



MIAMI  
WATERKEEPER®

# Report to the City of Fort Lauderdale: Weekly Waterway Monitoring

YEAR 4

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CITY OF FORT LAUDERDALE



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## EXECUTIVE SUMMARY

Miami Waterkeeper (MWK), in partnership with the City of Fort Lauderdale, has been conducting waterway quality monitoring at ten high-use recreational sites from January 2021 to December 2024. This initiative provides residents and visitors with real-time data through the Swim Guide app, social media, and the Miami Waterkeeper website, helping them make informed decisions about conducting recreational activities while enjoying local waters.

In August 2023, the MWK monitoring sites were adjusted to reflect locations which were entry points for recreational use of the waterways for reporting to the Swim Guide App. The City continues to actively monitor two of the previous monitoring sites (Himmarshee and Tarpon River) which did not fit this criterion.

The focus of the monitoring has been on enterococci, a bacteria commonly used to indicate the presence of potential contaminants from human or animal waste. While enterococci itself is not harmful, its presence in high concentrations can signal the risk of more dangerous pathogens. Key sources of contamination include stormwater runoff, wastewater discharges, and wildlife activity. However, enterococci can persist in the environment even when new sources of pollution are not present, which makes interpreting the data complex. Environmental factors, such as temperature and salinity, also influence bacterial survival rates, adding another layer to the proper evaluation and interpretation of this type of water quality data.

Over the course of the monitoring program, the frequency of exceedances for the Florida Department of Health (DOH) standard for swimming beaches has steadily increased. By 2024, the number of exceedances had reached 270, up from 74 in 2021. This increase is influenced by several factors. While elevated FIB levels, such as enterococci, indicate potential fecal contamination, they do not pinpoint the source of the high levels. Enterococci can persist in the environment under favorable conditions and originate from multiple sources, including human sewage, wildlife, pets, and runoff. Storm events, in particular, can exacerbate levels by flushing these bacteria into water bodies. Additionally, changes in monitoring site selection, along with the number and intensity of rain events, contribute to variability in FIB levels.

This upward trend is particularly evident at sites like Sweeting Park, Middle River NE 18th St Dock, and Annie Beck Park, which consistently recorded the highest levels of fecal-indicating bacteria during 2024. It should be noted that these sites are inland and subject to a less conservative enterococci regulatory standard (Florida Department of

Environmental Protection (DEP) than the standard at swimming beaches. Sites designated by the City under Section 8-166(c) of the City Code of Ordinances for watersports activities—Sandbar, Middle River at George English Park, Lake Sylvia, and Sunrise Bay at Hugh Taylor Birch Park—have the highest rate of passing the DOH standard.

The analysis also revealed significant relationships between environmental factors and enterococci levels. Rainfall, chlorophyll a, and turbidity were all positively correlated with increased bacterial concentrations, while salinity and dissolved oxygen showed negative correlations. These findings suggest that environmental conditions play a crucial role in shaping waterway quality in these waterways and highlight areas for further study and intervention.

In conclusion, this monitoring effort has provided invaluable insights into these waterway quality trends, emphasizing the need for continued vigilance and targeted actions at the most impacted recreational sites.

## HIGHLIGHTS

### FOUR YEARS OF WATERWAY QUALITY MONITORING (2021 - 2024)

*All metrics below exclude the discontinued sites and resamples unless noted otherwise.*

- Miami Waterkeeper analyzed 2,961 samples across the four years, including the discontinued sites and the resampled sites (2,070 samples, 891 resamples)
- Rising exceedances: Yearly exceedance rate of DOH recommended enterococci threshold for safe water contact in beaches. These numbers include all sites that were monitored over the years, including the discontinued sites.
  - 2021: 40% exceedance rate (500 weekly samples collected)
  - 2022: 39% exceedance rate (508 weekly samples collected)
  - 2023: 44% exceedance rate (515 weekly samples collected)
  - 2024: 51% exceedance rate (529 weekly samples collected)
- The geometric mean of enterococci levels rose from 34.5 MPN (most probable number) per 100 mL in 2021 to 80.7 MPN/ 100 mL in 2024.
- The median enterococci concentration has increased over the years, rising from 31 MPN/100 mL in 2021 to 74 MPN/100 mL in 2024, reflecting a similar upward trend observed in the geometric mean values.
- During 2024, 270 samples exceeded the DOH threshold for swimming beaches (70 MPN/ 100 mL), and 194 failed in resampling.
- Sites with the Greatest Number of Exceedances (2024):
  - Sweeting Park had the highest number of exceedances, surpassing DOH standard 94% and DEP standard 92% of the time.
  - Middle River Dock exceeded DOH standard 87% and DEP standard 77% of the time.
- Site with the Highest Passing Rate (2024):
  - Sunrise Bay at Hugh Taylor Birch State Park (met the DOH threshold 95% of the time).
- 2024 relationships between parameters: Correlations between enterococci and rainfall, salinity, temperature, and dissolved oxygen varied across sites, with notable patterns such as strong correlation with rainfall at Sweeting Park and Cooley's Landing, and negative salinity correlations at several locations.
- There were 42,924 total Swim Guide views at City of Fort Lauderdale-sponsored locations (11,509 in 2021, 10,652 in 2022, 11,280 in 2023 and 9,483 in 2024)
  - Recreational area with the most views in 2024: Sandbar
  - Recreational area with the least views 2024: Sunrise Paddleboards

## INTRODUCTION

Florida's beaches and waterways are the state's top tourist attractions, driving its \$112 billion annual tourism industry. In Miami-Dade County, Biscayne Bay alone contributes approximately \$64 billion each year, with residents and visitors spending an estimated 119.8 million days enjoying its waters. These recreational activities generate \$15.1 billion annually, highlighting the essential role clean water plays in South Florida's economy and way of life.

However, South Florida's waters are particularly vulnerable to pollution due to low elevation, porous limestone geology, aging infrastructure, and rising sea levels. Without proper protection, our ocean economy, jobs, recreation, environment, and culture face significant risks. Failing to safeguard these waters jeopardizes the future of our coastal communities.

The City of Fort Lauderdale hosts a thriving community fueled by tourism, recreation, and real estate. The recreational use of its waterways is valuable to Broward County's economy; however, despite its importance to the community, relatively little data about waterway quality was readily available to the residents or visitors who use the waterways for recreation. While the Florida Department of Health (DOH) monitors for Fecal Indicator Bacteria (FIB) through its Florida Healthy Beaches program, the data is hard to find and only focuses on beaches rather than inland waterways such as canals, rivers, or lakes. While there is a higher potential for ingestion of the bacteria while swimming at the beach, the canals and rivers are often used by residents and visitors who enjoy kayaking, paddle boarding, canoeing, and other recreational watersports.

Over the past four years, Miami Waterkeeper has partnered with the City of Fort Lauderdale to close these gaps. Our weekly waterway quality monitoring program emulates the DOH methodology and frequency for ten inland waterways for which publicly accessible waterway quality data is a necessity. Miami Waterkeeper makes the FIB data available to the public as soon as it is available, along with the DOH data, through the Swim Guide app and social media so that residents and visitors can make informed decisions before interacting with the inland waterways in the City of Fort Lauderdale. While the City of Fort Lauderdale is the only municipality in Broward County with FIB data actively shared through Swim Guide and Miami Waterkeeper's social media, it is not the only entity collecting such data. Broward County, through its [Environmental Monitoring Laboratory](#) and a county-funded monitoring program, has collected and analyzed [FIB](#) and [MST](#) data across various locations. Some of this information is publicly accessible, such as through the Broward County MST and FIB dashboards hosted on their GIS platform. However, the dashboard does not appear to be regularly updated.

Waterway quality issues can significantly impact the health of individuals who come into contact with recreational waters. For residents and visitors, access to reliable waterway quality data is essential for making informed decisions and minimizing health risks. The City of Fort Lauderdale is actively addressing waterway quality concerns, including promptly

addressing Sanitary Sewage Overflows (SSOs), which can temporarily elevate FIB levels.

Thanks to ongoing infrastructure investments, these incidents have been significantly reduced in recent years.

By consistently monitoring waterway quality at the same locations over time, we can establish baseline conditions and keep the public informed about any changes. This report summarizes four years of weekly sampling data collected from ten sites across the City of Fort Lauderdale.

## ABOUT MIAMI WATERKEEPER

Miami Waterkeeper, a Miami-based nonprofit founded in 2010, is dedicated to protecting South Florida’s coastal waters and surrounding watershed. As a leading advocate for clean water, we empower citizens to achieve swimmable, drinkable, and fishable water for all. Through community outreach, scientific research, and civic and legal action, we tackle environmental, social, and policy issues impacting waterway quality.

Our mission centers on protecting South Florida’s waters by advocating for resilient solutions grounded in science, rooted in nature, and driven by community.

Serving more than 5 million people across Miami-Dade and Broward counties, our jurisdiction includes the mid-section of the Florida Reef Tract. As part of our science and research efforts, Miami Waterkeeper’s water quality monitoring program samples 25+ locations weekly in both counties, testing for the FIB enterococci. We promptly share results with the public to ensure the waters are safe for swimming and recreation.



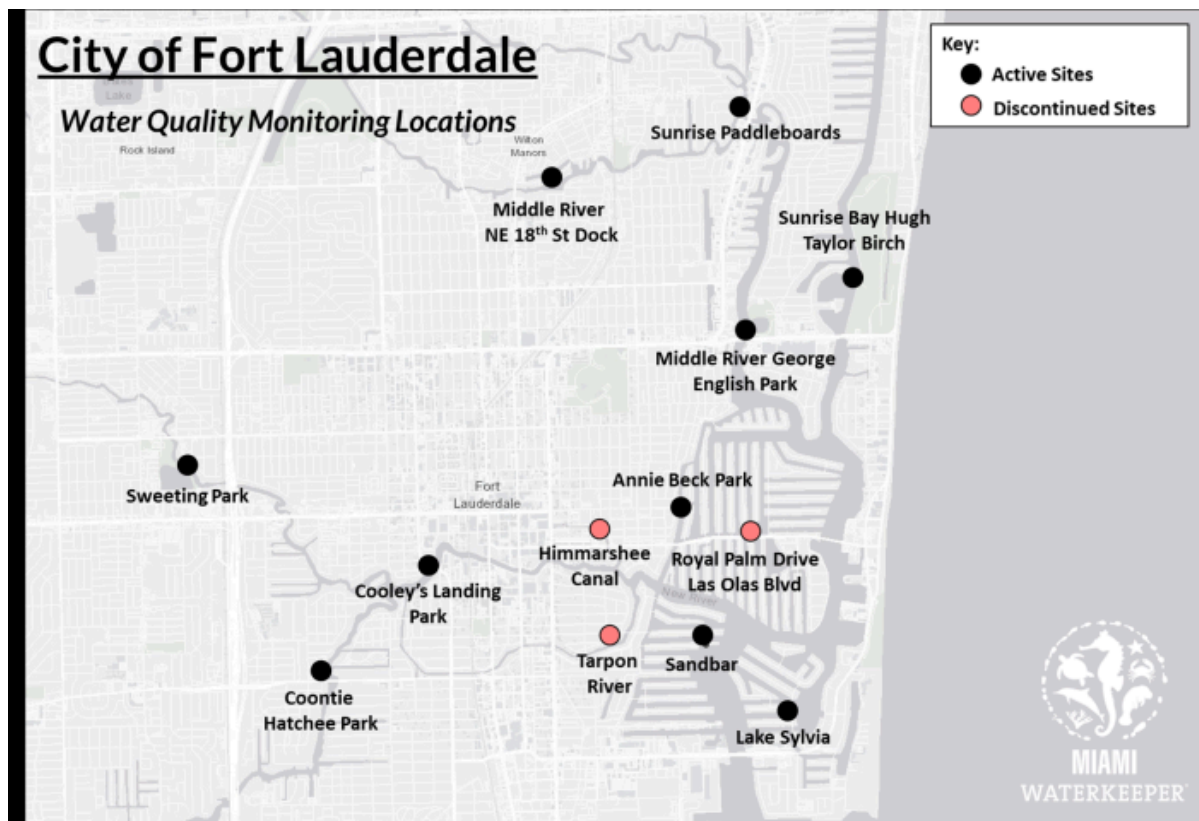
## ABOUT THIS PROGRAM

The City of Fort Lauderdale initially contracted with Miami Waterkeeper on November 13, 2020, to expand waterway quality monitoring to inland waterways, focusing on areas of high recreational value. The contract was renewed to include sampling throughout 2025, and includes the right to extend the agreement for two (2) additional one-year terms.

The aims of the contract were to:

- Provide weekly waterway quality monitoring at ten City of Fort Lauderdale sites
- Provide a baseline understanding of FIB in local waterways
- Inform the local community about waterway quality monitoring results

In 2023, the contract was amended to replace three sites with sites of higher recreational value. The City of Fort Lauderdale continues to monitor FIB in the Himmarshee Canal and Tarpon River. While results from these sites are available in MWK's public spreadsheet and are also shared on Swim Guide, they are not analyzed in this report, as the data are collected independently of our monitoring program contract.



**Figure 1.** Map of the ten sites that are monitored for waterway quality by Miami Waterkeeper, including the three discontinued sites. All monitoring is sponsored by the City of Fort Lauderdale. Independent of this contract, all of the discontinued sites are being sampled by either the City of Fort Lauderdale or Miami Waterkeeper and reported to Swim Guide weekly.

**Site Descriptions:**

Ten locations in the City of Fort Lauderdale were selected in coordination with the Public Works Department (**Figure 1**). These included:

**Annie Beck Park (ABP)** is approximately 2.4 acres and is located in the Victoria Park neighborhood. It is located next to the Rio Navarro canal. It offers amenities such as nature trails, open areas, and waterfront suitable for kayak launching.

**Coontie Hatchee Park (CH)** (South Fork of the New River) is approximately 2.6 acres along the South Fork of the New River and has amenities such as a kayak/canoe launch, waterfront views, bicycle racks, fitness trail with stations, picnic tables and pavilions.

**Lake Sylvia (LS)** is designated by the City of Fort Lauderdale as a Watersports Activity Area suitable for water skiing, tubing, kneeboarding, and wakeboarding. Lake Sylvia is within the Harbor Beach neighborhood.

**Middle River at George English Park (MRGE)** is designated by the City of Fort Lauderdale as a Watersports Activity Area suitable for water skiing, tubing, kneeboarding, and wakeboarding. George English Park is approximately 19.7 acres and offers amenities such as kayaking, paddleboarding, fishing, boat access/ramp, and walking/jogging trails.

**Sandbar (SBR)** is designated by the City of Fort Lauderdale as a Watersports Activity Area suitable for water skiing, tubing, kneeboarding, and wakeboarding. It is also a popular area for boaters to moor and enjoy the water.

**Sunrise Bay at Hugh Taylor Birch State Park (SBHT)** is designated by the City of Fort Lauderdale as a Watersports Activity Area suitable for water skiing, tubing, kneeboarding, and wakeboarding. Sunrise Bay is within the Coral Ridge neighborhood and is adjacent to Hugh Taylor Birch State Park. Hugh Taylor Birch is the city's own "Central Park," complete with gopher tortoises and boat access from the intracoastal waterway.

**Sweeting Park (SWP)** (North Fork of the New River) is approximately 0.3 acres along the North Fork of the New River and has amenities such as fishing, a dock, and park benches.

*Added Sites - initiated August 8, 2023*

**Cooley's Landing Park (CL)** is a 2.96 acre park offering boat ramps, fishing, picnic areas, and waterfront walkways. The marina is dedicated to William Cooley, one of Fort Lauderdale's founding settlers.

**Middle River NE 18th St Dock (MRD)** is located in a residential community on 18th Street in Middle River. This small dock offers water access and features a floating dock to launch paddleboards and kayaks.

**Sunrise Paddleboards (SPB)** is a popular surf shop that offers paddleboard rentals and guided tours on Middle River.

*Discontinued Sites - sampled under contract until August 1, 2023*

**Himmarshee Canal (HC)** was a tributary of the New River, historically a major artery in and out of the Everglades. The word translates to "new water" or "new river." The Himmarshee Canal now starts near US1/Federal Highway and traverses the neighborhoods of Colee Hammock and Beverly Heights as it flows under Las Olas Blvd and out to the New River. Floating vegetation, foam/organic film on the water's surface, and slow flow are frequently noted at this site. Independent of this contract, the City is continuing FIB sampling at this location.

**Royal Palm Drive at Las Olas (RPLO)** is located within the Nurmi Isles neighborhood north of Las Olas Blvd. The Isles were dredged in the 1920's to create land for one of the City's most picturesque waterfront residential districts. Independent of this contract, Miami Waterkeeper is continuing FIB sampling at this location.

**Tarpon River (TR)** at Rio Vista Boulevard intersects with the New River at two locations, SW 8th Ave and Ponce De Leon Drive. The Tarpon River traverses the neighborhoods of Tarpon River, Downtown Fort Lauderdale, and Rio Vista. Independent of this contract, the City is continuing FIB sampling at this location.

## METHODS

This monitoring program implements Miami Waterkeeper's FIB protocols to include ten sites of high recreational value in the City of Fort Lauderdale. Samples have been collected weekly at all sites, with resampling and reanalysis conducted whenever FIB levels exceed the 70 MPN threshold.

### *Sample Collection*

Samples were collected weekly, following the U.S. Environmental Protection Agency (EPA) Method 1600 protocol and Florida DOH standards for enterococci monitoring. Field technicians, including recent graduates and students, were trained in sample collection, processing, and analysis.

Water samples were taken 6-12 inches below the surface to represent recreational conditions. Care was taken to avoid disturbing sediments or introducing contamination. Samples were placed on ice within 15 minutes of collection. A field blank was included with each sampling batch, and one random site was sampled in duplicate. A temperature control bottle was also used to confirm that samples remained below 6°C during transport. Photographs were taken to document the sampling sites.

### *Sample Processing and Analysis*

Upon returning to the laboratory, samples were processed using the IDEXX Enterolert system, which employs a defined-substrate method to detect and quantify enterococci. A 1/10 dilution of the water samples was performed, as recommended by IDEXX for marine waters. The water sample was mixed with IDEXX Enterolert reagent and incubated for 24-28 hours at  $41^{\circ} \pm 0.5$  °C. After incubation, samples were analyzed under UV light to count the Most Probable Number (MPN) of enterococci, based on fluorescent wells (Figure 2).

Sterilized sampling bottles, sanitized using an autoclave, were used for all collections, and gloves were worn during handling to prevent contamination. Regular calibration of instruments ensured accurate results.



*Figure 2. IDEXX Enterolert system workflow: This figure outlines the IDEXX Enterolert workflow for detecting enterococci in water samples. It begins with collecting grab samples, which are transported to the lab, where a substrate reagent is added. The sample mixture is then poured into a Quanti-Tray, sealed, and incubated overnight. The next day, results are read under fluorescent light to identify and count positive wells, providing an estimate of the most probable number (MPN) of enterococci present in the sample.*

### Quality Assurance

To maintain rigorous quality assurance (QA) throughout the monitoring program, several measures were implemented:

1. Field and Laboratory Blanks: Every sampling batch included a field blank to assess collection and handling techniques and a laboratory blank to evaluate aseptic techniques, laboratory sanitation practices, and equipment sterility.
2. Audits: Field technicians underwent audits in the first month of independent sampling, followed by biannual audits and additional random audits as necessary. Laboratory technicians were similarly audited after their initial month of independent analysis, with follow-up audits conducted every six months.
3. Chain of Custody: A documented chain of custody was maintained for all samples to ensure their integrity from collection to analysis. This included logging the date, time, location, and personnel involved in each sampling event.
4. Documentation: Images of each IDEXX tray were taken during UV analysis for documentation and traceability of results.
5. Sample Integrity: The integrity of samples was ensured through the use of sterilized sampling bottles, which were sanitized using an autoclave, and gloves were worn at all times during sample handling to prevent contamination.
6. Calibration of Instruments: Routine calibration of field instruments and equipment was conducted to maintain accuracy in measurements and analysis.

### **Quantitative PCR Source Tracking**

In an effort to better understand potential sources of elevated FIB at select monitoring sites, MWK conducted molecular source tracking analyses using quantitative PCR (qPCR). While not part of the City of Fort Lauderdale monitoring contract, this preliminary analysis was conducted to provide additional context on possible sources of pollution. Water samples were collected from Middle River Dock, Royal Palm Las Olas, and Sweeting Park on May 7, 2024, and represent a single sampling event.

Samples were filtered and sent to [Jonah Ventures](#), an environmental DNA laboratory based in Boulder, Colorado, for analysis. DNA was extracted from water samples and subjected to qPCR amplification targeting the NADH dehydrogenase, subunit 5 (*ND5*) gene for human, bovine, and swine sources, and the Cytochrome b (*Cytb*) gene for dog, poultry, and sheep sources. The qPCR reactions were carried out on the QuantStudio 5 qPCR instrument, with an initial denaturation step at 95°C for 5 minutes, followed by 50 cycles of denaturation at 95°C for 15 seconds and annealing at 60°C for 1 minute. Each reaction contained QuantaBio PerfeCTa Multiplex qPCR ToughMix, primers, probes, and genomic DNA, with a total reaction volume of 20 µL.

Each qPCR run included a 7-point, 10-fold serial dilution of standards to generate calibration curves for absolute quantification. Reaction efficiency and fit ( $R^2$ ) were used to evaluate assay performance, aiming for efficiencies between 85–110% and  $R^2 > 0.98$ . qPCR reactions were run on the QuantStudio 5 platform, utilizing a multiplex format when applicable to amplify multiple targets within a single reaction.

These results are considered preliminary and are intended to inform future monitoring and targeted source identification efforts.

### **Environmental Data**

A datasonde is utilized to collect water quality parameters, including temperature, dissolved oxygen (mg/L), salinity (ppt), turbidity (NTU), and chlorophyll (µg/L), immediately after each sample collection. Additionally, we record observational data on environmental conditions at the time of sampling, such as weather, tide, air temperature (°C), and rainfall (inches). Wind speed and air temperature data are obtained from the NavClock app, which sources information from National Oceanic and Atmospheric Administration (NOAA) weather sites. Cumulative rainfall data for 24, 48, and 72 hours prior to sampling events and tide information is retrieved from the NOAA National Centers for Environmental Information (NCEI) database.

### *Documentation and Data Management*

Data is recorded on a datasheet and manually entered into a master spreadsheet maintained on Google Drive by a technician. The Science & Research Manager conducts audits and analyzes all entered data to ensure quality assurance and accuracy. Scans of the datasheets, along with images documenting field and laboratory quality control protocols, are stored on Google Drive for easy access and reference. After sample analysis, the Science Engagement Coordinator reviews the results and publishes the results on Swim Guide.

### *Statistical analysis*

#### Enterococci Criteria for Safe Recreational Water Contact

In Florida, the Department of Environmental Protection (DEP) uses enterococci bacteria as a fecal indicator bacteria (FIB) to assess water quality in Class III surface waters, which are designated for recreation and the protection of fish and wildlife. These criteria, outlined in the Florida Administrative Code (FAC) 62-302, specifically apply to predominantly marine waters. According to FAC 62-302.530, enterococci levels must not exceed a monthly geometric mean of 35 MPN or MF counts per 100 mL, nor exceed the Ten Percent Threshold Value (TPTV) of 130 MPN or MF counts per 100 mL in more than 10% of samples within a 30-day period. Alongside environmental regulatory thresholds, the [Florida Healthy Beaches Program](#) provides public health guidance using a single-sample threshold of 70 MPN per 100 mL as an advisory limit for potential health risks. Exceedances of these regulatory and public health thresholds indicate possible fecal contamination, which may pose risks to human health and aquatic ecosystems. The statewide DOH testing program monitors enterococci bacteria due to their stronger correlation with swimming-associated gastrointestinal illness in both marine and freshwater environments compared to other bacterial indicators. The following are the enterococci categories that the DOH uses to determine the quality of the water as part of the Florida Healthy Beaches Program.

- 0-35 MPN/CFU enterococci per 100 mL sample: **Good**
- 36 – 70 MPN/CFU enterococci per 100 mL sample: **Moderate**
- 71+ MPN/CFU enterococci per 100 mL sample: **Poor**

In this report, exceedance rates were calculated annually for the full monitoring period and for each site in 2024. The exceedance rate reflects the proportion of samples surpassing the DOH threshold of 70 MPN/100 mL and the DEP threshold of 130 MPN/100 mL. This rate is determined using the following formula:

$$\text{Exceedance Rate} = \left( \frac{\text{Number of exceedances}}{\text{Total samples collected}} \right) \times 100$$

### Testing for Differences Between Sampling Sites

Data analysis was conducted to assess differences in enterococci levels among sampling sites for the 2024 data. The Shapiro-Wilk test confirmed that enterococci data at each site did not meet the assumptions of normality, and Levene's test indicated that variances were not homogeneous. Consequently, an ANOVA was not performed. A log transformation of the enterococci data was applied to address these violations; however, the Shapiro-Wilk and Levene's tests still showed that normality and homogeneity assumptions were not met. Given these violations, the Kruskal-Wallis test, a non-parametric alternative to ANOVA, was used to determine whether significant differences existed among sampling sites. If the Kruskal-Wallis test yielded a significant result ( $p < 0.05$ ), a post-hoc Dunn's test with Bonferroni correction was performed to identify specific pairwise differences between sites while controlling for multiple comparisons. Statistical analyses were conducted using R, and significance was set at  $\alpha = 0.05$ .

### Assessing Relationships Between Environmental Parameters and Enterococci Levels

To evaluate the relationships between enterococci levels and various environmental parameters, a Kendall rank correlation analysis was conducted on the selected numeric variables, including 24-hour, 48-hour, and 72-hour rainfall, water temperature, salinity, turbidity, and chlorophyll concentration. Kendall's tau was chosen because it is effective at assessing the strength and direction of monotonic relationships, particularly in cases where data may exhibit non-linear patterns. This method is less sensitive to outliers and provides a more robust assessment of correlations in non-normally distributed data. Correlation coefficients and corresponding p-values were calculated to evaluate the strength and significance of these relationships.

### **Swim Guide**

We publish our water quality testing information along with the water quality testing information produced by the state DOH for Broward County beaches via the Swim Guide application, our social media channels, and on our website.

Swim Guide utilizes an easy-to-read format, with green indicating “good ” water quality and red indicating “poor” water quality. Enterococci results that fall within the “moderate” range are reported as “good” on [Swim Guide](#). Numeric data are also available for the public to download on our website.

The app utilizes an easy-to-read format, with **green** indicating good water quality (0-70 CFU/MPN enterococci per 100 mL sample) and **red** indicating poor water quality (71+ CFU/MPN enterococci per 100 mL sample). Historical data is also accessible. All of our weekly monitoring sites and the most recent results are available to the public for easy access.



**Download the  SWIM GUIDE app.**

- 1 Download the Swim Guide App**  
Available in the App Store and on Google Play.
- 2 Search for your beach**  
Free real-time water quality information for over 7,000 beaches, lakes, rivers, and swimming holes all over the world.
- 3 Find out the water quality**  
Use the water quality icons to find out if your beach is safe for swimming.

**Current Status**

-  Most recent test results met water quality standards
-  Most recent test results failed to meet water quality standards
-  Water quality information is too old to be considered current

**Historical Status**

-  Beach passed water quality tests 95% of the time
-  Beach passed water quality tests 60-95% of the time
-  Beach failed water quality tests 40% of the time or more

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## RESULTS

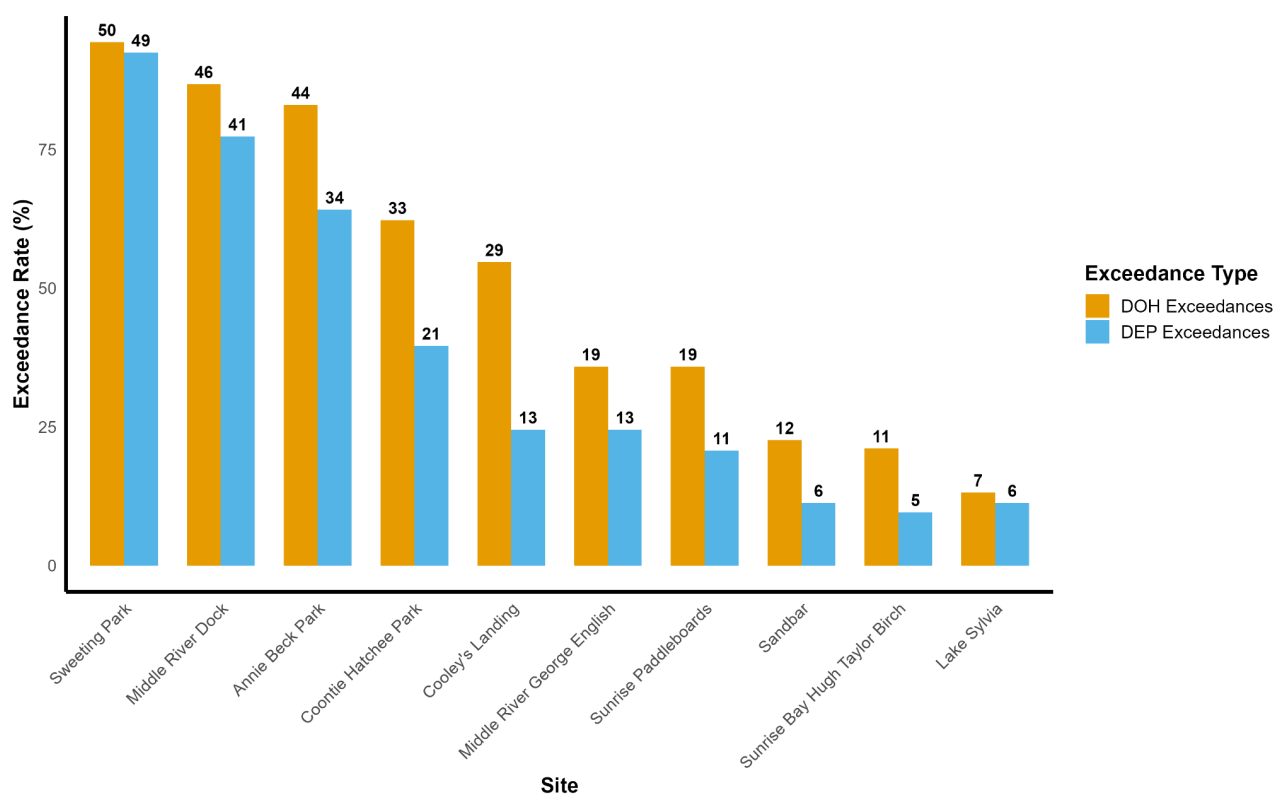
### Waterway Quality Results in 2024

Since the launch of this monitoring program, Miami Waterkeeper has collected 2,349 water samples, including 680 resamples. Of these, 782 samples were collected in 2024, which included 253 resamples. For the purposes of this report, waterway results are provided without accounting for resamples, unless stated otherwise.

#### *Enterococci Exceedances of DOH and DEP Criteria in 2024*

The following summarizes the frequency of water quality exceedances at various monitoring sites in 2024, based on DOH and DEP standards. Percentages indicate how frequently each location exceeded the safety standards for swimming established by the respective agencies (Figure 3, Table S1).

- Sweeting Park: Exceeded DOH threshold 94% of the time and DEP threshold 92% of the time.
- Middle River Dock: Exceeded DOH threshold 87% of the time and DEP threshold 77% of the time.
- Annie Beck Park: Exceeded DOH threshold 83% of the time and DEP threshold 64% of the time.
- Coontie Hatchee Park: Exceeded DOH threshold 62% of the time and DEP threshold 40% of the time.
- Cooley's Landing: Exceeded DOH threshold 55% of the time and DEP threshold 25% of the time.
- Lake Sylvia: Exceeded DOH threshold 13% of the time and DEP threshold 11% of the time.
- Middle River George English, Sandbar, and Sunrise Paddleboards: DOH exceedances ranged from 21% to 36%, and DEP exceedances ranged from 11% to 21%.



**Figure 3. Exceedance Rates by Site in 2024.** This bar plot compares the exceedance rates of the DOH and DEP thresholds across different sites. The y-axis represents the exceedance rate as a percentage, while the numbers on the bars indicate the total count of exceedances for each site. The sample size for all sites is 53, except for Sunrise Bay Hugh Taylor Birch, which had a sample size of 52.

From the 270 samples that exceeded the DOH threshold in 2024, 194 failed in subsequent resampling efforts. This scenario is particularly important for public health and safety at beaches, as the DOH follows a specific protocol for issuing advisories at beaches. If an enterococci result exceeds the threshold of 70 MPN (most probable number) per 100 milliliters of beach water, the site is resampled. If the resampling result also exceeds the 70 MPN threshold, a “Beach Advisory” is issued for that location. It is important to note that this process applies specifically to the Healthy Beaches Program and does not extend to other waterway sites, which can be managed according to different criteria depending on whether sites are predominantly marine or freshwater sites. However, the resampling results from all sites are presented in this report as part of the contract, with the context of beach advisories provided for clarity.

**Table S2.** presents the descriptive statistics for enterococci in 2024, including resamples. For most sites, the average and median enterococci levels increase when resamples are considered, reflecting persistent bacterial contamination rather than isolated spikes.

### Differences in Enterococci Levels Across Sampling Sites in 2024

In microbiological data, where bacterial levels can vary widely with occasional extreme spikes, the average (mean) can be misleading because it is heavily influenced by high values. A single extreme reading can significantly raise the average, making it seem like contamination is consistently high when, in reality, most values may be lower. Therefore sometimes, the median is a more reliable measure of central tendency because it represents the middle value of the dataset and is less affected by outliers. Since the 2024 data were not normally distributed, a non-parametric approach was used for comparisons. This method ranks data and compares medians instead of means.

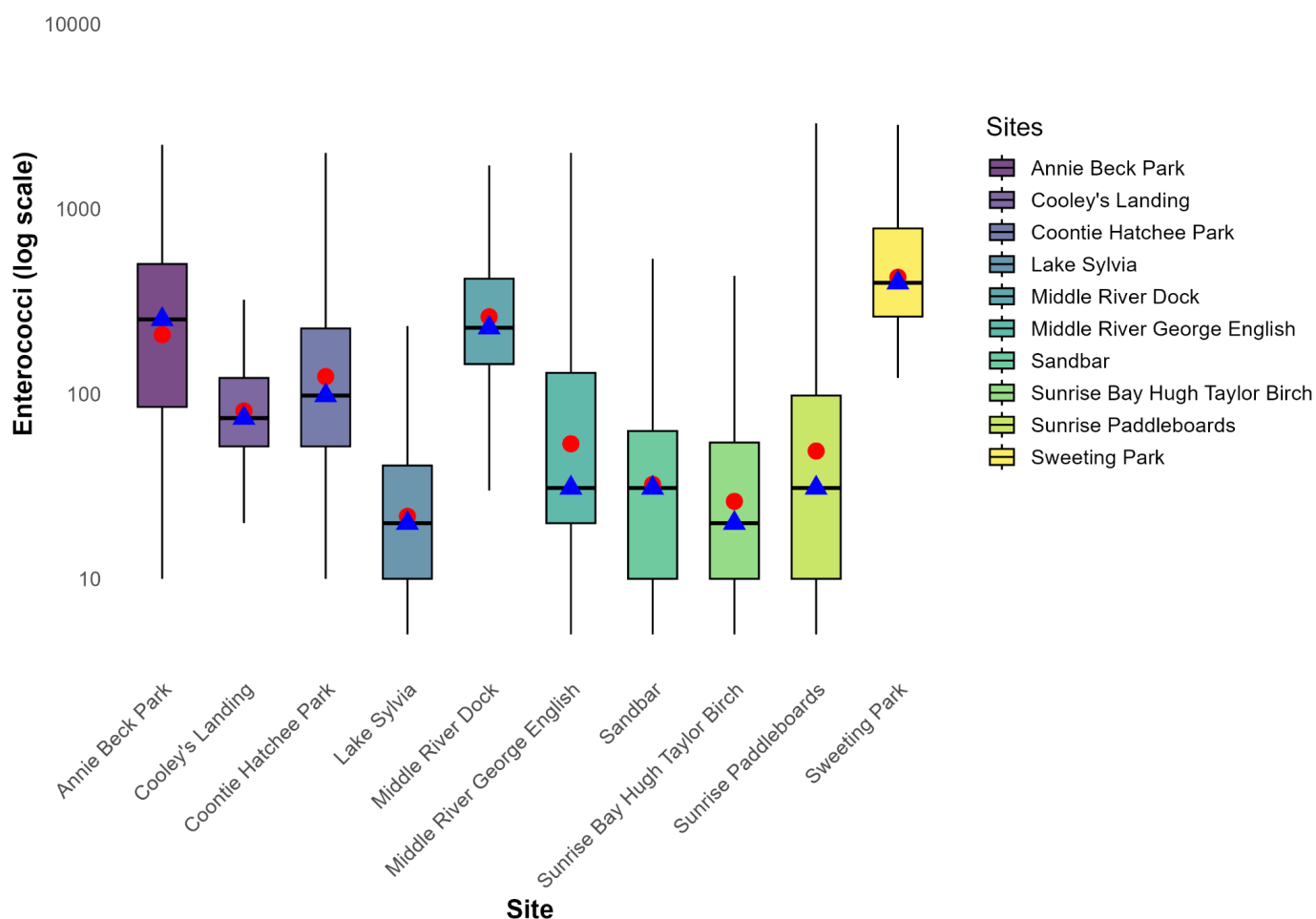
**Table 1.** Summary Statistics for Enterococci Levels Across Sampling Sites. Minimum, maximum, mean, standard deviation, median, and interquartile range (Q1–Q3) of enterococci levels (MPN/100 mL) recorded at each sampling site in 2024. The sample size for all sites is 53, except for Sunrise Bay Hugh Taylor Birch, which had a sample size of 52.

Enterococci (MPN/100 mL)								
Site	Minimum	Maximum	Mean	±	Standard Deviation	Median	Interquartile Range	
							Q1	Q3
Annie Beck Park	10	2,224	420	±	499	253	85	504
Cooley's Landing Park	<10	3,873	204	±	558	74.25	52	122
Coontie Hatchee Park	<10	17,329	639	±	2,419	98	52	226
Lake Sylvia	<10	3,076	120	±	449	20	10	41
Middle River NE 18th St Dock	<10	24,196	1,420	±	4,679	228	145	420
Middle River George English	<10	9,208	369	±	1,296	31	20	130
Sandbar	<10	2,495	128	±	392	31	10	63
Sunrise Bay Hugh Taylor Birch Park	<10	2,382	147	±	459	20	10	55
Sunrise Paddleboard	<10	24,196	1,019	±	4,254	31	10	98
Sweeting Park	<10	5,794	734	±	1,017	399	262	785

Sweeting Park and Middle River NE 18th St Dock had the highest median enterococci levels, with Sweeting Park at 399 MPN/100 mL and Middle River Dock at 228 MPN/100 mL, suggesting consistently elevated bacterial contamination. Annie Beck Park followed closely with a median of 253 MPN/100 mL (Table 1, Figure 4). Statistical analysis using the Dunn test found significant differences between several sites. Sweeting Park had significantly higher median values than sites in the City’s Designated Watersport Areas; Lake Sylvia (20 MPN/100 mL) (Z = -9.31, p < 0.001), Sandbar (31 MPN/100 mL) (Z = -8.06, p < 0.001), and

Sunrise Bay Hugh Taylor Birch (31 MPN/100 mL) ( $Z = -8.73, p < 0.001$ ) (Table S3). Similarly, Middle River NE 18th St Dock had significantly higher levels than Lake Sylvia ( $Z = -7.54, p < 0.001$ ) and Sunrise Bay Hugh Taylor Birch ( $Z = -6.97, p < 0.001$ ) (Table S3). In contrast, there was no significant difference between Annie Beck Park and Middle River NE 18th St Dock ( $Z = -0.34, p = 1$ ), suggesting similar bacterial levels (Table S3).

Sites such as Cooley’s Landing (median: 74.25 MPN/100 mL) and Coontie Hatchee Park (median: 98 MPN/100 mL) had lower levels than the previously mentioned sites, which had medians greater than 200 MPN/100 mL, while Sunrise Paddleboards and the Sandbar had lower median levels at 31 MPN/100 mL (Figure 4). The lowest levels were observed at Sunrise Bay Hugh Taylor Birch and Lake Sylvia, with a median of 20 MPN/100 mL (Figure 4).



**Figure 4.** Boxplot showing enterococci levels by site with log-scale y-axis. The boxplots represent the distribution of enterococci concentrations for each site, with red dots indicating the mean and blue triangles indicating the median. The sample size for all sites is 53, except for Sunrise Bay Hugh Taylor Birch, which had a sample size of 52.

### *Preliminary Results: Sources of FIB Levels at Middle River Rock Dock, Royal Palm Las Olas, and Sweeting Park*

On May 7, 2024, water samples were collected from Middle River Dock, Royal Palm Las Olas, and Sweeting Park for molecular source tracking using mitochondrial DNA (mtDNA) markers. Enterococci were also cultured from the same samples to provide additional context. mtDNA markers are commonly used in molecular source tracking due to their high cellular copy number and ability to identify host species directly (e.g., human, dog, bird). Fecal material contains abundant exfoliated epithelial cells, which contribute to the mtDNA detected in environmental samples. Because mtDNA can originate from non-fecal sources, the *uidA* gene from *E. coli* was used alongside host markers to help establish a link to fecal contamination. Accordingly, *E. coli* and host DNA results are considered together in this report to interpret whether the bacteria originate from potential fecal sources.

At Middle River Dock, enterococci levels measured 63 MPN/100 mL. Human DNA (369 copies/100 mL) and *E. coli* (148 copies/100 mL) were detected in all replicates, suggesting that *E. coli* levels may be linked to human fecal sources. Dog and poultry DNA were also detected, but with lower consistency—defined as the proportion of three replicate reactions in which amplification occurred. For instance, human markers consistently amplified in all three replicates (100%), while dog and poultry markers appeared in only two (67%) replicates, suggesting more sporadic or minor additional contributions. At Royal Palm Las Olas, enterococci were not detected (<10 MPN/100 mL); while *E. coli* (121 copies/100 mL) was present, no host-specific DNA was amplified, suggesting no dominant source among the targets screened. At Sweeting Park, elevated enterococci (199 MPN/100 mL), human DNA (313 copies/100 mL), and *E. coli* (557 copies/100 mL) (Table 2) indicate likely human-associated fecal contamination. Poultry DNA was also detected at lower levels and with less consistency, appearing in only one of three replicates (33%), which suggests a possible but limited additional source. Overall, Sweeting Park showed the strongest signal of *E. coli* levels being associated with human sources on the day of sampling, though further analysis is needed to confirm source origin.

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*Table 2. Results of the DNA Source Tracking Kits from Jonah Ventures for Human, Dog and Poultry assays. Samples were collected on May 7, 2024. The average number of copies per filtered 100mL of water for each assay was of triplicate samples processed. The shades of blue indicate the percent of triplicates that had a positive detection of the DNA assay. Sheep, Bovine and Swine markers were also processed and not detected.*

Results	Enterococci	Salinity	E.Coli01		Human01		Dog01		Poultry01	
Sample Site	MPN/100 mL	ppt	avg. copies/ 100 mL	% detection	avg. copies/ 100 mL	% detection	avg. copies/ 100 mL	% detection	avg. copies/ 100 mL	% detection
Middle River Dock	63	18.3	148	100	369	100	38	67	222	67
Sweeting Park	199	4.1	557	100	313	100	0	0	17	33
Royal Palm Las Olas	<10	27.9	121	100	0	0	0	0	0	0

### *Environmental data among sites*

Salinity levels varied across sites as expected, with lower values recorded at inland locations and higher values near the coast. Sweeting Park had the lowest salinity, with an average of 1.74 ppt, followed by Coontie Hatchee Park (4.48 ppt) and Middle River Dock (5.69 ppt) (Table S4). These sites are located further inland, where the influence of seawater is reduced. Both are also in close proximity to large stormwater outfalls, which can further contribute to localized variations in salinity. In contrast, coastal sites such as Lake Sylvia and Sandbar had significantly higher salinity levels, averaging 24.41 ppt and 20.54 ppt, respectively. The salinity distribution reflects the balance of freshwater inflows and marine influence at each site. (Table S4).

Dissolved oxygen (DO) levels were generally above the biologically sufficient threshold of 4.00 mg/L, with the highest average recorded at Sandbar (6.28 mg/L) and the lowest at Sweeting Park (4.35 mg/L) (Table S4). Coastal sites such as Lake Sylvia (6.00 mg/L) and Sunrise Bay Hugh Taylor Birch Park (5.98 mg/L) exhibited higher DO levels, whereas more inland locations like Middle River NE 18th St Dock (4.41 mg/L) and Cooley’s Landing (5.20 mg/L) had lower averages (Table S4). The highest individual DO measurement (9.16 mg/L) was recorded at Sunrise Bay Hugh Taylor Birch Park, while the lowest (3.21 mg/L) occurred at Sweeting Park (Table S4). Several sites recorded individual DO measurements below the [Broward County marine water quality standard](#) of 4.00 mg/L (Figure S1). The number of exceedances per site included: Sweeting Park (24), Middle River Dock (18), Sunrise Paddleboards (11), Cooley’s Landing (5), Coontie Hatchee Park (1), and Middle River George English (1).

Turbidity levels showed variability across sites but were generally below the [Broward County marine water quality standard](#) of 10 NTUs. Sweeting Park exhibited the highest

average turbidity (8.33 NTU) and Coontie Hatchee Park the lowest (2.42 NTU) (Table S4). While Sweeting Park's median turbidity was lower (2.84 NTU), occasional high spikes (up to 48.84 NTU) indicate episodic disturbances, likely linked to runoff or resuspension of sediments (Table S4). Coastal sites like Sandbar and Lake Sylvia had relatively low turbidity, with median values of 1.15 NTU and 1.08 NTU, respectively (Table S4). During storms, turbidity in Florida is expected to increase due to heavy rainfall, stormwater runoff, and sediment disturbances, which can temporarily elevate turbidity levels across all sites. Only a single exceedance of 10 NTU was recorded at each of the following sites: Coontie Hatchee Park, Middle River Dock, Middle River George English, and Sandbar.

Chlorophyll-a concentrations were highest at Sweeting Park (10.96 µg/L) and Sandbar (3.60 µg/L), suggesting increased algal presence at these locations (Table S4). Middle River Dock had the lowest chlorophyll-a levels, with an average of 1.35 µg/L (Table S4). The elevated concentrations at Sweeting Park align with its lower salinity, higher turbidity, and its inland location in a dense urban area, which increases proximity to potential nutrient inputs from impervious surfaces, stormwater runoff, and other land-based sources—unlike coastal sites that are more influenced by tidal exchange.

### *Site-specific relationships between environmental parameters and enterococci levels in 2024*

Enterococci levels in 2024 showed significant positive correlations with rainfall at the 24 hr, 48 hr, and 72 hr intervals across most sites (**Figure S2**), indicating that rainfall events contribute to increased bacterial concentrations which is not unexpected in urban environments. Sweeting Park and Cooley's Landing exhibited some of the strongest significant relationships at these time intervals ( $r = 0.30$  to  $0.38$ ) (**Figure S2**). While all sites showed significant correlations with rainfall at the 24 hr mark, correlations at longer time lags varied by site.

The relationship between enterococci and salinity was site-dependent. Significant negative correlations were observed at Middle River Dock ( $r = -0.21$ ), Sandbar ( $r = -0.26$ ), Sunrise Bay Hugh Taylor Birch ( $r = -0.28$ ), and Sunrise Paddleboards ( $r = -0.29$ ) (**Figure S2**), suggesting that higher salinity was associated with lower enterococci levels. At Sweeting Park, a weak negative correlation ( $r = -0.06$ ) was detected (**Figure S2**), which might be due to the low salinity levels at this inland site and the potential for other environmental factors influencing microbial concentrations.

The strongest correlations overall were found between water temperature and dissolved oxygen, with all sites—except Sweeting Park—showing significant negative correlations ( $r = -0.32$  to  $-0.58$ ) (**Figure S2**). This highlights the inverse relationship between temperature and

oxygen solubility, where warmer waters hold less oxygen. Sweeting Park, being the most inland site, is more influenced by freshwater inputs, including stormwater runoff, which can introduce variable nutrient loads and organic matter. Additionally, Sweeting Park may experience less mixing and greater stratification of the water, which can limit the natural exchange of oxygen between surface and deeper waters. This stratification may lead to localized DO fluctuations driven by microbial activity and decomposition, rather than temperature alone.

While Sweeting Park is heavily influenced by freshwater inputs, it is important to recognize that other sites are also significantly impacted by stormwater. For example, Cooley's Landing is just upstream from two large storm pump stations that drain the downtown area, and Middle River Dock is sandwiched between two 42-inch stormwater outfalls. The City has over 1000 stormwater outfalls into its waterways, further contributing to nutrient loading and organic matter in various locations.

Turbidity showed no significant correlations with enterococci at any site, suggesting that turbidity is not a major driver of enterococci levels in these locations (**Figure S2**).

## DISCUSSION

### Waterway Quality Trends: Historical Data from 2021 to 2024

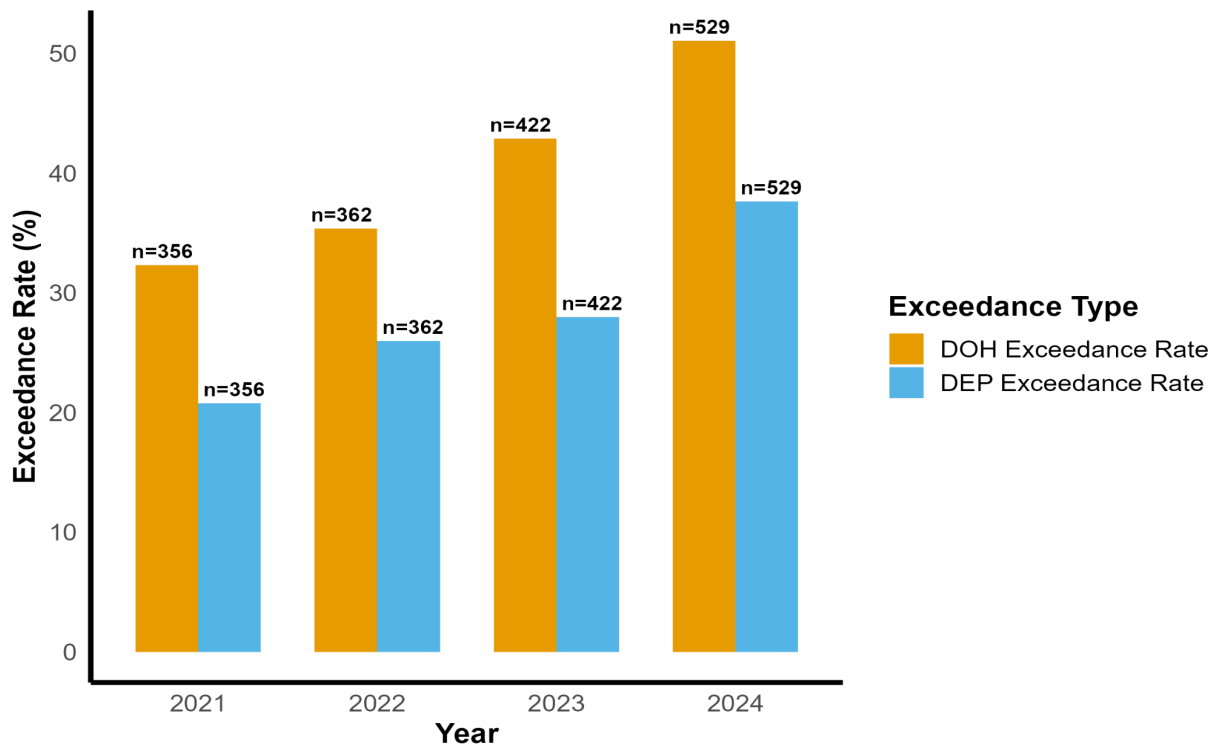
#### *Enterococci Exceedances of DOH and DEP Criteria (2021 to 2024)*

From 2021 to 2024, the total number of exceedances consistently increased. In 2021, 115 weekly samples exceeded the DOH threshold, while 74 samples exceeded the DEP threshold. In 2022, DOH exceedances rose to 128, and DEP exceedances increased to 94. By 2023 and noting a change in the sites monitored, these numbers climbed further to 181 for DOH and 118 for DEP. In 2024, the highest exceedances were recorded, with 270 samples exceeding the DOH threshold and 199 samples surpassing the DEP threshold. The total number of samples tested also increased annually, from 356 in 2021 to 529 in 2024. As a result, the exceedance rate, calculated as the percentage of samples exceeding either threshold relative to the total samples, showed a steady upward trend. For example, the exceedance rate for the DOH threshold increased from 32.3% in 2021 to 51.0% in 2024. This trend reflects a growing proportion of samples surpassing health risk thresholds over the monitoring period (**Figure 5**). It is important to note that a sanitary sewer overflow from a large main caused by a negligent contractor resulted in a multi-week discharge of untreated sewage into the Intracoastal Waterway. This incident occurred during the sampling period

and likely contributed to elevated bacteria levels and exceedances observed in 2024.

Given the correlation of the data to rainfall, it should be noted that both 2023 and 2024 had rainfall totals well above those in 2021 and 2022. In addition, a sanitary sewer overflow from a large main caused by a negligent contractor resulted in a multi-week discharge of sewage into the Intracoastal Waterway impacting bacteria levels for several weeks and driving up exceedances.

The data shows a consistent increase in the geometric mean of enterococci levels over the years. In 2021, the geometric mean was 45.34, rising slightly to 47.68 in 2022. The increase became more noticeable in 2023, with the geometric mean reaching 74.40, and further rising to 108.63 in 2024. The geometric mean is especially useful for analyzing microbiological data because it minimizes the effect of extreme values. Given that the sample size increased over time, the geometric mean is ideal as it is less influenced by uneven sample sizes, making it a more reliable measure for tracking bacterial levels, compared to the arithmetic mean, which can be skewed by occasional spikes.



**Figure 5.** Exceedance rates by year comparing DOH exceedance rates with DEP exceedance rates. Bars represent the exceedance rates for each year, with color differentiation for the two categories. Sample sizes for each year are displayed above the bars.

Waterway quality trends indicate increasing bacterial concentrations at several sites, with increasing enterococci levels and exceedance rates from 2023 to 2024 (**Table S1, S4** and **S5**). Sweeting Park remains the most elevated site, with a median of 399 MPN/100 mL in 2024, up from 243 MPN/100 mL in 2023, and consistently high exceedance rates exceeding 90% for both DOH and DEP thresholds (**Table S4**). Annie Beck Park showed a sharp rise in levels, with enterococci levels spiking from 75 MPN/100 mL in 2023 to 253 MPN/100 mL in 2024, and DOH exceedances surging from 54% to 83% (**Table S1** and **S5**). Coontie Hatchee Park also experienced a substantial increase, with DOH exceedances jumping from 35% to 62%, indicating growing bacterial levels (**Table S1**).

Middle River NE 18th St Dock remains a persistently elevated site, with enterococci levels slightly increasing to 228 MPN/100 mL in 2024, and DEP exceedances rising from 71% to 77%, despite a minor drop in DOH exceedances (**Table S1**). Conversely, some sites, primarily those in the City's Designated Watersport Activity Areas, showed improvements—Sandbar had a slight decrease in DOH exceedances from 28% in 2023 to 23% in 2024, while Sunrise Bay Hugh Taylor Birch Park remained relatively stable at 21% (from 20% in 2023). Median enterococci levels at these sites were 31 MPN/100 mL (Sandbar) and 20 MPN/100 mL (Sunrise Bay Hugh Taylor Birch Park), reinforcing their status as comparatively lower-risk locations (**Table S1** and **S5**). Lake Sylvia continues to be the least contaminated, with a consistently low median of 10-20 MPN/100 mL (**Table S5**).

Overall, total exceedance rates rose from 43% (DOH) and 28% (DEP) in 2023 to 51% and 38% in 2024, underscoring a decreasing trend in waterway quality at multiple locations and reinforcing the need for targeted pollution mitigation and increased monitoring efforts (**Figure 5, Table S5**).

### ***Evidence on Sources of FIB Levels at Middle River Rock Dock, Royal Palm Las Olas, and Sweeting Park***

With respect to the source of high levels of fecal FIB, it is important to note that FIB levels alone do not provide direct information about the source of pollution. Nevertheless, MWK has data available from various locations that suggest FIB sources could be linked to specific host species. The results presented here are based on a single round of sampling conducted on May 7, 2024, and should be interpreted with caution. While molecular source tracking data provide valuable insights into potential sources of pollution, broader conclusions about contamination sources require additional sampling over time and space.

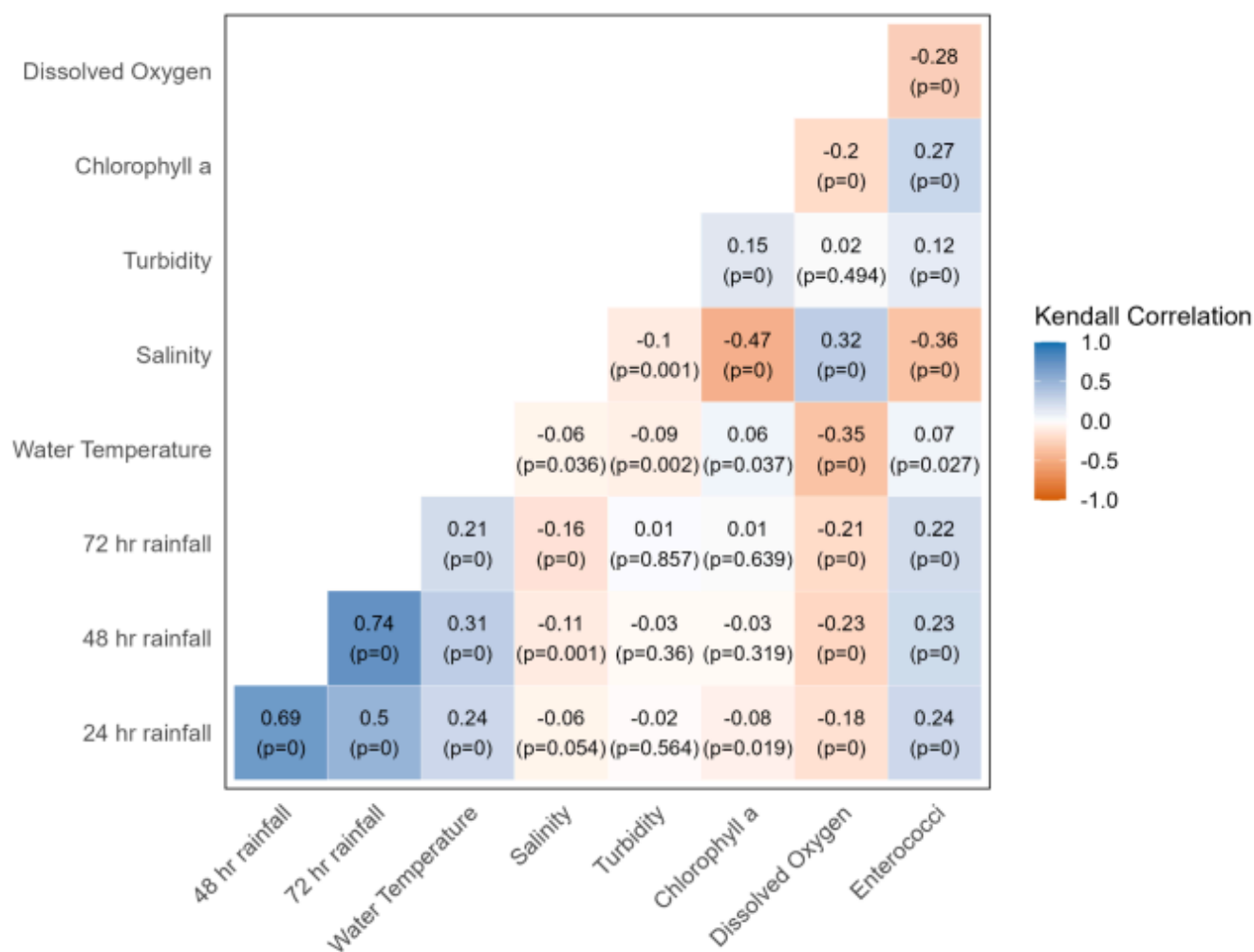
Despite the limited scope of this sampling event, the results suggest potential contributions

from human, dog, and poultry sources, particularly at Middle River Dock and Sweeting Park. Notably, Sweeting Park has shown chronically high FIB levels, with exceedance rates exceeding 90% in recent years. This site also closely overlaps with Broward County monitoring, which provides multi-year FIB and microbial source tracking data through a public dashboard. Their dataset, spanning from 2017 to 2023, confirms the persistent presence of human-associated sewage markers, such as HF183, and dog-specific markers at Sweeting Park (**Figure S3** and **S4**). Furthermore, the data show that this site has experienced occasional exceedances of QMRA (Quantitative Microbial Risk Assessment) derived human exposure risk thresholds (**Figure S5**), which underscores the importance of continued monitoring and public awareness. Risk-Based Thresholds have been developed to align qPCR-based methods with traditional culture-based standards. The EPA sets the regulatory threshold for viable enterococci at 70 MPN/100 mL, corresponding to a 75% chance of fewer than 36 illnesses per 1,000 swimmers. For qPCR, the EPA recommends a threshold of 1,000 gene copies (gc)/100 mL for Enterococcus 1A and 525 gc/100 mL for the human-specific marker HF183, each based on a similar illness risk level. While Florida accepts the qPCR thresholds as optional guidance, they are not currently used for official beach advisories.

Note: Cooley's Landing Park, Middle River NE 18th St Dock, and Sunrise Paddleboards are relatively new monitoring sites, with sampling beginning around August 2023. When interpreting trends or comparisons involving these locations, it is important to consider the shorter data record (approximately 18 months) compared to other sites with over four years of data.

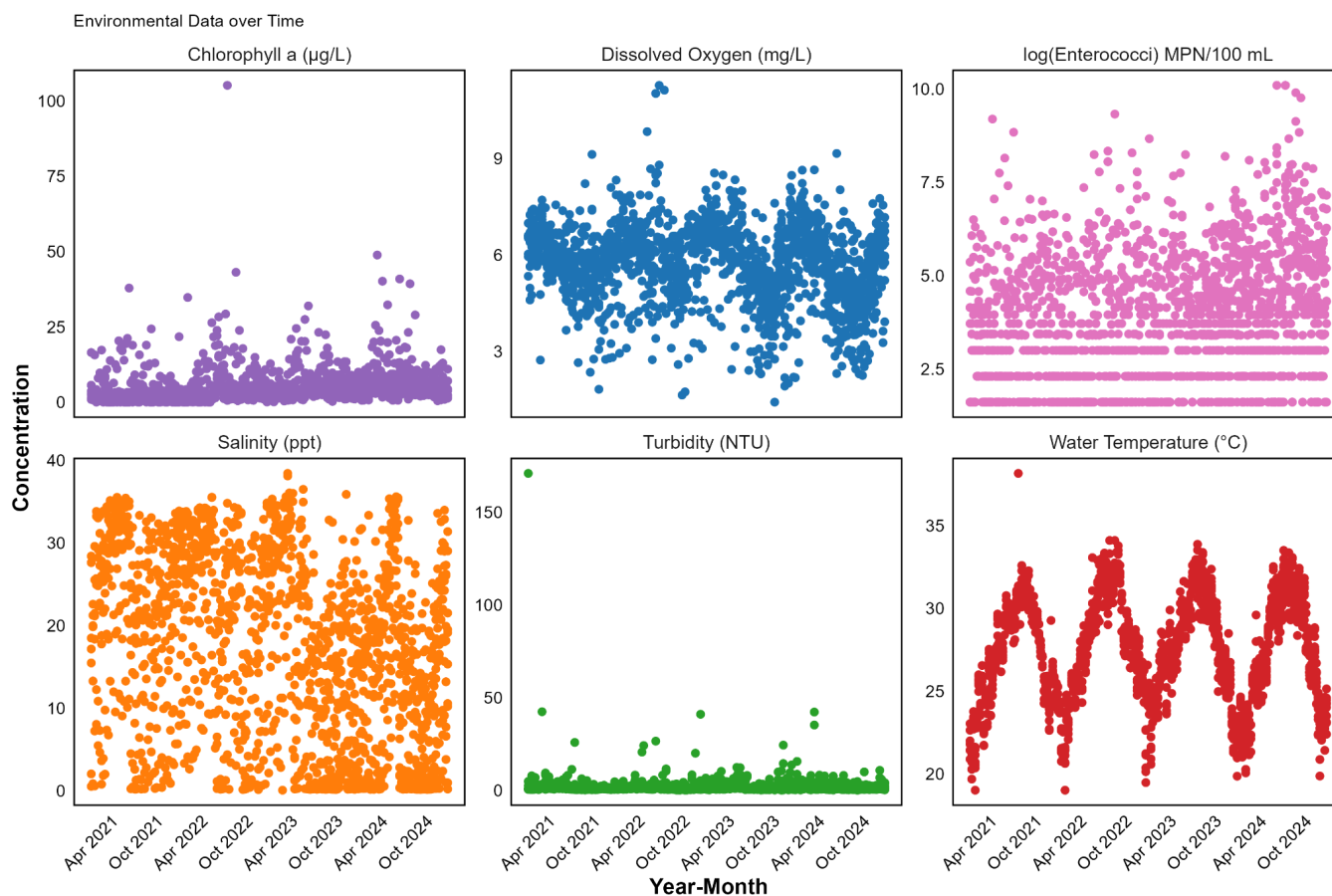
### ***Relationships Between Environmental Factors and Enterococci Levels (2021 to 2024)***

The analysis reveals several significant correlations between enterococci levels and various waterway quality parameters, highlighting key environmental patterns in Fort Lauderdale's waterways. Enterococci levels show a significant positive correlation with rainfall over 24-hour ( $r = 0.24$ ), 48-hour ( $r = 0.23$ ), and 72-hour ( $r = 0.22$ ) periods, suggesting that increased precipitation is associated with higher bacterial concentrations in the water (**Figure 6**).



**Figure 6.** Heatmap of Spearman correlation coefficients among environmental variables and enterococci levels, using a colorblind-friendly blue-red palette. Blue represents positive correlations, red represents negative correlations, and white indicates weak or no correlation. Numerical values show correlation coefficients with associated p-values in parentheses. A p-value of less than 0.05 is considered significant.

Additionally, enterococci levels are significantly positively correlated with chlorophyll a ( $r = 0.27$ ) and turbidity ( $r = 0.12$ ), indicating that areas with greater algal presence and suspended particles tend to have higher bacterial levels (**Figure 6**). In contrast, salinity is significantly negatively correlated with both chlorophyll a ( $r = -0.47$ ) and enterococci ( $r = -0.36$ ), suggesting that higher salinity conditions are associated with lower bacterial and algal concentrations (**Figure 6**). These relationships suggest complex interactions between freshwater inputs, nutrient dynamics, and bacterial persistence, providing valuable insight into the environmental factors influencing enterococci levels in these waterways. Regardless, turbidity measured in the weekly samples consistently meets the environmental regulatory standard.



**Figure 7.** Time series of environmental variables including chlorophyll a ( $\mu\text{g/L}$ ), dissolved oxygen ( $\text{mg/L}$ ), turbidity (NTU), water temperature ( $^{\circ}\text{C}$ ), salinity (ppt), and log-transformed enterococci (MPN/100 mL) concentrations over time. Data points are shown by color-coded markers for each variable. Each panel represents a different environmental parameter, with y-axis scales adjusted for variable ranges.

**Figure 7** presents the time series of all environmental variables. DO and water temperature both exhibit a sigmoidal seasonal pattern, but in an inverse manner. On average, water temperature is highest during the summer months (e.g.,  $30.5^{\circ}\text{C} \pm 0.8^{\circ}\text{C}$  from July to August) and lowest in winter ( $22.7^{\circ}\text{C} \pm 0.6^{\circ}\text{C}$  from December to February). In contrast, DO follows the opposite trend, with higher concentrations in winter ( $6.5 \pm 0.5 \text{ mg/L}$ ) and lower values in late summer to early fall ( $4.8 \pm 0.4 \text{ mg/L}$ ). This inverse relationship suggests that as water temperature increases, DO concentrations decline, likely due to reduced oxygen solubility and enhanced biological activity. Correlation analysis confirmed a significant negative relationship between the two variables, reinforcing the seasonal coupling between temperature and oxygen availability (**Figure 7**). Regardless, oxygen measured in the weekly samples consistently meets the environmental regulatory standard.

## Swim Guide Views

In this reporting period, there were a total of 9,483 visits to the thirteen City of Fort Lauderdale sites that we sampled (**Table 3**). Since the initiation of this monitoring program, there have been 42,924 total views. The website was the preferred platform when compared to accessing the app from a mobile device. In 2024, Sandbar was visited the most, followed by Annie Beck Park, and Middle River George English Park.

**Table 3. Total mobile and internet visits on the Swim Guide application**

Swim Guide Traffic Analytics	2024			2023			4-Year Total (2021-2024)			
	Mobile Visits	Internet Visits	Total Visits	Mobile Visits	Internet Visits	Total Visits	Mobile Visits	Internet Visits	Total Visits	
Annie Beck Park	5	1238	1,243	94	1,269	1,363	470	4,786	5,256	
Cooley's Landing Park	1	735	736	5	291	296	6	1,026	1,032	
Coontie Hatchee Park	5	739	744	95	699	794	519	2,729	3,248	
Middle River George English	3	1132	1,135	96	1,098	1,194	376	4,070	4,446	
Middle River NE 18th St Dock	16	1168	1,184	13	175	188	29	1,343	1,372	
Lake Sylvia	2	531	533	73	1,203	1,276	281	4,070	4,351	
Sandbar	13	1382	1,395	235	1,252	1,487	832	4,694	5,526	
Sunrise Bay Hugh Taylor Birch	6	1037	1,043	75	941	1,016	260	3,668	3,928	
Sunrise Paddleboard	3	457	460	6	306	312	9	763	772	
Sweeting Park	3	1007	1,010	102	700	802	640	2,959	3,599	
<b>Discontinued (January 2021- July 2023)</b>										
Himmarshee Canal				44	441	485	227	1,933	2,160	
Royal Palm Drive Las Olas Blvd				64	1,074	1,138	499	3,299	3,798	
Tarpon River				77	852	929	607	2,829	3,436	
			<b>TOTAL</b>	<b>9,483</b>			<b>TOTAL</b>	<b>11,280</b>		
					<b>TOTAL</b>	<b>11,280</b>		<b>TOTAL</b>	<b>42,924</b>	

\*The Discontinued Sites are still monitored weekly and reported to Swim Guide but are no longer part of this project.

## CONCLUSIONS AND RECOMMENDATIONS

1. Sweeting Park and Middle River Dock had the highest enterococci contamination, with median levels of 418 MPN/100 mL and 266 MPN/100 mL, respectively. Exceedances occurred over 94% and 87% of the time for both DOH and DEP thresholds, indicating persistent bacterial contamination. This may be due to stormwater runoff or proximity to outfalls, highlighting the need for continuous monitoring and management at these sites.
2. *Public Health Implications:* While we are unaware of current advisories in Fort Lauderdale waterways, the 2024 data shows consistently high median and average bacterial levels—Sweeting Park (Median: 418 MPN/100 mL, Mean: 502 MPN/100 mL) and Middle River Dock (Median: 266 MPN/100 mL, Mean: 1302 MPN/100 mL). These elevated bacterial levels suggest a potential health risk for water contact recreation. Given these consistently high levels, it may be advisable to consider posting signage at these sites to inform the public about the elevated bacterial levels and associated health risks.
3. *Public Perception Implications:* The City of Fort Lauderdale is the only city in Broward County posting FIB data for its waterways through platforms like Swim Guide and Miami Waterkeeper’s social media. The lack of monitoring data from other coastal cities can lead to the perception that Fort Lauderdale’s inland waterways may have contamination issues while nearby municipalities do not. The City’s willingness to monitor bacteria in its inland waterways can have the unintended consequence of driving recreational waterway users to other locations that simply have no data on their waterway quality.
4. *Focused Monitoring with Advanced Source Tracking:* Given the high exceedance rates at Sweeting Park and Middle River Dock, more frequent monitoring and resampling are essential. Traditional fecal indicator bacteria (FIB) methods cannot identify the specific sources of contamination. Therefore, microbial source tracking (MST) is recommended over mitochondrial or chemical tracers, as it relies on host-specific bacterial markers such as HF183, which are more directly linked to fecal origin and have established relevance to public health. Broward County currently conducts MST monitoring, and other local agencies, such as the City of Miami Beach (located in Miami-Dade County), have also implemented MST in targeted studies—for example, a collaboration with the University of Miami in Parkview. The use of MST by multiple agencies supports greater data comparability across jurisdictions. This approach provides actionable information—for example, high dog marker levels could support targeted outreach to

reduce pet waste. MST offers a more practical, prevention-focused strategy compared to costly stormwater treatment. All sites with high enterococci levels could benefit from source tracking efforts to guide targeted mitigation strategies. Monitoring upstream and downstream sites is also important to understand the full pollution scope and track contamination pathways.

5. *Suspected Human Fecal Contamination at Middle River Dock and Sweeting Park:* A human-specific mitochondrial marker was consistently detected in all replicates of a single sample at both Middle River Dock and Sweeting Park, suggesting potential human influence. At Sweeting Park, the human-specific fecal microbial source tracking marker HF183 has also been consistently detected at elevated levels, with some measurements exceeding the QMRA risk-based threshold of 525 gc/100 mL. Although more sampling is needed to confirm ongoing contamination at Middle River Dock, the findings at Sweeting Park suggest a persistent human fecal source that warrants further investigation and continued monitoring.

Possible sources of human contamination could include leaking or aging sewer infrastructure, cross-connections between stormwater and sanitary systems, illicit discharges, compromised lateral lines on private property, and transient or unhoused populations using natural areas without access to sanitation. These possibilities warrant further investigation through infrastructure assessments, targeted inspections, and additional microbial source tracking.

6. *Dog Waste Impacts:* A dog-specific mitochondrial DNA marker was detected in one sample at Middle River Dock, with amplification observed in only 2 out of 3 replicates. This suggests a potential signal but does not provide conclusive evidence of dog-related contamination. Additional sampling is needed to better assess the presence and extent of this source. For future monitoring, we recommend using the DG3 microbial marker, which has previously been applied and detected in the region. This approach would allow for more reliable source identification and support targeted mitigation efforts. Potential mitigation strategies include increasing the number of dog waste stations, enhancing public education on proper pet waste disposal, strengthening enforcement of cleanup regulations, and expanding manual removal efforts in grassy or high-traffic dog walking areas.
7. *Poultry and Avian contributions:* A poultry mitochondrial DNA marker was inconsistently detected—amplifying in 2 out of 3 replicates at Middle River Dock and 1 out of 3 at Sweeting Park—providing limited evidence of a sustained poultry-related source. In an urban setting, backyard poultry (e.g., chickens) could explain the presence of poultry DNA. Additionally, frequent bird activity at several sites—such as Annie

Beck Park and Middle River NE 18th St Dock—suggests that broader avian contributions may also be influencing water quality. To better evaluate potential impacts from wild birds, we recommend additional sampling and the use of microbial source tracking markers such as the general bird (GFD) and gull-specific (Gull2) assays, which are designed to detect fecal contamination from avian wildlife rather than domestic poultry.

8. *Support public outreach and education to address stormwater pollution:* Given the observed correlation between rainfall and enterococci levels there is a strong indication that stormwater runoff may play a role in transporting bacteria, highlighting the need for increased community awareness and education. Outreach and education efforts focused on proper pet waste disposal, septic system care, and reducing pollutants entering storm drains can play a vital role in improving water quality. Additionally, voluntary implementation of stormwater mitigation measures such as improved filtration or retention systems may help reduce bacterial loading near affected sites. Preventing pollution at the source is typically far more cost-effective than addressing contamination after it occurs.
9. Sites such as Lake Sylvia, Sunrise Bay Hugh Taylor Birch, and Sandbar exhibited the lowest bacterial levels and fewer exceedances, making them comparatively safer for recreational activities, consistent with the City's designation of these locations as Watersport Activity Areas. These sites had consistently low median and average enterococci levels, with Lake Sylvia showing the lowest median at 18 MPN/100 mL. Given their cleaner waterway quality, these sites are less likely to pose public health risks related to bacterial contamination.
10. Some sites, such as Sweeting Park, Cooley's Landing, and Middle River NE 18th St Dock, are predominantly freshwater, with average salinity levels of 1.74, 7.73, and 5.69 ppt, respectively, and median values even lower at 0.28, 5.09, and 3.20 ppt. Given their low salinity, measuring *E. coli* alongside enterococci would provide a more accurate assessment of bacterial contamination, as *E. coli* is a better indicator for freshwater environments. Miami Waterkeeper has the capacity to measure *E. coli*, and incorporating it into the monitoring program could improve risk assessments and management strategies for these sites. Since technicians are already driving to these locations, the additional cost of incorporating *E. coli* testing would be minimal. The mileage and travel time are already accounted for, so the primary cost would be the test itself. The extra grab sample and processing time required are not significant, making this an efficient and cost-effective enhancement to the monitoring program.

11. Sustain long-term monitoring to support public health and transparency: Continued water quality monitoring is critical for identifying trends, assessing the impact of pollution mitigation efforts, and detecting new sources of contamination. A key goal of the MWK monitoring program is to make microbiological water quality data publicly available, supporting transparency and empowering communities with information about local water quality conditions.

### *Future Work*

The City remains committed to enhancing Fort Lauderdale's waterway quality. Monitoring Fecal Indicator Bacteria (FIB) provides timely insights into bacteria concentrations at key sites, ensuring residents are informed about health risks associated with water recreation.

Miami Waterkeeper's partnership with the City of Fort Lauderdale has been instrumental in providing crucial information through Swim Guide, a valuable resource relied on by residents and visitors.

Additionally, we recently participated in the first meeting of the FLL Waterway Working Group, which demonstrates the collective commitment to improving water quality. This group focuses on monitoring, restoration, and outreach, with upcoming meetings on 5/23, 7/7, and 8/1. Coordinating efforts with various agencies, researchers, and stakeholders, the group will work to better understand and improve Fort Lauderdale's waterways.

Moving forward, Miami Waterkeeper will continue to expand monitoring efforts and educational initiatives. Together, we strive to foster a more informed community that actively contributes to preserving the health of Fort Lauderdale's waterways.

# WATERWAY QUALITY MONITORING REPORT TO THE CITY OF FORT LAUDERDALE

## Supplementary Tables

*Table S1. Summary of DOH and DEP exceedance rates for each sampling site in 2024 and 2023, along with cumulative data from 2021 to 2024.*

Number of Exceedances	2024					2023					Total (2021-2024)					
	Number of Samples	Number of Exceedances				Number of Samples	Number of Exceedances				Number of Samples	Number of Exceedances				
		DOH	DOH %	DEP	DEP %		DOH	DOH %	DEP	DEP %		DOH	DOH %	DEP	DEP %	
Annie Beck Park	53	44	83%	34	64%	52	28	54%	18	35%	208	121	58%	82	39%	
Cooley's Landing Park	53	29	55%	13	25%	21	12	57%	5	24%	74	41	55%	18	24%	
Coontie Hatchee Park	53	33	62%	21	40%	52	18	35%	11	21%	208	96	46%	51	25%	
Lake Sylvia	53	7	13%	6	11%	52	7	13%	5	10%	208	23	11%	16	8%	
Middle River NE 18th St Dock	53	46	87%	41	77%	21	20	95%	15	71%	74	66	89%	56	76%	
Middle River George English	53	19	36%	13	25%	52	16	31%	8	15%	208	55	26%	34	16%	
Sandbar	53	12	23%	6	11%	50*	14	28%	10	20%	206	40	19%	24	12%	
Sunrise Bay Hugh Taylor Birch Park	52	11	21%	5	10%	51*	10	20%	3	6%	203	26	13%	10	5%	
Sunrise Paddleboard	53	19	36%	11	21%	21	8	38%	3	14%	74	27	36%	14	19%	
Sweeting Park	53	50	94%	49	92%	50*	48	96%	40	80%	206	199	97%	180	87%	
<b>Discontinued (January 2021- July 2023)</b>																
Himmarshee Canal						31	17	55%	12	39%	132	101	77%	76	58%	
Royal Palm Drive Las Olas Blvd						31	6	19%	4	13%	132	23	17%	16	12%	
Tarpon River						31	22	71%	15	48%	132	83	63%	51	39%	
<b>TOTAL</b>	<b>529</b>	<b>270</b>	<b>51%</b>	<b>199</b>	<b>38%</b>	<b>515</b>	<b>226</b>	<b>44%</b>	<b>149</b>	<b>29%</b>	<b>2,065</b>	<b>901</b>	<b>44%</b>	<b>628</b>	<b>30%</b>	

## Supplementary Materials

*Table S2. Summary Statistics for Enterococci Levels Across Sampling Sites Including Resamples. Minimum, maximum, mean, standard deviation, median, and interquartile range (Q1–Q3) of enterococci levels (MPN/100 mL) recorded at each sampling site in 2024, including resamples.*

2024 Enterococci (MPN/100 mL) with Resamples									
Site	n	Minimum	Maximum	Mean	±	Standard Deviation	Median	Interquartile Range	
								Q1	Q3
Annie Beck Park	95	<10	2,909	428	±	579	211	85	500
Cooley's Landing Park	81	<10	>24,196	568	±	2,732	85	52	169
Coontie Hatchee Park	85	<10	17,329	620	±	2,143	98	49	241
Lake Sylvia	60	<10	3,076	164	±	497	20	10	52
Middle River NE 18th St Dock	97	<10	>24,196	1,264	±	4,275	233	129	461
Middle River George English	72	<10	17,329	616	±	2,320	52	20	186
Sandbar	65	<10	2,495	158	±	406	41	10	86
Sunrise Bay Hugh Taylor Birch Park	62	<10	4,106	210	±	666	20	10	63
Sunrise Paddleboard	71	<10	>24,196	905	±	3,702	41	10	179
Sweeting Park	101	<10	8,664	776	±	1,223	381	261	791

## Supplementary Materials

**Table S3.** Dunn's Test Results for Multiple Comparisons of Enterococci Levels Across Sites. The table includes Z-values, unadjusted p-values (P.unadj), and adjusted p-values (P.Value) to indicate statistical significance. A p-value < 0.05 indicates statistical significance.

Site Comparison	Z_Value	P.unadj	P_Value
Annie Beck Park - Cooley's Landing	2.967530003	0.00300	0.13509
Annie Beck Park - Coontie Hatchee Park	1.841300654	0.06558	1
Cooley's Landing - Coontie Hatchee Park	-1.126229349	0.26007	1
Annie Beck Park - Lake Sylvania	7.196220477	6.19E-13	2.79E-11
Cooley's Landing - Lake Sylvania	4.228690474	2.35E-05	0.00106
Coontie Hatchee Park - Lake Sylvania	5.354919823	8.56E-08	3.85E-06
Annie Beck Park - Middle River Dock	-0.342419548	0.73204	1
Cooley's Landing - Middle River Dock	-3.30994955	0.00093	0.04199
Coontie Hatchee Park - Middle River Dock	-2.183720201	0.02898	1
Lake Sylvania - Middle River Dock	-7.538640025	4.75E-14	2.14E-12
Annie Beck Park - Middle River George English	4.495052149	6.96E-06	0.00031
Cooley's Landing - Middle River George English	1.527522146	0.12663	1
Coontie Hatchee Park - Middle River George English	2.653751495	0.00796	0.35821
Lake Sylvania - Middle River George English	-2.701168328	0.00691	0.31093
Middle River Dock - Middle River George English	4.837471696	1.32E-06	5.92E-05
Annie Beck Park - Sandbar	5.951608162	2.66E-09	1.19E-07
Cooley's Landing - Sandbar	2.984078159	0.00284	0.12800
Coontie Hatchee Park - Sandbar	4.110307508	3.95E-05	0.00178
Lake Sylvania - Sandbar	-1.244612315	0.21327	1
Middle River Dock - Sandbar	6.294027709	3.09E-10	1.39E-08
Middle River George English - Sandbar	1.456556013	0.14524	1
Annie Beck Park - Sunrise Bay Hugh Taylor Birch	6.632299345	3.30E-11	1.49E-09
Cooley's Landing - Sunrise Bay Hugh Taylor Birch	3.678934244	0.00023	0.01054
Coontie Hatchee Park - Sunrise Bay Hugh Taylor Birch	4.799787766	1.59E-06	7.15E-05
Lake Sylvania - Sunrise Bay Hugh Taylor Birch	-0.529571435	0.59641	1
Middle River Dock - Sunrise Bay Hugh Taylor Birch	6.973084422	3.10E-12	1.40E-10
Middle River George English - Sunrise Bay Hugh Taylor Birch	2.158703415	0.03087	1
Sandbar - Sunrise Bay Hugh Taylor Birch	0.709099976	0.47826	1
Annie Beck Park - Sunrise Paddleboards	4.973993988	6.56E-07	2.95E-05
Cooley's Landing - Sunrise Paddleboards	2.006463986	0.04481	1

## Supplementary Materials

Site Comparison (contd)	Z_Value	P_unadj	P_Value
Coontie Hatchee Park - Sunrise Paddleboards	3.132693335	0.00173	0.07794
Lake Sylvia - Sunrise Paddleboards	-2.222226489	0.02627	1
Middle River Dock - Sunrise Paddleboards	5.316413536	1.06E-07	4.76E-06
Middle River George English - Sunrise Paddleboards	0.47894184	0.63198	1
Sandbar - Sunrise Paddleboards	-0.977614173	0.32827	1
Sunrise Bay Hugh Taylor Birch - Sunrise Paddleboards	-1.682047707	0.09256	1
Annie Beck Park - Sweeting Park	-2.109253497	0.03492	1
Cooley's Landing - Sweeting Park	-5.076783499	3.84E-07	1.73E-05
Coontie Hatchee Park - Sweeting Park	-3.95055415	7.80E-05	0.00351
Lake Sylvia - Sweeting Park	-9.305473974	1.33E-20	6.00E-19
Middle River Dock - Sweeting Park	-1.766833949	0.07726	1
Middle River George English - Sweeting Park	-6.604305645	3.99E-11	1.80E-09
Sandbar - Sweeting Park	-8.060861658	7.58E-16	3.41E-14
Sunrise Bay Hugh Taylor Birch - Sweeting Park	-8.731484748	2.51E-18	1.13E-16
Sunrise Paddleboards - Sweeting Park	-7.083247485	1.41E-12	6.34E-11

## Supplementary Materials

**Table S4.** Descriptive statistics of the environmental data collected with a YSI datasonde. Minimum, maximum, mean, standard deviation, median, and interquartile range (Q1–Q3).

Environmental Data								
Site	Minimum	Maximum	Mean	±	Standard Deviation	Median	Interquartile Range	
							Q1	Q3
<b>Temperature (C)</b>								
Annie Beck Park	21.06	33.66	27.77	±	3.43	27.54	25.16	31.17
Cooley's Landing Park	21.60	33.32	28.13	±	3.52	28.21	24.68	31.48
Coontie Hatchee Park	21.97	33.62	28.54	±	3.49	28.71	25.71	31.75
Lake Sylvia	21.64	32.55	27.34	±	3.29	27.46	24.47	30.49
Middle River NE 18th St Dock	19.83	31.92	26.49	±	3.53	26.36	23.46	29.75
Middle River George English	20.60	33.44	27.51	±	3.60	27.73	24.75	30.78
Sandbar	21.59	32.71	27.50	±	3.22	27.86	24.55	30.44
Sunrise Bay Hugh Taylor Birch Park	20.28	33.00	27.57	±	3.75	27.82	24.33	31.03
Sunrise Paddleboard	20.69	32.88	27.52	±	3.64	27.64	24.03	30.88
Sweeting Park	19.77	32.60	26.46	±	3.23	26.55	24.25	29.28
<b>Salinity (PPT)</b>								
Annie Beck Park	3.61	31.67	14.69	±	5.96	13.41	11.10	18.17
Cooley's Landing Park	0.33	29.75	7.73	±	7.96	5.09	1.12	10.81
Coontie Hatchee Park	0.33	24.82	4.48	±	5.87	1.50	0.73	5.67
Lake Sylvia	8.32	35.47	24.41	±	7.46	24.40	19.84	31.38
Middle River NE 18th St Dock	0.24	26.64	5.69	±	6.08	3.20	1.38	9.41
Middle River George English	1.25	32.03	16.13	±	7.95	16.26	11.26	21.41
Sandbar	7.02	35.60	20.54	±	7.31	19.08	15.64	25.48
Sunrise Bay Hugh Taylor Birch Park	0.22	33.53	19.53	±	6.86	19.02	15.32	24.07
Sunrise Paddleboard	0.47	30.79	12.69	±	8.01	12.57	6.85	17.82
Sweeting Park	0.17	16.57	1.74	±	3.46	0.28	0.22	1.33
<b>Dissolved Oxygen (mg/L)</b>								
Annie Beck Park	4.07	8.65	5.98	±	1.05	6.08	5.04	6.63
Cooley's Landing Park	3.59	7.83	5.20	±	0.98	5.25	4.37	6.12
Coontie Hatchee Park	3.58	7.76	5.57	±	1.01	5.52	4.66	6.44
Lake Sylvia	4.32	8.23	6.00	±	0.72	6.04	5.33	6.54
Middle River NE 18th St Dock	2.07	7.27	4.41	±	1.18	4.36	3.43	5.17
Middle River George English	3.98	7.78	5.83	±	1.03	5.84	5.07	6.66
Sandbar	4.45	8.64	6.28	±	0.85	6.38	5.63	6.92
Sunrise Bay Hugh Taylor Birch Park	4.56	9.16	5.98	±	0.92	5.92	5.33	6.68
Sunrise Paddleboard	3.21	7.74	5.04	±	1.12	4.95	4.02	5.92
Sweeting Park	2.11	7.97	4.35	±	1.38	4.19	3.43	5.23

## Supplementary Materials

Environmental Data (contd)								
Site	Minimum	Maximum	Mean	±	Standard Deviation	Median	Interquartile Range	
							Q1	Q3
<b>Turbidity (NTU)</b>								
Annie Beck Park	0.36	30.21	1.91	±	3.13	1.35	0.87	1.97
Cooley's Landing Park	0.23	9.46	1.42	±	1.14	1.12	0.89	1.57
Coontie Hatchee Park	0.23	10.84	2.12	±	1.86	1.61	1.08	2.33
Lake Sylvania	0.28	6.82	1.44	±	1.16	1.08	0.71	1.79
Middle River NE 18th St Dock	0.71	35.20	2.22	±	3.64	1.53	1.08	2.13
Middle River George English	0.25	42.19	2.51	±	5.24	1.31	0.78	2.05
Sandbar	0.20	15.60	1.96	±	2.43	1.15	0.66	1.96
Sunrise Bay Hugh Taylor Birch Park	0.00	2.45	1.03	±	0.61	0.88	0.58	1.51
Sunrise Paddleboard	0.24	8.69	1.40	±	1.46	0.90	0.63	1.71
Sweeting Park	0.96	10.31	2.56	±	1.38	2.20	1.79	2.84
<b>Chlorophyll a (ug/L)</b>								
Annie Beck Park	0.66	20.98	4.19	±	4.51	2.26	3.34	4.92
Cooley's Landing Park	1.53	13.01	5.24	±	5.51	2.03	4.32	6.47
Coontie Hatchee Park	3.77	19.80	6.19	±	6.66	2.42	5.01	7.32
Lake Sylvania	0.46	10.06	2.76	±	2.93	1.84	1.76	3.43
Middle River NE 18th St Dock	1.89	23.77	6.40	±	7.90	4.39	4.80	9.79
Middle River George English	0.62	16.91	3.96	±	4.49	2.72	2.86	5.21
Sandbar	0.68	9.94	3.44	±	3.60	1.64	2.67	4.58
Sunrise Bay Hugh Taylor Birch Park	0.82	40.89	4.06	±	5.24	5.24	2.63	6.35
Sunrise Paddleboard	0.61	39.29	3.55	±	4.26	4.47	2.82	4.70
Sweeting Park	2.27	48.84	10.96	±	13.25	8.33	8.09	16.31

## Supplementary Materials

**Table S4.** Summary Statistics for Enterococci Levels Across Sampling Sites for 2024, 2023, and Total Monitoring Years (2021-2024). Sample size, mean, standard deviation, of enterococci levels (MPN/100 mL) recorded at each sampling site.

Enterococci Concentrations	2024			2023			Total (2021-2024)		
	n	MPN	± SD	n	MPN	± SD	n	MPN	± SD
Annie Beck Park	53	420	± 499	52	295	± 715	208	300	± 613
Cooley's Landing Park	53	204	± 558	21	146	± 198	74	187	± 483
Coontie Hatchee Park	53	639	± 2419	52	109	± 199	208	251	± 1260
Lake Sylvia	53	120	± 449	52	39	± 68	208	55	± 235
Middle River NE 18th St Dock	53	1420	± 4679	21	241	± 208	74	1085	± 3986
Middle River George English Park	53	369	± 1296	52	62	± 86	208	152	± 700
Sandbar	53	128	± 392	50	108	± 240	206	84	± 249
Sunrise Bay Hugh Taylor Birch Park	52	147	± 459	51	41	± 55	203	63	± 245
Sunrise Paddleboard	53	1019	± 4254	21	90	± 135	74	756	± 3616
Sweeting Park	53	734	± 1017	50	518	± 890	206	670	± 1347
<b>Discontinued (January 2021- July 2023)</b>									
Himmarshee Canal				31	1377	± 4513	134	952	± 3295
Royal Palm Drive Las Olas Blvd				31	65	± 135	134	59	± 134
Tarpon River				31	922	± 2417	133	531	± 1641
<b>TOTAL</b>	<b>529</b>	<b>521</b>	<b>± 2250</b>	<b>515</b>	<b>278</b>	<b>± 1342</b>	<b>2070</b>	<b>328</b>	<b>± 1558</b>

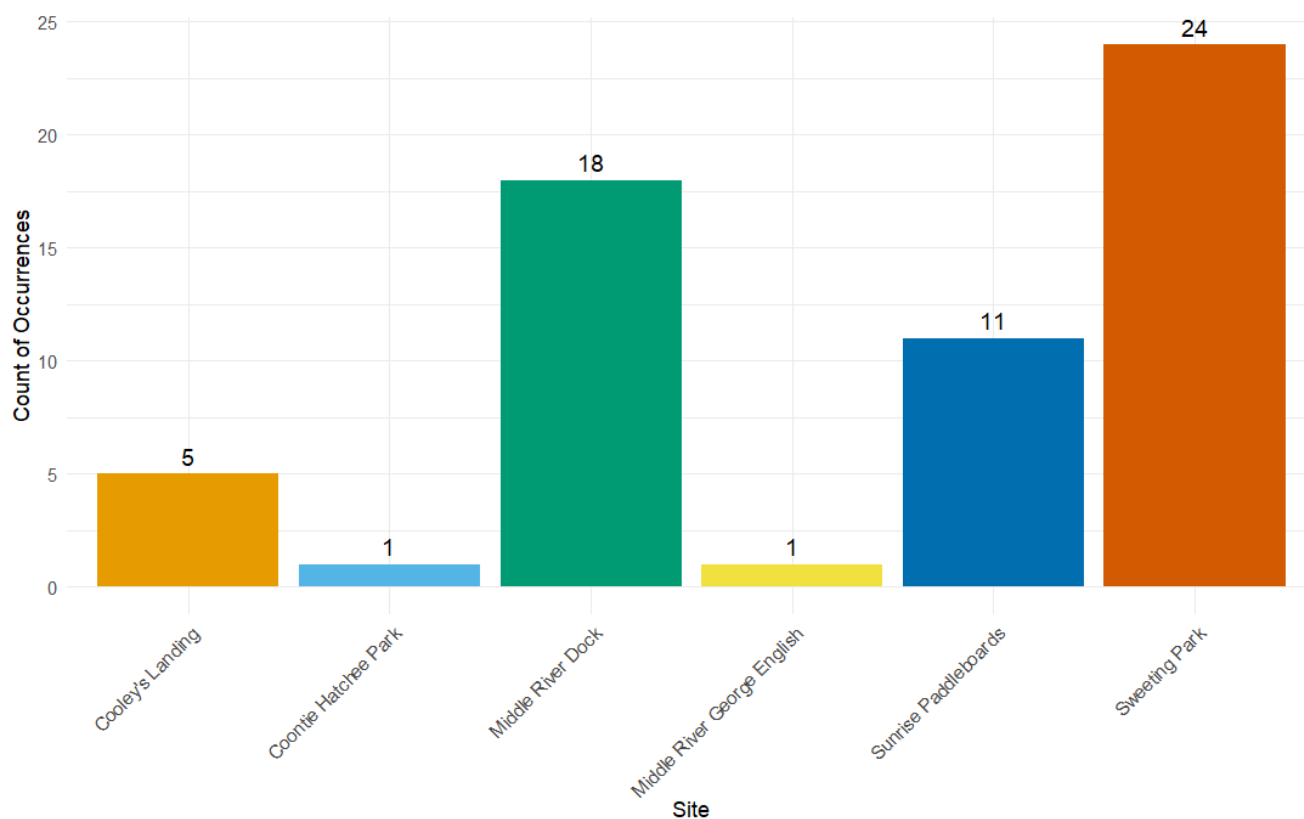
## Supplementary Materials

**Table S5.** Summary Statistics for Enterococci Levels Across Sampling Sites for 2024, 2023, and Total Monitoring Years (2021-2024). Sample size, median, and interquartile range (Q1–Q3), of enterococci levels (MPN/100 mL) recorded at each sampling site.

Enterococci Medians	2024				2023				Total (2021-2024)			
	n	Median	IQR		n	Median	IQR		n	Median	IQR	
			Q1	Q3			Q1	Q3			Q1	Q3
Annie Beck Park	53	253	85	504	52	75	41	217.25	208	86	31	256.75
Cooley's Landing Park	53	74	52	122	21	75	52	97	74	74	52	122
Coontie Hatchee Park	53	98	52	226	52	41	20	95.5	208	63	31	121
Lake Sylvia	53	20	10	41	52	10	5	31	208	10	5	31
Middle River NE 18th St Dock	53	228	145	420	21	185	109	238	74	205	134.25	324.75
Middle River George English Park	53	31	20	130	52	30	10	74.25	208	20	10	74
Sandbar	53	31	10	63	50	30	10	81.25	206	20	5	52
Sunrise Bay Hugh Taylor Birch Park	52	20	10	54.75	51	20	10	52	203	20	10	41
Sunrise Paddleboard	53	31	10	98	21	52	20	97	74	41	10	98
Sweeting Park	53	399	262	785	50	243	146.5	487.75	206	301	175	577
<b>Discontinued (January 2021- July 2023)</b>												
Himmarshee Canal					31	106	46	223.5	134	163	75	326.25
Royal Palm Drive Las Olas Blvd					31	10	5	31	134	10	5	40.75
Tarpon River					31	122	46	442.25	133	97	62	216
<b>TOTAL</b>	<b>529</b>	<b>74</b>	<b>20</b>	<b>262</b>	<b>515</b>	<b>52</b>	<b>20</b>	<b>158</b>	<b>2070</b>	<b>52</b>	<b>10</b>	<b>173</b>

## Supplementary Materials

### Supplementary Figures



**Figure S1.** Number of observations per site where dissolved oxygen (DO) levels fell below 4 mg/L. According to Broward County Water Quality Standards for Marine Waters (Table 1), no single reading should fall below 4,000  $\mu\text{g/L}$  (4 mg/L). This figure highlights exceedances of that minimum threshold. The sample size for all sites is 53, except for Sunrise Bay Hugh Taylor Birch, which had a sample size of 52.

# Supplementary Materials

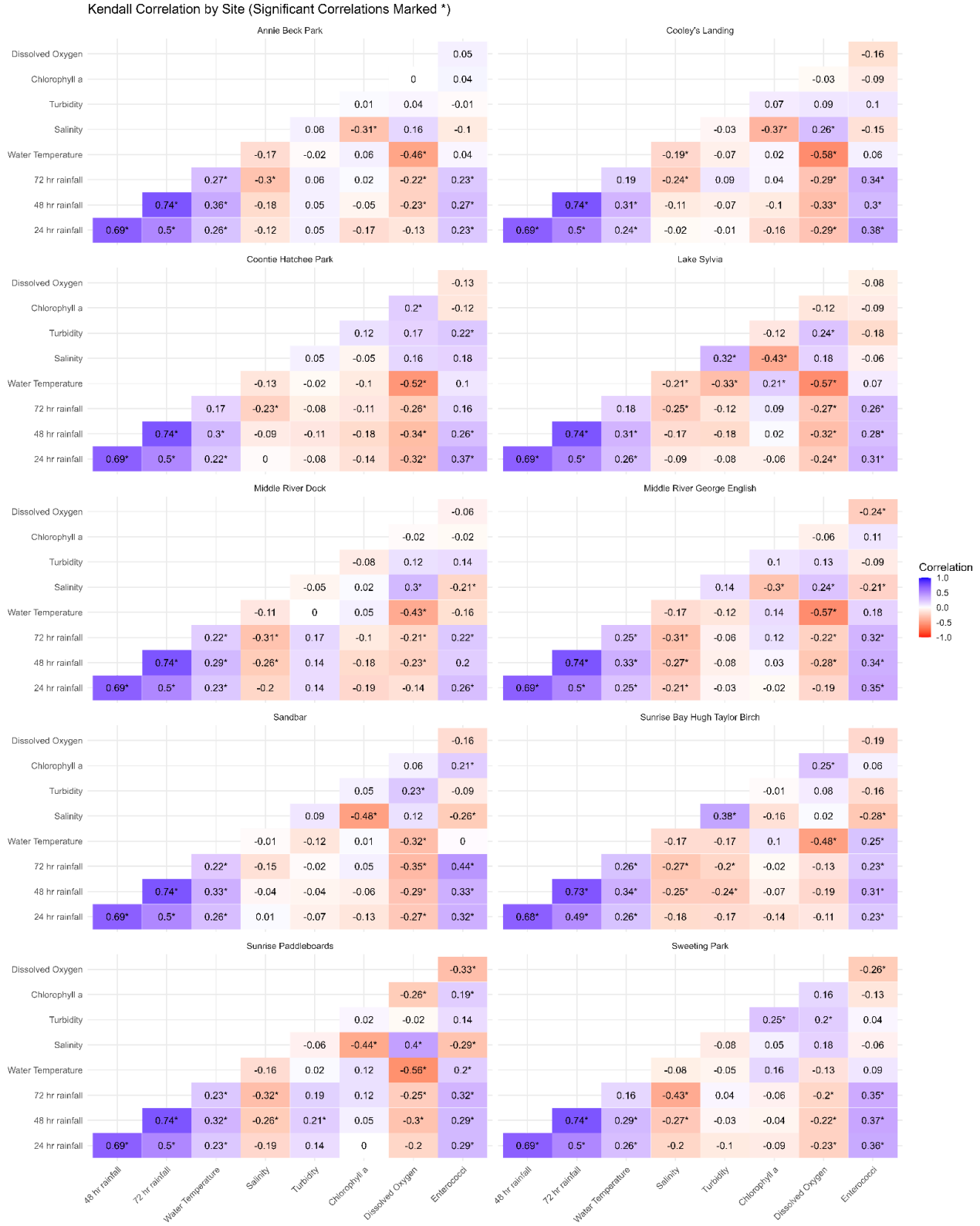
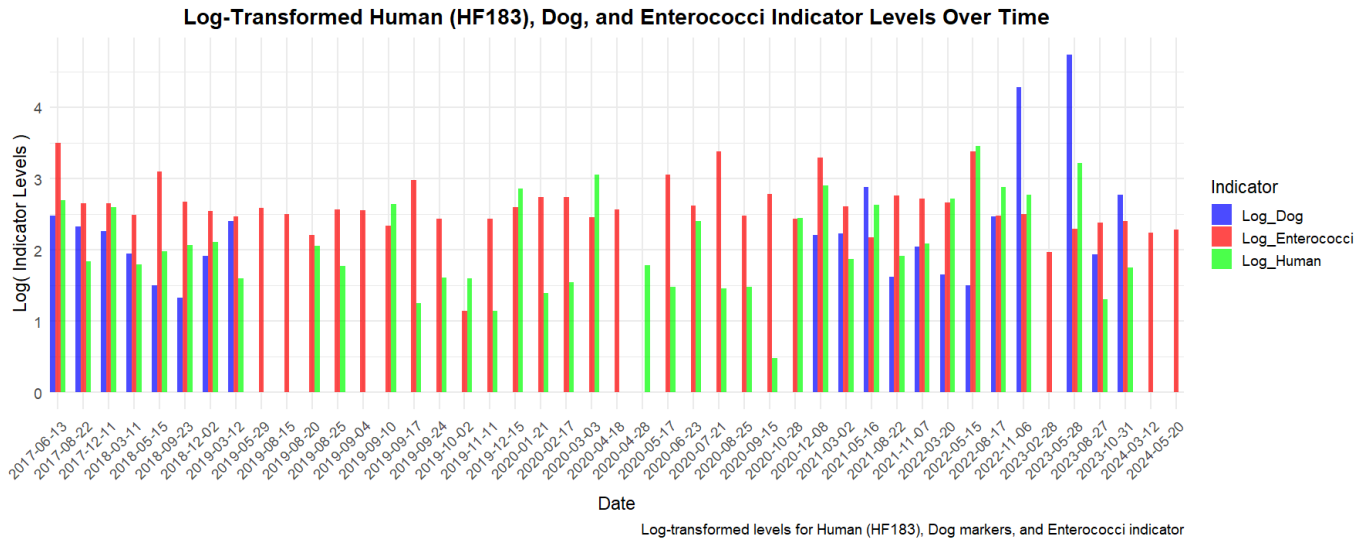


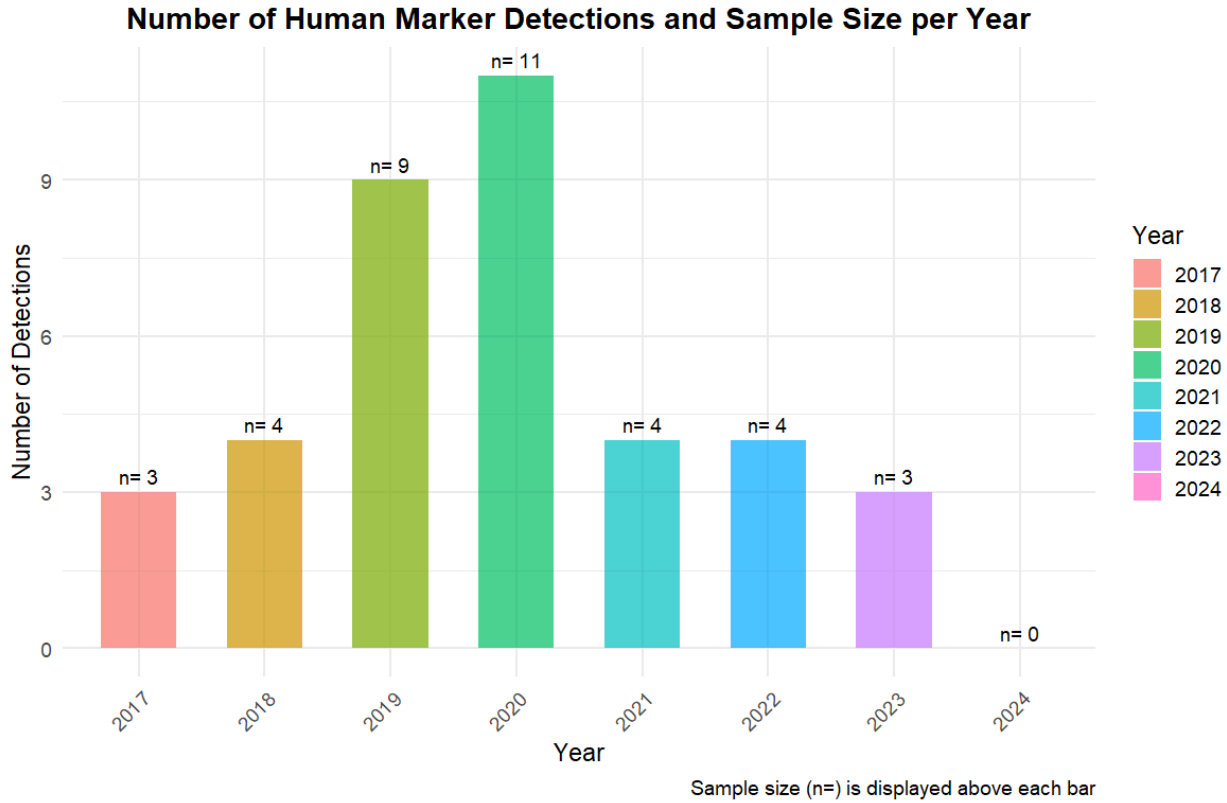
Figure S2. Kendall correlation heatmaps for all variables across different sites during 2024.

## Supplementary Materials



**Figure S3.** Shows the levels of human and dog markers over time, side by side. Note that dog marker data was not available for all dates, so only the dates with data for both markers are included. Additionally, enterococci data has been incorporated into the plot where available for comparison. While we cannot confirm whether the enterococci data was cultured from the exact same samples as the MST measurements, we have matched the data as closely as possible. Summary statistics for the three markers/indicator are as follows: For the Human (HF183) marker, the average level is  $334 \pm 552$  GC/100 mL, and the maximum observed level is 2853 GC/100 mL. The Dog marker has an average level of  $3888 \pm 12,814$  GC/100 mL, and a maximum of 55,323 GC/100 mL. The Enterococci indicator shows an average of  $583 \pm 673$  MPN/100 mL, and a maximum level of 3200 MPN/100 mL. This plot is based on data collected by the Broward County Environmental Monitoring Laboratory.

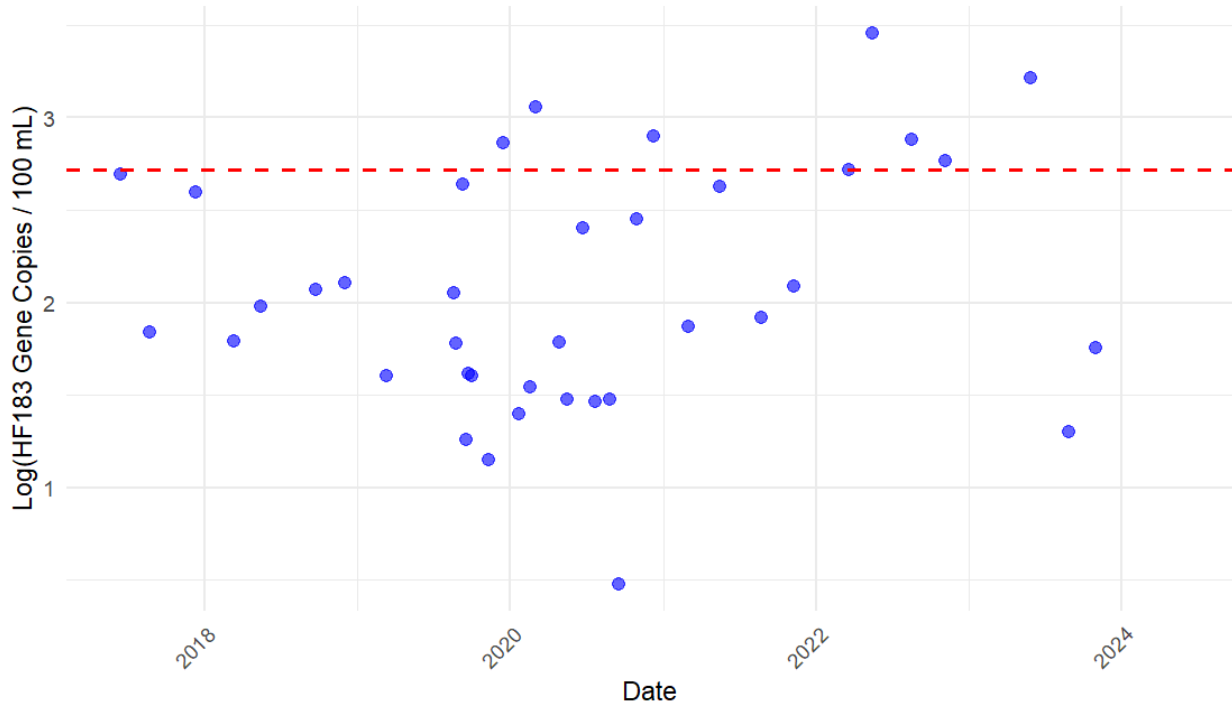
## Supplementary Materials



**Figure S4.** Annual number of HF183 (human-associated) marker detections at Sweeting Park based on available data from 2017 through November 2023. Interpretation should consider variation in sampling effort across years. While data may exist through late 2024, updates are currently delayed due to staffing constraints. This plot is based on data collected by the Broward County Environmental Monitoring Laboratory.

## Supplementary Materials

### Human Fecal Indicator (HF183) Levels at Sweeting Park Over Time



Red dashed line indicates human exposure risk-based threshold (525 copies of HF183 human Bacteroides marker)

**Figure S5** Concentration of human-associated marker HF183 at Sweeting Park. The red dashed line represents the Quantitative Microbial Risk Assessment (QMRA) threshold of 525 gene copies per 100 mL, which corresponds to an estimated illness risk of greater than 32 cases per 1,000 exposures. HF183 levels at this site have occasionally exceeded this threshold, indicating potential periods of elevated public health risk. This plot is based on data collected by the Broward County Environmental Monitoring Laboratory.



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