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Water Quality Analysis
Indian Landing

Dissolved Oxygen, Salinity, and Clarity Analysis

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Executive Summary: This analysis focuses on three important parameters of water quality: dissolved oxygen, salinity, and clarity, at Indian Landing. Indian Landing is SRA's water quality monitoring station along the shores of the Point Field Landing and Ben Oaks communities located at the headwaters of the Severn River (figure 1).

In 2020, water quality at Indian Landing was generally poor, and the worst of the river's mainstem water quality monitoring stations. We observed dead zones (dissolved oxygen < 2.0 mg/L) through most of the monitoring season. A dead zone on the bottom persisted for 11 weeks from July through October.

Salinity on average fell within the mesohaline range of 5-18 ppt, but surface water was often more fresh than downriver stations. This fresher salinity is due to freshwater inputs from Severn Run and Bear Branch. A historic location for yellow perch exists here, but salinity is too high to support successful reproduction (egg salinity is optimal at 2 ppt).

Clarity was also poor in comparison to downriver stations. Clarity was highest at 0.98 m but the majority of readings fell below 0.5 m. Low clarity resulted from multiple mahogany tide algal blooms fueled by excess nutrients from storm water runoff due to the widespread impervious surfaces surrounding this station. Consistent poor clarity, and frequent and persistent dead zone conditions also arose from upstream construction work on Bear Branch.

WQM volunteer, Ann Bangert, records water quality parameters at Indian Landing station.

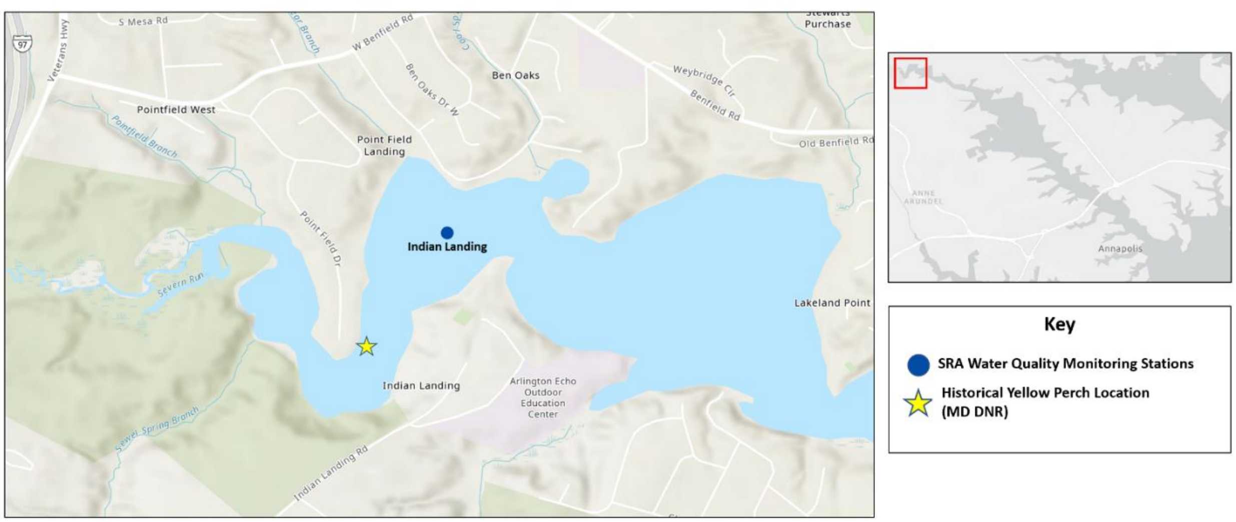

Figure 1. Indian Landing water quality monitoring station located in the Headwaters of the Severn River. Monitoring at Indian Landing in the 2020 monitoring season occurred weekly from May to November. This resulted in a total of 23 monitoring days and 226 volunteer hours.

Dissolved Oxygen by Depth Profile

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

In the 2020 monitoring season, dissolved oxygen measurements were taken weekly from May 27 to November 4 at Indian Landing station. A YSI probe was lowered to the deepest depth where the first measurement was recorded. The probe was then raised through the water column, taking measurements at every subsequent 0.5 meters. 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 displays the high prevalence of dead zone conditions through the entire water column at Indian Landing station. The lighter bars represent the dissolved oxygen in surface water, with the darker bars representing dissolved oxygen at deeper depths. The red X symbols indicate days during the 2020 monitoring season that dead zone conditions were recorded anywhere in the water column.

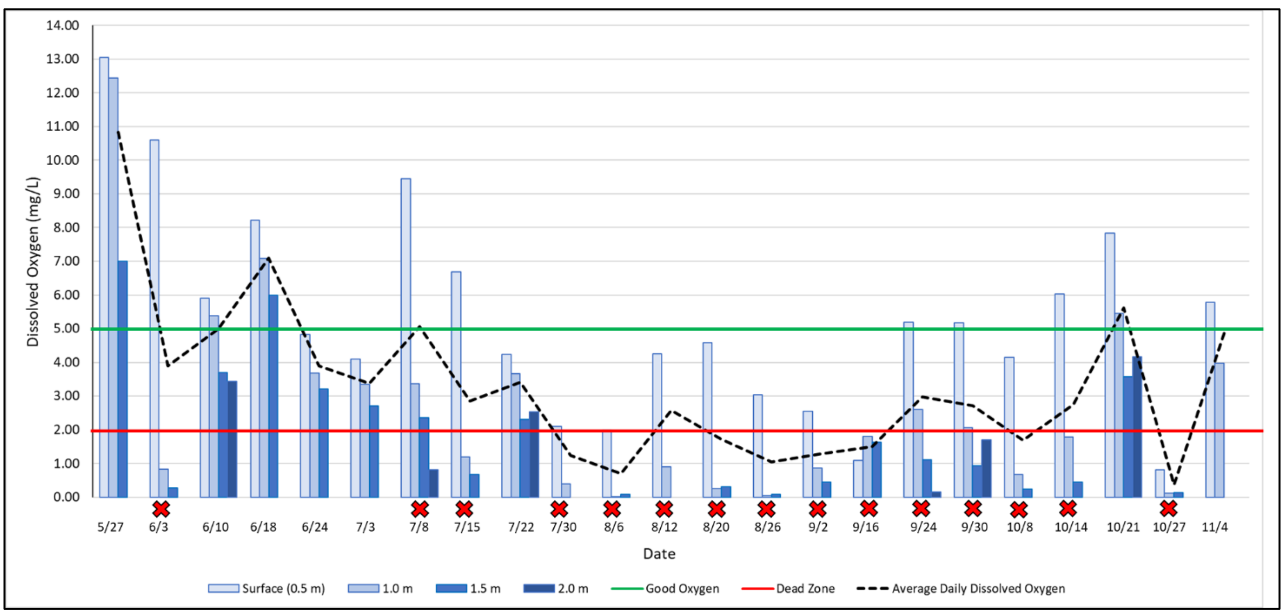

Figure 2. Dissolved oxygen levels through the water column at Indian Landing in 2020.

Of the total 23 days monitored in 2020, dead zone conditions were recorded on 15 days, totaling 65% of the time (figure 2). The dead zone existed throughout most of the water column on those days, and sometimes even extended throughout the entire water column (August 6, September 16, and October 27). The lowest dissolved oxygen reading of 0.01 mg/L was recorded in 1.0 meters of water on August 6 and is considered anoxic.

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The best oxygen readings occurred on May 27 and June 18, where dissolved oxygen at every depth was above the good oxygen level of 5.0 mg/L. The highest dissolved oxygen reading recorded was in the surface water on May 27 (13.04 mg/L). Additionally, the month June generally had moderate/good oxygen levels. For 4 consecutive weeks, moderate to good oxygen levels (>2.0-5.0 mg/L) were observed through the entire water column (6/10-7/3). It is evident that dead zone was more likely to occur in late summer and fall, as a persistent dead zone lasted for 11 consecutive weeks from late July to October (7/30-10/14). Additionally, dissolved oxygen never rebounded to the high levels observed in the Spring.

Bottom Dissolved Oxygen

Measuring dissolved oxygen on the bottom is important for understanding conditions for sedentary or less mobile creatures that cannot move through the water column and escape dead zone conditions, such as oysters, mollusks, and other benthic organisms. Oysters currently do not live in this location on the Severn River, but tracking dissolved oxygen on the bottom is still important in recognizing future possible oyster restoration sites, and understanding how other bottom creatures may be affected.

In the 2020 monitoring season, bottom dissolved oxygen measurements were taken weekly from May 27 to November 4 at Indian Landing station. A YSI probe was lowered until the bottom was felt by slack in the chord. Then the probe was raised to the nearest 0.5 m depth as to not be in the mud. Bottom dissolved oxygen measurements were recorded at depths 1-2 meters deep and are displayed on figure 3 below.

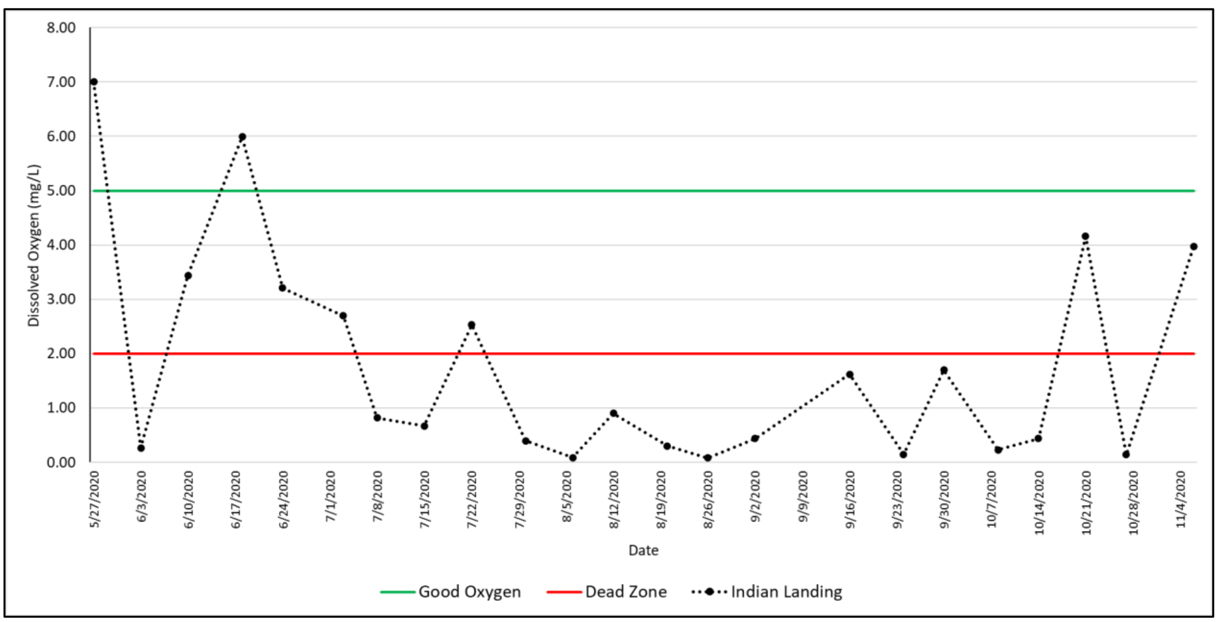

Figure 3. Bottom dissolved oxygen measured at Indian Landing in 2020.

Dead zone conditions on bottom of the river were recorded on 15 of the 23 monitoring days (65%). The dead zone on the bottom was constant for 11 weeks from late July through October, and averaged 0.58 mg/L. The lowest bottom dissolved oxygen reading recorded was 0.08 mg/L on August 26.

Bottom readings barely fell in the moderate to good range above 2.0 mg/L. Moderate to good dissolved oxygen was recorded most often in June, and only twice in the fall. Of the 8 times bottom dissolved oxygen reached above 2.0 mg/L, bottom dissolved oxygen only reached the good level of 5.0 mg/L on 2 days. These readings were 7.0 mg/L on May 27, and 5.99 mg/L on June 18.

Salinity

The Severn River is a brackish water body. This means that it is neither fully freshwater (0 ppt) or fully ocean/saltwater (35 ppt) (Chillrud 2020). Instead the typical salinity range, or amount of dissolved salt in the water, of the Severn River is mesohaline (5-18 ppt). 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, decreased reproduction and growth, and lessened survival.

Salinity measurements were taken weekly from May 27 to November 4 at Indian Landing station. A YSI probe was lowered to the deepest depth where the first measurement was recorded. The probe was then raised through the water column, taking measurements at every subsequent 0.5 meters. On figure 4 below, bars that fall between the green and red line indicates depths where the typical mesohaline range was measured.

Indian Landing is a unique location in that it is located in the headwaters of the Severn River, and therefore receives freshwater inputs from Severn Run and Bear Branch. Because of this, salinity is lower than downriver stations and historically, yellow perch have spawned here and in the fresher Severn Run, as they migrate to fresher salinities to lay their eggs (MD DNR). The salinity tolerance of yellow perch eggs is 2-13 ppt, though egg viability diminishes above 2 ppt (yellow line below) (Harmon 2011). Currently yellow perch reproduction is not successful in the Severn River due to many complex interactions including increasing salinity in spawning areas, poor dissolved oxygen in juvenile habitat, increased flow from development disturbing egg chains, and environmental contaminants that interfere with normal hormone release and egg development (MD DNR). Without further intensive investigation it is difficult to know if yellow perch spawning and reproduction will be successful in the Severn River in the future. Nevertheless it is important to track salinity to better understand this possibility.

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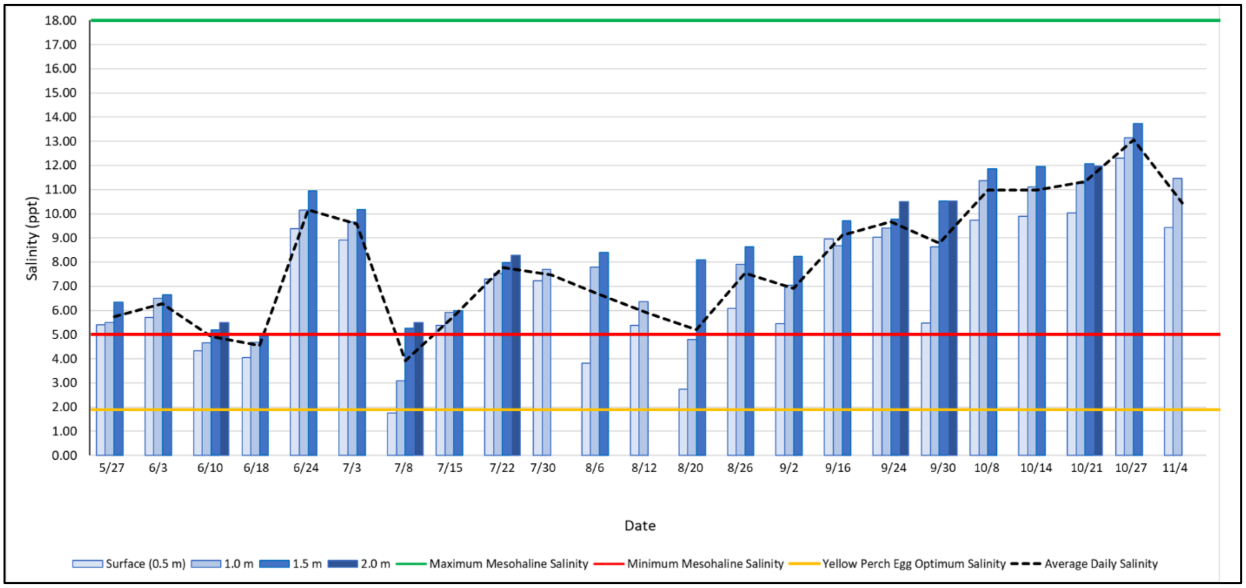

Figure 4. Salinity through the water column and average salinity at Indian Landing in 2020.

Salinity in surface water was generally fresher than deeper water, and could differ by as much as 5.34 ppt over 1.5 meters. The lowest salinity observed was 1.77 ppt on July 8, and the highest recored was 13.74 ppt on October 27.

Average salinity generally remained in the expected mesohaline range of 5-18 ppt. It only dipped below 5 ppt twice in June, and once in July. It only fell to a level conducive for yellow perch reproduction once, in July, a month in the late range for spawning. Average salinity was mostly below 8 ppt in summer, except for a peak in late June. This peak in June was then followed by a sharp decline in July. Starting in late August, and into the fall months, average salinity steadily increased. This salinity increase was likley due to less freshwater inputs as summer rainfall subsided.

Bottom Salinity

Just as tracking dissolved oxygen on the bottom is important for understanding potential abiotic stress to oysters and other benthic organisms, so is tracking bottom salinity. Sedentary benthic organisms and submerged aquatic vegetation cannot escape salinity outside of their tolerance ranges. Oysters thrive in salinities of 10-28 ppt (Chesapeake Bay Program). SAV grows in fresher salinity; sago pondweed prefers 0-12 ppt, and redhead and widgeon thrive in salinities 5-10 ppt and 5-15 ppt respectively (Bergstrom et. al., 2006).

Submerged aquatic vegetation is also spawning and juvenile habitat for yellow perch (egg chains are often found strewed across SAV). If we want to track possible reproduction success we need to track the conditions that allow SAV to grow. Bottom salinity was tracked from May 27 to November 4 and is displayed below (figure 5).

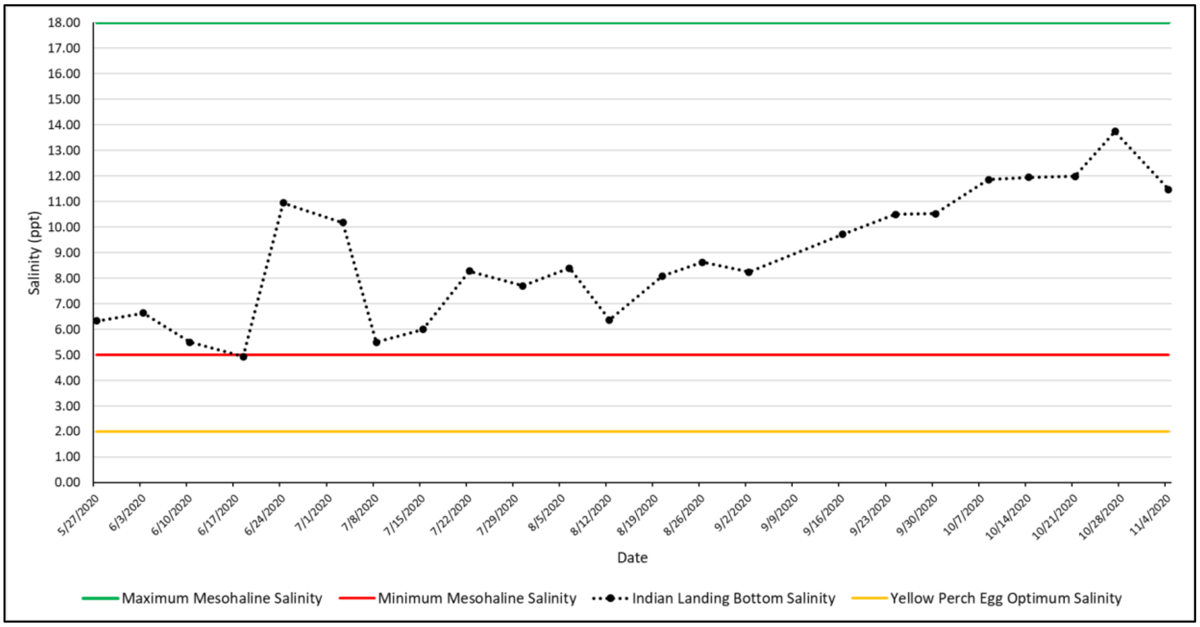

Figure 5. Bottom salinity measured at Indian Landing in 2020.
Bottom salinity remained in the mesohaline range of 5-18 ppt for the entire 2020 monitoring season, except for June 18 when the lowest bottom salinity recorded was 4.93 ppt. Despite a bottom salinity peak from June 24 to July 1, bottom salinity tended to slightly increase over the monitoring season. Salinity began low at 6.33 ppt and steadily grew to 13.74 ppt in October.

Bottom salinity was in the correct ranges to support many SAV species, though other factors limit SAV growth at this location including low clarity from suspended sediment and algal blooms. Salinity at this location is generally too fresh to support oyster growth and survival.

Water Clarity
Water clarity is a measure of how far we can see down into the water column. Higher 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.

Clarity was measured weekly through the 2020 monitoring season. 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.

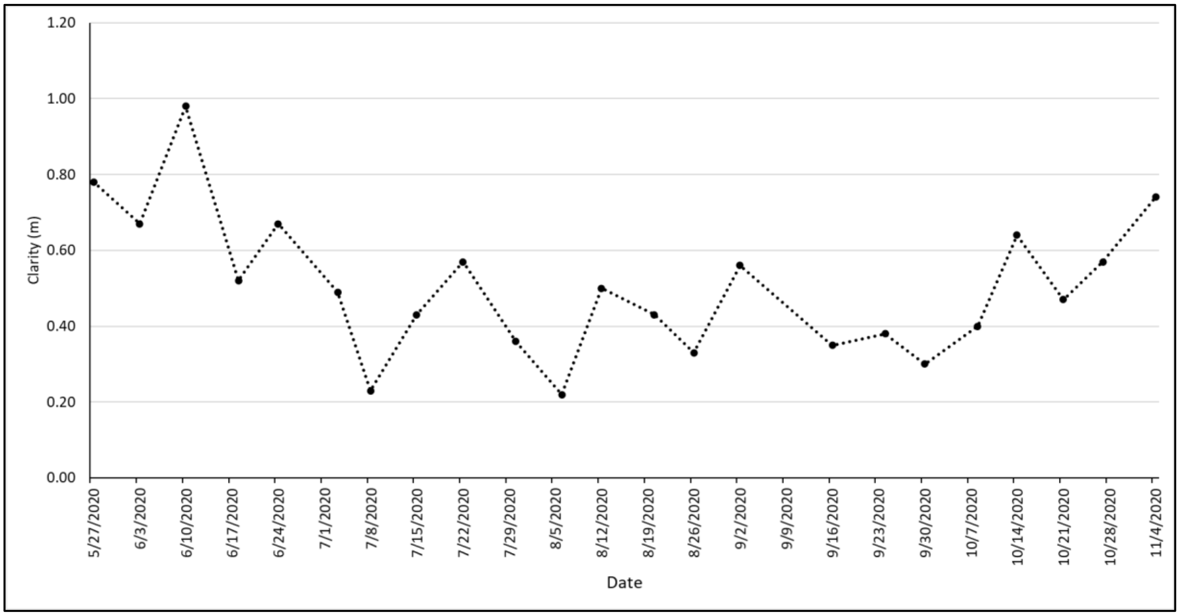

Figure 6. Water clarity measured at Indian Landing in 2020.
Clarity was poor in comparison to downriver stations. Clarity ranged from 0.22 m to 0.98 m. The majority of readings fell below 0.5 m. Clarity was generally higher at the beginning of the monitoring season in spring and early summer and towards the end of monitoring in November. July, August, and September were the worst months for clarity.

Excess nutrients and sediments from stormwater runoff due to widespread impervious surfaces from Severna Park, and along the Severn Run watershed to Ft. Meade, is the likely cause of such consistently poor clarity readings at Indian Landing station. We visually saw first-hand the impact of this increased runoff as we observed a mahogany tide bloom in early fall. A tell-tale sign of the microscopic algae, *Prorocentrum minimum,* that causes the mahogany tide, is water that is a rusty-red color. These algal blooms decrease light reaching submerged aquatic vegetation and contribute to fish kills when blooms die and decay, so it is important to track them on the Severn River (Maryland Department of Natural Resources).

Observing mahogany tide in the fall at Indian Landing station.

Additionally, clarity was impaired due to the directly upstream work on the Shipley's Choice Dam. Communities frequently observed muddy erosion, contributing to cloudy water, and silting in around community piers.

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