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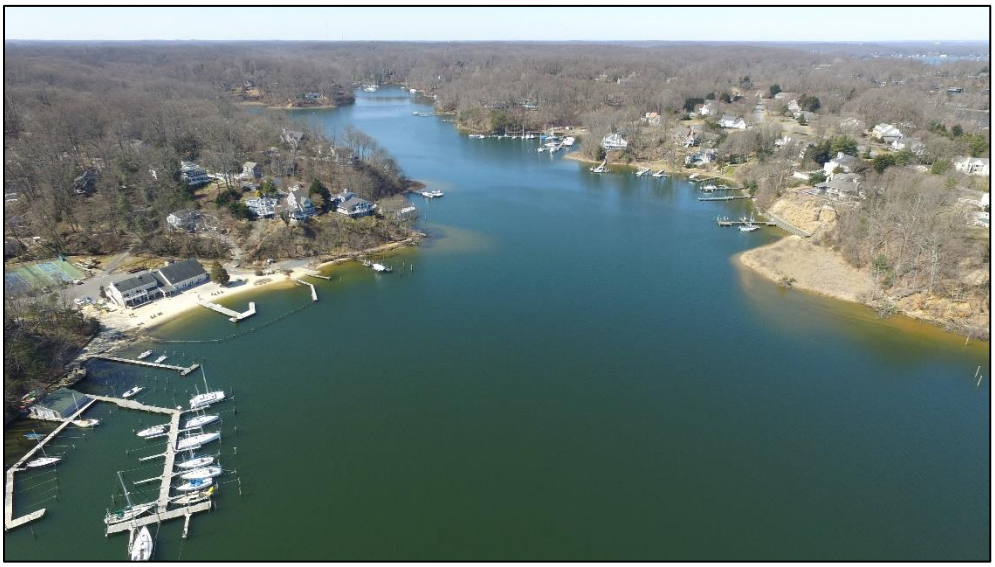
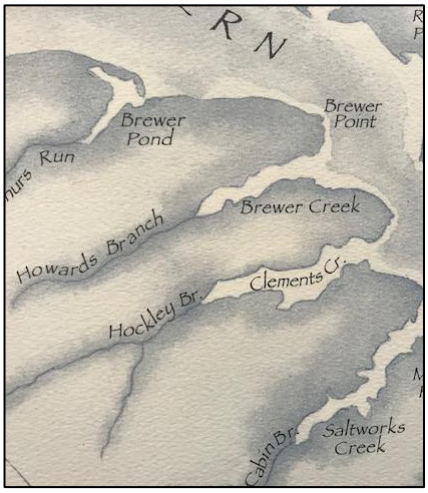
SRA Creek-by-Creek Report
Clements Creek

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

By Emi McGeady, Field Investigator





Abstract
Clements Creek water quality was bad in 2020. Dead zone was very common through summer, and even persisted into September and October. On most days when dead zone was recorded, insufficient levels for fish and crabs were found at multiple depths. Average salinity steadily increased from May to November and was always in the expected mesohaline range of 5-18 ppt. Clarity ranged 0.6-1.0 m for most of the year, though bad clarity was observed near the headwaters of the creek.

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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 Clements Creek. Clements Creek is located on the mid-Severn River in Annapolis, upriver of Saltworks Creek and downriver of Brewer Creek. Along its shores are the Saefern, Epping Forest, and Downs on the Severn communities. The areas studied in this report include SRA's water quality monitoring stations titled Clements Creek #1 (CL1) and Clements Creek #2 (CL2) (figure 1).

Monitoring in Clements Creek occurred weekly from May 28th to November 5th in 2020. This resulted in a total of 24 monitoring days and 203 volunteer hours.

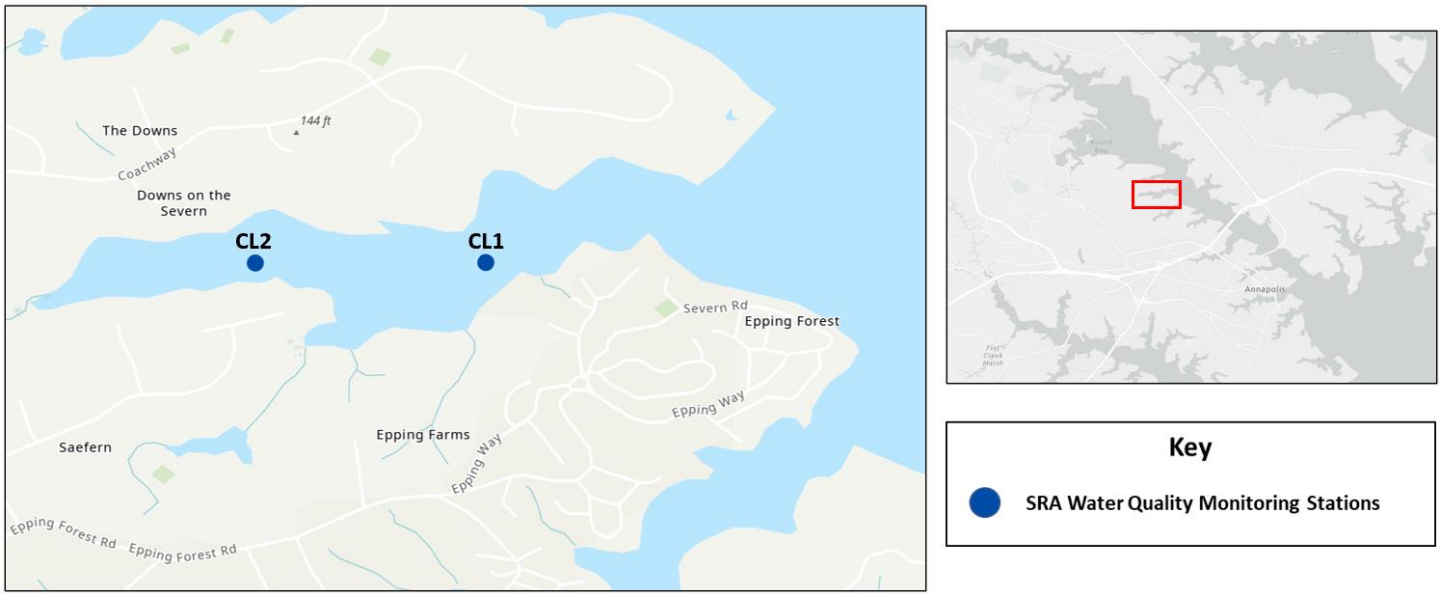

Figure 1. Clements Creek water quality monitoring stations on the mid-Severn River.

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EXECUTIVE SUMMARY

In 2020, dissolved oxygen in Clements Creek was very bad, as dead zone conditions (d.o. < 2.0 mg/L) were measured for over 2/3 of monitoring. Similar d.o. levels and trends of were observed at both stations, but dead zone was measured more frequently at CL2. Dead zone was constant at CL2 as it was measured for 18 consecutive weeks from June to October. Additionally, depth was shallower at CL2 so the dead zone took up the majority of the water column when measured.

At both Clements Creek stations, average salinity fell within the mesohaline range of 5-18 ppt for the entire monitoring season, though in the summer it was fresher and became saltier over time, growing from about 5.50 ppt to 13.50 ppt. This salinity range is within the tolerance of many Severn River species. No major differences between stations existed for average salinity, but average salinity tended to be slightly higher (only about 0.2 ppt) at CL1.

Clarity was generally moderate (0.6-1.0 m) in Clements Creek for the majority of 2020 monitoring. Clarity was typically lower at CL2 than CL1, and bad clarity (under 0.6 m) was more likely to be recorded at CL2. Clarity began increasing to good readings (over 1.6 m) in early October at CL1 and late October at CL2.

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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 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 meter at CL1 and every half meter at CL2. Clements Creek #1 was usually 5 or 6 meters deep while Clements Creek #2 was shallower, usually 3.5- 4 meters deep.

Dissolved oxygen measurements are displayed for each depth on figures 2 and 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.

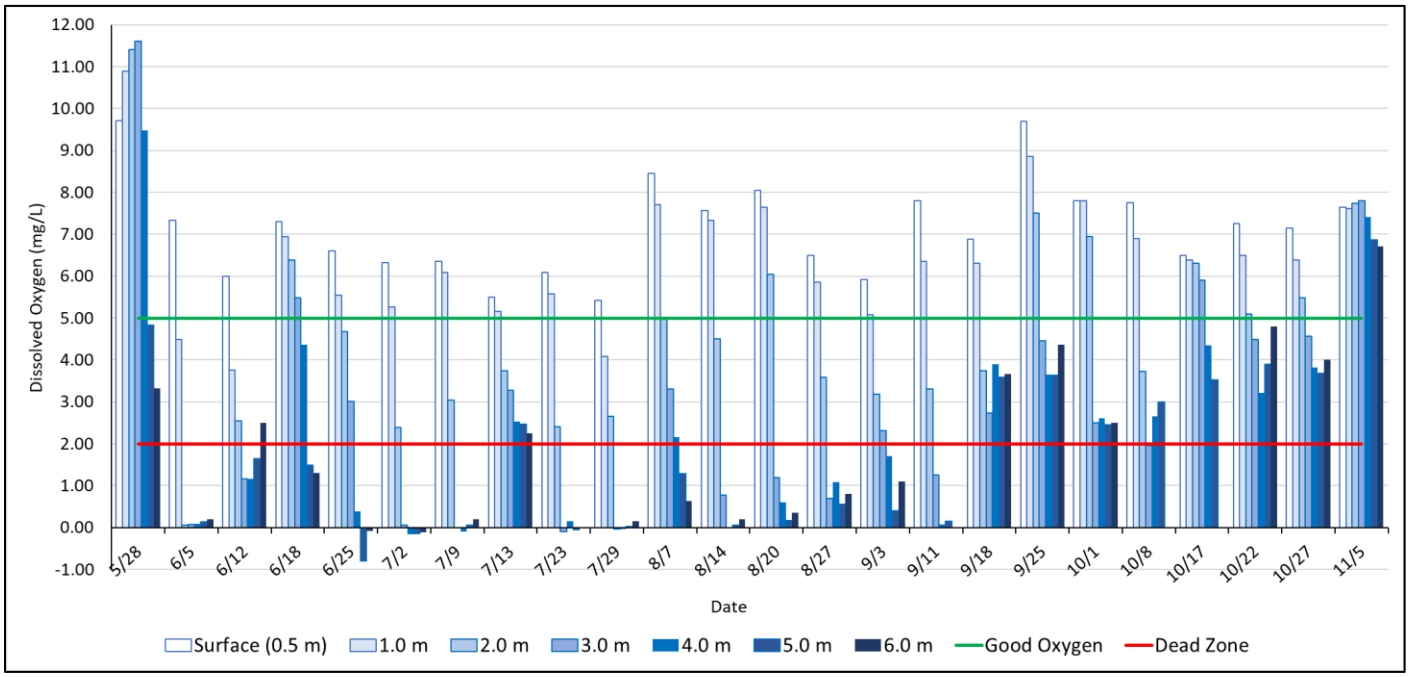

Figure 2. Dissolved oxygen levels through the water column at Clements Creek #1 in 2020.

- Dead zone conditions were recorded at CL1 for approximately 2/3 of monitoring, specifically on 15 days in 2020. Dead zone occurred most in summer (12 days), but was also recorded twice in September and once in October.
- On days that dead zone was recorded the dead zone was found at multiple depths, usually extending from the bottom, up 2 or 3 meters in the water column.

- The tallest dead zone occurred on June 5th where dead zone was recorded from depths of 2 meters to 6 meters. Readings were abysmally low, ranging from 0.06mg/L to 0.19 mg/L.
- The lowest d.o. measured was -0.8 mg/L[1] on June 25th at 5 meters deep. Other negative d.o. values were measured on July 2nd, 9th, 23rd, and 29th.
- By October, all depths began to exhibit moderate or good levels of dissolved oxygen.
- The highest d.o. readings were recorded on May 28th. Readings of 9.48 mg/L to 11.61 mg/L were measured in the top 4 meters of the water column, likley indicative of an algal bloom.

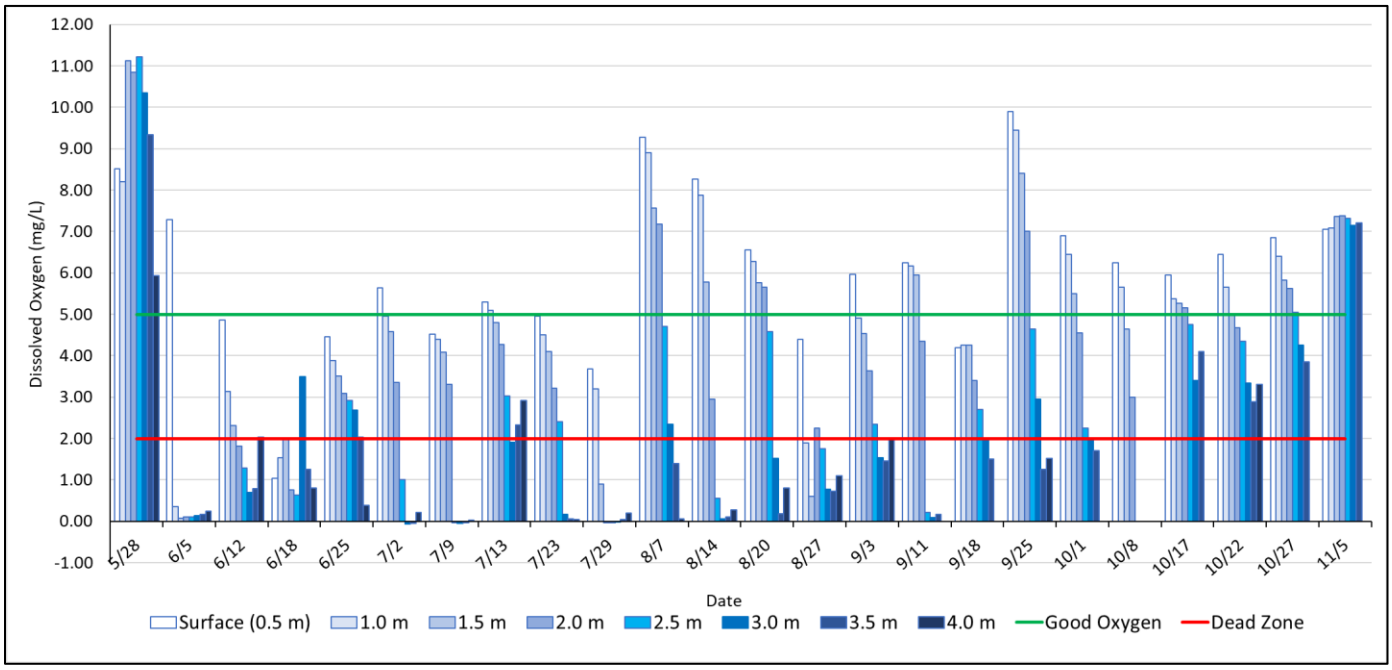

Figure 3. Dissolved oxygen levels through the water column at Clements Creek #2 in 2020.

- Like CL1, dead zone was recorded for over 2/3 monitoring at CL2, specifically on 18 days in 2020. The dead zone at CL2 was more persistent however, as it was constant from June 5th to October 5th.
- On days that dead zone was recorded, the dead zone was usually found at multiple depths and took up the majority of the water column.
- The tallest and worse dead zone occurred on June 5th when dead zone was recorded from a depth of 1 meter to a depth 4 meters. Readings were abysmally low, ranging from only 0.08 mg/L to 0.35 mg/L.
- The lowest d.o. measured was -0.07 mg/L[1] on July 2nd at 3 meters deep. Negative d.o. readings were also measured on July 9th and 29th.
- Dissolved oxygen was generally good (d.o. > 5.0 mg/L) in the top 2 meters of water in late October, the bottom half of depths began to exhibit moderate levels (2.0 mg/L < d.o. < 5.0 mg/L) of dissolved oxygen by fall.
- The highest d.o. reading, 11.22 mg/L, was recorded on May 28th at a depth of 2.5 meters.

[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 Clements Creek station on figure 4 below.

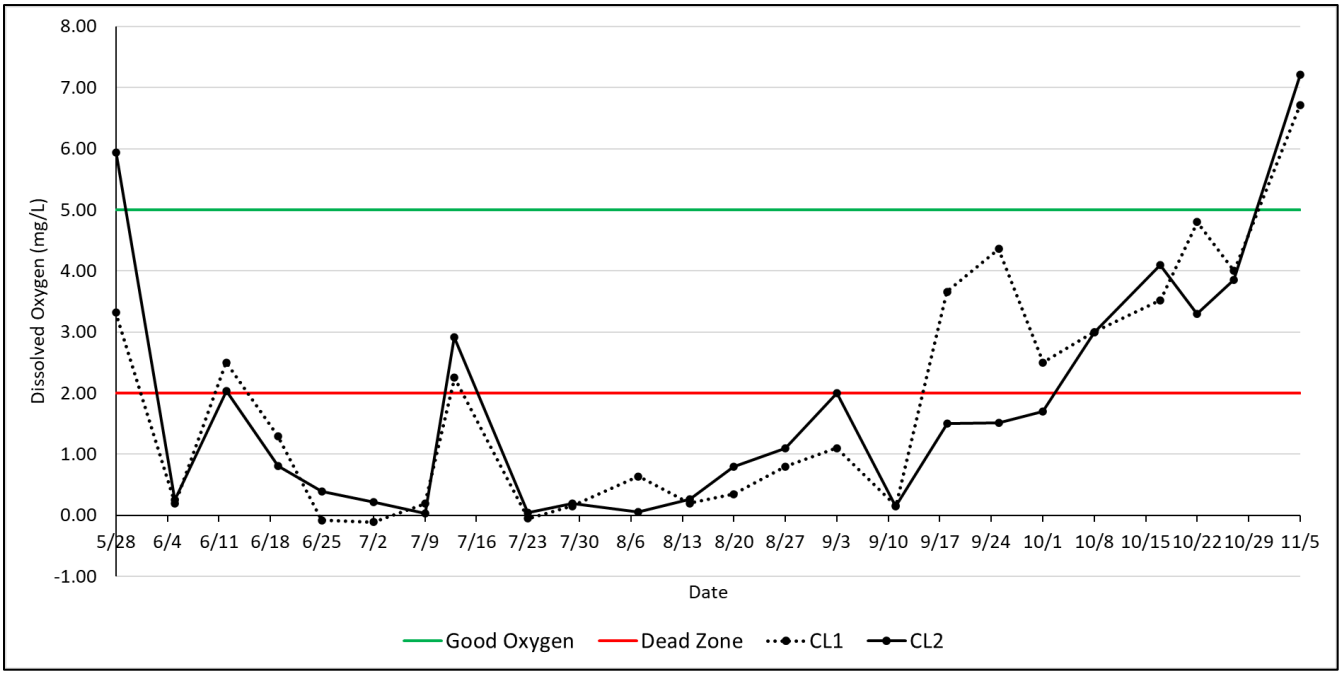

Figure 4. Bottom dissolved oxygen measured at Clements Creek stations in 2020.

- Bottom dissolved oxygen at all stations begins high on May 28th then plummits into dead zone for the majority of the monitoring season. In October, bottom d.o. begins to more consistently enter moderate levels. Bottom d.o. only re-entered good levels in November.
- Bottom d.o. was in dead zone conditions at CL1 on 13 days, whereas bottom d.o. at CL2 was dead zone for 15 days of monitoring.
- The highest bottom d.o. recorded at CL1 and CL2 was on the last day of monitoring, November 5th (6.71 mg/L at CL1 and 7.21 mg/L at CL2).
- The lowest bottom d.o. at CL1 was -0.11 mg/L[2] recorded on July 2nd. The lowest bottom d.o. at CL2 was the next week, July 9th, and was 0.03 mg/L.

[2] 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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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)[3]. Instead the typical salinity range (amount of dissolved salt) of the Severn River is mesohaline (5-18 ppt)[4]. 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.

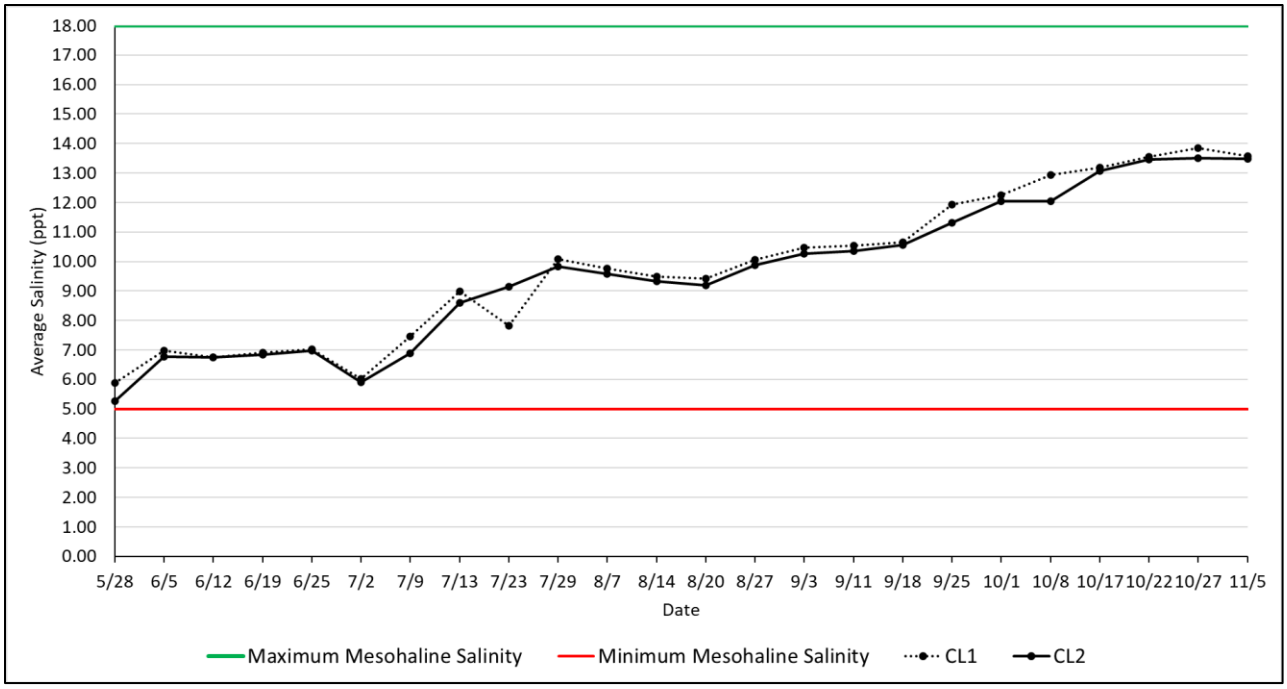

Figure 5. Daily average salinity measured at Clements Creek stations in 2020.

- Average salinity over the 2020 monitoring season fell within the mesohaline range of 5-18 ppt, and steadily increased from spring to fall at both stations. Neither station had a major difference in average salinity over the monitoring season but average salinity at CL1 was slightly higher than average salinity at CL2 from August to November.
- In May, salinity was lowest, averaging 5.88 ppt at CL1 and 5.26 ppt at CL2.
- Salinity was highest on October 27th, averaging 13.84 ppt at CL1 and 13.51 ppt at CL2.

[3] 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

[4] 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.

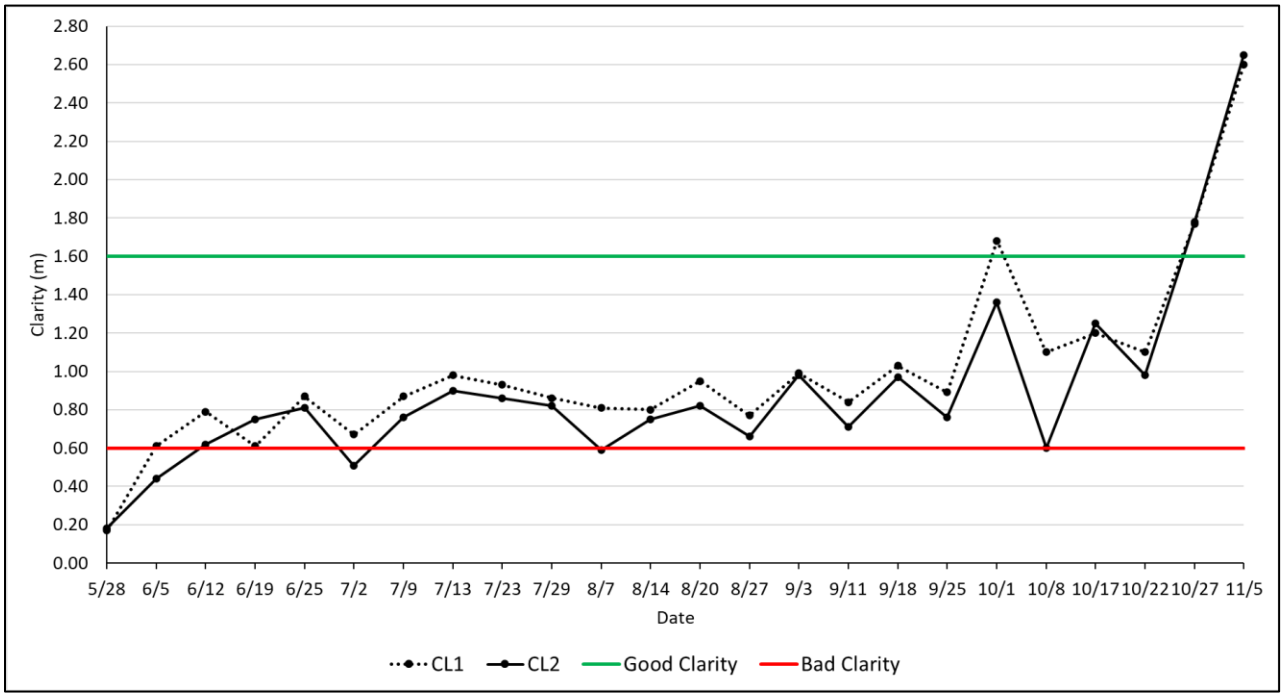

Figure 6. Water clarity at Clements Creek stations in 2020.

- Clarity was generally moderate at Clements Creek stations, with clarity worse more often at CL2.
- Clarity began bad at both stations due to a river-wide mahogany tide algal bloom. This algal bloom clouded surface water at both stations resulting in 0.17 m clarity at CL1 and 0.18 m clarity at CL2.
- Clarity was consistent at CL1 from June to September, typically in moderate levels, specifically ranging from about 0.7 to 1.0 meter. In October clarity began increasing at CL1, and reached good clarity three times, specifically 1.68 m on October 1st, 1.77 m on October 27th, and 2.60 m on November 5th.
- Clarity at CL2 was moderate from July to September, typically ranging 0.7-0.8 m. Bad clarity was measured more often at CL2 during the summer and even once in October. In late October clarity entered the good range and remained for the following week, measuring 1.78 m on October 27th and 2.65 m on November 5th.