DC Citizen Science Water Quality Monitoring Report

2018-2021

DEPARTMENT OF ENERGY & ENVIRONMENT

GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

Grant #RFA 2018-1805-WQD-VWQM

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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 threats that can be found in urban waterways. For recreators to safely enjoy our local waterways, timely and current publicly-available water quality data needs to be made accessible to the public at large so that they can make effective and informed recreation decisions. Seeing the success of past water quality efforts by watershed organizations, in 2018 the District Department of Energy and Environment (DOEE) awarded a grant to Anacostia Riverkeeper to fund the establishment of a volunteer-based water quality monitoring program that would test primary surface waters in the District of Columbia weekly throughout the primary recreation season (May to September).

Monitoring activities took place weekly from May to September every year from 2019 to 2021. Anacostia Riverkeeper led a multi-stakeholder team consisting of Alliance for the Chesapeake Bay, Audubon Naturalist Society, Potomac Riverkeeper Network, and Rock Creek Conservancy, who, over the course of three years, trained over 300 volunteers, collected over 1,500 water quality samples, and provided weekly water quality updates to DC recreators for a total of 60 weeks. Volunteers were recruited to participate from throughout the capital region with water quality monitors coming from all 8 Wards in DC and also from Virginia and Maryland. Over the three-year monitoring period, the following trends were observed throughout DC surface waters including:

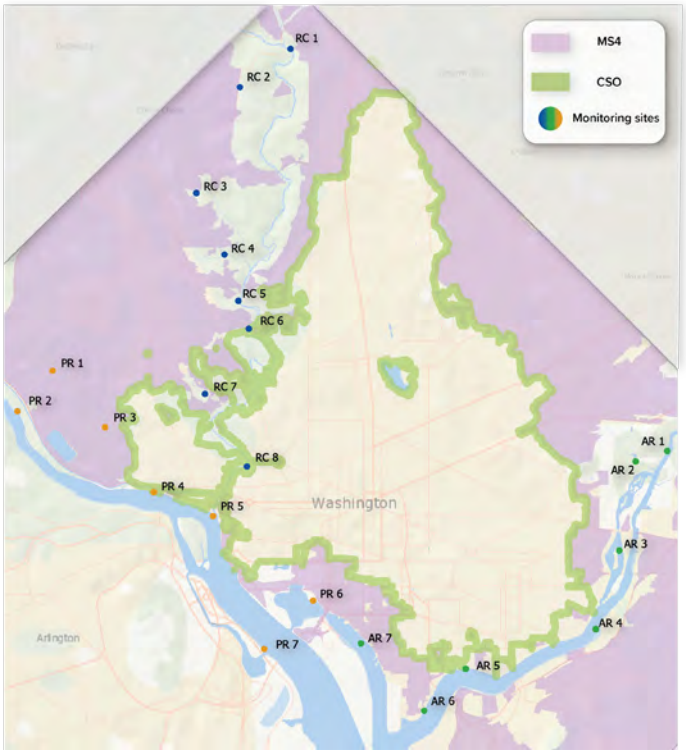
- The average overall single sample value passing rate for *E. coli* increased modestly from 60% the first two years (2019 and 2020) to 63% in 2021.
- In all three project years, average overall site single sample passing rates decreased 39% when over 0.5" of precipitation was recorded 72 hours before monitoring.
- Sites with increased mixing and located furthest from combined sewage outfalls towards the south end of DC have some of the highest passing rates and recreation potential (i.e., Buzzard Point, Washington Channel, Tidal Basin, and Columbia Island).
- High bacteria counts during "dry" weather days (<0.5" precipitation 72-hours before monitoring) persisted year-to-year and may be indicative of outdated infrastructure, leaking sewer pipes, or uninvestigated point-source pollution.
- Each year, on average, sites overwhelmingly passed DC recreational contact standards for turbidity (<20NTU), pH (between 6.5 and 8), and water temperature (<32.5) with fluctuations occurring most often after periods of high precipitation.

Overview

1,500+
samples collected to date

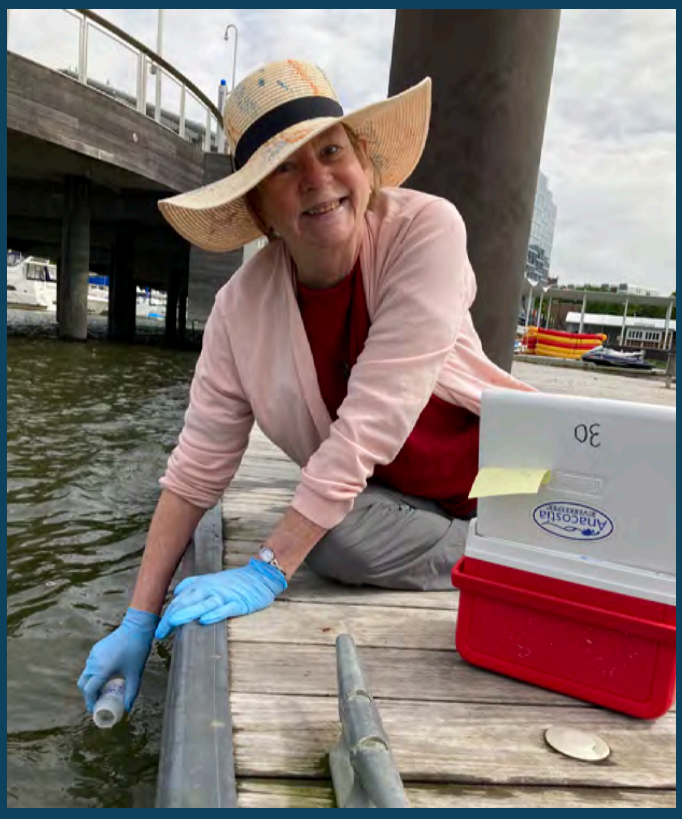
volunteers from all
8
Wards

300
voluteers trained



'I really enjoyed being a water quality monitor. The training was thorough - I felt quite prepared when I started out. In my over 30 years at EPA, I had never actually taken a sample. "My" site - the Wharf - was an easy walk from home and I felt good about doing something useful for my neighborhood. I was pleased that we had a perfect record of passing *E. coli* samples."

-Beth Hall



- Mainstem 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.

As in most urban watersheds, the project data shows that rainfall is one of the biggest contributors to high bacteria levels in District surface waters. Heavy rains, increasingly fueled by climate change are producing more stormwater which serves as a vector for pollution. With increased attention and funding going towards DC's rivers and streams, capital improvement projects have been or are planned to be built to further reduce the burden that rainfall has on the city's water quality. With the goal of lifting the District swim ban and achieving swimmable waters, this project has produced several recommendations to achieve that milestone as well as increasing equitable recreation along with it:

- Continue the development of capital improvement projects throughout the District that seek to not only use the best available and sustainable practices, but also increase the use of green infrastructure in CSO and SSO areas.
- Develop and implement more policies and programs 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.

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Anacostia RIVERKEEPER®
POTOMAC RIVERKEEPER® NETWORK
ROCK CREEK CONSERVANCY
Audubon Naturalist Society
ALLIANCE for the Chesapeake Bay

This report was prepared by Anacostia Riverkeeper with contributions from our partners: Alliance for the Chesapeake, Audubon Naturalist Society, Potomac Riverkeeper Network, and Rock Creek Conservancy.

Introduction

Background

Washington D.C. 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 flowing 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, Potomac, 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 database of quality baseline water quality data needed to be built through robust and frequent monitoring of rivers and streams. To accomplish this, the District 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 waterways.

Program Overview

This project was awarded to Anacostia Riverkeeper in 2018 through funding from the District Department of Energy and Environment (DOEE) via Grant #RFA 2018-1805-WQD-VWQM. A total of 22 monitoring locations were selected across all DC surface waters in the District's three primary watersheds, the Anacostia, Potomac 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 Alliance for the Chesapeake Bay, Audubon Naturalist Society, Potomac Riverkeeper Network, 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.

The water quality parameters sampled were chosen with recreation as the primary concern. In the District, fecal indicator bacteria (e.g., *E. coli*), turbidity, pH, and water temperature are the four water quality parameters that dictate the recreation potential in a body of water; making them the primary parameters of concern when it comes to potential swimmability and permitted recreation. 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)

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

Measured ~1ft below the water surface at each site with an armored thermometer.

Air Temperature

Measured over the water at each monitoring location with an armored field thermometer.

Volunteer Recruitment and Training

All data in this program is collected by volunteers, making them the cornerstone of this citizen 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 the three years this program has been taking place we've trained nearly 300 volunteers and have reached countless others through the sharing of project data and other 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.

Water Quality Monitoring Program by the Numbers

~300
volunteers

1500
bacteria samples

10
trainings
+
1
recorded training

60
weeks monitored

7,140
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 approved 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. **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 armored glass thermometers.

Photo credit: ANS

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 - 8.5	<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*

Sample duplicates are collected from each watershed each week to ensure quality assurance and check volunteer sampling techniques. 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.

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 published in "Most Probable Number of Colony Forming Units" or MPN/100mL (comparable to CFUs).

Bacteria

A Colilert chemical reagent is mixed with each sample

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

Lab Processes

Samples are sealed in a sampling tray

After 24 hrs samples are read under a UV blacklight

Turbidity

Turbidity samples are assessed using an in-lab LaMotte 2020we/wi turbidimeter, which uses light attenuation passing through a 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. Lab turbidity samples are run concurrently with bacterial samples so both results are available within 24 hours. Temperature and pH parameters are measured in the field so do not require lab analysis.

Data Methods

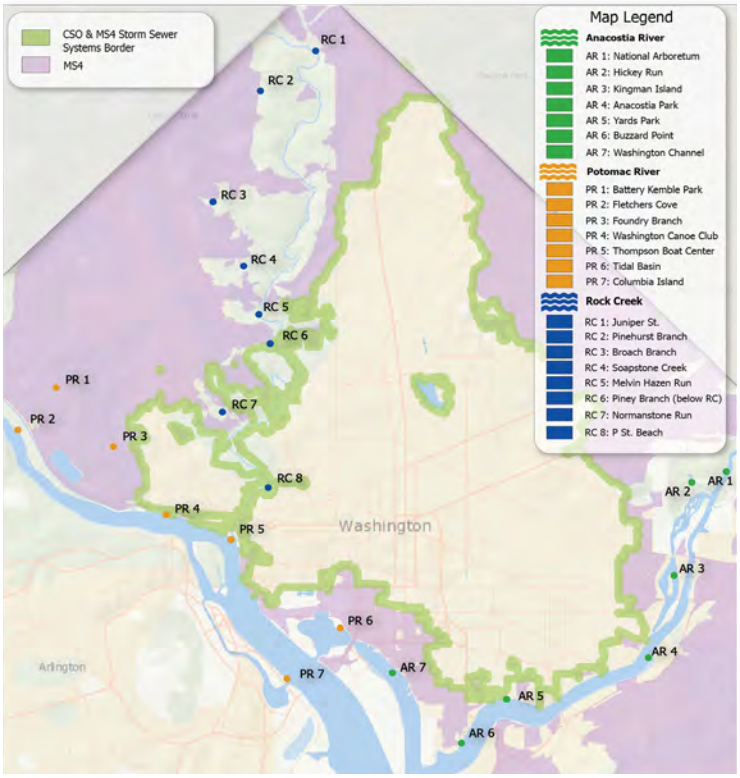
Data is recorded 24 hours after sampling and uploaded to multiple platforms for public access: Water Reporter, SwimGuide, Chesapeake Monitoring Cooperative, and a database portal on Anacostia Riverkeeper's website. Full data is primarily accessed via Anacostia Riverkeeper's Water Quality Results Portal, as it is updated weekly with helpful maps, graphs, and general program information. Anacostia Riverkeeper additionally uploads the data to all social media platforms (Twitter, Instagram, and Facebook) when results are reported. 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.

"Thank you for giving citizen volunteers the opportunity to play a role in monitoring the local waterways to sustain Washington's incredible wild environment. As a three-year veteran of this effort I encourage all citizens who benefit from this great resource of Rock Creek Park to join us in the coming years to maintain and improve our precious natural heritage. It is also fun and an opportunity to meet other like-minded concerned friendly neighbors."

-William Sittig

WATERSHED TRENDS FROM 2019-2021



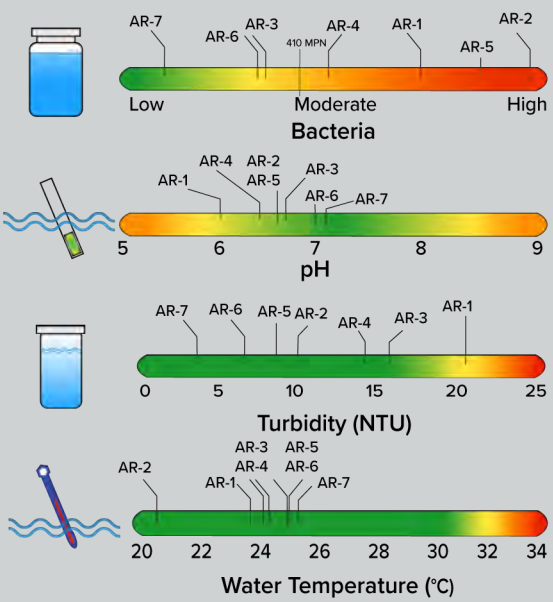
While bacteria levels ranged across the three watersheds and often violated both the standard for single-samples and geometric mean, all other measures of water quality including pH (6.5-8), water temperature (<32.3) and turbidity (<20NTU above ambient) were generally within the acceptable range.

For the Anacostia River, turbidity tended to decrease downstream. The average turbidity for all Anacostia sites, except the National Arboretum (AR-1), were well below the standard. The National Arboretum had a higher average due to a few rain events with very high turbidity spikes. The median turbidity (13.4 NTU) at the National Arboretum falls well within the standard. For pH, violations occasionally (<10% of the time) occurred for low pH. Again, the National Arboretum (AR-1) was the exception in 2021 which had low pH values 45% of the time. This was a very different trend from 2019 and 2020 where pH only violated the standard 5% and 0% of the time, respectively. No other sites experienced unusual pH readings during the 2021 season suggesting that this issue is localized. Considering broad scale water quality metrics, the National Arboretum (AR-1) and Hickey Run (AR-2) have the worst overall water quality of all sites on the Anacostia River.

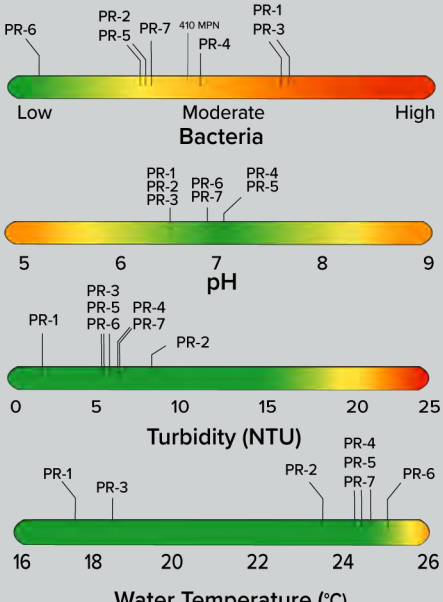
The Potomac River sites showed generally good water quality in terms of pH, turbidity, and temperature. Foundry Branch (PR-3) and Battery Kemble (PR-1) tributary site pH levels trended slightly towards the acidic, but well within the normal range. Turbidity levels were very low at all locations, with Battery Kemble showing the lowest numbers by a sizable margin. Fletcher's Cove turbidity was highest on average amongst the Potomac sites, not surprising given the river flow patterns and sedimentation issues in that section of the Potomac. 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, influenced by higher spring and summer air temperatures and other factors.

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. For pH, Normanstone Run (RC-7) had the lowest average value at 6.4, and Melvin Hazen Run (RC-5) had the highest average at 7.3. For turbidity, Pinehurst Branch (RC-2), Soapstone Creek (RC-4), and Normanstone Run had the lowest averages; Melvin Hazen Run and Piney Branch (RC-6) had the highest. 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.

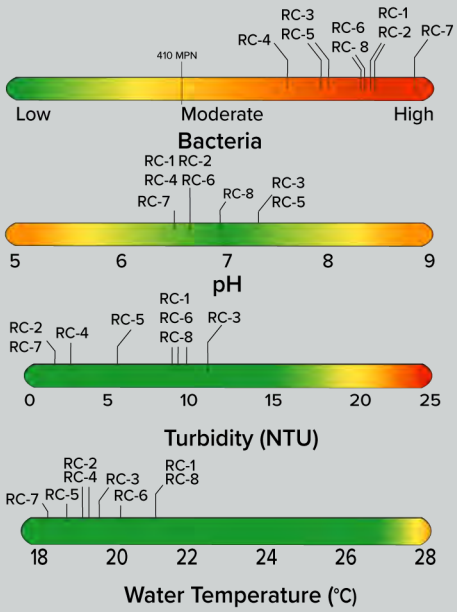
ANACOSTIA RIVER



POTOMAC RIVER



ROCK CREEK

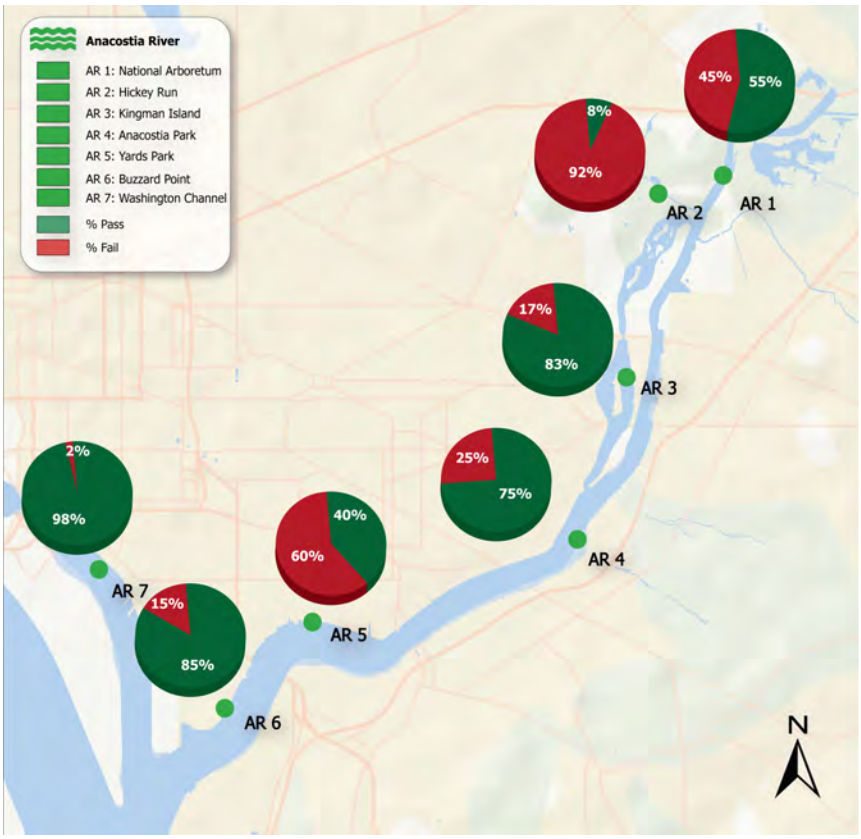


*Average values for 2019-2021

Anacostia River Bacteria Trends

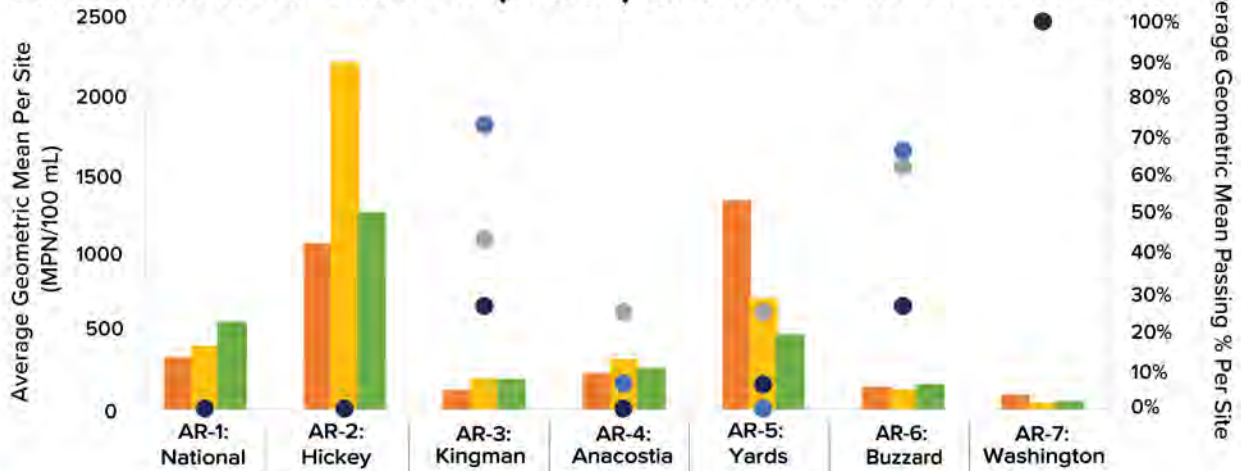
The Anacostia River sites are located on the 8-mile main stem beginning at the National Arboretum (AR-1) and ending at the Washington Channel (AR-7), with one tributary site located on Hickey Run (AR-2). Bacteria levels were generally lower downstream than upstream except for Yards Marina (AR-5) which only passed 40% of the time. For the single-sample primary contact standard, Kingman Island (AR-3), Anacostia Park (AR-4), Buzzard Point (AR-6), and the Washington Channel (AR-7) passed 75% of the time or more. Given their high passing rates, these sites could be good locations to promote recreation.

Bacteria (*E. coli*) Passing Percentage 2019-2021: Single-Sample Value



The geometric mean trends mirrored the single-sample value trends with the downstream sites passing more often than upstream sites. The Washington Channel (AR-7) passed for geometric mean 100% of the time. Buzzard Point (AR-6) and Kingman Island (AR-3) had high single-sample passing rates (>80%) but only passed the geometric mean about half the time (52% for Buzzard Point and 48% for Kingman Island). These sites had average geometric means of 164 MPN for Kingman Island and 137 MPN for Buzzard Point which were just above the 126 MPN threshold. While Anacostia Park (AR-4) often passed for single-sample, it only passed for geometric mean 10% of the time, because bacteria levels were moderate at this site with an average geomean of 265 MPN. The National Arboretum and Hickey Run (AR1 and 2) both failed for geometric mean 100% of the time. As these sites regularly fail both single-sample and geometric mean standards, they likely have a systemic bacteria problem. The poor water quality in this section of the river may be surprising to recreators as this section of the river is bordered by green space including the National Arboretum on the west bank and Kenilworth Park and Kenilworth Aquatic Gardens on the east bank.

Anacostia River Bacteria (*E. coli*) Geometric Mean 2019-2021

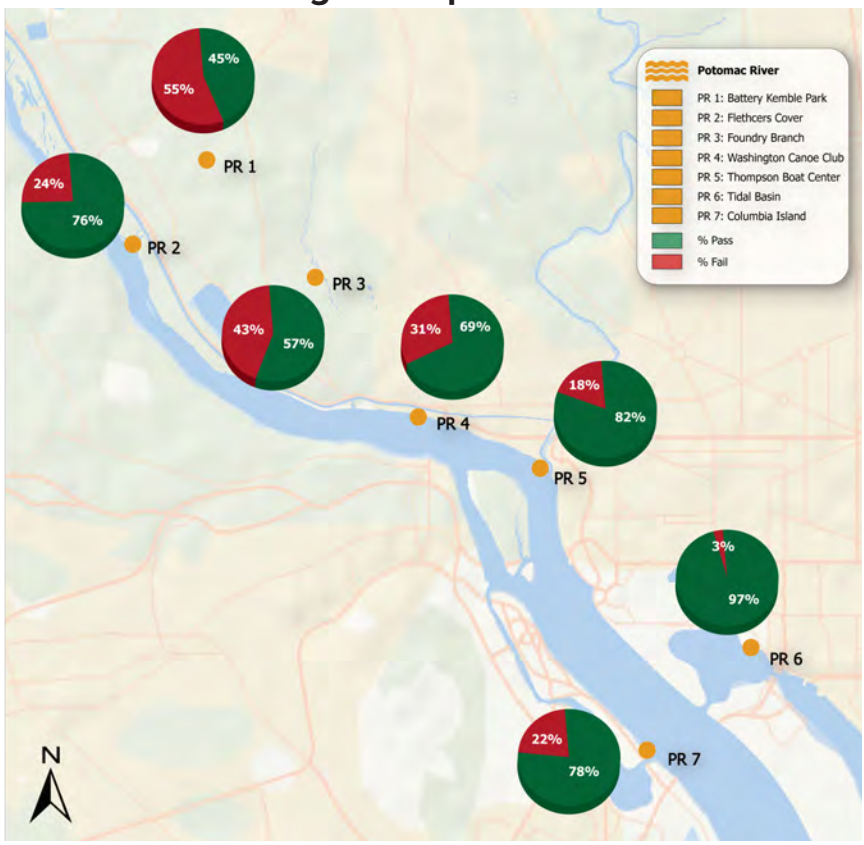


	AR-1: National Arboretum	AR-2: Hickey Run	AR-3: Kingman Lake	AR-4: Anacostia Park	AR-5: Yards Park	AR-6: Buzzard Point	AR-7: Washington Channel
2019 Average	323.0	1064.2	114.0	223.9	1340.3	136.7	80.6
2020 Average	402.7	2228.7	189.5	314.5	707.4	118.3	33.4
2021 Average	557.8	1262.9	187.7	257.9	476.5	155.1	41.8
2019 % Pass	0%	0%	73%	7%	0%	67%	100%
2020 % Pass	0%	0%	44%	25%	25%	63%	100%
2021 % Pass	0%	0%	27%	0%	6%	27%	100%

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). Several of the mainstem sites reported consistently low bacteria levels throughout the three years of monitoring, including the Tidal Basin (PR-6), which met water quality standards for swimming 97% of the time. Bacteria levels at Washington Canoe Club (PR-4) fluctuated but increased over time, with 45% of samples failing to meet the standards in 2021. This merits further investigation, given the proximity of a CSO outfall to the Club and sampling location. Battery Kemble Park and Foundry Branch frequently exhibited very high bacteria loads (55% failure rate for Battery Kemble and 43% for Foundry Branch), including in dry weather, indicating likely contamination from leaking, degraded sewer infrastructure.

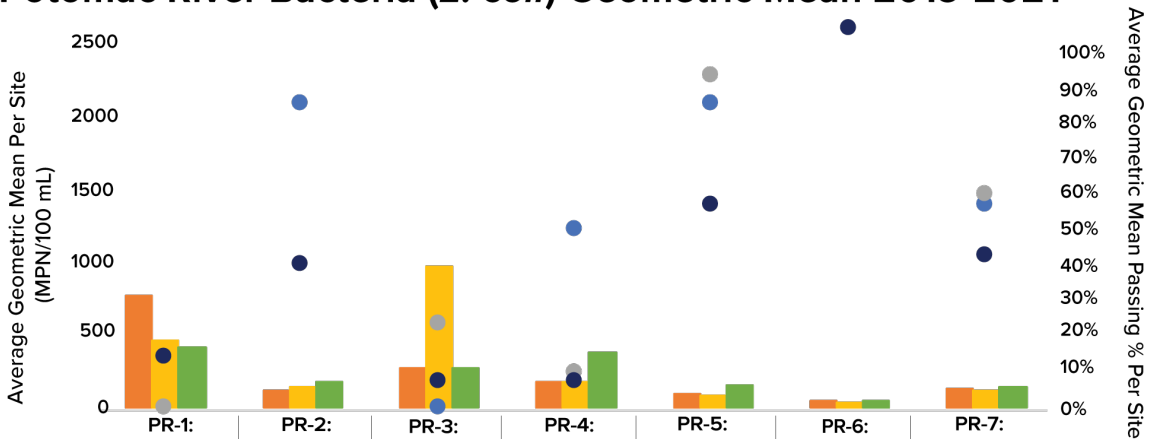
Bacteria (*E. coli*) Passing Percentage 2019-2021: Single-Sample Value



Overall trends included a direct correlation between rainfall and increased bacteria levels at mainstem sites which exhibited generally better water quality than tributaries, with some exceptions. The two Potomac tributaries report consistently high bacteria levels regardless of precipitation, indicating potential leakage of raw sewage from deteriorating infrastructure. Sites farther from CSOs have generally lower bacteria levels throughout the season.

There was a slight increase in recreational use of mainstem sites during the height of the pandemic in summer 2020. Increased recreation at Thompson Boat Center (PR-5) and Fletchers Cove where public boat rentals are available supports increased public interest in recreation. The recreation potential at Tidal Basin (PR-6) and Thompson Boat Center (PR-5) is very high as both sites had low bacteria levels over extended periods during the summer.

Potomac River Bacteria (*E. coli*) Geometric Mean 2019-2021

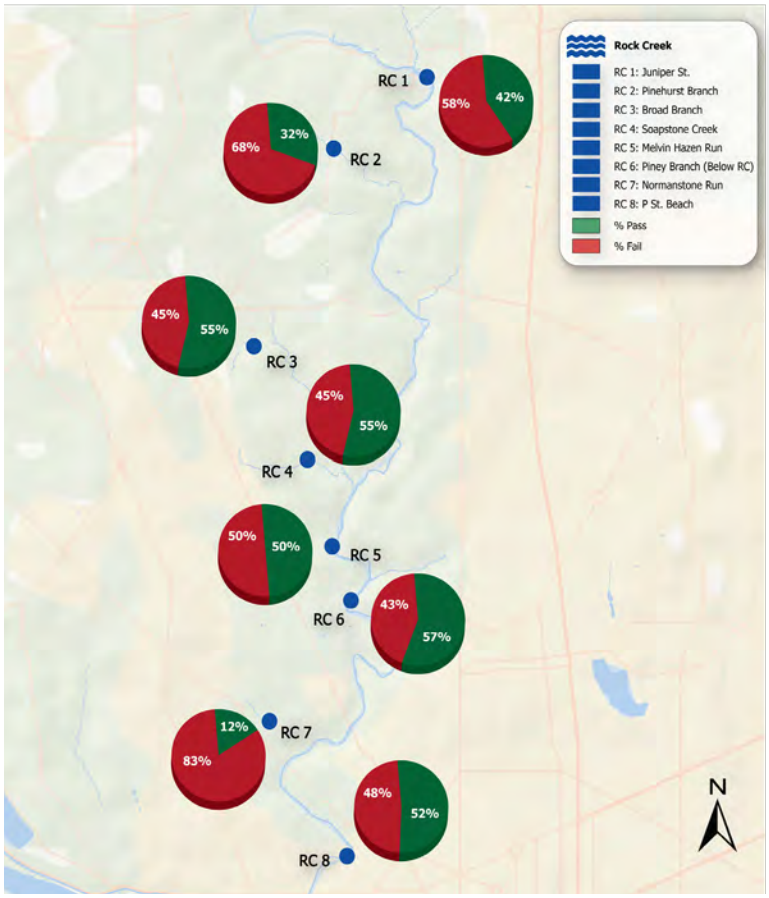


	PR-1: Battery Kemble	PR-2: Fletchers Cove	PR-3: Foundry Branch	PR-4: Washington Canoe Club	PR-5: Thompson Boat Center	PR-6: Tidal Basin	PR-7: Columbia Island
2019 Average	747.7	116.7	257.1	169.9	93.8	43.7	126.9
2020 Average	443.0	137.9	944.9	172.5	74.1	30.2	117.8
2021 Average	405.9	175.2	258.2	368.9	145.8	44.8	140.6
2019 % Pass	0%	80%	0%	47%	80%	100%	53%
2020 % Pass	0%	38%	22%	9%	88%	100%	56%
2021 % Pass	13%	38%	7%	7%	53%	100%	40%

Rock Creek Bacteria Trends

You may know Rock Creek as the lush and beautiful oasis that runs through the heart of DC. Yet the results of this monitoring project show that Rock Creek suffers from 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 2019-2021: Single-Sample Value

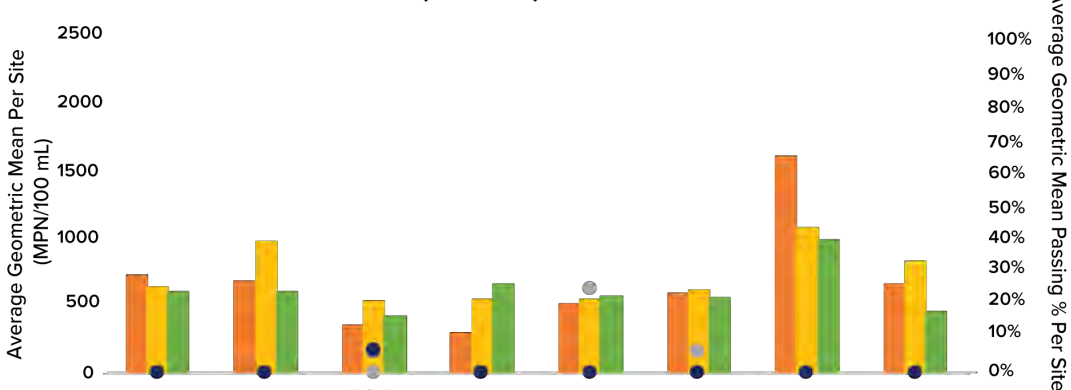


Single-sample passing rates for bacteria were low (<50%) across nearly all sites. Normanstone Run (RC-7) had the lowest passing rate at 20% for the 2021 season, and P Street Beach (RC-8) had the highest passing rate at 80% for the season. Normanstone Run also had the lowest passing percentage in the 2020 season (again, at 20%).

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 Broad Branch (RC-3) and P St Beach (RC-8) had a geometric mean passing rate of 0%, meaning that the average bacteria count across the entire season was in the unsafe range. The highest geometric mean passing rate was at Broad Branch, which passed 13% of the time; P St Beach had a geometric mean passing percentage of 6%. The geometric mean fluctuated throughout the season; bacteria levels started out low in most sites, steadily rose through June before dropping in July, then rose again through August and September. All sites ended well above the healthy 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.

Across all three years of the program, the Rock Creek sites showed low geometric mean passing rates. No sites averaged below the bacteria safety threshold of 400 MPN across the 3-year window, and the highest passing rate for 2021 was just over 8% at Melvin Hazen Run (RC-5). Normanstone Run (RC-7) exhibited the highest bacteria levels in Rock Creek across all three years, but dropped steadily from 2019-2021. As conditions in the sewershed well outside the stream valleys can impact bacteria levels in the streams, it is difficult to pinpoint specific causes for improvement or degradation at any given site.

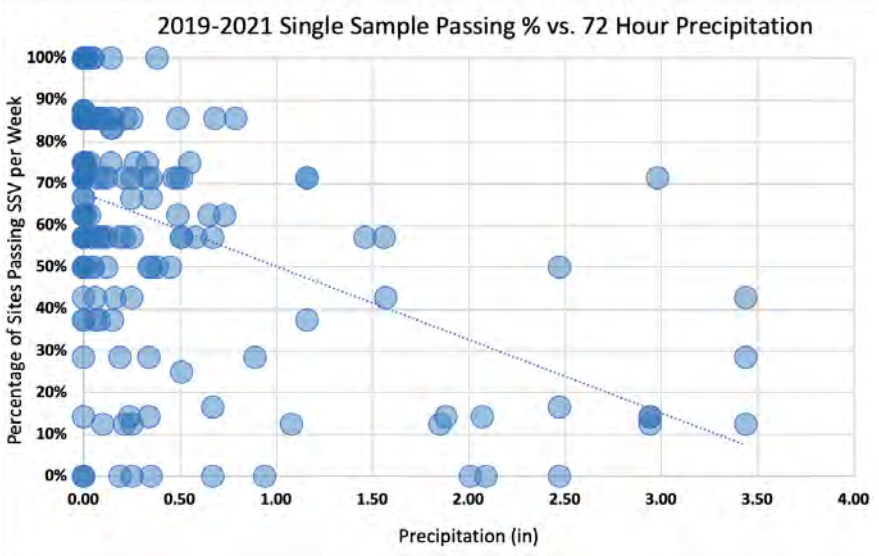
Rock Creek Bacteria (*E. coli*) Geometric Mean 2019-2021



	RC-1: Juniper Street	RC-2: Pinehurst Branch	RC-3: Broad Branch	RC-4: Soapstone Creek	RC-5: Melvin Hazen	RC-6: Piney Branch	RC-7: Normanstone Run	RC-8: P Street
2019 Average	737.5	688.6	363.2	302.1	523.5	597.4	1617.3	666.9
2020 Average	648.3	980.4	540.9	551.2	554.8	620.8	1091.0	840.4
2021 Average	607.1	614.7	427.4	663.4	578.7	563.8z	999.3	462.6
2019 % Pass	0%	0%	6%	0%	0%	0%	0%	0%
2020 % Pass	0%	0%	0%	0%	25%	6%	0%	0%
2021 % Pass	0%	0%	7%	0%	0%	0%	0%	0%

Precipitation Trends

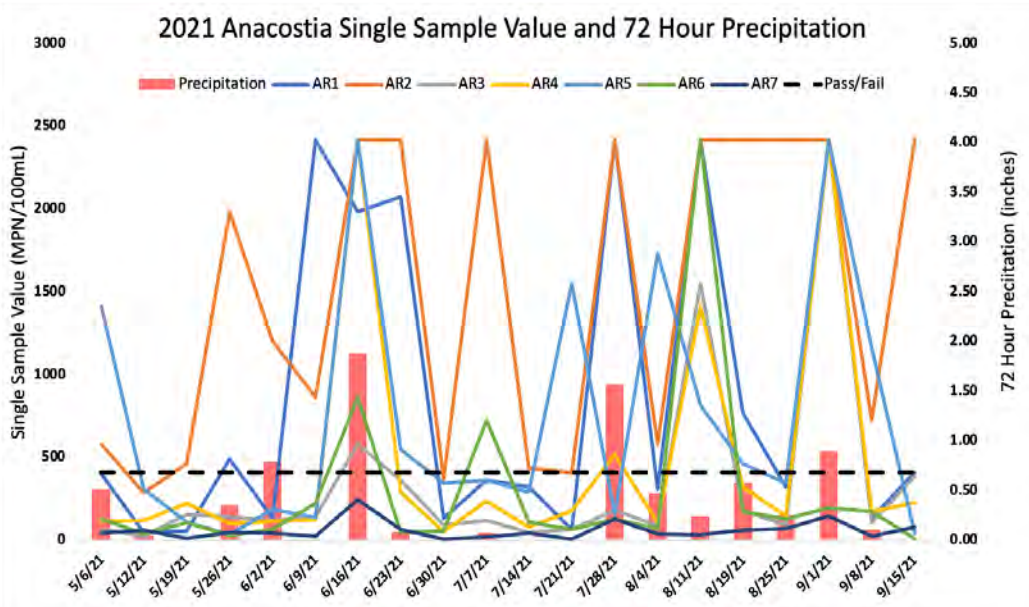
In urban waterways, precipitation is believed to be a primary driver of elevated bacteria counts with an excess volume of stormwater serving as a vector for sources of potential bacterial pollution like animal waste and sewage. Regional precipitation totals fluctuated each sampling year (May to September) with 2019 and 2020 recording 17.97" and 21.11" of rain, respectively, while 2021 was higher at 26.77" recorded at DCA. 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.



Anacostia Precipitation Trends

From 2019 to 2021 the seven sites along the Anacostia River displayed a range of behavior when it came to bacteria counts and safety for potential recreation. For this program, we categorized any sampling period with more than 0.5" of rain up to 72 hours beforehand as "wet" weather conditions and anything below 0.5" of rain as "dry" weather conditions. For three years of monitoring on the Anacostia from 2019 to 2021 the average single-sample passing rate for bacteria was 71% during "dry" conditions and 50% during "wet" conditions, marking a 30% decrease in passing rates when at least 0.5" has fallen up to 72 hours before sampling. Looking at Anacostia single-sample passing rates over the three years, elevated precipitation totals in 2020 could explain the lower passing rates along Anacostia sites; a trend mirrored across the Potomac and Rock Creek watersheds as well.

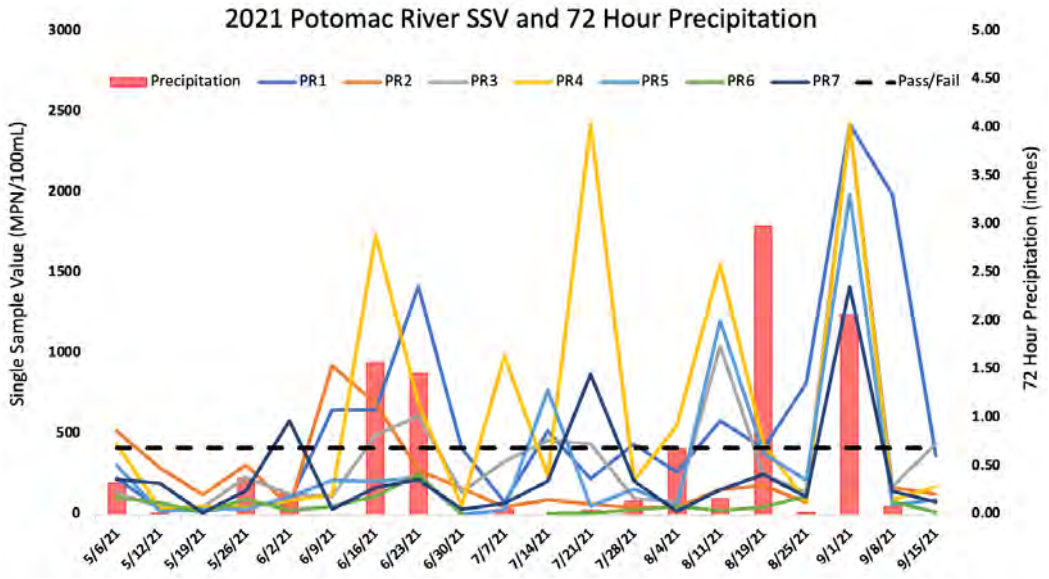
An issue of particular importance with relation to precipitation is "dry" weather conditions with low passing rates (<50%), or put simply, weeks with little to no rainfall but high bacteria counts. In 2019 the Anacostia recorded four such weeks, while only two were recorded in 2020 and one in 2021. High bacteria counts during "dry" conditions are particularly hazardous to the common recreator as they may base their recreation on that week's rainfall, meaning they decide to recreate in "dirty" water unbeknownst to them because of the lack of rainfall. 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, however, that on the Anacostia when these "dry" weather high bacteria counts occurred, they primarily occurred in sites either in close proximity to CSOs or at upstream sites. Sites located further from CSOs, and nearer the confluence with the Potomac, like AR-6 (Buzzard Point) and AR-7 (Washington Channel) 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 lower on the Anacostia, increasing their overall recreation potential.



Potomac Precipitation Trends

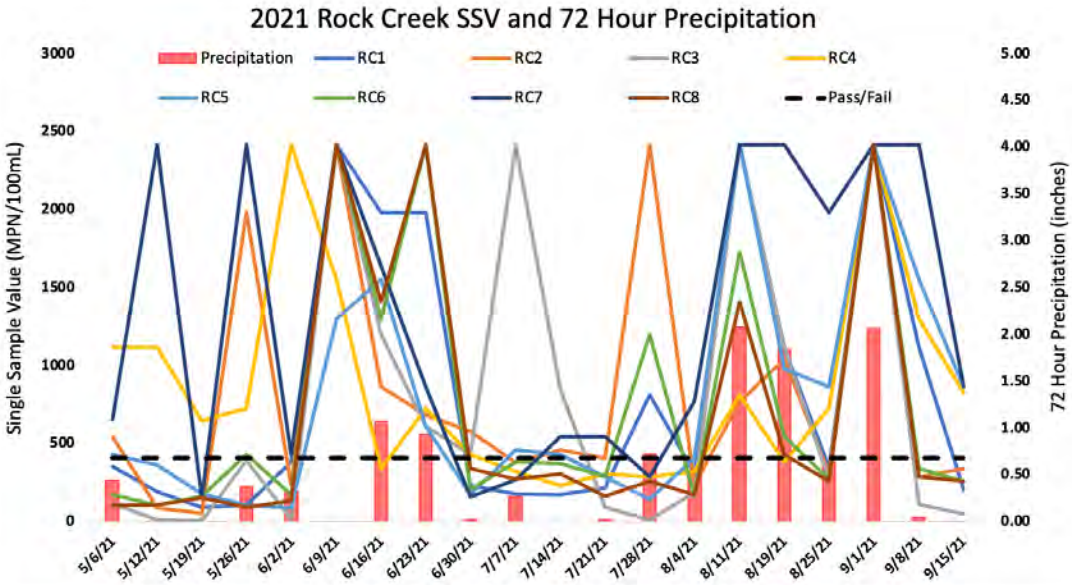
The Potomac river is the largest body of water in the District of Columbia. It continues to be a popular site for recreation, and offers opportunities from hiking, kayaking, and boating tours, to name a few. Data collected from monitored Potomac River sites all display spikes in bacteria and turbidity 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 PR-4 (Washington Canoe Club, as described above). This is expected due to the increase of the width and depth of the river as it travels to the Chesapeake Bay. While data shows that the Potomac's tributaries experience extreme variability during both wet and dry conditions.

As the Potomac river widens, generally turbidity decreases, and bacteria levels are lower. Columbia Island (PR-7) provides consistent data showing significant decreases of these two variables. Hurricane Ida passed through D.C. on September 1, 2021, leaving around 3 inches of rainfall along the Potomac River sites, causing high bacteria levels throughout the watershed. Columbia Island (PR-7) bacteria levels, while high, continued to be the lowest of the Potomac River sites. While the Tidal Basin (PR-6) data show a consistent trend of the lowest bacteria and turbidity levels, water retention structures (the dam and concrete barriers) as well as a restricted use park may be large contributors to the better overall water quality.



Rock Creek Precipitation Trends

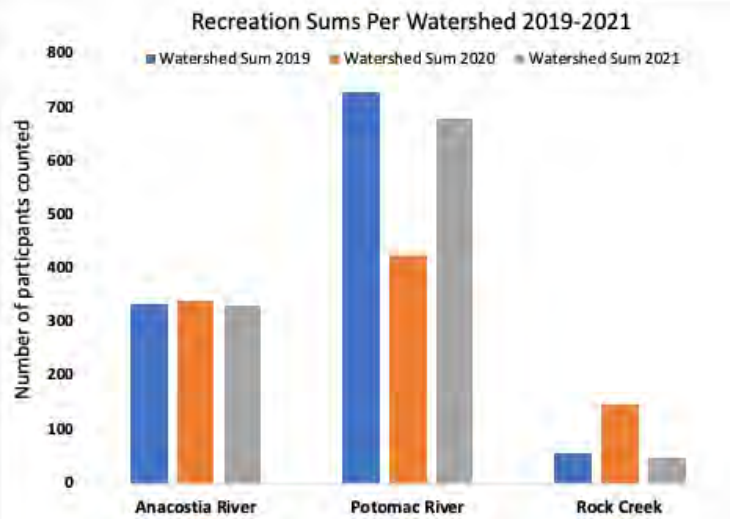
Precipitation during the 2021 monitoring season was higher than it was in the previous two years. There was 9.45 inches of rainfall in the 2021 season observed during 72-hour windows preceding monitoring, as opposed to 6.10 inches in 2019 and 7.9 inches in 2020. The expected impact of the increase in rainfall would be a lower passing rate of sites due to increased stormwater runoff, however, in Rock Creek, the 2021 season had the highest average passing rate of 47% (this number is not with respect to specific sites -- this represents the observation that 47% of all bacteria single-samples collected in 2021 passed their threshold). This was an increase over all of the previous years; the passing rate was 45% in 2019 and 43% in 2020.



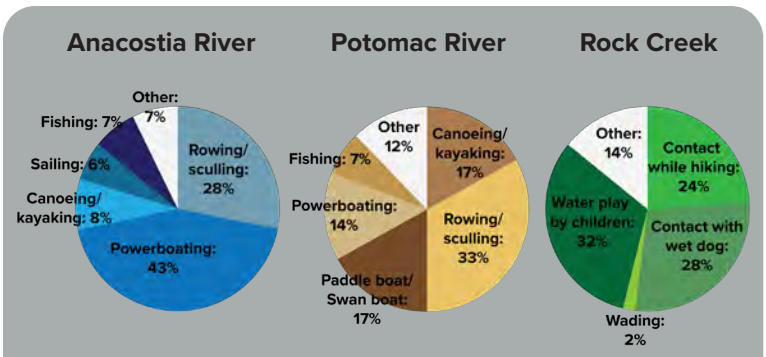
Generally, weeks with higher precipitation corresponded to a lower passing rate. Most of the weeks that experienced greater than 0.5 inches of rain also had lower passing rates. Weeks 6 and 18 were exceptions to this observation, where there was virtually no rain and a 0% passing rate across the Rock Creek sites.

Recreational Use Trends

All three District waterways see weekday recreational use throughout the summer. The Potomac River generally had the highest number of participants recreating on the water with Rock Creek seeing the lowest. Rock Creek and the Potomac River saw fluctuations in the amount of recreation occurring from year to year with fluctuations likely connected to the COVID-19 pandemic. The Anacostia did not experience the same fluctuations with nearly the same number of recreants each year.



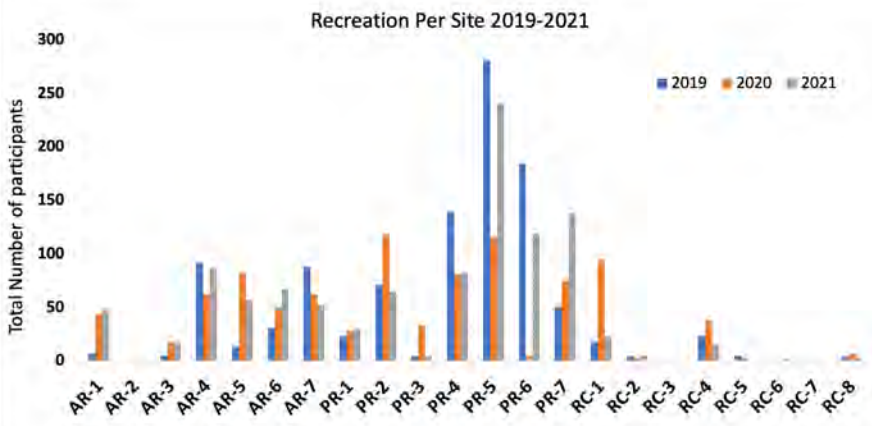
Most of the recreation activities on the Anacostia River were recorded starting at Anacostia Park (AR 4) moving downriver towards the Washington Channel (AR-7) which coincides with the portions of the river with generally better water quality. Except for Yards Marina (AR-5), the sites that recorded the most activity on the Anacostia, also passed for water quality most of the time for single-sample value (greater than >75 percent passing). Yards Marina only passed 40% of the time, suggesting that recreators would want to limit contact with the water at this location much of the time. The most common types of recreation at Yards Marina were rowing/ sculling and powerboating. Future outreach could focus on connecting with powerboaters through the local marinas and rowing clubs to ensure these groups are aware of the weekly bacteria data.



Main categories of recreation recorded in each watershed from 2019-2021.

In the Potomac, there was a clear differentiation between the types of recreation seen at the mainstem sites compared to the tributary sites. While the mainstem sites saw the majority of recreation, particularly at Fletchers Cove and Thompson Boat Center, there was some seen at the tributary sites. Most recreation on the mainstem was secondary contact activities, such as canoeing, kayaking, fishing, rowing, and power boating (with a few instances of water play by children at Fletchers Cove). The tributary sites (Battery Kemble Park and Foundry Branch) saw more high contact activities like contact with water while hiking/crossing streams and contact with wet dogs after playing in water.

Over the course of three years of observation, recreational use in Rock Creek was concerning given the high levels of bacteria recorded at these sites. Recreational use - mostly people wading, crossing, or playing with dogs in the creek- peaked in 2020 due to the pandemic's closure of public pools and spray parks. Rock Creek Conservancy and the National Park Service implemented the #Recreate Responsibly campaign to educate visitors about the safe ways to enjoy Rock Creek.



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

Recreational use has been most prevalent at Juniper Street (RC-1), near a residential neighborhood, and Soapstone Creek, 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.

Conclusions

DOEE has stated an intention to ultimately lift the swimming ban on District waterbodies and has funded our work in order to advance scientific and community understanding of safety in our immense aquatic 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. But the need to reduce bacterial pollution continues, not only in those places where CSOs continue to discharge raw sewage (Potomac 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. And 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. Today, with the swimming ban in place, families having cookouts in Rock Creek Park enjoy splashing in the creek. Hikers and dog walkers get wet crisscrossing tributaries. Boaters get splashed or fall out of their crafts on the larger rivers. The Nation's Capital, bound together by its three major waterways, should provide residents with the opportunity to swim and cool off everywhere--increasingly important as the climate crisis makes our summers hotter and hotter, as well as stormier. Let's get the bacteria out and get DC swimming again!

My photos are my testimonial. There is always the one nature shot that never ceases to amaze us of the natural beauty that exists with the DMV. Of course, we strive to see and experience such beauty - make it a timeliness adventure, experience, sensation.
The ying-and yang of it demands that we submit and inspect those pictures that make us recall the heat, humidity, that smell, a foul smell? How much of that decay is natural or man made? Wait, how much of those tranquil pictures hide the hidden bacteria that make our flowing streams a look-but-don't touch cautionary tale of our abuse of environment?

-Robert Fabia

THANK YOU VOLUNTEERS!

This project would not succeed without the dedication of all our volunteers who, for the past three 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

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GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

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ALLIANCE for the Chesapeake Bay