DC Citizen Science Water Quality Monitoring Report

2022

DEPARTMENT OF ENERGY & ENVIRONMENT

GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

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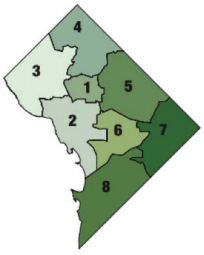
Executive Summary

Year after year, thousands of residents and visitors enjoy the waters that chart their course through the nation's capital, despite the potential hazards that can lurk in urban waterways. In order for recreators to safely enjoy our local waterways, timely and current water quality data needs to be made available to the public at large so that they can make effective and informed decisions about their potential recreation.

Knowing this, in 2018 the Department of Energy and Environment (DOEE) awarded a grant to Anacostia Riverkeeper and their partners to establish a volunteer-based water quality monitoring program that would test primary surface waters in DC weekly throughout the primary recreation season (May to September). The summer of 2022 marked the fourth year of this project, with Alliance for the Chesapeake Bay taking over implementation of the project. Alliance for the Chesapeake Bay led a multi-stakeholder team consisting of Anacostia Riverkeeper, Nature Forward (formerly Audubon Naturalist Society), and Rock Creek Conservancy; who, over the course of the summer, trained 80+ volunteers, collected over 500 bacteria samples, and provided weekly water quality updates to DC recreators. Volunteers were recruited from throughout the capital region with residents from all Wards in DC, Virginia, and Maryland participating in monitoring. Over the summer of 2022 select trends were observed that include:

- The average single-sample passing rate for E. *coli* throughout District waters was 54%. The mean passing rate recorded for the Anacostia was 53%, for the Potomac was 72%, and for Rock Creek was 37%. It's important to note that higher E. *coli* concentrations in tributaries may reduce overall passing rates for their respective watersheds.
- Sites with increased mixing of tidal water, higher daily amounts of discharge and located furthest from combined sewage outfalls towards the south end of DC have some of the highest passing rates and recreation potential.
- Mainstem river sites typically exhibited lower bacteria counts when compared to tributary sites, potentially due to dilution from higher water volumes and bacteria die-off from increased UV exposure at sites in direct sunlight.
- Assessing overall trends in District water quality, the Anacostia River and Potomac River had multiple sites that passed geometric mean standards for E. *coli* most of the summer. Buzzard Point (93%), the Wharf (93%), Thompson Boat House (53%), the Tidal Basin (100%), and Columbia Island (73%) all met the strictest standards for primary recreation over 50% of the time. The highest geometric mean passing rate for Rock Creek sites was Pinehurst Branch, passing geometric mean standards 6% of the summer.
- "Wet" conditions (>0.5 in of rain in 72 hrs) were recorded for just over a third of monitoring days with average passing rates across the District dropping from 57% during "dry'" weather scenarios to 47% during "wet" weather scenarios.

Overview

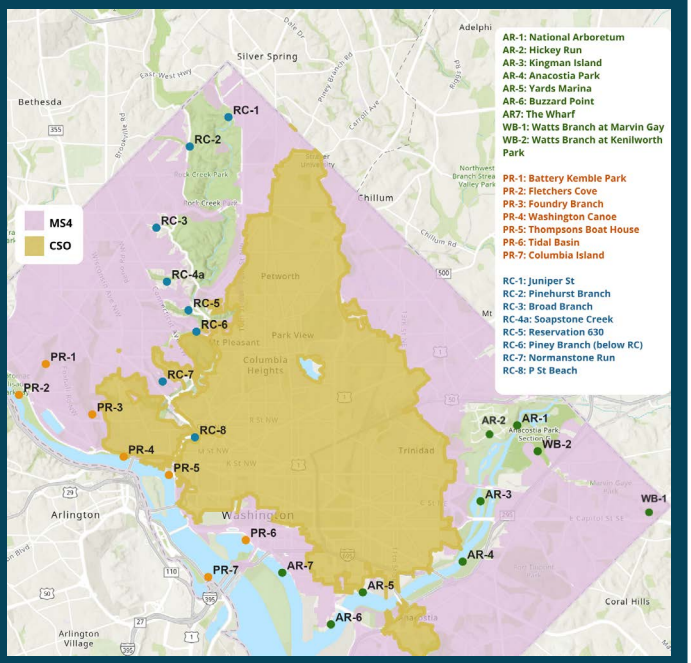


500+
samples collected in 2022

volunteers from all
8
Wards

80
voluteers trained

2022 Volunteer Water Quality Monitoring Sites:



"I started monitoring because I wanted to learn more about my local environment and the water quality issues facing it. I think it's important as community members that we understand where our water goes and how it affects those living downstream. I study urban environmental issues, and the water quality monitoring program gave me a chance to understand such matters firsthand. Plus, it was always fun to take a little walk in the woods every Wednesday morning!"

-Douglas McRae

While a correlation between precipitation and higher E. *coli* concentrations still persist, the signal was more subdued this year when compared to past years.

- High bacteria counts during "dry" weather days (<0.5 in precipitation 72-hours before monitoring) persisted year-to-year and may be indicative of outdated infrastructure, leaking sewer pipes, or uninvestigated point-source pollution.
- On average, sites overwhelmingly passed DC swimming contact standards for turbidity (<20NTU), and pH (between 6.5 and 8) with fluctuations occurring most often after periods of high precipitation.

As in most urban watersheds, rainfall is one of the biggest contributors to high bacteria levels in District surface waters as heavy rains producing more stormwater often serve as vectors for pollution. With increased attention and funding going towards DC's rivers and streams, capital improvement projects are being implemented to reduce the burden that rainfall has on the city's water quality. This project has produced several recommendations to achieve future swimmability as well as increasing equitable recreation along with it:

- Continue the development of capital improvement projects throughout the District that seek to use the best available and sustainable practices, and increase the use of green infrastructure in Combined Sewer Overflow (CSO) and Sanitary Sewer Overflow (SSO) areas.
- Develop and implement more resources for pollution investigations and bacteria source tracking to better uncover sources of E. *coli* contamination in District waters and implement policies to curtail them.
- Produce a comprehensive "Recreation Plan" (see NYC Vision 2020 Plan) for DC surface waters to better understand recreational use and recreator behavior while simultaneously planning locations for potential recreation infrastructure and how to allow for more inclusive and equitable recreation in the future.
- Continue outreach and educational efforts surrounding recreational water quality in the District, specifically focusing on E. *coli* pollution and its sources around the city.

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ALLIANCE for the Chesapeake Bay

ANACOSTIA RIVERKEEPER

ROCK CREEK CONSERVANCY

nature forward

Introduction

Background

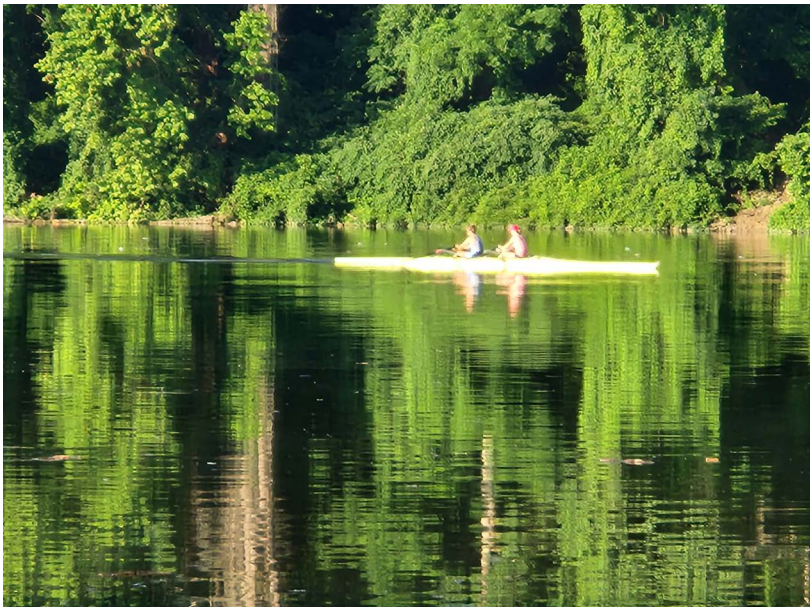
Washington, DC truly is a city influenced by water. From the canals that used to flow past the Capitol, to the waterfront communities like Anacostia and Georgetown, surface water in the District has long been a source of recreation and enjoyment for the city's many residents and visitors. Across its 69 mi^2 land area, 39 miles of surface water run through the District, all eventually vflowing into the Potomac River estuary. These 39 river miles in the District don't just bring enjoyment to the communities they surround, but can also unintentionally serve as vectors for pollution and environmental contaminants to move throughout the city. With a resident population of over 700,000, and millions of tourists converging on DC each year, the health of the city's surface waters are of the utmost concern not just for aquatic organisms, but most importantly for those who wish to recreate on or around these waters as well.

While recreation along DC's surface waters is widely encouraged and increasingly popular, swimming has been illegal in DC waters since the 1970s. This ban is considered a human health protection as waters throughout the District have long suffered from poor and lapsing water quality due to antiquated infrastructure, geography, and the nature of urbanized watersheds. By building a city around the Anacostia River, Potomac River, and Rock Creek, we've increased the amount of impervious surface area throughout the city, creating the need to deal with the increased demands that rain, stormwater, and sewage place on our waterways. With stormwater increasing the potential that sewage or animal waste could end up in our waters, recreational water quality can be highly variable from watershed to watershed and even stream to stream. Thankfully, due to advancement in technologies and capital investments in green and grey infrastructure throughout the city, overall water quality in some District surface waters has begun to exhibit noticeable improvements. In order to track and assess the scope and scale of these improvements, especially with respect to recreational water quality, a strong database of baseline water quality information needed to be built through robust and frequent monitoring of rivers and streams. To accomplish this, the Department of Energy and Environment (DOEE) decided to utilize the power of citizen science to not only collect weekly recreational water quality data from primary waterways, but to also strengthen the bond between District residents and their local streams.

Program Overview

This project was awarded to Alliance for the Chesapeake in 2021 through funding from the Department of Energy and Environment (DOEE) via Grant #RFA 2021-2116-WQD-VWQM-02. A total of 24 monitoring locations were selected across all DC surface waters in the District's three primary watersheds, the Anacostia River, Potomac River, and Rock Creek. Watershed partners were selected based on their in-depth understanding of their select watersheds and ability to choose pertinent monitoring sites, volunteer management expertise, and shared commitment to clean water in DC. Watershed partners who worked on this project include Anacostia Riverkeeper, Nature Forward, and Rock Creek Conservancy.

To ensure Tier II compliance in the District of Columbia, a Quality Assurance Project Plan (QAPP) was developed to ensure consistency in sample collection and methodology, lab procedures, and data management. DOEE reviewed and approved this QAPP, allowing the data to be certified as Tier II data and to be considered in policy and regulation decisions.



as the primary concern. In the District, fecal indicator bacteria (e.g., E. *coli*), turbidity, and pH are the water quality parameters that dictate the recreation; making them the primary parameters of concern when it comes to potential swimmability and permitted recreation. This project also collects water and air temperature due to their impact on biological and physical characteristics of an ecosystem. Water quality parameters monitored for this program include:

Fecal Indicator Bacteria (*E. coli* & fecal coliform)

These bacteria enter our waterways from sewage, runoff, and the waste of warm-blooded animals in the watershed. Our water quality monitoring program analyzes District waters for *E. coli* as it can be used as an indicator of the presence of more dangerous bacteria that can cause illness in humans and pets.

Turbidity

Turbidity is a measure of water clarity, or how much light can pass through it. Turbidity levels can vary in waterways depending on where you are geographically as well as seasonally in certain waters. It can also serve as a vector for bacteria and other contaminants, increasing its importance to recreational water quality.

Acidity or Alkalinity (pH)

pH is the measure of how acidic or alkaline a waterbody is. pH for this project is measured with pH litmus paper on a scale of 0 to 14, with anything 0 to 7 considered an acid and anything 7 to 14 considered alkaline.

Water Temperature

Water temperature has daily and seasonal cycles and affects both biological and physical characteristics of an ecosystem. Water temperature is measured at the water surface at each site with a digital thermometer.

Air Temperature

Air temperature has daily and seasonal cycles and affects both biological and physical characteristics of an ecosystem. Air temperature is measured over the water at each monitoring location with an digitial field thermometer.

Volunteer Recruitment and Training

All data in this program is collected by volunteers, making them the cornerstone of this community science project. Volunteers are continually recruited by watershed partners from all Wards in the District of Columbia, as well as in Maryland and Virginia. In 2022 approximately 80 volunteers were trained and countless others have been reached through the sharing of project data and targeted outreach programs.

The training regimen for this program was developed by Anacostia Riverkeeper with assistance from Alliance for the Chesapeake Bay and other watershed partners. Additionally, Anacostia Riverkeeper and Alliance for the Chesapeake Bay developed the DC Volunteer Water Quality Monitoring Training Manual which is provided to all volunteers as an in-field reference for sampling and project information.

2022 Water Quality Monitoring Program by the Numbers

~80
volunteers

500+
bacteria samples

3
trainings
+
1
recorded training

20
weeks monitored

2,500
data points

21.5 mi.
of water monitored

Methodology

Field Methods

Water quality samples are collected on the Wednesday of each week from every site for 20 weeks during the monitoring season. At each site, water quality samples are collected according to methods established in the project QAPP for fecal indicator bacteria (E. *coli* and fecal coliform), pH, turbidity, air temperature, and water temperature. Additionally, information about the site (i.e., flow conditions, weather, tide) is recorded on a designated field sheet. To develop a clearer picture of on-water recreation in DC waters, a Recreational Use Survey (RUS) was developed for volunteers to complete while at a monitoring site. While monitoring, volunteers make observations on the type of recreation activity witnessed and the number of participants engaged in that activity. Activities included on the survey are recreational activities of interest like boating, swimming, fishing, etc.
All sampling methods are established in the project QAPP, laid out in the DC Volunteer Water Quality Monitoring Training Manual, and based on well-used US Environmental Protection Agency (USEPA) water quality sampling methods for tidal and non-tidal waters.

Bacteria and turbidity are the only physical water samples taken. **Bacteria** samples are collected using a sterilized and sealed 100mL IDEXX sample bottle with sodium thiosulfate preservative inside and stored on ice to be analyzed within 6-hours. **Turbidity** samples are collected in standard 100mL polyurethane sample bottles and analyzed in Anacostia Riverkeeper's water quality lab along with bacteria. Due to equipment calibration issues, turbidity samples

What are the legal water quality standards for DC?

The District has water quality standards that are upheld to meet Clean Water Act requirements and to restore and protect the District waters. They are regularly reevaluated and updated with the latest scientific findings. The most recent iteration of DC's water quality standards states these healthy standards for Class A waters:

Bacteria *(E. coli)*	**pH**	**Turbidity**
Single-sample value: <410 MPN/100 mL Geometric mean: <126 MPN/100 mL	6.5 - 8	<20 NTU above ambient

What does geometric mean and single-sample bacteria values mean?

Bacteria standards have two cutoff values considered safe for **"primary contact"** recreation.

Single-Sample Standard: At or below **410** MPN/100 mL. Direct measurement of what is in the water at that place and time, it is very dependent on short term changes in precipitation, temperature, etc.

EXAMPLE

Week 1→AR-4 is 260 MPN/100 mL *Pass*
Week 2→AR-4 is 566 MPN/100 mL *Fail*

Geometric mean standard: At or below **126** MPN/100 mL. An average of 5 samples over 30 days (one sample a week) that is not heavily swayed by very high or very low values. The geometric mean gives a broader picture of water quality beyond a single-sample.

EXAMPLE

Week 1→AR-4 is 260 MPN/100 mL
Week 2→AR-4 is 566 MPN/100 mL
Week 3→AR-4 is 123 MPN/100 mL
Week 4→AR-4 is 875 MPN/100 mL
Week 5→AR-4 is 80 MPN/100mL

263 MPN/100 mL geometric mean *Fail*

were transported from the Riverkeeper lab to a University of the District of Columbia lab for analysis for seven weeks from July 13 to August 24 until Anacostia Riverkeeper's equipment could be replaced. **Alkalinity (pH)** is analyzed using Hydrion 0-14 pH litmus paper with a colorimetric scale. Finally, **air temperature** and **water temperature** are both collected using annually NIST certified digital thermometers.

Sample duplicates are collected from each watershed each week to ensure quality assurance and check volunteer sampling techniques. Field audits were performed twice in each watershed. At this time, a field blank was also collected as an additional way to ensure high quality data is being collected. All physically collected samples are recorded on a Chain-of-Custody (CoC) form to ensure sample fidelity and provide quality assurance for all samples coming into the Anacostia Riverkeeper lab.

Bacteria

A Colilert chemical reagent is mixed with each sample

Samples are sealed in a sampling tray

Then placed in an incubator at 35 °C for 24 hrs

After 24 hrs samples are read under a UV blacklight

Turbidity

Lab Methods

Field samples are delivered by volunteers to the Anacostia Riverkeeper water quality lab each Wednesday, in addition to site field sheets, recreational use surveys, and chain-of-custody forms. Anacostia Riverkeeper analyzes both *E. coli* and turbidity samples in-lab. Both samples are required to be delivered within six hours on ice at approximately 4 °C to ensure sample representativeness. All lab activities are recorded in a designated lab notebook specific to the project for quality control and data assurance.

Bacteria samples are collected and analyzed using the IDEXX Colilert system (Method 9223 Enzyme Substrate Coliform Test 2017) and results are published in "Most Probable Number of Colony Forming Units" or MPN/100mL (comparable to CFUs).

Turbidity samples are assessed using an in-lab LaMotte 2020we/wi turbidimeter, which uses light attenuation passing through the sample compared to lab standards to determine the turbidity of a sample in nephelometric turbidity units (NTUs). Standards 0 NTU, 1 NTU, 10 NTU, and 100 NTU are run before each week's samples to ensure accurate readings.

"Sampling each week was a great way to see how the river is used and the changes that occur each week. Watching the rowing clubs, the birdlife and contributing to the Waterkeepers was a weekly highlight for me this spring and summer. Will be so great to see the continued improvement in water quality over time."

-Liza Murphy

Lab turbidity samples are run concurrently with bacterial samples so both results are available within 24 hours. When the samples were analyzed by the University of District of Columbia lab, an Anacostia Riverkeeper staff member would compile and deliver all the samples at the same time. UDC used a HACH 2100P Portable Turbidimeter for their analysis.

Temperature and pH parameters are measured in the field so do not require lab analysis.

Data Methods

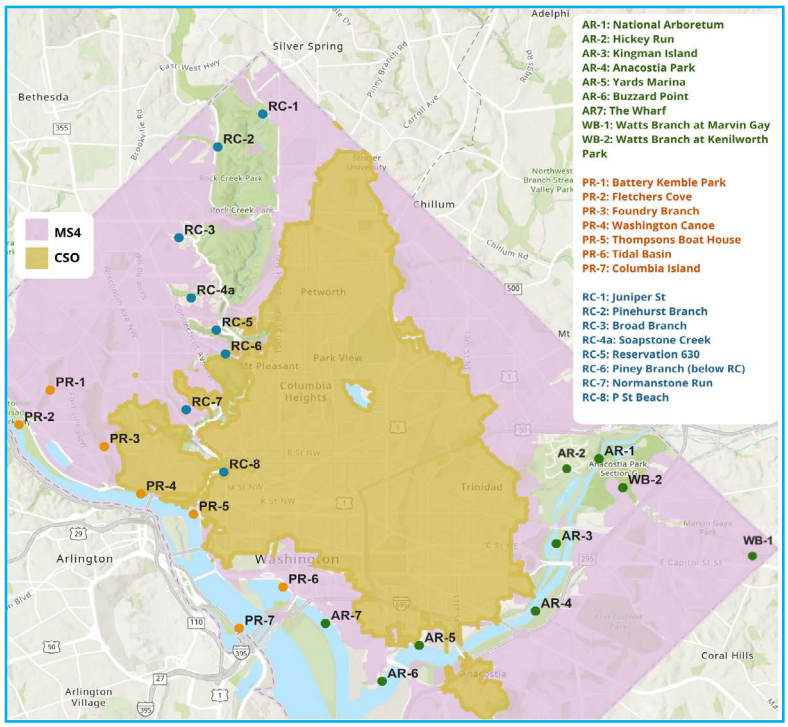
Data is recorded 24 hours after sampling and uploaded to multiple platforms for public access: Water Reporter, SwimGuide, Chesapeake Monitoring Cooperative. Alliance for the Chesapeake Bay also uploads the data to all social media platforms (Twitter, Instagram, and Facebook) which are then shared by the project partners. Additionally, all project data is reported to DOEE each week as a compliment to DOEE's internal water quality efforts.

All charts, graphs, tables, and data analysis were created in or performed in Excel. Data was assessed using standard mean, geometric mean, median, and other pertinent statistical analyses.

Outreach Methods

This year, the project team made a concerted effort to reach community members before and during the monitoring period with two goals: to recruit volunteers to the project who reside in all 8 wards, and to promote education and information about the goals of the project, sources of bacteria to the city's waterways, and the District's and DC Water's efforts to clean it up. Outreach to the publc was conducted through email listservs, social media posts, and communications with the media. Additionaly, the project team conducted outreach by organizing and attending community-focused events such as trash cleanups, community festivals, and community meetings (both virtual and in-person) to present on the project, lead stream and green infrastructure walking tours, distribute flyers, and demonstrate bacteria monitoring protocols.

2022 DC Water Quality Snapshot

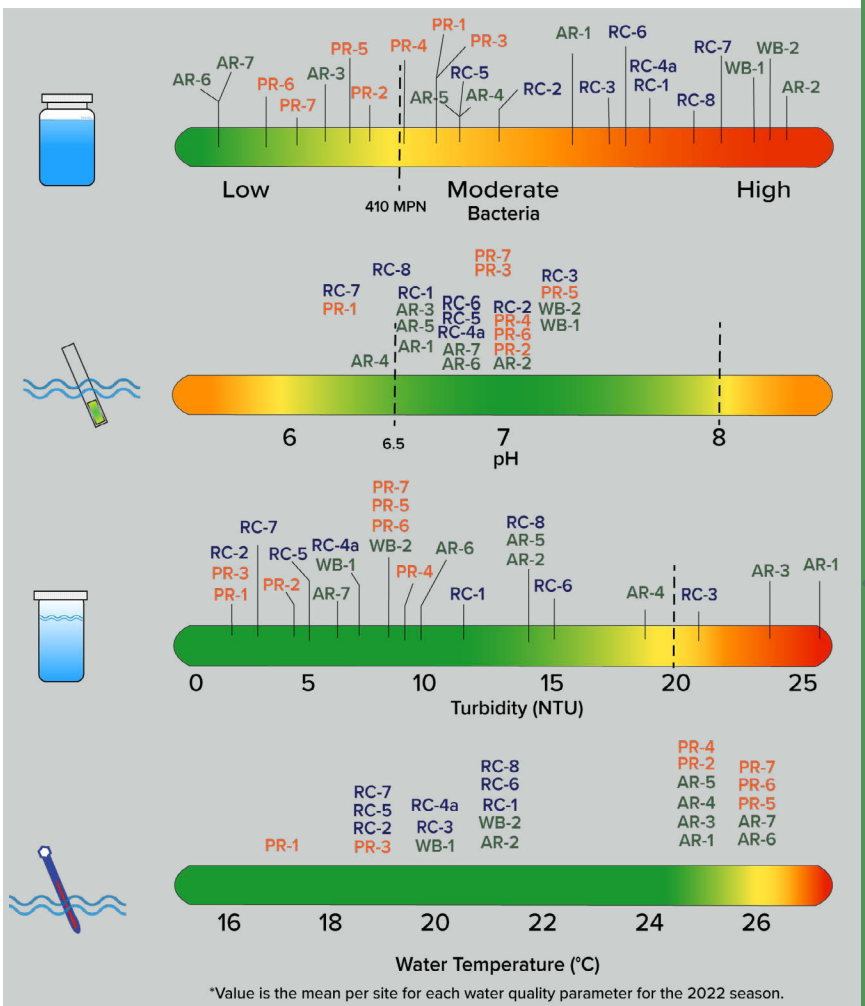


While bacteria levels ranged across the three watersheds and often violated both the standard for single samples and geometric mean, all other measures of water quality including pH (6.5-8) and turbidity (<20NTU above ambient) were mostly within the acceptable range. Additionally, though water temperature does not have a standard for recreation, the typical acceptable range for aquatic life is <32.2 degrees Celcius.

For the Anacostia River, turbidity tended to decrease downstream. The average turbidity for most Anacostia sites was well below the standard. The National Arboretum (AR-1) and Kingman Island (AR-3) were above the standard. The average turbidity at Anacostia Park (AR-4) was elevated but still below the limits in the water quality standard. The turbidity gradient from AR-1 to AR-4 on the mainstem of the Anacostia suggests a potential upstream source. The average pH for the summer at each site met the water quality standards, but from week to week sites violated the standard for low pH 21% of the time. The two Watts Branch sites never violated the standard for pH while all other sites violated from time to time. AR-4 violated the pH standard 11 weeks consistently with recordings just below the standard at 6. Considering broad scale water quality metrics, Buzzard Point (AR-6) and The Wharf (AR-7) had the best overall water quality of all sites on the Anacostia.

The Potomac River sites showed generally good water quality in terms of pH, turbidity and temperature. The Battery Kemble (PR-1) tributary site pH levels trended slightly toward acidic, but well within the normal range. Turbidity levels were very low at all locations, with Battery Kemble (PR-1) and Fletcher's Cove (PR-2) showing the lowest numbers by a sizable margin. Washington Canoe Club (PR-4) turbidity was highest on average amongst the Potomac sites, but still below the acceptable standard. Lastly, water temperature varied widely between the sites, with the two tributary sites (PR-1, PR-3) remaining much cooler overall during the sampling season, and the remaining sites on the mainstem Potomac exhibiting higher average temperatures overall.

Across the other metrics (pH, turbidity, and water temperature), the Rock Creek sites did much better than they did in bacteria concentrations. The average for these metrics at every Rock Creek site fell within the healthy ranges for each category except for average pH for Normanstone Run (RC-7) which was just below the standard and the average turbidity for Broad Branch (RC-3) which was just above the standard. For turbidity, Pinehurst Branch (RC-2) and Normanstone Run (RC-7) had the lowest averages. For temperature, every site fell within a range of 18 - 22 degrees Celsius, likely a function of the extensive tree canopy over relatively narrow water bodies. Bacteria levels at all Rock Creek sites were moderate to high.

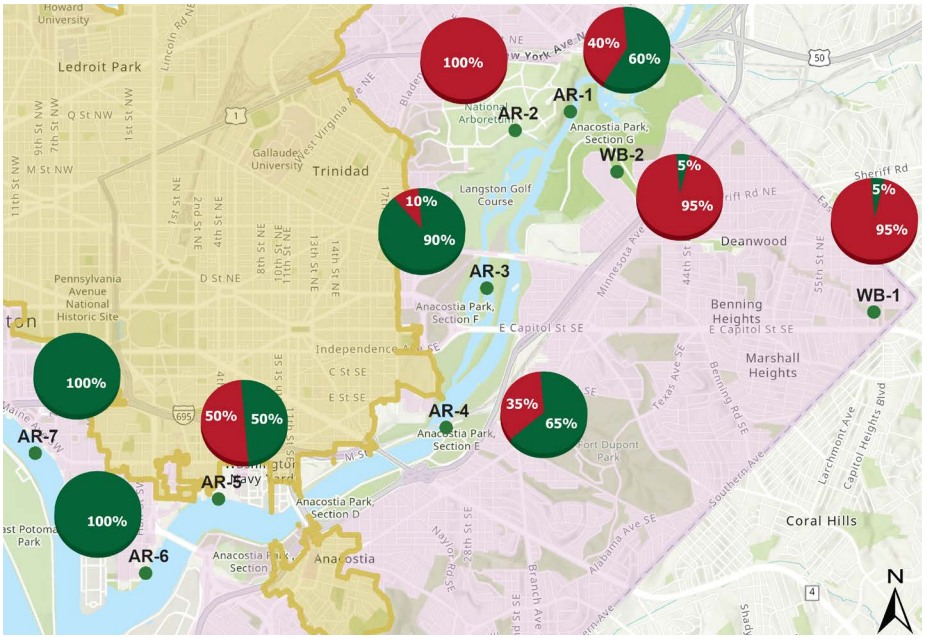


*Value is the mean per site for each water quality parameter for the 2022 season.

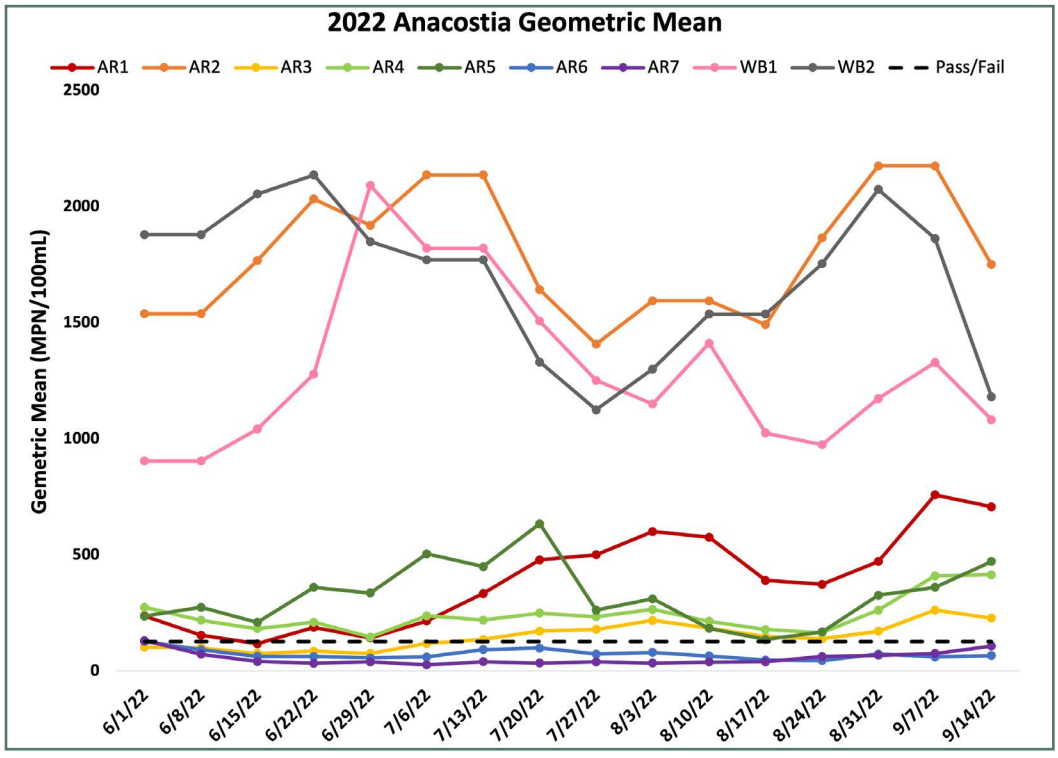
2022 Anacostia River Bacteria Trends

The Anacostia River sites are located on the 8 mile mainstem beginning at the National Arboretum (AR-1) and ending at the Washington Channel (AR-7), with three tributary sites located on Hickey Run (AR-2), Watts Branch at Marvin Gaye Park (WB-1), and Watts Branch at Kenilworth Park (WB-2). For the single sample primary contact standard, Kingman Island (AR-3), Buzzard Point (AR-6), and The Washington Channel (AR-7) passed 90% of the time or more. Given their high passing rates, these sites could be good locations to promote recreation. The tributary sites consistently had higher bacteria levels than mainstem sites. Hickey Run (AR-2), Watts Branch at Marvin Gaye Park (WB-1), and Watts Branch at Kenilworth Park (WB-2) failed 95% of the time or more.

Bacteria (*E. coli*) Passing Percentage in 2022: Single-Sample Value



The geometric mean trends mirrored the single sample value trends with the mainstem sites passing more often than the tributary sites. The Washington Channel (AR-7) and Buzzard Point (AR-6) passed over 90% of the season and had an average geometric mean of 72 MPN and 54 MPN respectively. Kingman Island (AR-3) passed the geometric mean standard nearly 40% of the season and averaged 149 MPN. While the National Arboretum (AR-1) often passed for single-sample (60%), it only passed for geometric mean 6% of the time, because bacteria levels were moderate at this site with an average geometric mean of 389 MPN. Anacostia Park (AR-4) and Yards Marina (AR-5) had mixed single-sample bacteria levels, but never passed for geometric mean which has a stricter standard. Geometric mean at Anacostia Park averaged 241 MPN and Yards Marina averaged 325 MPN. The Anacostia River tributaries, Hickey Run (AR-2), Watts Branch at Marvin Gaye Park (WB-1), and Watts Branch at Kenilworth Park (WB-2), all failed for geometric mean every week by a large margin. As these sites regularly fail both single sample and geometric mean standards, they likely have a systemic bacteria problem. The poor water quality in these sections of the river indicates that a focused communication effort on using caution when recreating in these areas should be implemented, especially since Watts Branch 1 and 2 are both in parks heavily used by the communities around them. There is even annectdotal evidence that people wade into the stream at these locaitons.

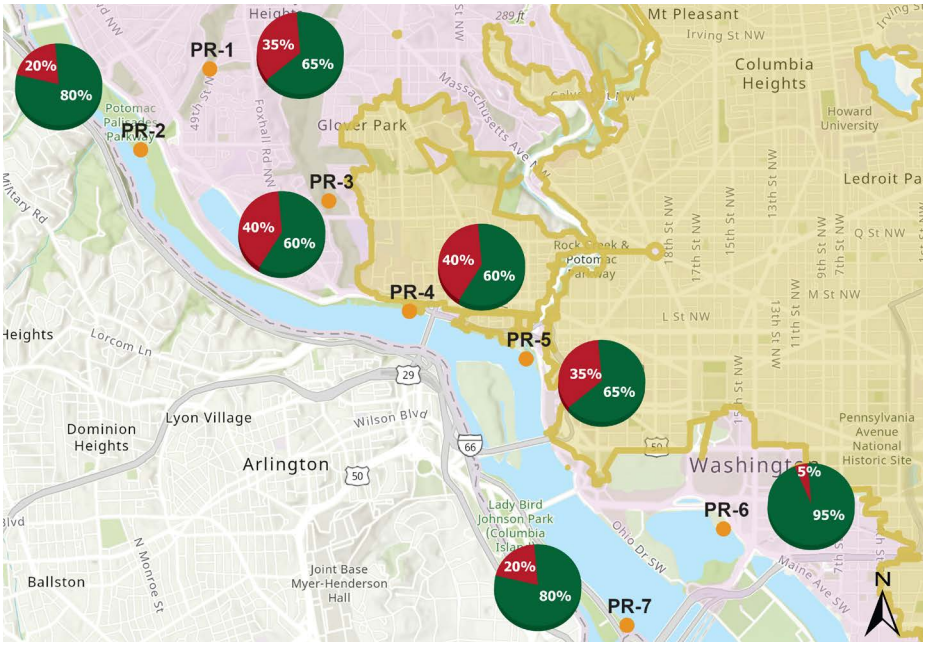


Note:
The geometric means for the three tributary sites were consistently much higher than for the sites along the mainstem of the Anacostia River.

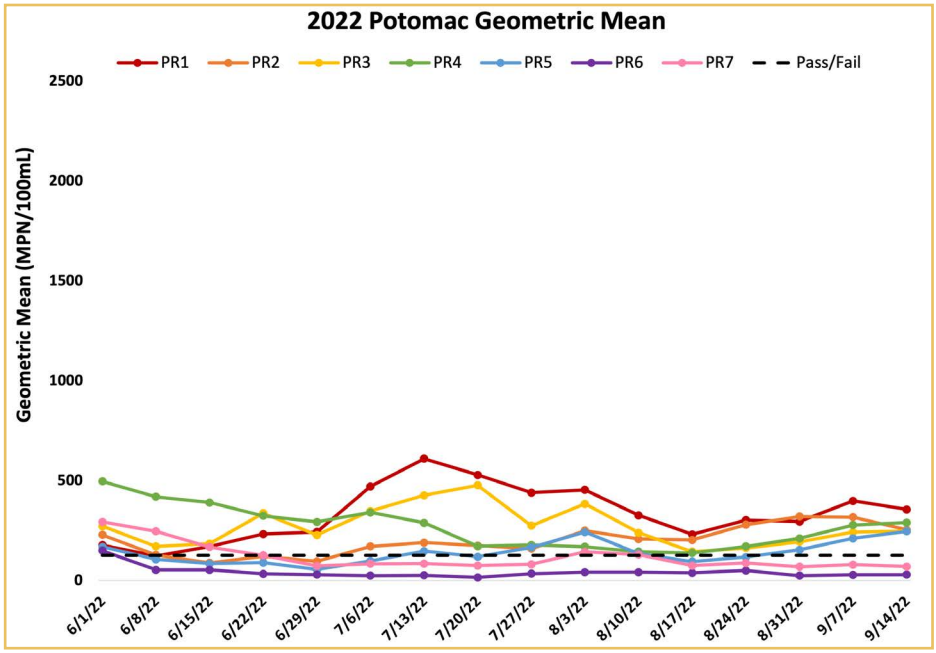
2022 Potomac River Bacteria Trends

The seven Potomac River sites include five on the mainstem, from Fletcher's Cove (PR-2) just south of Chain Bridge to Columbia Island (PR-7) on the most southern shoreline of the District near the Pentagon. The two Potomac tributaries sampled were Battery Kemble Park (PR-1) (Maddox Branch) and Foundry Branch (PR-3). In this year's analysis of the bacteria single sample value water quality standard (410 MPN), Tidal Basin (PR-6) reported consistently low bacteria levels which met water quality standards for recreation 95% of the time. Only one sampling day indicated a bacteria level higher than the single sample value (SSV) recreational water quality standard. Bacteria levels at Fletcher's Cove (PR-2) and Columbia Island (PR-7) met water quality standards for recreation 80% of the time. Foundry Branch (PR-3) and Washington Canoe Club (PR-4) had the highest bacterial loads (40% failure rate for Foundry Branch (PR-3) and 40% for the Washington Canoe Club). Battery Kemble Park (PR-1), Fletcher's Cove (PR-2), Thompson Boat Center (PR-5), and Columbia Island Marina (PR-7) exceeded the recreational water quality standard more than 10% of the time.

Bacteria (*E. coli*) Passing Percentage 2022: Single-Sample Value



The geometric mean water quality standard (126 MPN) trends mirrored the single sample value trends in the Potomac Sites. The geometric means of Foundry Branch (PR-3) and Washington Canoe Club (PR-4) failed the water quality standard throughout the monitoring season, with averaging geometric means of 270.51 and 268.70 MPN respectively. The remaining sites, Battery Kemble Park (PR-1), Fletcher's Cove (PR-2) and Thompson Boat Center (PR-5) were inconsistent throughout the sampling season at 20%, 53%, and 67% passing the geometric mean water quality standard respectively. The average geometric mean for Battery Kemble Park (PR-1), Fletcher's Cove (PR-2), and Thompson Boat Center (PR-5) was 334.71 MPN, 199.15 MPN, and 139.52 MPN. Columbia Island Marina (PR-7) is an interesting case with a geometric mean average of 117.68 MPN, but a rather high failure rate at 33%, when analyzing each interval geometric mean at PR-7. Tidal Basin (PR-6), as well as passing the single sample standard for the season, also passed the geometric mean 94% of the time, with a geometric mean average of 42 MPN. Five out of the seven sites completely failed to meet the criteria, meaning they likely have a systemic bacteria problem. The poor water quality in these sections of the river could indicate a need for focused communication on using caution when recreating, particularly around the boathouses at or near Fletcher's Cove, Washington Canoe Club and Thompson's Boat Center.

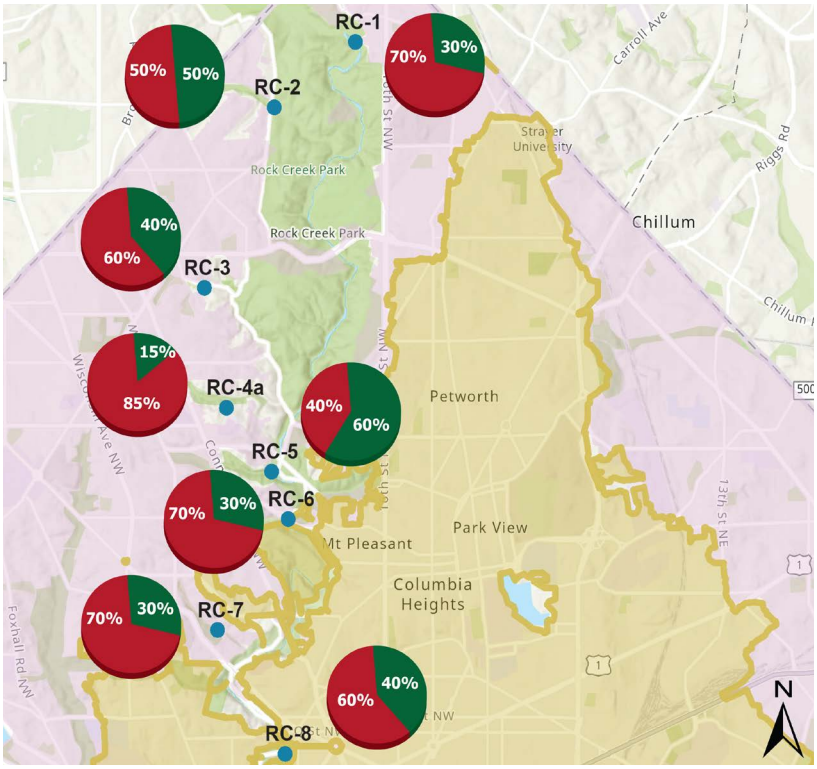


Note:
If you compare the geometric mean trends for the Potomac sites to the other watersheds, the Potomac sites are consistently lower than most of the Anacostia and Rock Creek sites.

2022 Rock Creek Bacteria Trends

Most consider Rock Creek an urban oasis, with lush forests and iconic streams. Monitoring results for the Rock Creek watershed reveal very high levels of bacteria, oftentimes more than the Anacostia and Potomac Rivers. Monitoring sites in Rock Creek span from the most northern part of the District at Juniper St NW (RC-1), all the way down to P Street Beach (RC-8) near where Rock Creek converges with the Potomac River. These sites cover the lower quarter of the Rock Creek watershed which runs from Montgomery County through Washington, DC.

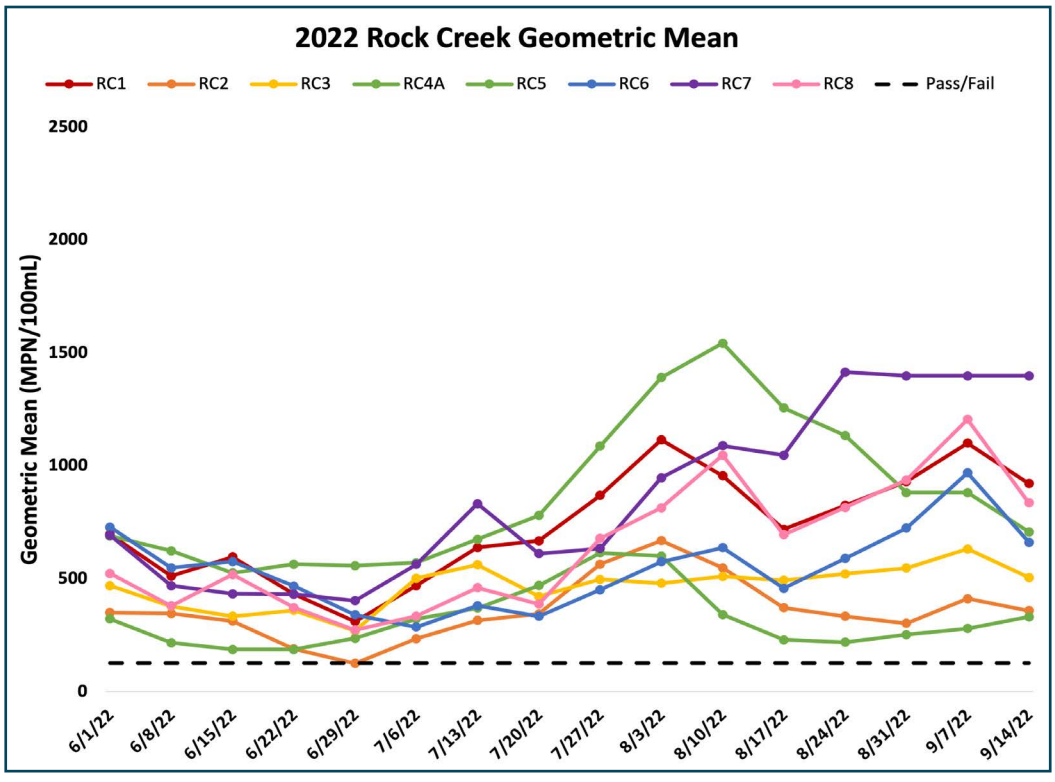
Bacteria (*E. coli*) Passing Percentage 2022: Single-Sample Value



Bacteria single-sampling had low passing percentages (<50%) across all but one site. Soapstone Run (RC-4a; the location of this site shifted slightly to accommodate a restoration project's construction) had the lowest passing rate at 15% for the 2022 season, and Reservation 630 (RC-5) had the highest passing rate at 60% for the season.

Geometric mean passing percentages in Rock Creek are significantly lower than single-sample passing percentages, reflecting the significant impairment of the creek and its tributaries. Every site except for Pinehurst Branch (RC-2) had a geometric mean passing rate of 0%, meaning that the average bacteria count across the entire season was consistently in the unsafe range. At Pinehurst Branch the geometric mean was still low with a pass rate of 14% of the time.

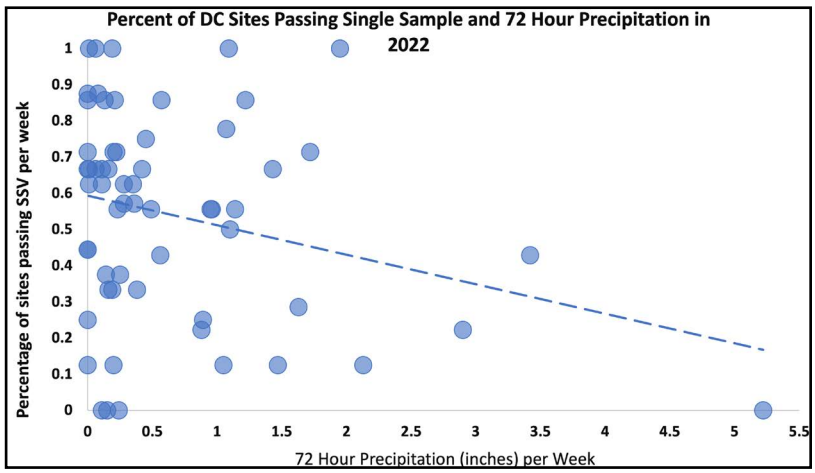
The geometric mean fluctuated throughout the season; bacteria levels started out lower in most sites, steadily rose through June before dropping in July, then rose again through August and September. All sites ended well above the safe threshold for bacteria. The consistently unsafe levels of bacteria across nearly every Rock Creek site show that the creek remains significantly impaired throughout the section of it that runs through DC.



Note:
The geometric mean for bacteria generally gets higher as the summer progresses.

Precipitation Trends

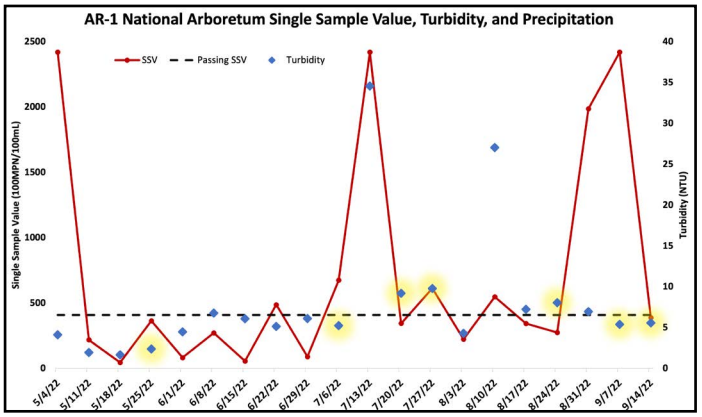
In urban waterways, precipitation is believed to be a primary driver of elevated bacteria counts with an excess volume of stormwater serving as a vector for sources of potential bacterial pollution like animal waste and sewage. Regional precipitation totals fluctuated from May to September with the DC area receiving a total of 19.35 inches of rain this summer. In the coming years, precipitation data and the infrastructure to collect it needs to be advanced to a watershed level in order to further investigate the magnitude of localized precipitation effects on DC bacteria counts in surface waters. Data for more localized precipitation by watershed are collected via the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) database.



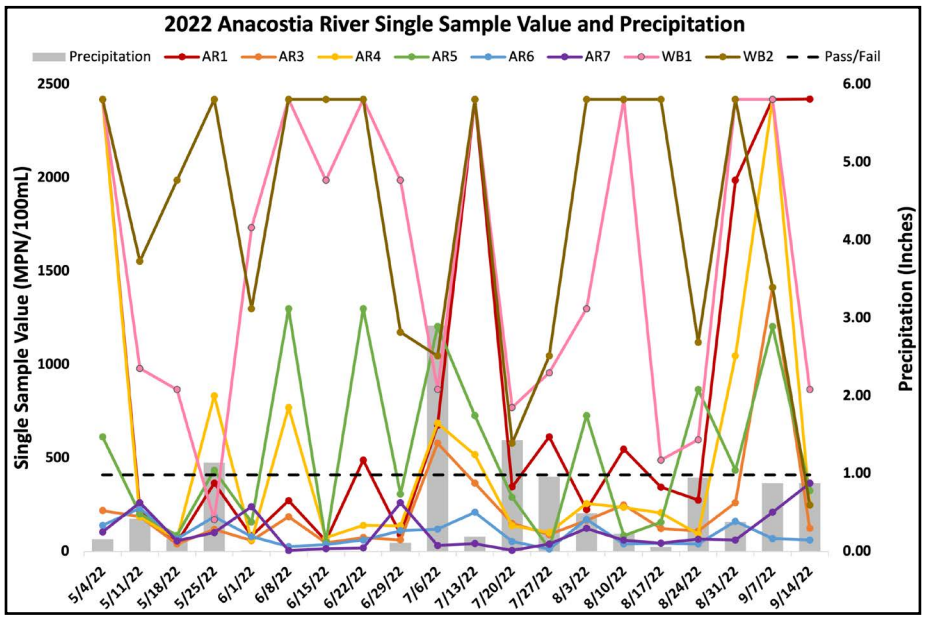
For this program, we categorized any sampling period with more than 0.5 inches of rain within the preceeding 72 hours as "wet" weather conditions and anything less than 0.5 inches of rain as "dry" weather conditions. The graph above demonstrates that with increasing precipitation, the percentage of sites which pass decreases.

Anacostia Precipitation Trends

In 2022, the sites along the Anacostia River displayed a range of behaviors when it came to bacteria levels and safety for recreation. The average single-sample passing rate for bacteria was 54% during "dry" conditions and 51% during "wet" conditions.



An issue of particular importance are days with "dry" weather conditions and low single sample passing rates (<50%), or put simply, weeks with little to no rainfall but high bacteria counts. In 2022, there were 5 weeks with high bacteria and dry conditions which resulted in lower passing rates during "dry" conditions. High bacteria counts during "dry" conditions are particularly hazardous to the common recreator as they may base their recreation on that week's rainfall, and unknowingly decide to recreate in "dirty" water. No firm evidence has been presented as to the direct cause of these types of conditions in DC waters but old, outdated, and leaky infrastructure is a suspected cause. It's important to note that on the Anacostia, sometimes during these "dry" weather conditions, high bacteria counts occurr. Dry weather with high bacteria days primarily occurred in sites either in close proximity to Combined Sewer Outfall (CSO) or at the tributary sites which all exhibit persistent high bacteria levels: Hickey Run, Watts Branch sites at Marvin Gaye and Kenilworth Park (AR-2, WB-1, and WB-2). The sites in close proximity to a CSO include Anacosta Park (AR-4), which is 325 meters from a CSO and Yards Marina (AR-5) which is just 12 meters from a CSO. Sites located further from from CSOs, such as the National Arboretum (AR-1) and Kingman Island (AR-3), or nearer the confluence with the Potomac River, like Buzzard Point (AR-6), and Washington Channel (AR-7) typically still passed the single-sample recreation standard even on "dry" weather high, bacteria days. This is promising as it indicates a higher frequency and longevity of safe recreation days at these sites, increasing their overall recreation potential. Turbidity is another metric which the highlights intersection between precipitation and water quality on the Anacostia River. The figure above indicates how precipitation influences the clarity of the water at the National Arboretum and how "wet" weather conditions align with high turbidity levels. This is valuable because some recreators may base their recreation choices and locations based on how the water looks.

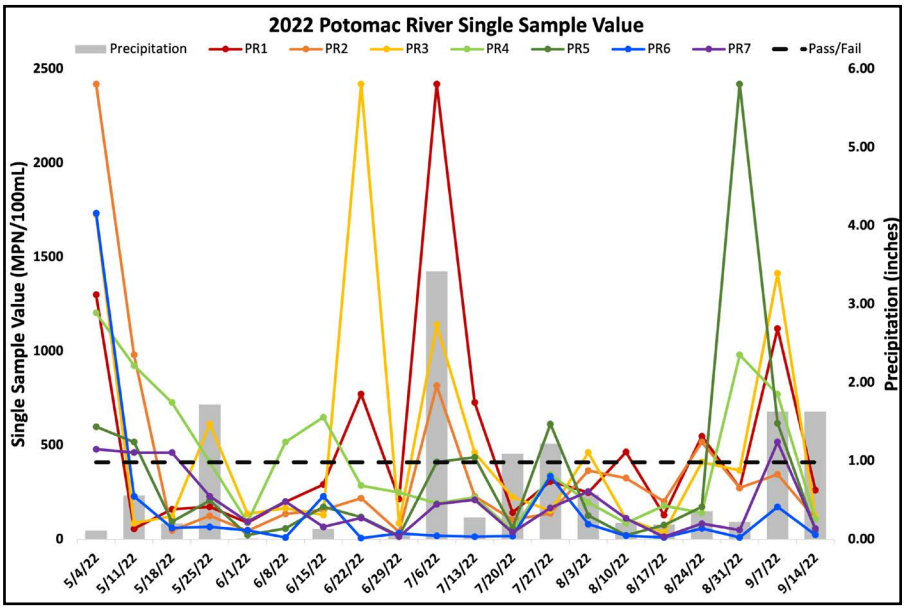


Potomac Precipitation Trends

Data collected from monitored Potomac River sites,

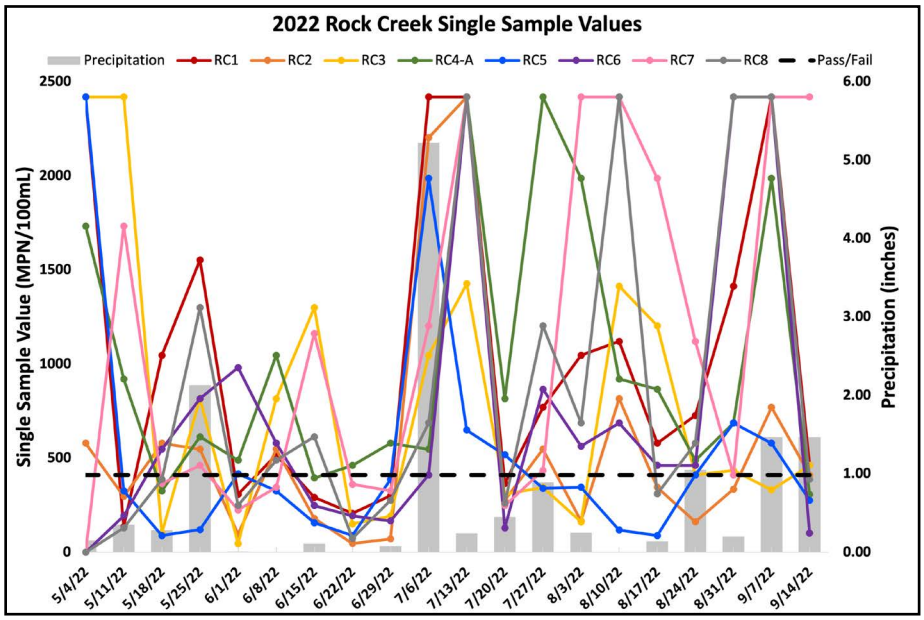
particularly tributary sites or furthest upstream, Battery Kemble Park (PR-1), Fletcher's Cove (PR-2), and Foundry Branch (PR-3)

displayed spikes in bacteria and turbidity levels during rain events. Monitored sites along the main stem of the Potomac river (sites PR-2, PR-4, PR-5, PR-6, and PR-7) are fairly resilient to bacteria spikes in both "wet" conditions (>0.50 in) and dry conditions (<0.50 in), with the exception of Washington Canoe Club, (PR-4). This is expected due to the increase of the width and depth of the river as it travels to the Chesapeake Bay. However, there were three outliers to these patterns. In June, conditions were considered "dry", but a lone, high spike from Foundry Branch (PR-3) at 2419.6 single sample value went well above its range this summer of 85.7 - 1723.9 MPN (excluding the outlier). A sudden large rain event in early July caused a large spike in bacteria, particularly in Foundry Branch (PR-3) and Battery Kemble Park (PR-1). At the end of August, Thompson Boat Center (PR-5) had a surprise spike just before high precipitation fell in the region. The site measured at 2419.6 MPN/100mL on August 31, far above its range this summer between 18.7 - 598.15MPN (excluding the outlier). As the Potomac River widens, generally turbidity decreases and bacteria levels are lower. While data shows that the Potomac's tributaries experience more extreme variability during both wet and dry conditions, it is also important to examine downstream locations as these sudden increases in bacteria loads in "dry" conditions could be an indicator of additional unaccounted for sources of pollution not from known CSO outfalls or stormwater runoff.



Rock Creek Precipitation Trends

Generally, weeks with higher precipitation corresponded to higher single sample values at most Rock Creek sites. Most of the weeks that experienced greater than 0.5 in of rain also had lower passing rates. The blue line for Reservation 630 (RC-5) demonstrates this relationship well. However, high bacteria levels were observed at nearly all sites even when conditions were considered dry, suggesting bacteria is entering streams through sources such as storm drains or leaking sewer lines. Single sample values were higher later in the summer, irrespective of precipitation levels. This can be seen clearly with the bacteria spike in mid-June (6/8-6/15) where there is low precipitation and again in early-to-mid August (8/3-8/10) when multiple many sites saw increased bacteria levels without heavy rain. These trends were not consistent across all weeks at all sites; much additional study of bacteria inputs and sources is recommended.

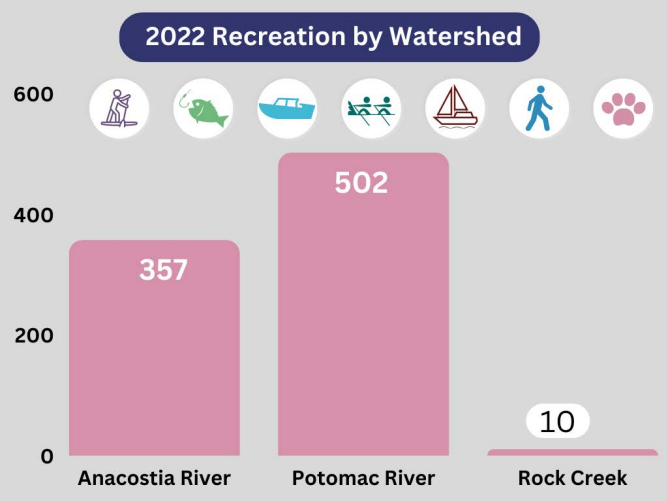


"I've worked in the global water conservation field for 15 years, and staying connected to the local waterways that I care about is one of the things that keeps me motivated in my work. Rock Creek is a treasure in this city, and my family and I enjoy spending much of our time near the water and in the park. Monitoring the creek's water quality with RCC has been a fun and tangible way for me to stay engaged with efforts to better understand and protect the health of this beloved urban oasis."

-Tara Varghese

Recreational Use Trends

All three District waterways see weekday recreational use throughout the summer. The Potomac River had the highest number of participants recreating on the water with Rock Creek seeing the lowest. The low number of recreators in Rock Creek is likely a reflection of Rock Creek Conservancy's Recreate Responsibly campaign to educate park visitors about the risks of water contact.

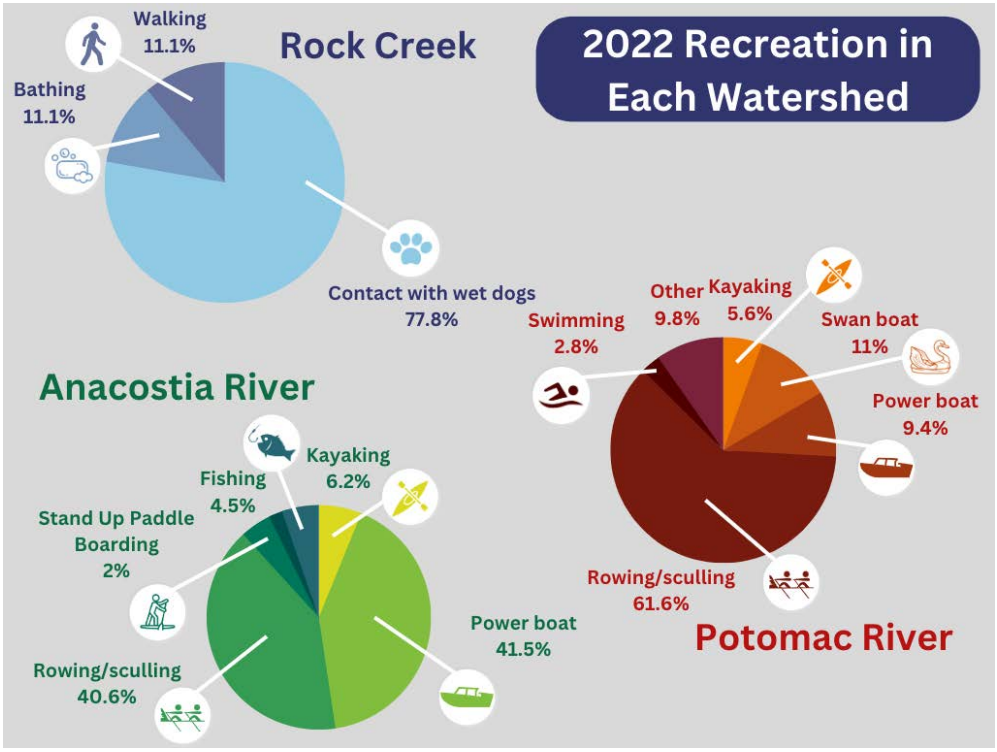


The ways in which people recreate on the three rivers varies as well. The main types of recreation recorded on Wednesday mornings along the Anacostia River in 2022 were rowing/sculling, powerboat use, kayaking and canoeing, fishing, and stand up paddle boarding. The Potomac River is the largest body of water in the District of Columbia. It continues to be a popular site for recreation with multiple boat houses along its banks. The Potomac River had similar top categories of recreation with a high volume of human powered boating such as rowing, swan boating, kayaking, and canoeing. On two separate monitoring days, recreational swimmers were observed at Thompson Boat Center (PR-5). This area is frequently used by college and high school rowing teams. Rock Creek differed greatly from the Anacostia and Potomac Rivers in the amount of recreation and the types of recreational activities that people participated in. The top categories were contact with wet dogs after playing in the water, contact with the water while hiking and crossing streams, other contact with the water (often recorded as construction work), water play by children, and wading.

Most of the recreation activities on the Anacostia River were recorded starting at Anacostia Park (AR-4) moving downriver towards the Washington Channel (AR-7). Buzzard Point (AR-6) and the Washington Channel (AR-7) have the best water quality on the Anacostia River passing the SSV standard 100% of the time and the geomean standard nearly every week (95% passing rate). Yards Marina (AR-5) only passed 50% of the time, suggesting that recreators should be more careful with water contact at this site. The most common types of recreation at Yards Marina were rowing/sculling with kayaking and paddleboarding as the second most common type. Future outreach could focus on outreach to rowing clubs and kayak/SUP rental places to ensure these groups are aware of the weekly bacteria data.

In the Potomac, there was a clear differentiation between the types of recreation seen at the mainstem sites compared to the tributary sites. The mainstem sites saw the majority of recreation through secondary contact activities like rowing (most popular at 61%), swan boating, power boating, and kayaking. The boathouse sites, Thompson's Boat Center (PR-5), and Washington Canoe Club (PR-4) had the highest counts of observed recreation in the form of rowing and powerboating. Rowing has a high risk of secondary contact with water, which could be cause for concern as Thompson Boat Center (PR-5) passed the geometric mean water quality standard 53% of the time and Washington Canoe Club (PR-4) never passed the geometric mean water quality standard. The Tidal Basin (PR-6) swan boats saw a steady stream of use in July and August, which is a big positive since this site passed 93% of the time. The tributary sites (Battery Kemble Park and Foundry Branch) saw more potentially high contact activities like contact with water while hiking/crossing streams and contact with wet dogs after playing in water. The water level at these sites tends to fluctuate, especially in the "dry" conditions where stream crossings may be dried up.

Overall, Rock Creek, as a much smaller body of water, has significantly less observed recreational use than the Anacostia and Potomac Rivers. Many of the recreational activities that can be



Recreational Use Trends Continued

done on the larger and deeper rivers, such as boating, cannot be done in Rock Creek.

Following the implementation of the #RecreateResponsibly campaign by Rock Creek Conservancy and the National Park Service, observed recreational use dropped more than 50%. Recreate Responsibly signs warn visitors to 'Stay Dry, Stay Safe,' and are placed near common stream entry points ('beaches' along trails) in late spring. The signs are offered in both English and Spanish. Rock Creek Conservancy uses its social media accounts to share this caution during rain events. The Conservancy also trained volunteers who lead volunteer events such as litter cleanups to educate their volunteers and park visitors about Recreate Responsibly principles.

Recreational use has been most prevalent at Juniper Street (RC-1), near a residential neighborhood, and Soapstone Creek (RC-4a), which has a trail with many creek crossings. While these two sites comprised nearly half of all recorded observations, the issue of exposure to bacteria during recreational activities is widespread throughout Rock Creek Park.

More than half of the recreational use of Rock Creek was dogs using the water.

Contact with wet pets can create a health hazard for humans, and direct exposure to and/or consumption of contaminated water can pose a health risk to pets. This use could also increase bacteria levels, as dogs in the creek are usually offleash, and their waste is less likely to be properly disposed of.

Community Participation and Outreach Outcomes

Of the two goals for community outreach (increasing the volunteer corps to include representatives from all 8 Wards; and promoting the project, its goals, and water quality education to the public), excellent progress was made on both. Participants came from all DC Wards, Maryland, and Virginia. The volunteer corps for the 2022 monitoring season included 83 people. Nearly half the volunteers were 18-34 years old, but volunteers spanned a wide age range from young children volunteering with their parents to retired community members. Each of our organizations heavily promoted the project to our existing membership and volunteer corps, collectively reaching thousands of people through e-newsletters and targeted promotions.

Collectively the grant partners attended or held 15 outreach events and 7 meetings, with nearly all in Wards 4, 7, and 8. Through these activities, 535 people (see table below for details) were engaged. Highlights included Ward 4 Councilmember Janeese Lewis-George and Attorney General Democratic nominee Brian Schwalb attending a walking tour of DC Water green infrastructure installations in the Piney Branch watershed at an event in Ward 4. Lessons learned from outreach activities and meetings included a need for more oral and hands-on demonstrations vs written materials to accommodate varying literacy levels, and Spanish-language materials (oral and writing). However, at the event where the team provided Spanish-language materials and a bilingual educator, even though it took place in a neighborhood with a significant Latine population, nobody used the Spanish materials. A lesson learned for future outreach is to better promote in Spanish-language channels ahead of time.

Outreach Events

LOCATION	# OF MEETINGS AND EVENTS	ATTENDANCE
Ward 4	2	153
Ward 7	9	165
Ward 8	9	149
Ward 7 and 8	1	36
All Wards	4	32

Total people reached: 535

Photo Credit: Rock Creek Conservancy

Conclusions

DOEE has funded our work in order to advance scientific and community understanding of safety in our immense watery natural resources. Ultimately, all District waterways should be safe and clean enough to support swimming, fishing, and other primary contact recreation as well as a healthy aquatic ecosystem. DC Water's completion of the first phase of the Anacostia tunnel in the Clean Rivers Project has been immensely helpful, with 80% of historic sewage overflows eliminated prior to the beginning of this project. The need to reduce bacterial pollution continues, not only in those places where CSOs continue to discharge raw sewage (Potomac River mainstem, lower Rock Creek mainstem) but also in the smaller tributaries. High bacteria levels on tributary streams, even on dry days, are very concerning. These streams do not have CSOs, so while on wet days we might expect some bacteria levels from dog waste and other overland sources, they should have very low counts on dry days. Potential sewer leaks should be investigated quickly. The high bacterial loads in some of these streams on wet days could indicate more than overland contamination - perhaps a sewer line has been improperly connected to the storm system.

Historically, people swam all throughout the District. Most public swimming pools prohibited black families from entering, so they taught their children to swim in the Anacostia and Potomac Rivers. Even with the swimming ban in place today, family gatherings in Rock Creek Park still splash in the creek. Hikers and dog walkers get wet crossing tributaries. Boaters get splashed or fall out of their crafts on the larger rivers. A city so bound together by its three major waterways should provide residents with the opportunity to swim and cool off everywhere, which is increasingly important as the climate crisis makes our summers consistently hotter and subject to more significant storm events. Let's get the bacteria out and get DC swimming again!

"I had a very positive experience volunteering with the water quality monitoring program. It was a great way to contribute to the community and connect with the river myself! Communication and training from Alliance for the Chesapeake Bay and Anacostia Riverkeeper staff made it easy to know exactly what to do. 10/10 would recommend."

-Julie Sepanik

THANK YOU VOLUNTEERS!

This project would not succeed without the dedication of all our volunteers who, for the past four years, have spent their Wednesday mornings collecting samples for this project.

We thank them for their time, enthusiasm, and commitment to the District's waterways!

A project of:

DEPARTMENT OF ENERGY & ENVIRONMENT

GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

Implemented by:

ALLIANCE for the Chesapeake Bay

In partnership with:

nature forward

ROCK CREEK CONSERVANCY

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