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SRA Creek-by-Creek Report
Valentine and Plum Creek

2020 Water Column Dissolved Oxygen, Bottom Dissolved Oxygen, Average Salinity, and Clarity Analysis

By Emi McGeady, Field Investigator

Abstract

Valentine and Plum Creek experienced moderate water quality in 2020. Dissolved oxygen levels tended to be sufficient for river life from May to June, but dead zone occurred frequently from July to October, totaling over 50% of monitoring in both creeks. Average salinity however was always in the expected mesohaline range of 5-18 ppt. Clarity ranged in moderate levels for most of the year, though bad clarity was observed in Plum Creek three times.

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INTRODUCTION

Thanks to support from the Delaplaine Foundation, The Severn River Association (SRA) created a water quality program in 2018 to track conditions throughout the Severn River, a natural resource Maryland residents and communities enjoy for fishing, crabbing, swimming, and boating. Since 2019 the program has run weekly from late May to early November and tracks temperature, dissolved oxygen, pH, salinity, and clarity throughout the entire water column at 44 stations across the watershed.

This analysis focuses on dissolved oxygen (d.o.), salinity, and clarity, three important metrics of water quality, in Valentine and Plum Creek. Valentine and Plum Creek are on the upper Severn River and are located in Crownsville (figure 1). Arden on the Severn is along Plum Creek, and Herald Harbor is located on Valentine Creek. The areas studied in this report include SRA's water quality monitoring stations known as Valentine Creek (VC) and Plum Creek (PC) (figure 1).

Monitoring in these two creeks occurred weekly from May 27th to November 4th in 2020. This resulted in a total of 23 monitoring days and 226 volunteer hours.

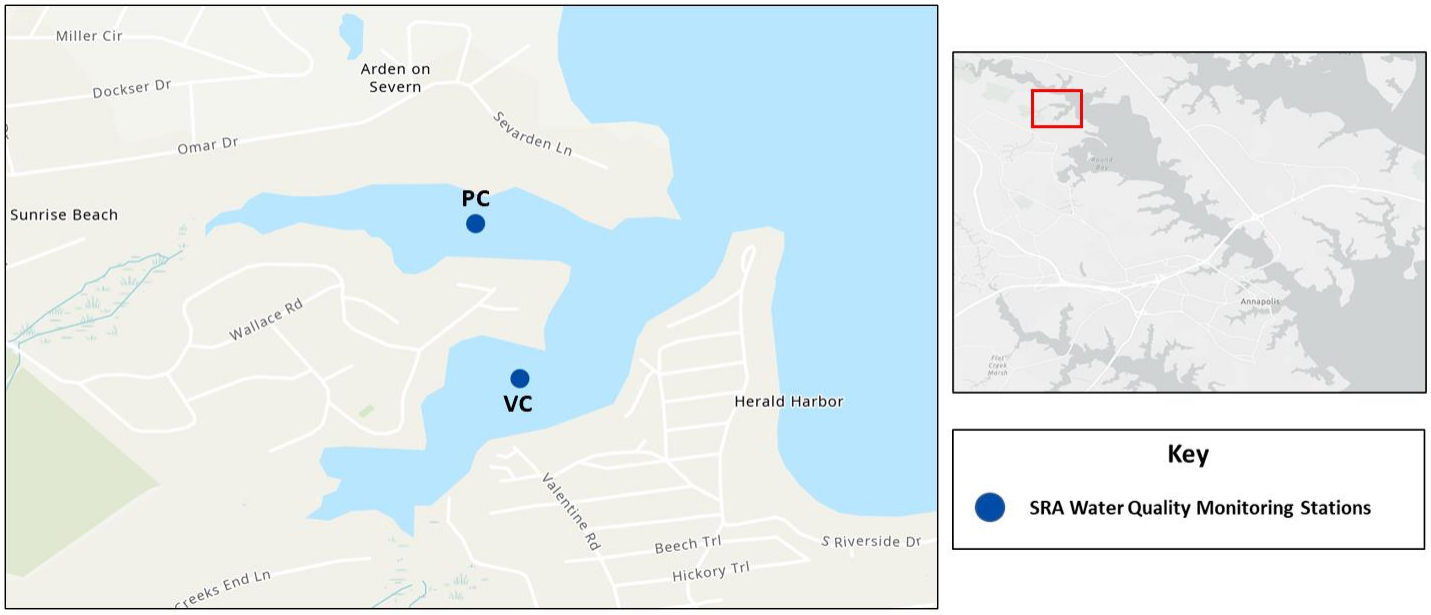

Figure 1. Water quality monitoring stations in Valentine and Plum Creek.

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EXECUTIVE SUMMARY

In 2020, dissolved oxygen in Plum Creek and Valentine Creek was similar. Both stations had very high d.o. on May 27th (above 16.00 mg/L at multiple depths) due to a river-wide mahogany tide algal bloom. Then in June neither station experienced dead zones (d.o. < 2.0 mg/L). However, dissolved oxygen quickly depleted in both creeks in July. Dead zone was measured for 57% of monitoring in Plum Creek and 65% of monitoring in Valentine Creek.

Dissolved oxygen proved to be worse in Valentine Creek as dead zone was recorded for 11 consecutive weeks from July 30th to October 14th and was often 1.5 m tall.

Average salinity fell within the mesohaline range of 5-18 ppt for the entire monitoring season at both stations. In the summer it was fresher and became saltier over time, growing from 6.14 ppt to 13.50 ppt at PC and from 6.22 ppt to 13.48 ppt at VC. Both stations experienced a sharp peak in average salinity on June 24th where salinity ranged 13.00-13.03 ppt. Average salinity was very similar and no clear difference existed by station.

Clarity at both stations was moderate, within 0.6-1.6 m, for the majority of 2020. However, clarity at Valentine Creek averaged 0.13 meters above clarity at Plum Creek. Plum Creek also had 3 instances of bad clarity (clarity under 0.6 m).

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ANALYSIS

Water Column Dissolved Oxygen

River life, including oysters, fish, and crabs, prefer dissolved oxygen (d.o.) levels above 5.0 mg/L (green line on the graphs below). Oxygen levels below 2.0 mg/L are insufficient for survival and are therefore designated as dead zone conditions (red line on the graphs below).

On each day of monitoring in Round Bay, dissolved oxygen measurements were taken with a YSI probe. The probe was lowered to the bottom where the first measurement was recorded. The probe was then raised through the water column, taking measurements at every following half meter. Total depth at Plum Creek was usually 2.5 to 3.5 meters deep. Valentine Creek total depth was similar, usually 3.0 to 3.5 meters deep.

Each station's dissolved oxygen data is displayed on figures 2 & 3 below. The lighter bars represent d.o. content in surface water (0.5 m deep), with the darker bars representing d.o. at subsequent deeper depths. Bars above the red line indicate depths where moderate to good oxygen levels were measured, and bars that fall below the red line indicate depths exhibiting dead zone conditions.

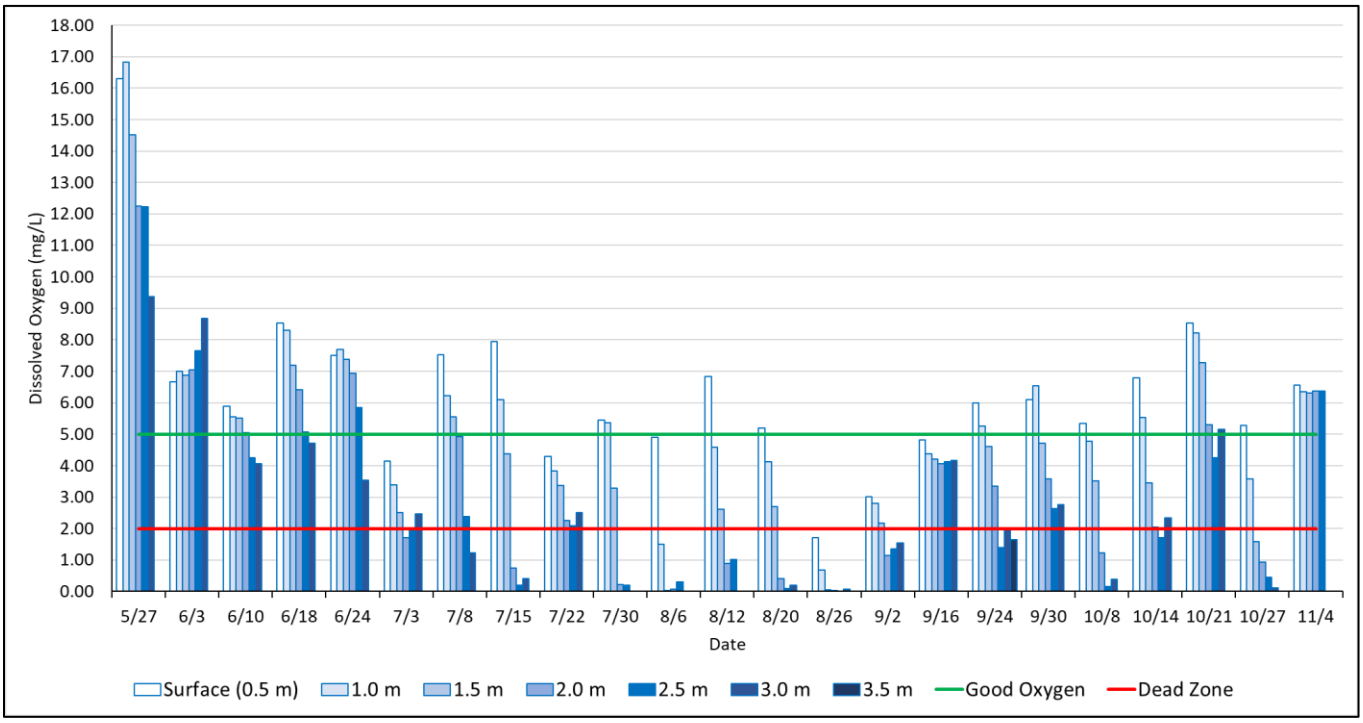

Figure 2. Dissolved oxygen levels through the water column at Plum Creek (PC) in 2020.

- Dissolved oxygen began very high on May 27th. The highest d.o. measured at this station was 16.83 mg/L at 1.0 m deep, and similar levels were found at other depths. This high value is likely indicative of the river-wide mahogany tide algal bloom which was observed throughout May 2020.
- Dead zone conditions were measured at PC on 13 days in 2020, approximately 57% of monitoring. The dead zone on these days was typically about a half meter tall, spanning from 2.0 to 2.5 meters.

- However on other days the dead zone was more extensive i.e. on August 26th when dead zone was found at every depth. Dissolved oxygen ranged from 1.70 mg/L at the surface to 0.00 mg/L at 2.5 m deep.
- Dead zone was common from July to October. No dead zone was recorded in June or November. Dissolved oxygen in June was relatively good compared to other stations as all depths displayed moderate or good levels of dissolved oxygen.

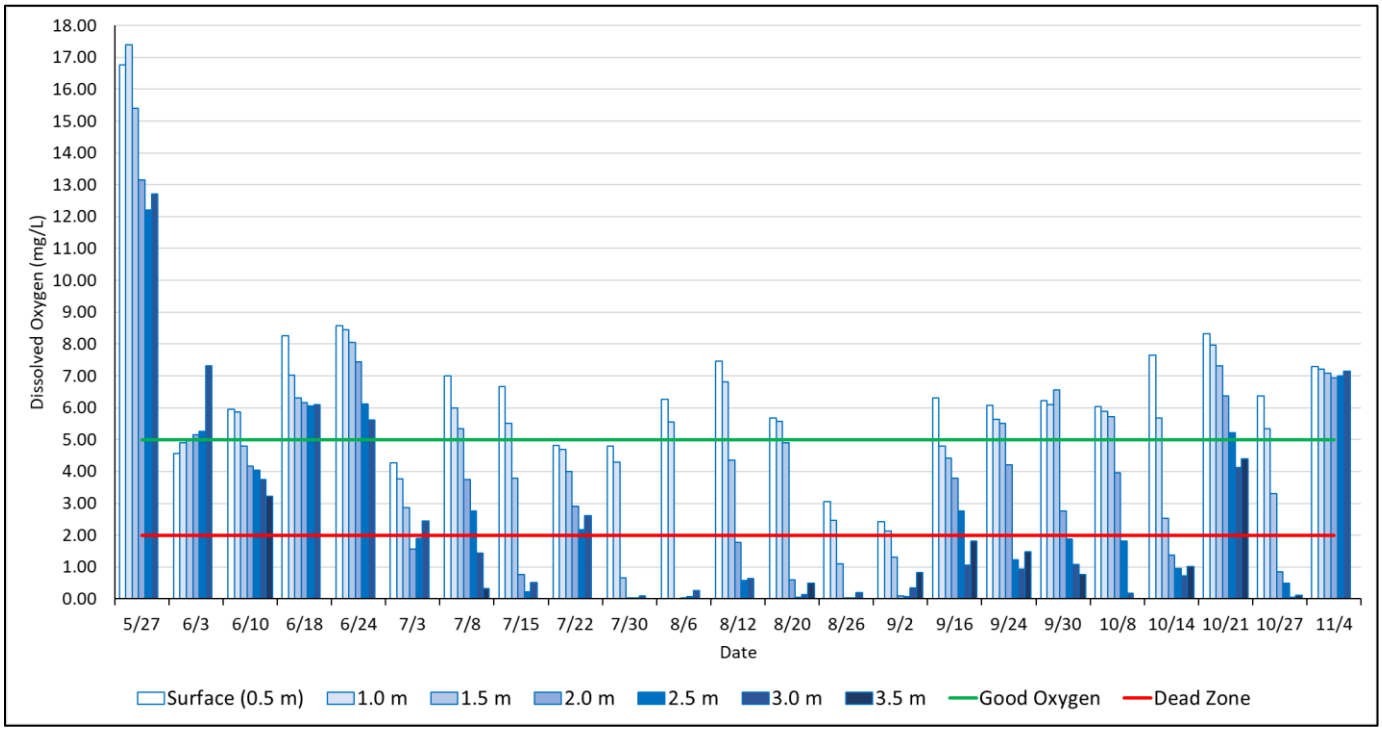

Figure 3. Dissolved oxygen levels through the water column at Valentine Creek (VC) in 2020.

- Dissolved oxygen was worse at VC than PC. Shallower depths displayed similar levels to PC but dead zone was taller (usually 1.5 meters tall) and occurred more frequently.
- Dead zone was recorded for 65% of monitoring at VC, specifically on 15 days in 2020. Dead zone was very persistent in summer as dead zone was measured for 11 consecutive weeks from July 30th to October 14th.
- The worst dead zone ocurred on August 6th. It was measured from 1.5 to 3.0 meters and readings ranged -0.01 mg/L[1] to 0.27 mg/L.
- Dissolved oxygen tended to be better in June, with more depths displaying moderate or good levels, and no dead zone measured.
- The highest d.o. reading, 17.40 mg/L, was recorded on May 27th at 1.0 m deep. This high d.o. value is likely indicative of an algal bloom at the surface.

[1] Negative d.o. readings indicate a near zero dissolved oxygen environment. The YSI instrument on this day was likely measuring slightly below the true value of dissolved oxygen, however this data still indicates a very low measure of d.o. at this depth.

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Bottom Dissolved Oxygen

Measuring dissolved oxygen on the bottom is important for understanding conditions experienced by sedentary/less mobile creatures that cannot escape dead zone conditions, such as oysters, mollusks, and other benthic organisms. Bottom d.o. measurements were taken with a YSI probe. The probe was lowered until the bottom was felt by slack in the cord. Then the probe was raised to the nearest 0.5 m depth as to not be in the mud. Bottom d.o. measurements were recorded and displayed for each station on figure 4 below.

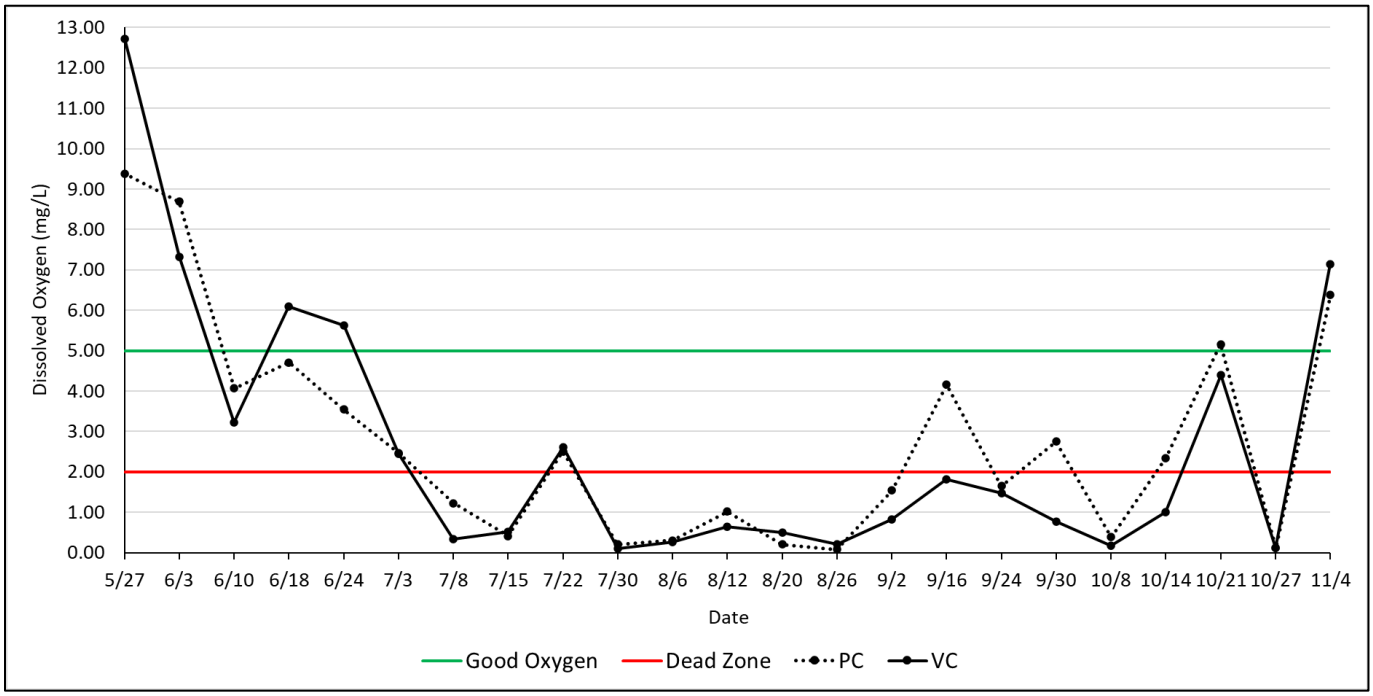

Figure 4. Bottom dissolved oxygen measured at Plum and Valentine Creek stations in 2020.

- Except for 3 weeks in May and June, bottom d.o. was usually better at PC than VC. However the two stations followed similar trends.
- Bottom d.o. started high (9.38 mg/L at PC and 12.72 mg/L at VC) and was never under 2.0 mg/L until July 8th. Then for the majority of July through October dead zone was observed for consecutive weeks (14 total days at VC and 11 total days at PC).
- Both stations entered good d.o. levels again on November 4th (6.38 mg/L at PC and 7.14 mg/L at VC).
- On June 18th and 24th bottom d.o. at VC was in good levels and higher than PC (6.09 and 5.62 mg/L).
- From September 2nd to October 21st bottom d.o. at PC was consistently higher than bottom d.o. at VC.
- The lowest bottom d.o. at PC was 0.08 mg/L on August 26th. The lowest d.o. at VC was 0.10 mg/L on July 30th.

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Average Salinity

The Severn River is a brackish water body. This means that it is neither fully freshwater (0 ppt) or fully saltwater (35 ppt)[2]. Instead the typical salinity range (amount of dissolved salt) of the Severn River is mesohaline (5-18 ppt)[3]. Severn River organisms and underwater grasses are adapted to this range of salt in their environment. Prolonged exposure to salinity outside of this range can cause negative effects such as stress, depressed growth, and decreased survival.

Salinity measurements were taken with a YSI probe at each depth on each monitoring day. The measurements were then averaged for each monitoring day because salinity did not vary much by depth. On figure 5 below, points that fall between the green and red line indicate average daily salinity in the expected mesohaline range.

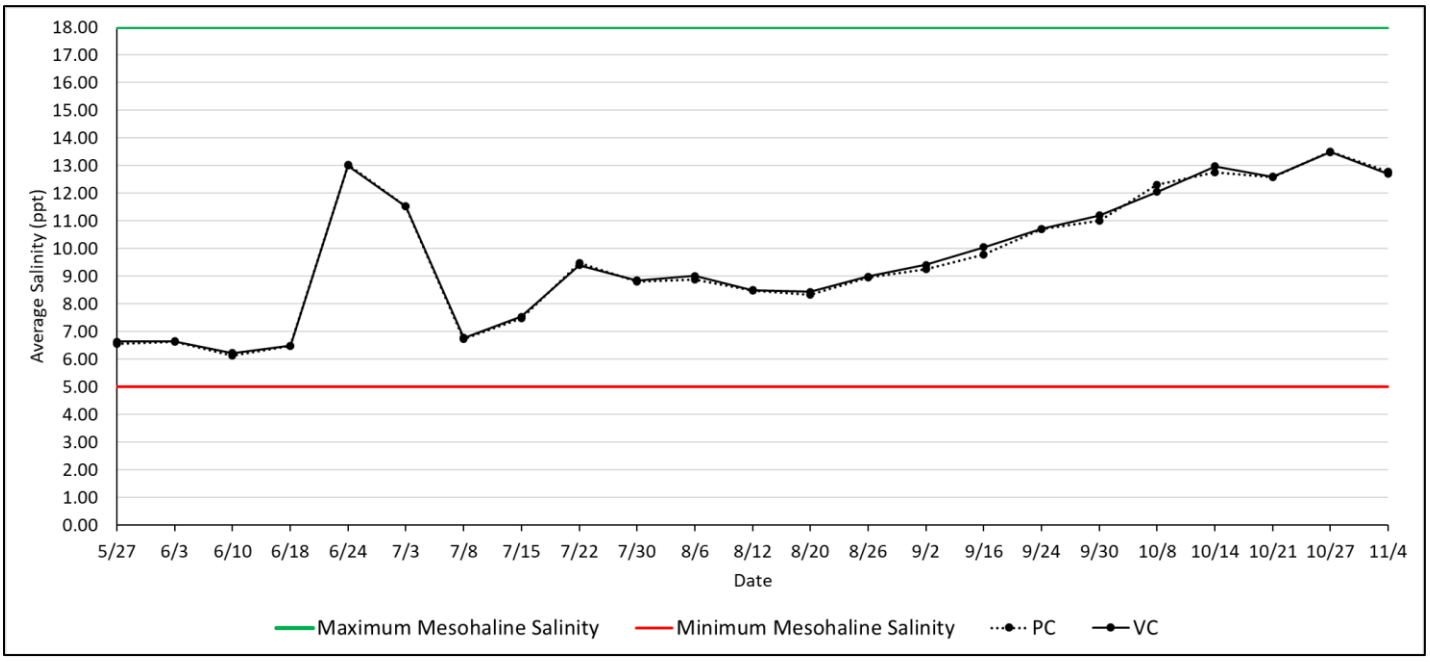

Figure 5. Daily average salinity measured at Plum and Valentine Creek stations in 2020.

- Average salinity over the 2020 monitoring season fell within the mesohaline range of 5-18 ppt, and steadily increased from spring to fall at each stations, except for an abrupt peak on June 24th and July 3rd. This peak around 12-13 ppt was followed by a drop to 7 ppt the following week.
- Each station had very similar average salinity week to week. No clear difference exists.
- Salinity was lowest at both stations on June 10th, averaging 6.14 ppt at PC and 6.22 ppt at VC.
- Salinity was highest at both stations on October 27th, averaging 13.50 ppt at PC and 13.48 ppt at VC.

[2] Chillrud, R. (2020, March 20). Is the Chesapeake Bay fresh or salty? Retrieved January 07, 2021, from https://www.chesapeakebay.net/news/blog/fresh_or_salty_bays_salinity_makes_a_big_difference_to_underwater_life

[3] Bergstrom, P., Murphy, R., Naylor, M., Davis, R., & Reel, J. (2006). *Underwater Grasses in Chesapeake Bay & Mid-Atlantic Coastal Waters*. College Park, MD: Maryland Sea Grant College.

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Water Clarity

Water clarity is a measure of how far we can see down into the water column. High clarity is indicative of less suspended sediment, algal blooms, and other pollutants that cloud the water. Tracking clarity allows us to understand water quality conditions better, and aid in determining sites suitbale for submerged aquatic vegetation (SAV) growth, that require sunlight to penetrate deeply into the water column.

To measure clarity, a Secchi disk was lowered into the water from the shady side of the boat until the pattern of the disk was no longer visible. The disk was then raised towards the surface of the water until barely visible. This depth was then recorded and displayed on figure 6 below. Secchi depths below 0.6 m and above 1.6 m are considered good and bad clarity in mesohaline environments, respectively.

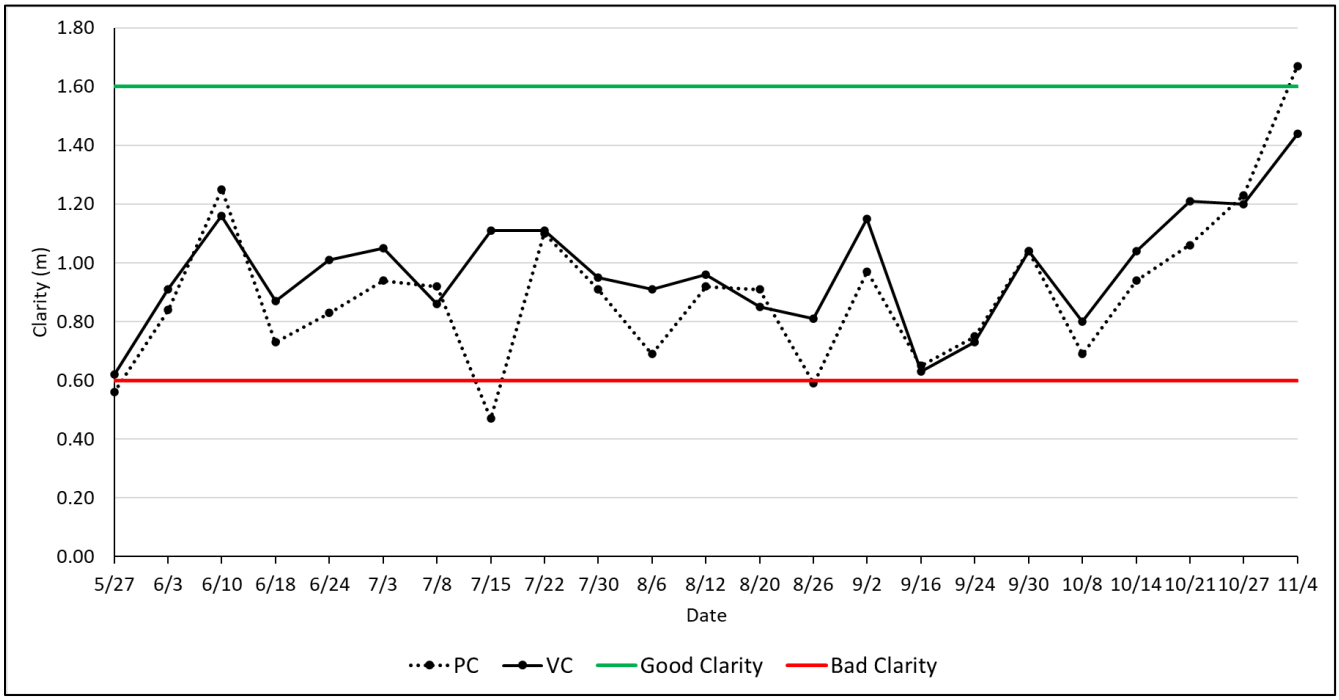

Figure 6. Water clarity at Plum and Valentine Creek stations in 2020.

- Clarity was generally moderate for both stations in 2020, though clarity was often better at VC than PC.
- Clarity at PC was bad 3 times in 2020: 0.56 on May 27th, 0.47 m on July 15th, and 0.6 m on August 26th. Otherwise, clarity generally stayed in a moderate range of 0.7-1.0 m. Clarity was good once at PC: 1.67 m on November 4th.
- Clarity was never bad or good at VC. Clarity was always in a moderate range of 0.62-1.44 m. Clarity was usually better at VC except for few days. On average, clarity was 0.13 m higher at VC than PC.
- Clarity was lowest at VC on May 27th (1.62 m) and lowest at PC on July 15th (0.47 m). Clarity was highest on November 4th at both stations (1.67 m at PC and 1.44 m at VC).