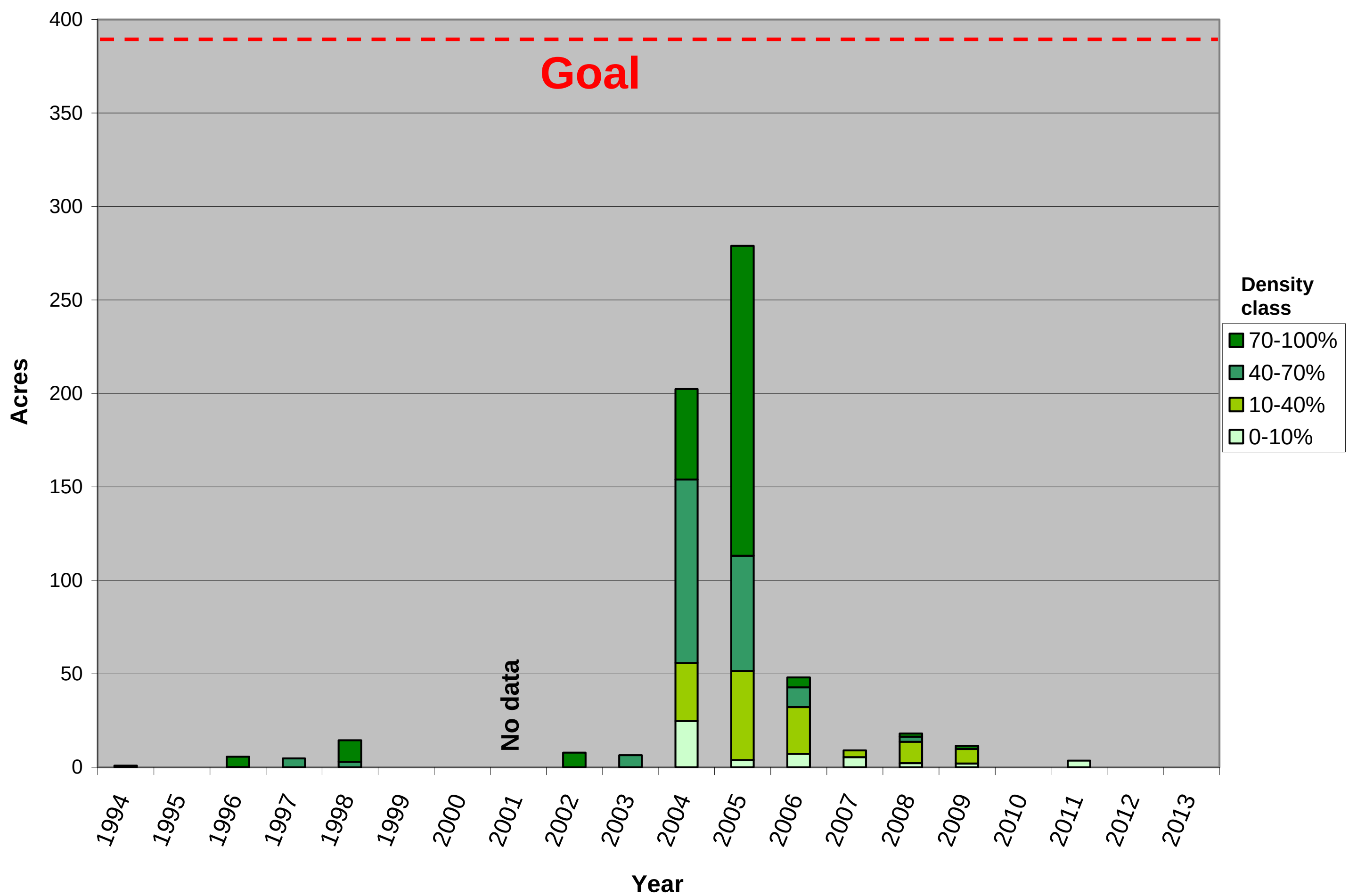

Figure 11. Total area and density of SAV in the Patapsco River. (*Restoration goal is 389 acres)*

Pigments, Suspended Solids, and Secchi Data

Bi-weekly grab samples of water were taken at the Masonville Cove station when the YSI meters were exchanged during Continuous Monitoring cruises. A few samples were collected monthly instead of bi-weekly (Table 4) in November and December, as well as months in which scheduling conflicts caused station visit postponements and the rescheduling of site visits. Secchi depth, a measure of water clarity, was also recorded at the Masonville Cove station each time a grab sample was collected.

For the grab samples, the water was processed in the field using vacuum filtration, and the resulting particulate samples were delivered to the laboratory for analysis. Samples collected during Continuous Monitoring cruises were analyzed for pigments and suspended solids. All analyses were performed by the University of Maryland's Chesapeake Biological Laboratory (CBL) Nutrient Analytical Services Laboratory (NASL). For details on methods, procedures, analysis and detection limits, refer to the Quality Assurance Project Plan (QAPP) for the Shallow Water Monitoring Program. This document can be found at http://mddnr.chesapeakebay.net/eyesonthebay/documents/SWM_QAPP_2013_2014_FINAL.pdf. Results of the laboratory analyses are presented graphically in Appendix A (Figures A-1 through A-3). Secchi depth measurements are presented in Figure A-4. The suspended sediments, pigments, and Secchi depth data are also presented in Table A-1 of Appendix A.

Ambient water quality data (dissolved oxygen, pH, salinity, and water temperature) were collected concurrently with the grab samples. The data values are presented graphically in Figures A-5 to A-8 in Appendix A. These water quality parameters are measured as a profile, with readings recorded at 0.5m depth intervals at the station. In the graphs, the data range for each profile is represented by a vertical bar for each sample date. The vertical bars are connected by a line that intersects each bar at the mean value for the station on that date. All data values for dissolved oxygen, pH, salinity, and water temperature are provided in Table A-2 of Appendix A.

Table 4. Deployment and calibration record for Masonville Cove continuous monitor 2013.

Scheduled calibration date	Samples collected	Comment
March 27, 2013	Yes	Initial deployment of sonde.
April 3, 2013	No	Site not visited due to scheduling conflict.
April 17, 2013	Yes	
May 1, 2013	Yes	
May 15, 2013	Yes	
May 30, 2013	Yes	
June 11, 2013	Yes	
June 25, 2013	No	Site not visited due to illness of field personnel.
July 1, 2013	Yes	
July 9, 2013	Yes	
July 25, 2013	Yes	
August 14, 2013	Yes	
August 29, 2013	No	Site not visited due to scheduling conflict.
September 5, 2013	Yes	
September 18, 2013	Yes	
October 1, 2013	Yes	
October 15, 2013	Yes	
October 29, 2013	Yes	
November 21, 2013	Yes	
December 5, 2013	Yes	Samples collected for measuring *Prorocentrum* and *Heterocapsa* algal bloom.

Water quality conditions at Masonville Cove in 2013 showed expected seasonal variability. Chlorophyll and phaeophytin concentrations generally rose during the warmer months of May through September. Chlorophyll values peaked above 50 µg/L in May, July and September but remained below 80 µg/L throughout the year (Figure A-1). Phaeophytin values were greatest in July with concentrations between 17 µg/L and 20 µg/L (Figure A-2). Very low values of chlorophyll and phaeophytin were observed in June 2013 following a period of high rainfall and corresponding large freshwater inputs. Rainfall in June also contributed to a peak value for total suspended solids of 53 mg/L during this month (Figure A-3). Another period of high rainfall occurred in October 2013 as the remnants of Tropical Storm Karen moved through the region. Salinity ranges at Masonville Cove reached minimum values of less than 1 ppt in both October and June due to the higher precipitation (Figure A-6).

In 2013, dissolved oxygen concentrations at Masonville Cove decreased beginning in May and values below 5 mg/L were observed through November (Figure A-5). Measured pH values at the site ranged from 7 to 9 during 2013 with lower values occurring during the summer months (Figure A-7). Water temperatures rose to around 28 degrees C in July, and then gradually decreased through December (Figure A-8). Secchi depth was generally less than 1 meter throughout 2013 except for an unusually high value on October 29th. Very clear water on this date allowed the Secchi disk to remain visible even when it reached the station bottom, resulting in a Secchi reading of greater than 2.2 meters (Figure A-4).

Conclusion

Shallow water monitoring was conducted in Masonville Cove in the upper Patapsco River during 2013. Continuous monitoring data provide a critical function for assessing the health of Maryland's tidal waters in areas historically lacking water quality information. Shallow water data provide information about the effects of nutrient pollution and weather events on the Patapsco River and in Masonville Cove. In 2013, heavy rain events led to large discharge events that affected salinity and turbidity, although turbidity readings were generally high throughout the year. A severe algal bloom of potentially toxic species occurred in early December, and dissolved concentrations were slightly poorer than the 5-year average. Finally, no submerged aquatic vegetation was found in Masonville Cove and total acreage is well below the goal for the river as a whole. Therefore, conditions remain poor for living resources in the upper Patapsco River.

Shallow water monitoring information is not only used for characterizing the health of shallow water habitats, but it is also useful for: 1) assessing Chesapeake Bay water quality criteria for dissolved oxygen, water clarity and chlorophyll in shallow water habitats; 2) determining attainment or non-attainment of shallow water habitats for their designated uses; 3) assessing SAV habitats and identifying potential SAV restoration sites; 4) providing information to better understand ecosystem processes and the impact of extreme events (e.g. hurricanes, high flows, sanitary sewer overflows) in shallow water and open water environments; 5) providing data for calibrating the Bay Eutrophication and Watershed Model; and 6) assessing mitigation efforts in relation to the dredged material containment facility at the Masonville Marine Terminal.

References

COMAR (Code of Maryland Regulations). 1995. Code of Maryland Regulations: 26.08.02.03 – Water Quality Criteria Specific to Designated Uses. Maryland Department of the Environment. Baltimore, Maryland.

Jordan, S., C. Stegner, M. Olson, R. Batiuk, and K. Mountford. 1992. Chesapeake Bay dissolved oxygen goal for restoration of living resources habitats. Chesapeake Bay Program, Reevaluation Report #7c. CBP/TRS88/93. Annapolis, Maryland.

Leffler, M. and J. Greer. 2001. Taking on toxics in Baltimore Harbor. Maryland Marine Notes 19(2). http://www.mdsg.umd.edu/MarineNotes/Mar-Apr01/

Appendix A

Results of laboratory and ambient water quality analyses for:
Masonville Cove Pier (Station XIE4742)

Vertical bars within a graph represent the data range for each profile and are intersected at the mean value.

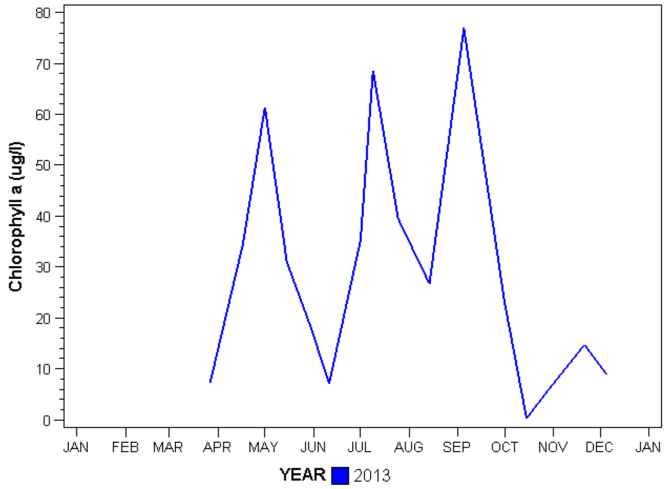

Figure A-1. Chlorophyll *a* concentrations at Masonville Cove in 2013.

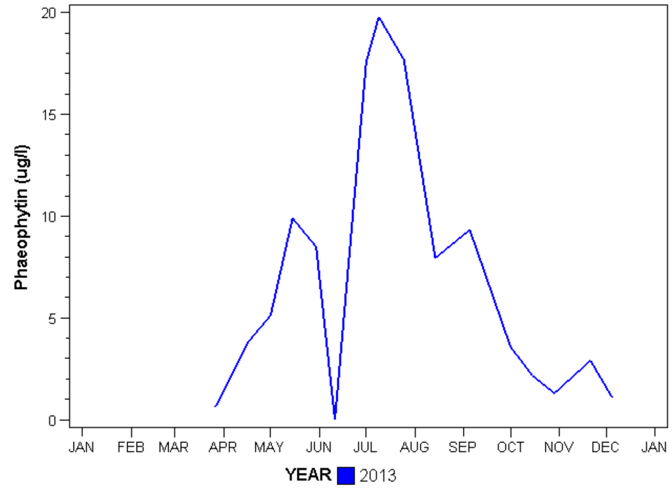

Figure A-2. Phaeophytin concentrations at Masonville Cove in 2013.

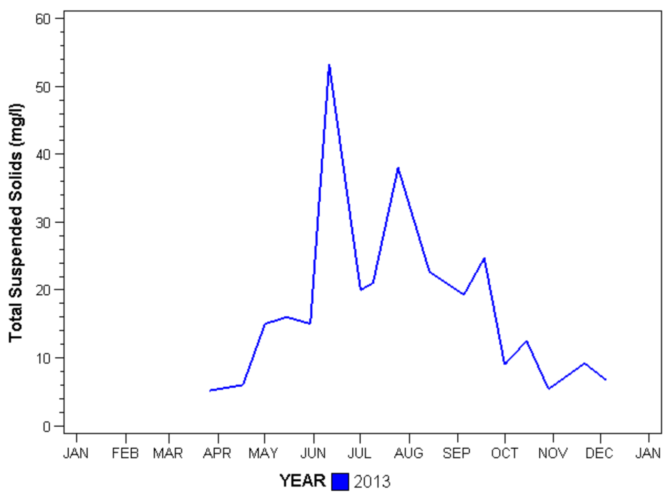

Figure A-3. Total suspended solids concentrations at Masonville Cove in 2013.

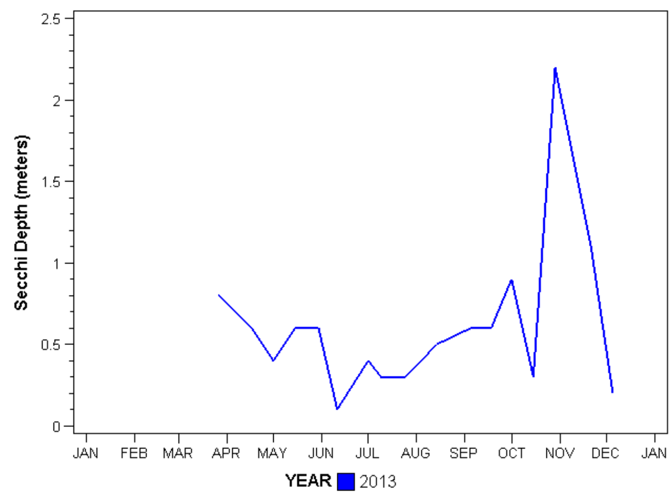

Figure A-4. Secchi depth at Masonville Cove in 2013.

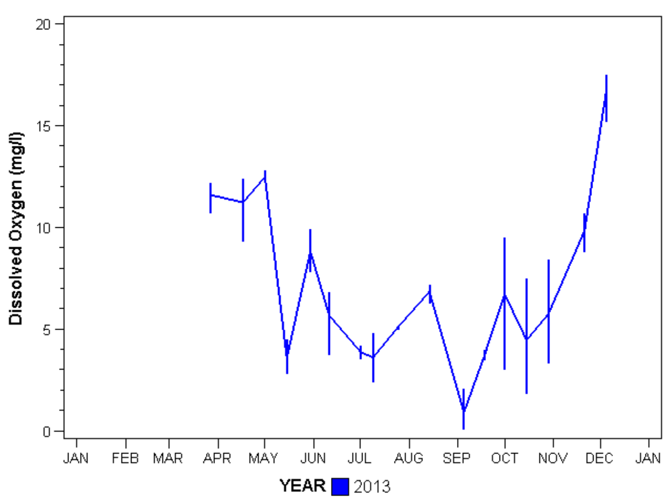

Figure A-5. Dissolved oxygen concentrations at Masonville Cove in 2013.

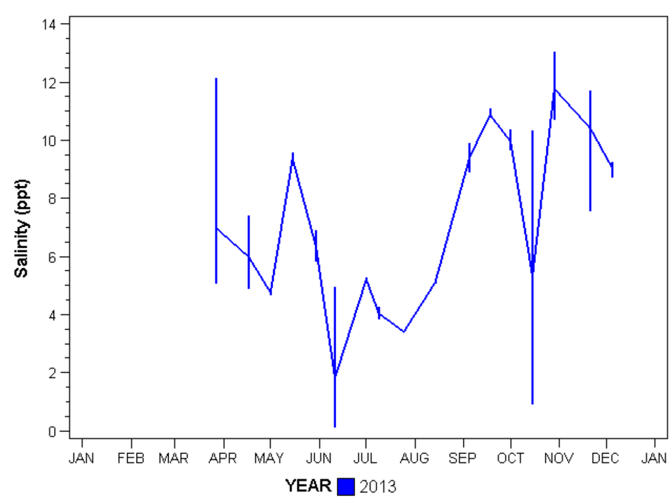

Figure A-6. Salinity concentrations at Masonville Cove in 2013.

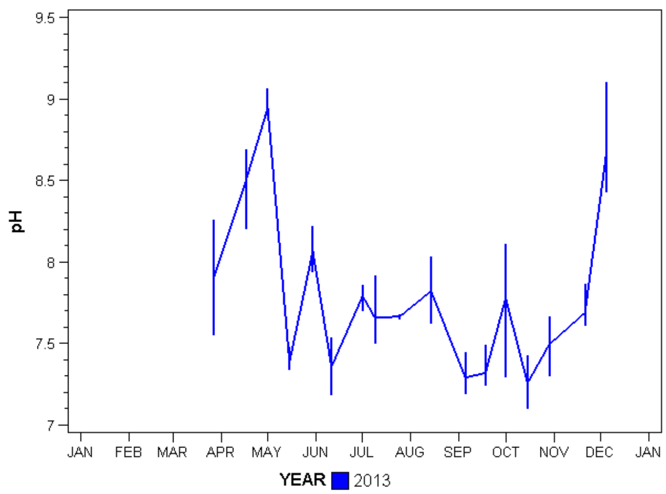

Figure A-7. Values of pH at Masonville Cove in 2013.

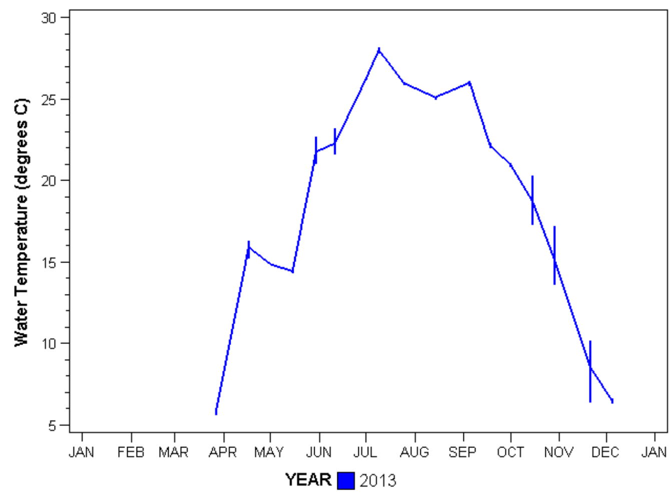

Figure A-8. Water temperature at Masonville Cove in 2013.

Vertical bars within a graph represent the data range for each profile and are intersected at the mean value.

Table A-1. Discrete Continuous Monitoring Data for Chlorophyll-a, Phaeophytin, Total Suspended Solids, and Secchi Disk Depth for Masonville Cove (XIE4742) in 2013.

Date	Sample Depth (m)	Chlorophyll-a (ug/L)	Phaeophytin (ug/L)	Total Suspended Solids (mg/L)	Secchi Depth (m)
03/27/13	1	7.262	0.662	5.2	0.8
04/17/13	1	34.532	3.845	6.0	0.6
05/01/13	1	61.410	5.126	15.0	0.4
05/15/13	1	30.972	9.897	16.0	0.6
05/30/13	1	18.423	8.491	15.0	0.6
06/11/13	1	7.120	0.000	53.3	0.1
07/01/13	1	35.244	17.586	20.0	0.4
07/09/13	1	68.619	19.785	21.0	0.3
07/25/13	1	39.516	17.675	38.0	0.3
08/14/13	1	26.700	7.939	22.7	0.5
09/05/13	1	76.896	9.327	19.3	0.6
09/18/13	1			24.7	0.6
10/01/13	1	22.962	3.578	9.0	0.9
10/15/13	1	0.267	2.163	12.5	0.3
10/29/13	1	5.874	1.303	5.4	> 2.2
11/21/13	1	14.738	2.905	9.2	1.1
12/05/13	1	8.900	1.068	6.7	0.2

Table A-2. Ambient Water Quality Data for Dissolved Oxygen (D.O.), pH, Salinity, and Water Temperature for Masonville Cove (XIE4742) in 2013 (continued on next page).

Date	Sample Depth (m)	D.O. (mg/L)	pH	Salinity (ppt)	Water Temperature (^oC)
03/27/13	0.5	12.1	7.85	5.08	5.6
03/27/13	1.0	12.2	8.26	5.28	5.6
03/27/13	1.5	11.4	7.90	5.44	5.7
03/27/13	2.0	10.7	7.55	12.17	6.0
04/17/13	0.5	12.3	8.63	4.87	16.3
04/17/13	1.0	12.4	8.69	5.39	16.3
04/17/13	1.5	10.9	8.47	6.26	15.8
04/17/13	2.1	9.3	8.20	7.42	15.2
05/01/13	0.5	12.4	8.91	4.68	14.8
05/01/13	1.0	12.8	9.07	4.73	14.9
05/01/13	1.5	12.3	8.90	4.71	14.8
05/01/13	2.0	12.4	8.90	4.89	14.9
05/15/13	0.5	4.1	7.48	9.18	14.5
05/15/13	1.0	4.5	7.38	9.34	14.5
05/15/13	1.5	2.9	7.34	9.35	14.4
05/15/13	2.2	2.8	7.34	9.58	14.3
05/30/13	0.5	9.8	8.22	5.83	22.7
05/30/13	1.0	9.9	8.12	5.88	22.1
05/30/13	1.5	8.7	8.06	6.23	21.7
05/30/13	2.0	7.9	7.99	6.75	21.3
05/30/13	2.3	7.8	7.94	6.92	21.0
06/11/13	0.5	6.6	7.54	0.12	21.8
06/11/13	1.0	6.8	7.28	0.43	21.6
06/11/13	1.5	5.6	7.42	1.74	22.5
06/11/13	2.2	3.7	7.18	4.97	23.2
07/01/13	0.5	3.9	7.80	5.25	26.3
07/01/13	1.0	4.2	7.86	5.06	26.2
07/01/13	1.5	3.9	7.80	5.25	26.3
07/01/13	2.2	3.5	7.70	5.29	26.3
07/09/13	0.5	4.5	7.70	3.85	28.2
07/09/13	1.0	4.8	7.92	3.91	28.1
07/09/13	1.5	2.4	7.50	4.12	27.9
07/09/13	2.2	2.7	7.50	4.27	27.8
07/25/13	0.5	5.2	7.67	3.40	26.0
07/25/13	1.0		7.68	3.42	26.0
07/25/13	1.5	5.0	7.65	3.40	26.0
07/25/13	2.1	5.1	7.66	3.40	25.9
08/14/13	0.5	7.0	7.81	5.10	25.2
08/14/13	1.0	7.2	8.03	5.14	25.1
08/14/13	1.7	6.3	7.62	5.09	25.0

Table A-2 (continued). Ambient Water Quality Data for Dissolved Oxygen (D.O.), pH, Salinity, and Water Temperature for Masonville Cove (XIE4742) in 2013.

Date	Sample Depth (m)	D.O. (mg/L)	pH	Salinity (ppt)	Water Temperature (^oC)
09/05/13	0.5	1.9	7.41	8.92	26.0
09/05/13	1.0	2.1	7.45	9.01	25.8
09/05/13	1.5	0.3	7.21	9.59	26.1
09/05/13	2.0	0.1	7.19	9.71	26.1
09/05/13	2.3	0.1	7.19	9.90	26.0
09/18/13	0.5	3.7	7.27	10.78	22.3
09/18/13	1.0	4.0	7.49	11.09	22.2
09/18/13	1.5	3.5	7.24	10.79	22.0
09/18/13	2.0	3.5	7.27	10.82	22.0
10/01/13	0.5	8.0	8.00	9.66	21.0
10/01/13	1.0	9.5	8.11	9.73	21.0
10/01/13	1.5	6.4	7.71	10.04	20.8
10/01/13	2.2	3.0	7.29	10.39	21.1
10/15/13	0.5	6.4	7.43	0.90	17.6
10/15/13	1.0	7.5	7.35	0.98	17.3
10/15/13	1.5	2.1	7.14	9.04	19.7
10/15/13	2.0	1.8	7.10	10.35	20.3
10/29/13	0.5	6.7	7.60	10.69	13.6
10/29/13	1.0	8.4	7.67	10.74	13.7
10/29/13	1.5	4.6	7.40	12.59	16.0
10/29/13	1.9	3.3	7.30	13.06	17.2
11/21/13	0.5	10.7	7.62	7.56	6.4
11/21/13	1.0	9.9	7.87	10.00	8.2
11/21/13	1.5	10.1	7.66	11.13	8.2
11/21/13	2.0	9.7	7.68	11.59	9.5
11/21/13	2.4	8.8	7.61	11.71	10.2
12/05/13	0.5	17.5	8.60	8.71	6.4
12/05/13	1.0	17.1	9.11	9.13	6.5
12/05/13	1.5	17.3	8.61	9.03	6.3
12/05/13	2.0	15.2	8.43	9.27	6.6