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Water Health: Testing and Determining Health of Local Bodies of Water

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Abstract

Ponds and rivers represent distinct aquatic ecosystems characterized by significant differences in size, flow, and water quality metrics through pH, salinity, total dissolved solids (TDS), specific gravity, temperature, electric current, and oxidation-reduction potential (ORP). While general metrics for assessing pond health are well-established, regional tolerance ranges can vary from commonly accepted values. This study aimed to evaluate the health of local ponds and rivers by comparing water quality data to standardized ranges and observing temporal changes in key metrics. Selecting three bodies of water in Loudoun County, Virginia (Living, Stagnant, and River), and using an all-in-one water quality tester, we measured pH, salinity, TDS, specific gravity, temperature, electric current, and oxidation-reduction potential (ORP) across three local bodies of water. These findings were compared to the data and results of the National Institutes of Health, the United States Environmental Protection Agency, and Kasco Marine. Results indicated that all three water bodies fell within healthy ranges, supported by evidence of abundant wildlife and stable environmental conditions. No significant pollution or stress-related changes were observed, suggesting that these ecosystems maintain good health over time. This study provides baseline data for local water quality and highlights the stability of these ecosystems under current conditions.

Key words: pond ecosystems, river ecosystems, water quality metrics, pH, salinity, total dissolved solids (TDS), oxidation-reduction potential (ORP), aquatic health, environmental stability, regional tolerance ranges, ecosystem assessment

Introduction

Water quality is a cornerstone of ecosystem health, shaping the survival of aquatic organisms and the stability of the surrounding environment. Aquatic ecosystems rely on balanced physical and chemical parameters such as pH, salinity, temperature, and total dissolved solids (TDS) to sustain biodiversity and maintain ecological equilibrium (Hook et al., 2014). However, human activities and climate change have introduced significant stressors, disrupting these balances and threatening water bodies worldwide. From nutrient runoff and pollution to increasingly frequent extreme weather events, these pressures have underscored the importance of monitoring and understanding water quality locally and globally (Luvhimbi et al., 2022).

In freshwater systems, water quality degradation can lead to harmful outcomes, such as algal blooms, habitat loss, and declining biodiversity. For example, harmful algal blooms (HABs), often fueled by nutrient runoff, elevated temperatures, and storm frequency, have become a growing concern. These blooms, dominated by cyanobacteria, deplete oxygen, produce toxins, and disrupt aquatic ecosystems, creating ecological and human health challenges (YSIStaff, 2024). Similarly, extreme weather events exacerbated by climate change—such as flooding—have demonstrated devastating effects on aquatic systems, particularly in nearshore marine environments. Studies along Australia's east coast showed that severe flooding altered salinity levels, causing significant mortality among kelp species like Ecklonia radiata (Davis et al., 2022). While marine impacts have been well-documented, freshwater systems face similar stressors, which remain less studied in localized contexts.

Despite using advanced tools like multi-parameter water quality testers, this study encountered challenges that complicated accurate assessments of freshwater ecosystems. Uncalibrated equipment, occasional measurement inaccuracies, and unaccounted-for variables impacted data collection and interpretation. These challenges provided firsthand insights into the complexities of water quality research and emphasized the importance of refining methodologies and tools to enhance the reliability and accuracy of environmental assessments.

This study evaluates water quality in local ponds and rivers in Northern Virginia by measuring key parameters, including pH, salinity, temperature, TDS, etc. Using a 7-in-1 water quality tester, we sought to assess the ecological conditions of these water bodies and identify potential factors influencing their health. Our findings offer insights into the challenges and opportunities of water quality assessment while contributing to a deeper understanding of freshwater ecosystem dynamics in the context of environmental change.

Factors

pH is one of the most important indicators of water quality, as it directly influences the survival of aquatic organisms. A pH of 7 is neutral, while values below 7 are acidic, and above seven are basic. The typical tolerance range for aquatic life is 6-9 pH (Saalidong et al., 2022). pH values during the study fluctuated between 7-8, with some sites showing a higher pH, reaching up to 10 in stagnant areas. This anomaly is likely due to natural factors such as temperature shifts and increased algal blooms, which can raise pH levels. Algae absorb CO2 during photosynthesis, reducing carbonic acid in the water and raising pH (Zerveas et al., 2021).

Salinity is another crucial measure, as most freshwater species are intolerant of high salt concentrations. Healthy freshwater systems generally have salinity levels of less than 0.1 percent (1000 ppm) (Rosinger et al., 2021). The salinity levels in our study aligned with this range, though a significant drop was observed during Hurricane Helene's flooding. The salinity dropped from approximately 145 ppm to 98 ppm, likely due to the dilution effect from excess rainwater.

Total Dissolved Solids (TDS), which include minerals and nutrients dissolved in water, are also critical for maintaining water quality (WorldHealthOrganization, 1996). TDS values help assess whether certain nutrients could be toxic to aquatic life. The average TDS levels in our study were relatively low, likely due to sampling limitations at the shallower edges of ponds and rivers, where TDS concentration is lower. TDS levels are typically higher in the water column, where convection currents facilitate the dissolution of minerals and nutrients. These lower TDS readings may be attributed to the limited depth of our sampling sites, which were chosen for ease of access rather than their ability to represent the entire water column.

Temperature affects a variety of water quality parameters, including pH, salinity, TDS, and specific gravity. It also influences aquatic organisms' metabolic rates and enzymatic activity (Fujimoto et al., 2015). This study's temperature data was taken at the shore, which can differ from the temperature in the deeper water column. This methodological flaw may have led to inaccurate assessments of how temperature affects other water quality parameters.

Oxidation-reduction potential (ORP) and Electrical Conductivity (EC) are additional measurements that help assess water quality, though both were unreliable in our study due to uncalibrated equipment. ORP measures the balance of electrolytes and can provide insight into oxygen availability, while electrical conductivity gauges the ion concentration in water (Pawlowicz, 2017). Unfortunately, both these measurements were inconclusive due to calibration issues; thus, the data must represent the true water quality.

Specific gravity, which measures the density of water relative to pure water, was also affected by calibration problems, resulting in inaccurate readings (Ugbolue, 2017). This measurement would have helped assess the concentration of dissolved ions and impurities in the water, but due to equipment errors, no meaningful conclusions could be drawn.

Materials and Method

This study employed an observational approach to evaluate the health of local ponds and rivers by collecting and analyzing water quality data at three distinct sites in Sterling, Virginia. The first site, Living Water, was located at Countryside Pond and will be denoted as Sites A, B, C, and D. This site, representing a relatively static, but living water body, was selected for its manageable environment. The second site, Stagnant Water, was situated at Claude Moore Regional Park Pond, chosen to reflect a more natural, isolated pond habitat. This site will be denoted as Sites I, J, K, and L. The third site, Running Water, was located at the Potomac River within Algonkian Regional Park, selected to represent a dynamic aquatic environment. This site will be denoted as Sites E, F, G, and H.

At each site, four sub-sampling points were selected at equal intervals along the banks to ensure spatial consistency and capture potential variations within the water body. These locations were carefully chosen to minimize disturbance to the ecosystems while providing representative data. Sampling occurred twice weekly between 12:00 PM and 4:00 PM to maintain consistency in temporal conditions, such as light and temperature, which could influence water quality parameters. A visualization of the selected bodies of water is presented in Figure 1, displaying the greater Sterling, Virginia, USA region (Google & Airbus, 2020). See Appendix B (Fig. 1B, 2B, 3B) for additional maps corresponding to each individual sampling site.

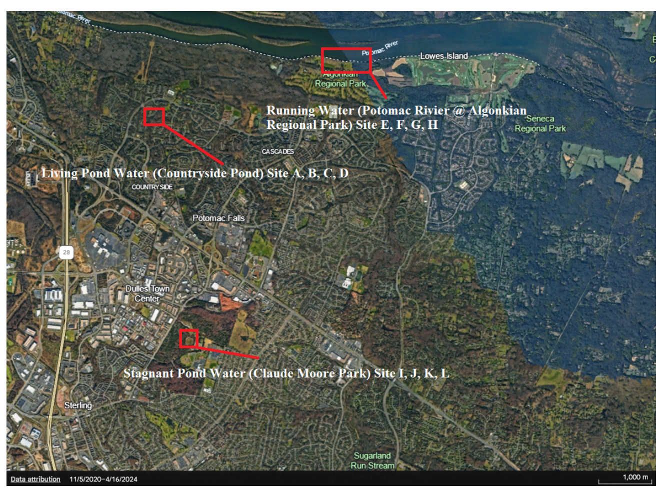

Fig. 1: Picture derived from Google Earth, displaying the Sterling, Virginia, USA region. Imagery from 8 August 2016 - 13 October 2024

Assessments and Measures

Water quality parameters, including pH, TDS, salinity, electrical conductivity (EC), oxidation-reduction potential (ORP), specific gravity, and temperature, were measured using the Rowyet BLE-C600 7-in-1 Digital Water Quality Tester. The device was calibrated for pH, salinity, and TDS prior to use; however, EC was not calibrated and should be interpreted with caution. To maintain sample integrity, standard nitrile gloves were worn during all sampling events. Data were recorded and exported through the YINMIK app and subsequently organized in Excel for analysis. At each site, the water tester probe was submerged into the water at the designated sub-sampling points (Sites A, B, C, D, etc.). After each measurement, the probe was rinsed with distilled water to prevent cross-contamination.

While the weather conditions were not standardized, environmental observations were documented for potential impacts on data accuracy. Observations included noting wildlife presence, pollution, algae blooms, weather conditions, and water characteristics such as turbidity and sedimentation. For instance, during visits to the Potomac River, observations indicated clearer water with noticeable wildlife and insects along the banks. At each of the three sampling sites—Living Water (Countryside Pond), Running Water (Potomac River), and Stagnant Water (Claude Moore Regional Park Pond)—four sub-sampling points were selected at equal intervals along the banks to ensure spatial consistency. The collected data were compared to reference values from established databases, such as the National Institutes of Health and the Environmental Protection Agency, to assess deviations and identify patterns in water quality.

Data Analysis

In this study, we collected various water quality measurements using a 7-in-1 tool measurer. While the tool is not guaranteed 100 percent accurate, we calibrated it for the most critical measurements (pH, salinity, TDS) to ensure reasonable accuracy. However, the Electrical Conductivity (EC) measurement was not calibrated, so results should be interpreted cautiously. The data collected were recorded in a table listing all measurements across locations and dates and general observations for each day and site. It is important to note that this was not an experimental study; instead, we gathered data for comparison with established benchmarks from published databases. Due to the absence of control and the inherent variability in environmental data, confounding factors may permanently affect the results.

Table 1

The data from Table 1 are reflected below, reflecting the first day of collection, which was characterized by lower efficiency and some disorganization. While no significant abnormalities were noted, there were clear differences in water quality parameters across the sites, with noticeable variation in most measurements.

Living Water (Countryside). The living water sites (A-D) demonstrate relatively stable water quality, with moderate EC (average 99.75 µS/cm) and TDS levels (49.50 ppm). pH levels hover near neutral (average 6.97), indicating a balanced chemical environment. ORP values (average 154.00 mV) suggest sufficient oxygenation for aquatic life. The water temperature averages 22.25°C, consistent with the cloudy weather and recent rainfall, which has elevated water levels. Qualitative observations describe the water as dark and murky with some fish present, indicating life despite low visibility. The absence of mosquito larvae or algae blooms highlights the water's health. Overall, this site shows no signs of pollution and reflects a moderately dynamic ecosystem influenced by weather patterns.

Running Water (Potomac River). The Potomac River sites (E-H) exhibit the highest conductivity (average 292.25 µS/cm) and TDS levels (145.75 ppm), likely attributed to their exposure to environmental inputs. Salinity is minimal at 0.01%, and pH levels average 7.57, slightly alkaline and conducive to riverine ecosystems. ORP readings (average 189.50 mV) and consistent water temperatures (22.30°C) suggest vigorous aeration and ecological activity. Observations describe a misty and foggy environment with moderate currents (5 mph), high tide, and muddy water with a noticeable odor. The absence of mosquito larvae and limited algae blooms indicates healthy water flow despite the turbidity and smell. These results highlight the river's resilience and active processing of natural and anthropogenic inputs.

Stagnant Pond (Claude Moore Pond). The stagnant pond (Sites I-L) reflects the challenges of limited water movement, with EC averaging 132.50 µS/cm and TDS levels at 66.00 ppm. The pH is slightly acidic (average 6.75), which, combined with observations of mosquito larvae and pollution, points to organic matter decomposition and nutrient accumulation. ORP values average 169.00 mV, indicating moderate oxygenation. Water temperatures (average 22.75°C) remain stable, consistent with the cool, misty, and foggy conditions observed during sampling. Geese and some life suggest a functioning ecosystem, but visible pollution and mosquito larvae highlight vulnerabilities in stagnant systems. These findings emphasize the pond's susceptibility to environmental stressors, underscoring the need for monitoring and management.

Date: 9/29	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	116.00	58.00	0.00	58.00	1.00	7.12	187.00	22.20
Site B	99.00	49.00	0.00	49.00	1.00	7.00	165.00	21.90
Site C	95.00	47.00	0.00	47.00	1.00	6.88	131.00	22.60
Site D	89.00	44.00	0.00	44.00	1.00	6.86	133.00	22.30
Average	**99.75**	**49.50**	**0.00**	**49.50**	**1.00**	**6.97**	**154.00**	**22.25**
Running Water (Potomac River)								
Site E	295.00	147.00	0.01	147.00	1.00	7.48	159.00	23.00
Site F	294.00	147.00	0.01	147.00	1.00	7.58	202.00	22.30
Site G	287.00	143.00	0.01	143.00	1.00	7.63	195.00	22.50
Site H	293.00	146.00	0.01	146.00	1.00	7.60	202.00	21.40
Average	**292.25**	**145.75**	**0.01**	**145.75**	**1.00**	**7.57**	**189.50**	**22.30**
Stagnant Pond (Claude Moore Pond)								
Site I	159.00	79.00	0.00	79.00	1.00	6.54	138.00	22.80
Site J	124.00	62.00	0.00	62.00	1.00	6.83	166.00	22.60
Site K	123.00	61.00	0.00	61.00	1.00	6.81	183.00	22.70
Site L	124.00	62.00	0.00	62.00	1.00	6.83	189.00	22.90
Average	**132.50**	**66.00**	**0.00**	**66.00**	**1.00**	**6.75**	**169.00**	**22.75**

Table 1. See Table 1A in Appendix A for enlarged table.

Table 2

Table 2 presents data reflected in below that highlights an anomaly, attributed to the effects of Hurricane Helene, which brought significant rainfall and flooding to Northern Virginia. The Potomac River experienced a rise in water levels of approximately 9 feet, resulting in muddy water and swift currents. The data from this day reflected these dramatic changes, showing lowered salinity and TDS values, as well as increased turbidity. These shifts in water quality were likely caused by the large influx of rainwater and sediment into the river, which contributed to the observed variations in the measurements.

Living Water (Countryside). The living water sites (A-D) show moderate water quality with a decline in average EC (84.50 µS/cm) and TDS (42.00 ppm) compared to the previous sampling. The pH remains slightly acidic (6.79 average), possibly influenced by sediment disturbances following recent rainfall. ORP values show variability (average 72.75 mV), with Site A having the lowest reading at 27 mV—water temperatures average 22.65°C. Observations highlight pollution along the pond's edges, with algae growth concentrated in shaded areas. The water is brown and murky, and the lack of current may be caused by sediment buildup. The muddy and smooth banks further reflect the impact of recent rainfall, signaling potential vulnerability to runoff and sedimentation.

Running Water (Potomac River). The Potomac River sites (E-H) demonstrate lower conductivity (196.25 µS/cm) and TDS (98.00 ppm) compared to prior measurements. The pH (average 7.65) remains slightly alkaline, suitable for sustaining aquatic biodiversity. ORP values (176.25 mV average) and stable water temperatures (21.33°C) suggest continued oxygenation despite the dynamic conditions. Observations describe a strong current and flooding, with tide levels increasing by 5–8 feet. Bugs are surfacing, and the sites have negligible algae blooms despite shaded sampling locations. The powerful current indicates resilience, effectively mixing and diluting potential contaminants, ensuring the river's ecological stability during high tide events.

Stagnant Pond (Claude Moore Pond). The stagnant pond sites (I-L) reveal significant changes, with elevated EC (154.75 µS/cm) and TDS (77.25 ppm), as well as strikingly high average pH levels (8.90). These values suggest alkalinity is potentially influenced by biological activity or external inputs such as runoff. ORP values (122.00 mV average) indicate moderate oxygenation, with higher temperature readings (25.43°C average) than other sites. Observations report muddy banks, negligible algae blooms in sunny areas, and the presence of bugs, bees, turtles, and geese. The absence of algae despite the hot sun could reflect nutrient imbalances or low organic matter. The high pH and stable ORP highlight the pond's unique response to rainfall, but the stagnant conditions remain a concern for long-term health.

Date: 10/3	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	120.00	60.00	0.00	60.00	1.00	6.67	27.00	21.50
Site B	101.00	50.00	0.00	50.00	1.00	6.88	117.00	23.70
Site C	103.00	51.00	0.00	51.00	1.00	6.79	48.00	22.70
Site D	14.00	7.00	0.00	7.00	1.00	6.83	99.00	22.70
Average	**84.50**	**42.00**	**0.00**	**42.00**	**1.00**	**6.79**	**72.75**	**22.65**
Running Water (Potomac River)								
Site E	186.00	93.00	0.00	93.00	1.00	7.72	151.00	21.20
Site F	187.00	93.00	0.00	93.00	1.00	7.45	174.00	21.70
Site G	182.00	91.00	0.00	91.00	1.00	7.74	189.00	20.80
Site H	230.00	115.00	0.01	115.00	1.00	7.70	191.00	21.60
Average	**196.25**	**98.00**	**0.00**	**98.00**	**1.00**	**7.65**	**176.25**	**21.33**
Stagnant Pond (Claude Moore Pond)								
Site I	210.00	105.00	0.01	105.00	1.00	8.28	121.00	26.30
Site J	124.00	62.00	0.00	62.00	1.00	8.64	133.00	25.50
Site K	165.00	82.00	0.00	82.00	1.00	9.30	119.00	24.40
Site L	120.00	60.00	0.00	60.00	1.00	9.37	115.00	25.50
Average	**154.75**	**77.25**	**0.00**	**77.25**	**1.00**	**8.90**	**122.00**	**25.43**

Table 2. See Table 2A in Appendix A for enlarged table.

Table 3

Table 3 shown below, displays water levels decreasing and no additional rainfall between Table 2 and Table 3. Measurements for pH, salinity, and TDS began to return to their normal ranges, indicating a stabilization of water quality. Observations also reflected a return to standard environmental conditions, with the water clearing up and currents stabilizing.

Living Water (Countryside). The countryside pond sites (A-D) demonstrated relatively consistent water quality parameters, with an average EC of 98.75 µS/cm and a TDS of 49.25 ppm. Salinity and salt levels were negligible, maintaining a Specific Gravity (S.G) of 1.00. The pH level was slightly acidic to neutral (7.02), and ORP values averaged 209 mV, indicating a well-oxygenated environment. The cooler weather likely contributed to the calmer atmosphere and reduced insects and aquatic life activity. While the water was clearer and more tranquil than prior observations, fewer signs of life, such as insect sounds and visible activity, were noted. This suggests a potential seasonal or temperature-driven reduction in biological activity.

Running Water (Potomac River). The Potomac River sites (E-H) displayed higher EC (239.25 µS/cm) and TDS (119.25 ppm) than the countryside and stagnant ponds. The pH was slightly alkaline at 7.40, and ORP levels were moderate (165.25 mV), indicating a balanced oxidative environment. Despite these stable metrics, observations noted more transparent water with less sediment and an unusual brackish quality. Wildlife activity, including bugs and other animals, was noticeable along the riverbanks. The moderate water movement and high tide levels suggest that the lack of recent rainfall allowed for evaporation, potentially concentrating solutes and affecting clarity.

Stagnant Pond (Claude Moore Pond). The stagnant pond sites (I-L) exhibited distinctive characteristics, including the highest pH average (9.43) and the lowest EC (101.75 µS/cm). TDS values averaged 50.50 ppm, while ORP was notably low (99.25 mV), which may indicate limited oxygen availability or microbial activity in this environment. Observations described a tranquil setting, with visible sediment along the banks but reduced muddiness compared to earlier data collections. Geese and lush greenery around the pond suggest an active surrounding ecosystem. While aquatic life appeared minimal, the cooler temperatures and slight breeze likely enhanced surface movement and oxygenation, creating a calm atmosphere.

Date: 10/7	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	98.00	49.00	0.00	49.00	1.00	6.82	212.00	22.70
Site B	98.00	49.00	0.00	49.00	1.00	7.20	177.00	21.80
Site C	100.00	50.00	0.00	50.00	1.00	7.05	232.00	21.90
Site D	99.00	49.00	0.00	49.00	1.00	7.00	215.00	22.00
Average	**98.75**	**49.25**	**0.00**	**49.25**	**1.00**	**7.02**	**209.00**	**22.10**
Running Water (Potomac River)								
Site E	239.00	119.00	0.01	119.00	1.00	7.32	171.00	23.00
Site F	245.00	122.00	0.01	122.00	1.00	7.21	183.00	21.70
Site G	229.00	114.00	0.01	114.00	1.00	7.65	151.00	19.70
Site H	244.00	122.00	0.01	122.00	1.00	7.43	156.00	19.70
Average	**239.25**	**119.25**	**0.01**	**119.25**	**1.00**	**7.40**	**165.25**	**21.03**
Stagnant Pond (Claude Moore Pond)								
Site I	51.00	25.00	0.00	25.00	1.00	9.59	69.00	26.80
Site J	117.00	58.00	0.00	58.00	1.00	9.55	94.00	25.50
Site K	115.00	57.00	0.00	57.00	1.00	8.83	133.00	24.00
Site L	124.00	62.00	0.00	62.00	1.00	9.73	101.00	24.60
Average	**101.75**	**50.50**	**0.00**	**50.50**	**1.00**	**9.43**	**99.25**	**25.23**

Table 3. See Table 3A in Appendix A for enlarged table.

Table 4

Table 4 below shows the further normalization in water quality, with no unusual water levels or current speeds observed in the Potomac River. Data trends stabilized, and all measurements returned to expected ranges for each site, indicating a return to typical environmental conditions following the disturbances of prior days. The data in Table 4 is presented below.

Living Water (Countryside) - Sites A–D showed stable conditions, with an average EC of 98.25 µS/cm and TDS at 48.75 ppm, indicating low ion concentrations. Salinity remained undetectable, and Specific Gravity was consistently 1.00. The pH averaged 7.24, close to neutral, reflecting a balanced aquatic system. ORP values were moderate, averaging 176.00 mV, suggesting healthy oxidation levels. Temperatures averaged 19.13°C, slightly cooler than previous observations, aligning with seasonal changes. The pond exhibited its typical brackish and slightly murky water with a minor current. The banks were notably dry and firm, with limited insect activity due to cooler weather. The sighting of a Mallard duck added a unique observation, though overall, surface activity remained minimal, consistent with past trends.

Running Water (Potomac River) - Sites E–H had elevated EC levels, averaging 306.00 μS/cm, and TDS at 152.75 ppm, reflecting higher dissolved ion content. Salinity was minimal at 0.01%, and Specific Gravity was stable at 1.00. The pH averaged 7.78, trending toward alkalinity, while ORP averaged 69.50 mV, showing reduced oxidation-reduction activity. Temperatures averaged 17.08°C, reflecting cooler conditions. Observations revealed murky water, likely due to sediment from upstream and muddy banks, making traversal difficult. Despite significant bug activity near the water, the windy conditions limited their presence in the air. The river appeared less clear than previous visits, with reduced current and murkier sediment content.

Stagnant Pond (Claude Moore Pond) - Sites I–L showed variable conditions. EC averaged 119.75 μS/cm, and TDS was 59.75 ppm, indicating moderate ionic content. Salinity was negligible, and Specific Gravity remained steady at 1.00. The pH was notably alkaline, averaging 8.21, with ORP at 111.75 mV, indicating moderate oxidation activity. Temperatures were warmer, averaging 20.33°C. Observations noted a significant algae bloom, consistent with the high pH, alongside minimal surface movement and transparent banks. Bug activity was present, though not excessive, and the area had a tranquil atmosphere. The water had a murky yellowish appearance, but there was no breeze, leaving the pond still. The presence of sediment was less pronounced than before, aligning with the pond's stagnant nature.

Date: 10/11	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	102.00	51.00	0.00	51.00	1.00	7.32	157.00	18.30
Site B	97.00	48.00	0.00	48.00	1.00	7.25	168.00	19.40
Site C	99.00	49.00	0.00	49.00	1.00	7.10	186.00	19.80
Site D	95.00	47.00	0.00	47.00	1.00	7.30	193.00	19.00
Average	**98.25**	**48.75**	**0.00**	**48.75**	**1.00**	**7.24**	**176.00**	**19.13**
Running Water (Potomac River)								
Site E	307.00	153.00	0.01	153.00	1.00	7.26	12.00	17.30
Site F	308.00	154.00	0.01	154.00	1.00	7.88	51.00	17.00
Site G	304.00	152.00	0.01	152.00	1.00	7.98	80.00	16.90
Site H	305.00	152.00	0.01	152.00	1.00	7.99	135.00	17.10
Average	**306.00**	**152.75**	**0.01**	**152.75**	**1.00**	**7.78**	**69.50**	**17.08**
Stagnant Pond (Claude Moore Pond)								
Site I	128.00	64.00	0.00	64.00	1.00	7.55	99.00	20.80
Site J	112.00	56.00	0.00	56.00	1.00	7.27	127.00	19.70
Site K	123.00	61.00	0.00	61.00	1.00	9.11	109.00	20.20
Site L	116.00	58.00	0.00	58.00	1.00	8.90	112.00	20.60
Average	**119.75**	**59.75**	**0.00**	**59.75**	**1.00**	**8.21**	**111.75**	**20.33**

Table 4. See Table 4A in Appendix A for enlarged table

Table 5

Table 5 shown below reflects consistent conditions similar to those observed in Table 4, with no significant changes in water quality or environmental conditions. The data remained stable, confirming the trends noted in previous days. The data in Table 5 is presented below.

Living Water (Countryside) - Sites A–D exhibited cooler temperatures with an average of 15.30°C, EC at 87.75 μS/cm, and TDS at 43.75 ppm, indicating relatively low dissolved ion content. Salinity remained at 0.00%, and Specific Gravity was stable at 1.00. The pH averaged 7.60, suggesting neutral to slightly alkaline conditions. ORP values averaged 132.00 mV, indicating moderate oxidation-reduction activity. Observations revealed moderately muddy banks and minimal surface activity early on, with some movement noted later. Wildlife sightings were limited, with no blue heron present. The pond appeared clean, with no major disturbances, and a slight northwest-to-northeast breeze contributed to the tranquil environment.

Running Water (Potomac River) - Sites E–H showed elevated EC, averaging 354.50 μS/cm, and TDS at 177.00 ppm, reflecting higher ionic concentrations typical of the river. Salinity was minimal at 0.01%, and Specific Gravity remained consistent at 1.00. The pH averaged 8.10, trending toward alkalinity, while ORP averaged 134.50 mV, showing moderate oxidation-reduction levels. Temperatures averaged 13.95°C, cooler than previous visits. Observations noted calm conditions with no algal blooms or mosquitoes. The water appeared brackish and had a lower tide, with no bird sightings. Seasonal changes were evident, as the sunny yet cold weather contributed to a relatively inactive river scene.

Stagnant Pond (Claude Moore Pond) - Sites I–L showed variable EC, averaging 121.50 μS/cm, and TDS at 60.50 ppm, indicating moderate ionic levels. Salinity was negligible, and Specific Gravity remained at 1.00. The pH averaged 8.14, reflecting alkaline conditions, and ORP was 117.25 mV, indicating moderate oxidation-reduction activity. Temperatures were warmer, averaging 16.88°C. Due to dry weather, observations revealed low water levels, shallow edges, and minimal muddiness. Ducks were abundant and active on the pond, contributing to surface movement. There were no signs of an algal bloom, and sunny weather provided clear visibility, making for a typical day without significant anomalies.

Date: 10/16	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	103.00	51.00	0.00	51.00	1.00	8.12	129.00	14.60
Site B	82.00	41.00	0.00	41.00	1.00	7.13	119.00	16.30
Site C	84.00	42.00	0.00	42.00	1.00	7.29	144.00	15.20
Site D	82.00	41.00	0.00	41.00	1.00	7.87	136.00	15.10
Average	**87.75**	**43.75**	**0.00**	**43.75**	**1.00**	**7.60**	**132.00**	**15.30**
Running Water (Potomac River)								
Site E	351.00	175.00	0.01	175.00	1.00	8.14	139.00	15.10
Site F	358.00	179.00	0.01	179.00	1.00	7.95	131.00	13.60
Site G	354.00	177.00	0.01	177.00	1.00	8.11	135.00	13.60
Site H	355.00	177.00	0.01	177.00	1.00	8.18	133.00	13.50
Average	**354.50**	**177.00**	**0.01**	**177.00**	**1.00**	**8.10**	**134.50**	**13.95**
Stagnant Pond (Claude Moore Pond)								
Site I	148.00	74.00	0.00	74.00	1.00	7.26	116.00	18.90
Site J	112.00	56.00	0.00	56.00	1.00	8.45	107.00	16.20
Site K	113.00	56.00	0.00	56.00	1.00	8.37	121.00	16.30
Site L	113.00	56.00	0.00	56.00	1.00	8.48	125.00	16.10
Average	**121.50**	**60.50**	**0.00**	**60.50**	**1.00**	**8.14**	**117.25**	**16.88**

Table 5. See Table 5A in Appendix A for enlarged table

Table 6

Table 6, shown below, also reflected no significant deviations from previous data, with measurements returning to normal. The averages from Table 6 aligned with those observed in earlier studies, and no unusual observations were recorded.The data in Table 6 is presented below.

Living Water (Countryside) - Sites A–D showed moderate ionic concentrations with an average EC of 99.75 μS/cm and TDS of 49.50 ppm. Salinity was consistent at 0.00%, and Specific Gravity remained stable at 1.00. The pH averaged 6.97, indicating slightly acidic conditions, while ORP was 154.00 mV, suggesting moderate oxidation-reduction activity. Temperatures were warmer, averaging 22.25°C. Observations noted minimal surface activity, no visible wildlife, and a cleaner appearance than usual, with no algal bloom or mosquito larvae. The water remained brackish and slightly murky, with some pollution on shaded pond edges, but the overall atmosphere was peaceful and undisturbed.

Running Water (Potomac River) - Sites E–H exhibited elevated EC at 292.25 μS/cm and TDS at 145.75 ppm, consistent with riverine conditions. Salinity was low at 0.01%, and Specific Gravity held at 1.00. The pH averaged 7.57, indicating slightly alkaline conditions, while ORP was 189.50 mV, reflecting moderate oxidative activity. Temperatures averaged 22.30°C, slightly higher than previous observations. The river showed murky, brackish water with sediment and a moderate five mph current. Low tide and warm weather contributed to a quiet, misty ambiance, with no signs of algal blooms or mosquito larvae, maintaining consistent conditions with prior visits.

Stagnant Pond (Claude Moore Pond) - Sites I–L showed higher EC and TDS levels than the countryside, averaging 132.50 µS/cm and 66.00 ppm, respectively. Salinity was negligible at 0.00%, and Specific Gravity remained at 1.00. The pH averaged 6.75, reflecting slightly acidic conditions, while ORP averaged 169.00 mV, indicating moderate oxidation-reduction activity. The pond temperature averaged 22.75°C. Observations revealed murky, yellowish water with sediment and signs of an algal bloom associated with elevated pH levels. Ducks were abundant; sunny weather with a gentle breeze added to the tranquil atmosphere. The water level was low, requiring care near the shore, but the day was beautiful overall.

Date: 10/20	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	116.00	58.00	0.00	58.00	1.00	7.12	187.00	22.20
Site B	99.00	49.00	0.00	49.00	1.00	7.00	165.00	21.90
Site C	95.00	47.00	0.00	47.00	1.00	6.88	131.00	22.60
Site D	89.00	44.00	0.00	44.00	1.00	6.86	133.00	22.30
Average	**99.75**	**49.50**	**0.00**	**49.50**	**1.00**	**6.97**	**154.00**	**22.25**
Running Water (Potomac River)								
Site E	295.00	147.00	0.01	147.00	1.00	7.48	159.00	23.00
Site F	294.00	147.00	0.01	147.00	1.00	7.58	202.00	22.30
Site G	287.00	143.00	0.01	143.00	1.00	7.63	195.00	22.50
Site H	293.00	146.00	0.01	146.00	1.00	7.60	202.00	21.40
Average	**292.25**	**145.75**	**0.01**	**145.75**	**1.00**	**7.57**	**189.50**	**22.30**
Stagnant Pond (Claude Moore Pond)								
Site I	159.00	79.00	0.00	79.00	1.00	6.54	138.00	22.80
Site J	124.00	62.00	0.00	62.00	1.00	6.83	166.00	22.60
Site K	123.00	61.00	0.00	61.00	1.00	6.81	183.00	22.70
Site L	124.00	62.00	0.00	62.00	1.00	6.83	189.00	22.90
Average	**132.50**	**66.00**	**0.00**	**66.00**	**1.00**	**6.75**	**169.00**	**22.75**

Table 6. See Table 6A in Appendix A for enlarged table

Results

The data collected from this study can only be fully understood if it is compared to established water quality standards and a clear definition of each parameter's purpose. The fluctuations in the data can be attributed to limitations in the water quality tester, which, though inexpensive and user-friendly, needed to be more accurate than professional testing equipment. mThe analysis of water quality in Countryside Pond (stagnant), Potomac River (running), and Claude Moore Pond (living) was based on several key parameters: pH, salinity, Total Dissolved Solids (TDS), temperature, Oxidation-Reduction Potential (ORP), electrical conductivity (EC), and specific gravity. Despite limitations in the testing equipment, which could not provide the same accuracy as professional tools, the data collected offered valuable insights into the health of these water bodies, comparing them to established water quality standards.

Across all three water bodies, the study highlighted the challenges of using multi-parameter water quality testers. Calibration issues and limitations in equipment accuracy were significant factors that impacted data reliability, particularly for parameters such as electrical conductivity and specific gravity. These limitations were particularly evident in the Potomac River and Countryside Pond, where fluctuations in EC and TDS readings could not be fully explained by natural factors alone. Despite these challenges, the study provided valuable insights into the dynamic nature of local aquatic ecosystems and underscored the importance of refining methodologies and tools for more accurate water quality assessments.

Countryside Pond (Stagnant Water)

In Countryside Pond, the pH fluctuated between 7 and 8, which is within the acceptable range for aquatic life, though higher pH values were observed in some areas, reaching up to 10. This increase is likely attributed to natural factors such as temperature shifts and increased algal blooms. Algae absorb CO2 during photosynthesis, reducing carbonic acid levels and raising pH. The salinity remained consistently low, indicating no issues with salt concentrations. TDS was also low, likely due to the shallow sampling locations, as deeper areas typically show higher concentrations. Temperature readings taken at the shore may have yet to accurately reflect conditions in the deeper parts of the pond, leading to potential inaccuracies. The ORP and EC measurements could have been more reliable due to calibration issues, preventing meaningful oxygen levels and ion concentrations analysis. Specific gravity, which could have provided more information on dissolved ions and impurities, also yielded inaccurate results due to equipment errors.

Potomac River (Running Water)

In the Potomac River, the pH ranged from 7 to 8, consistent with typical values for freshwater systems, although slight fluctuations in pH occurred, especially following weather events. Salinity levels were notably impacted by Hurricane Helene's flooding, which caused a decrease from 145 ppm to 98 ppm due to the dilution effect of rainwater. TDS levels in the river were relatively low, likely because the sampling occurred in shallow areas near the shore, where TDS concentrations are generally lower. Higher TDS values would be expected in deeper areas of the river, where convection and nutrient cycling are more prominent. Temperature readings taken at the shore may not have reflected the conditions in the deeper sections of the river, which could have affected the interpretation of how temperature influenced other parameters. As with Countryside Pond, the ORP and EC measurements were unreliable due to uncalibrated equipment, preventing a clear understanding of oxygen levels and ion concentrations. Specific gravity readings were similarly compromised by calibration errors, limiting the ability to assess the water's density and dissolved ion concentrations.

Claude Moore Pond (Living Water)

Claude Moore Pond exhibited pH levels between 7 and 8, within the normal range for healthy freshwater systems. The slight variations in pH could be attributed to natural processes such as photosynthesis by aquatic plants and algae. The salinity remained low throughout the study, consistent with typical conditions in freshwater ecosystems. TDS levels were low, likely due to the shallow sampling areas, though deeper sections would likely show higher TDS concentrations. Temperature readings taken from the shore may not have accurately represented the entire pond's temperature, especially in deeper areas. As in the other water bodies, the ORP and EC measurements were unreliable due to uncalibrated equipment, which hindered the ability to assess oxygen availability and ion concentrations. Specific gravity readings were also inaccurate due to calibration issues. Despite these limitations, the overall water quality in Claude Moore Pond appeared stable, with conditions conducive to supporting aquatic life.

Overview

The water quality study conducted across Countryside Pond, Potomac River, and Claude Moore Pond revealed distinct trends and insights into the ecological health of these water bodies. A key observation was Countryside Pond's relatively stable water quality, which displayed consistent pH and ORP levels, suggesting minimal external influence and a steady, sheltered environment. The pond's higher pH values indicated potential alkalinity, characteristic of less disturbed water bodies where natural processes dominate. However, the potential impact of nutrient loading from nearby land use or runoff still needs to be fully addressed, suggesting a need for further investigation into any localized sources of pollution. Despite limitations in the testing equipment, which could provide a different accuracy than professional tools, the data offered a comparative understanding of the health of these water bodies and established water quality standards.

Discussion

Several factors contributed to the limitations and inaccuracies of this study, and several improvements could be implemented to ensure more robust and accurate results in future research. The primary limitation lies in the data collection methodology, which was based on assumptions that needed to fully account for the complexity and variability of the studied water bodies. Specifically, water samples were collected from only four locations along the shorelines of the water bodies. This approach needs to adequately represent the overall health of the water body, as water quality parameters can vary significantly across different sections of the water body and at varying depths. Shoreline sampling alone is insufficient for capturing the full spectrum of environmental conditions, particularly in dynamic systems like rivers, where diverse ecological zones and biomes may exist. To improve the broadness of future studies, water quality measurements should be taken from multiple points across the water body, considering variations in depth and spatial location.

Moreover, this study focused on only seven key parameters—pH, salinity, total dissolved solids (TDS), temperature, oxidation-reduction potential (ORP), electrical conductivity (EC), and specific gravity. While these parameters are fundamental for understanding essential water quality, they do not encompass the full range of factors influencing aquatic health. Key indicators such as nitrates, phosphates, Gross Primary Production (GPP), Net Primary Productivity (NPP), and turbidity were not measured but are critical for assessing nutrient loading, ecosystem productivity, and water clarity. These additional parameters would provide essential data on the nutrient status of the water and potential stressors such as eutrophication or pollution (Isiuku and Enyoh, 2020). Incorporating these factors into future studies would offer a more comprehensive understanding of freshwater systems' ecological conditions and health.

The sampling process itself also introduced potential inaccuracies. When the water quality tester was submerged, it disturbed the sediment—mud and gravel—at the bottom of the water bodies, which likely resulted in contamination of the samples. This disturbance could have affected the integrity of measurements for most parameters, except temperature, which is less influenced by sediment resuspension. This methodological flaw highlights the need for more controlled sampling procedures. Future studies should consider collecting samples from various depths and locations within the water body to reduce the impact of sediment disturbance and improve the accuracy of measurements. Furthermore, sampling should ideally account for vertical and horizontal variations in water quality, especially in larger bodies of water like rivers, where different ecological zones can significantly differ in water quality.

Another significant limitation of this study was using the 7-in-1 water quality tester, which, though cost-effective and user-friendly, was not ideally suited for use in natural, uncontrolled aquatic environments. The tool was primarily designed for controlled environments, such as small ponds or pools, and its limitations were evident in this study. The precision and reliability of the tool were insufficient to capture the complexity of the aquatic systems studied, particularly in fluctuating conditions. Inaccuracies were especially problematic for sensitive parameters like ORP and EC, where precise measurements are essential for understanding oxygen availability and ion concentrations. Additionally, the lack of calibration for the tool further compromised the accuracy of the data. Minor errors in calibration can lead to significant discrepancies, especially in critical measurements like temperature, which influences a wide range of chemical and biological processes in aquatic ecosystems. Future studies should employ professional-grade instruments with better accuracy, calibration protocols, and reliability in fluctuating natural environments to improve data quality.

In light of these limitations, several recommendations for improvement are proposed. First, future studies should collect data from multiple locations across the entire body of water, ensuring that spatial and vertical variations are accounted for. This would provide a more comprehensive representation of the water body and improve the reliability of the results. Second, expanding the range of measured parameters to include additional indicators such as nitrates, phosphates, GPP, NPP, and turbidity would provide a more holistic understanding of the aquatic environment. These measurements would allow for better assessments of nutrient cycling, productivity, and potential pollution sources, thus facilitating a more accurate evaluation of the overall ecological health.

Additionally, future studies would benefit from using more precise and professional-grade tools and rigorous calibration procedures to minimize measurement errors. Using higher-quality instruments would enhance the accuracy and reliability of data, leading to more robust conclusions. Furthermore, carefully handling equipment and samples to minimize contamination and sediment disturbance should be a priority. A more refined methodology incorporating these improvements would yield more actionable results and better inform the management and conservation of freshwater systems.

Given this study's limitations, addressing these issues in future research would significantly enhance our understanding of freshwater ecosystems and improve the accuracy of water quality assessments. By refining the sampling strategy, broadening the range of measured parameters, and utilizing more accurate tools, future studies can provide a more comprehensive and reliable picture of water quality, ultimately contributing to more effective environmental management practices and conservation efforts.

Conclusion

This study served as a preliminary exploration into water quality assessment. However, more research is needed to provide a comprehensive understanding of the health of local water bodies. While the guiding questions and overall framework of the study were valuable, the execution could have been improved by several methodological flaws and limitations in tool accuracy. Due to our methods and equipment constraints, no definitive conclusions can be drawn regarding the health of the water bodies studied. The study showed initial promise, but upon further analysis, it became apparent that many key factors needed to be addressed, particularly the nuances of interpreting water quality parameters in natural aquatic environments.

One of the main limitations was the decision to measure water quality only along the banks of the bodies of water. This approach could have captured the variability in water quality across different areas and depths, which is critical for a comprehensive assessment. Reliable water quality research typically involves repeated, multi-location measurements across the entire water body to account for spatial and vertical differences in water chemistry. Using a low-cost, multi-parameter water quality tester designed primarily for controlled environments further compromised the reliability and accuracy of our results. Measuring water quality in dynamic, natural systems such as ponds and rivers requires tools capable of accurately capturing the complexity of these environments, and our equipment was not suitable for this purpose.

Despite these limitations, had the data been accurate, the results suggested that all bodies of water displayed overall good health, indicating that the environmental conditions in Northern Virginia's water bodies may generally support aquatic life. However, these findings cannot be definitively confirmed due to the inherent methodological and equipment-related issues.

Ultimately, this study provided a valuable introduction to the complexities of environmental research and highlighted the need for more rigorous and refined approaches to water quality assessment. Future research should focus on expanding the range of parameters measured, improving sampling strategies, and using more accurate, professional-grade tools. By addressing these gaps, future studies will be better positioned to assess the health of local water bodies in Northern Virginia and provide actionable data for conservation and management efforts.

Appendix A

Table 1A. Data collected on 9/29 between 12:00 PM and 4:00 PM EST. Observational notes have been excluded and replaced with analysis in the Data Analysis section.

Date: 9/29	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	116.00	58.00	0.00	58.00	1.00	7.12	187.00	22.20
Site B	99.00	49.00	0.00	49.00	1.00	7.00	165.00	21.90
Site C	95.00	47.00	0.00	47.00	1.00	6.88	131.00	22.60
Site D	89.00	44.00	0.00	44.00	1.00	6.86	133.00	22.30
Average	**99.75**	**49.50**	**0.00**	**49.50**	**1.00**	**6.97**	**154.00**	**22.25**
Running Water (Potomac River)								
Site E	295.00	147.00	0.01	147.00	1.00	7.48	159.00	23.00
Site F	294.00	147.00	0.01	147.00	1.00	7.58	202.00	22.30
Site G	287.00	143.00	0.01	143.00	1.00	7.63	195.00	22.50
Site H	293.00	146.00	0.01	146.00	1.00	7.60	202.00	21.40
Average	**292.25**	**145.75**	**0.01**	**145.75**	**1.00**	**7.57**	**189.50**	**22.30**
Stagnant Pond (Claude Moore Pond)								
Site I	159.00	79.00	0.00	79.00	1.00	6.54	138.00	22.80
Site J	124.00	62.00	0.00	62.00	1.00	6.83	166.00	22.60
Site K	123.00	61.00	0.00	61.00	1.00	6.81	183.00	22.70
Site L	124.00	62.00	0.00	62.00	1.00	6.83	189.00	22.90
Average	**132.50**	**66.00**	**0.00**	**66.00**	**1.00**	**6.75**	**169.00**	**22.75**

Table 2A. Data collected on 10/3 between 12:00 PM and 4:00 PM EST. Observational notes have been excluded and replaced with analysis in the Data Analysis section.

Date: 10/3	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	120.00	60.00	0.00	60.00	1.00	6.67	27.00	21.50
Site B	101.00	50.00	0.00	50.00	1.00	6.88	117.00	23.70
Site C	103.00	51.00	0.00	51.00	1.00	6.79	48.00	22.70
Site D	14.00	7.00	0.00	7.00	1.00	6.83	99.00	22.70
Average	**84.50**	**42.00**	**0.00**	**42.00**	**1.00**	**6.79**	**72.75**	**22.65**
Running Water (Potomac River)								
Site E	186.00	93.00	0.00	93.00	1.00	7.72	151.00	21.20
Site F	187.00	93.00	0.00	93.00	1.00	7.45	174.00	21.70
Site G	182.00	91.00	0.00	91.00	1.00	7.74	189.00	20.80
Site H	230.00	115.00	0.01	115.00	1.00	7.70	191.00	21.60
Average	**196.25**	**98.00**	**0.00**	**98.00**	**1.00**	**7.65**	**176.25**	**21.33**
Stagnant Pond (Claude Moore Pond)								
Site I	210.00	105.00	0.01	105.00	1.00	8.28	121.00	26.30
Site J	124.00	62.00	0.00	62.00	1.00	8.64	133.00	25.50
Site K	165.00	82.00	0.00	82.00	1.00	9.30	119.00	24.40
Site L	120.00	60.00	0.00	60.00	1.00	9.37	115.00	25.50
Average	**154.75**	**77.25**	**0.00**	**77.25**	**1.00**	**8.90**	**122.00**	**25.43**

Table 3A. Data collected on 10/7 between 12:00 PM and 4:00 PM EST. Observational notes have been excluded and replaced with analysis in the Data Analysis section.

Date: 10/7	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	98.00	49.00	0.00	49.00	1.00	6.82	212.00	22.70
Site B	98.00	49.00	0.00	49.00	1.00	7.20	177.00	21.80
Site C	100.00	50.00	0.00	50.00	1.00	7.05	232.00	21.90
Site D	99.00	49.00	0.00	49.00	1.00	7.00	215.00	22.00
Average	**98.75**	**49.25**	**0.00**	**49.25**	**1.00**	**7.02**	**209.00**	**22.10**
Running Water (Potomac River)								
Site E	239.00	119.00	0.01	119.00	1.00	7.32	171.00	23.00
Site F	245.00	122.00	0.01	122.00	1.00	7.21	183.00	21.70
Site G	229.00	114.00	0.01	114.00	1.00	7.65	151.00	19.70
Site H	244.00	122.00	0.01	122.00	1.00	7.43	156.00	19.70
Average	**239.25**	**119.25**	**0.01**	**119.25**	**1.00**	**7.40**	**165.25**	**21.03**
Stagnant Pond (Claude Moore Pond)								
Site I	51.00	25.00	0.00	25.00	1.00	9.59	69.00	26.80
Site J	117.00	58.00	0.00	58.00	1.00	9.55	94.00	25.50
Site K	115.00	57.00	0.00	57.00	1.00	8.83	133.00	24.00
Site L	124.00	62.00	0.00	62.00	1.00	9.73	101.00	24.60
Average	**101.75**	**50.50**	**0.00**	**50.50**	**1.00**	**9.43**	**99.25**	**25.23**

Table 4A. Data collected on 10/11 between 12:00 PM and 4:00 PM EST. Observational notes have been excluded and replaced with analysis in the Data Analysis section.

Date: 10/11	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	102.00	51.00	0.00	51.00	1.00	7.32	157.00	18.30
Site B	97.00	48.00	0.00	48.00	1.00	7.25	168.00	19.40
Site C	99.00	49.00	0.00	49.00	1.00	7.10	186.00	19.80
Site D	95.00	47.00	0.00	47.00	1.00	7.30	193.00	19.00
Average	**98.25**	**48.75**	**0.00**	**48.75**	**1.00**	**7.24**	**176.00**	**19.13**
Running Water (Potomac River)								
Site E	307.00	153.00	0.01	153.00	1.00	7.26	12.00	17.30
Site F	308.00	154.00	0.01	154.00	1.00	7.88	51.00	17.00
Site G	304.00	152.00	0.01	152.00	1.00	7.98	80.00	16.90
Site H	305.00	152.00	0.01	152.00	1.00	7.99	135.00	17.10
Average	**306.00**	**152.75**	**0.01**	**152.75**	**1.00**	**7.78**	**69.50**	**17.08**
Stagnant Pond (Claude Moore Pond)								
Site I	128.00	64.00	0.00	64.00	1.00	7.55	99.00	20.80
Site J	112.00	56.00	0.00	56.00	1.00	7.27	127.00	19.70
Site K	123.00	61.00	0.00	61.00	1.00	9.11	109.00	20.20
Site L	116.00	58.00	0.00	58.00	1.00	8.90	112.00	20.60
Average	**119.75**	**59.75**	**0.00**	**59.75**	**1.00**	**8.21**	**111.75**	**20.33**

Table 5A. Data collected on 10/16 between 12:00 PM and 4:00 PM EST. Observational notes have been excluded and replaced with analysis in the Data Analysis section.

Date: 10/16	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	103.00	51.00	0.00	51.00	1.00	8.12	129.00	14.60
Site B	82.00	41.00	0.00	41.00	1.00	7.13	119.00	16.30
Site C	84.00	42.00	0.00	42.00	1.00	7.29	144.00	15.20
Site D	82.00	41.00	0.00	41.00	1.00	7.87	136.00	15.10
Average	**87.75**	**43.75**	**0.00**	**43.75**	**1.00**	**7.60**	**132.00**	**15.30**
Running Water (Potomac River)								
Site E	351.00	175.00	0.01	175.00	1.00	8.14	139.00	15.10
Site F	358.00	179.00	0.01	179.00	1.00	7.95	131.00	13.60
Site G	354.00	177.00	0.01	177.00	1.00	8.11	135.00	13.60
Site H	355.00	177.00	0.01	177.00	1.00	8.18	133.00	13.50
Average	**354.50**	**177.00**	**0.01**	**177.00**	**1.00**	**8.10**	**134.50**	**13.95**
Stagnant Pond (Claude Moore Pond)								
Site I	148.00	74.00	0.00	74.00	1.00	7.26	116.00	18.90
Site J	112.00	56.00	0.00	56.00	1.00	8.45	107.00	16.20
Site K	113.00	56.00	0.00	56.00	1.00	8.37	121.00	16.30
Site L	113.00	56.00	0.00	56.00	1.00	8.48	125.00	16.10
Average	**121.50**	**60.50**	**0.00**	**60.50**	**1.00**	**8.14**	**117.25**	**16.88**

Table 6A. Data collected on 10/20 between 12:00 PM and 4:00 PM EST. Observational notes have been excluded and replaced with analysis in the Data Analysis section.

Date: 10/20	EC uS/cm	TDS (ppm)	Salinity (%)	Salt (ppm)	S.G	pH	ORP (mV)	Temperature (C)
Living Water (Country Side)								
Site A	116.00	58.00	0.00	58.00	1.00	7.12	187.00	22.20
Site B	99.00	49.00	0.00	49.00	1.00	7.00	165.00	21.90
Site C	95.00	47.00	0.00	47.00	1.00	6.88	131.00	22.60
Site D	89.00	44.00	0.00	44.00	1.00	6.86	133.00	22.30
Average	**99.75**	**49.50**	**0.00**	**49.50**	**1.00**	**6.97**	**154.00**	**22.25**
Running Water (Potomac River)								
Site E	295.00	147.00	0.01	147.00	1.00	7.48	159.00	23.00
Site F	294.00	147.00	0.01	147.00	1.00	7.58	202.00	22.30
Site G	287.00	143.00	0.01	143.00	1.00	7.63	195.00	22.50
Site H	293.00	146.00	0.01	146.00	1.00	7.60	202.00	21.40
Average	**292.25**	**145.75**	**0.01**	**145.75**	**1.00**	**7.57**	**189.50**	**22.30**
Stagnant Pond (Claude Moore Pond)								
Site I	159.00	79.00	0.00	79.00	1.00	6.54	138.00	22.80
Site J	124.00	62.00	0.00	62.00	1.00	6.83	166.00	22.60
Site K	123.00	61.00	0.00	61.00	1.00	6.81	183.00	22.70
Site L	124.00	62.00	0.00	62.00	1.00	6.83	189.00	22.90
Average	**132.50**	**66.00**	**0.00**	**66.00**	**1.00**	**6.75**	**169.00**	**22.75**

Appendix B

Fig. 1A: Map derived from Google Earth, depicting the Countryside, Sterling, Virginia, USA region (Site A-D) (Google and Airbus, 2020). Imagery captured between 8 August 2016 and 13 October 2024. The scale is 100 meters, highlighting sites A, B, C, and D at Countryside Pond, where data was collected for the Living Water water study.

Fig. 2A: Map derived from Google Earth, depicting the Algonkian Regional Park, Sterling, Virginia, USA region (Site E-G) (Google and Airbus, 2020). Imagery captured between 8 August 2016 and 13 October 2024. The scale is 300 meters, highlighting sites E, F, G, and H at Algonkian Park, where data was collected for the Running Water/River study.

Fig. 3A: Map derived from Google Earth, depicting the Claude Moore Park, Sterling, Virginia, USA region (Site I-L) (Google and Airbus, 2020). Imagery captured between 8 August 2016 and 13 October 2024. The scale is 100 meters, highlighting sites I, J, K, and K at Claude Moore Park, where data was collected for the Stagnant Water study.

Competing interests

No competing interest is declared.

Author contributions statement

C.S. and R.N. conceived the experiment(s) and designed the study. C.S. and R.N performed the experiments, C.S. and R.N. analyzed the data. C.S. wrote the initial draft, and R.N. edited and formatted the manuscript. Both authors contributed to the interpretation of results and reviewed the final manuscript.

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