Loxahatchee River District (LRD)
WildPine Ecological Laboratory
www.loxahatcheeriver.org

Jones Creek Drainage Basins Fecal Indicator Bacteria (FIB) and Turbidity Monitoring Preliminary Findings Summary – December 2019

Rachel Harris (Rachel.Harris@lrecd.org),
Susan Noel (Susan.Noel@lrecd.org),
Bud Howard (Bud.Howard@lrecd.org),
Loxahatchee River District (LRD) WildPine Ecological Laboratory

Anita Nash (Anita.Nash@dep.state.fl.us),
Puja Jasrotia (Puja.Jasrotia@dep.state.fl.us),
Sarah Menz (Sarah.Menz@dep.state.fl.us),
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration

Summary

This report provides a summary of preliminary findings from a special project conducted by the Loxahatchee River District (LRD) in partnership with the Florida Department of Environmental Protection (FDEP). The goal of this project is to try and improve our understanding of the source(s) of elevated Fecal Indicator Bacteria (FIB) concentrations and high turbidity events in the Jones Creek drainage basin in the Loxahatchee River watershed in Jupiter, Florida.

Some noteworthy observations include:

- Genetic testing indicates the presence of low levels of human waste at some sites. The concentrations and lack of common chemical tracers may indicate a single household rather than broken wastewater infrastructure. These findings are leading us to adjust our monitoring locations to try and narrow in on potential pollution sources such as a camper discharge, a homeless encampment, a residence still utilizing a septic system, or a broken sewer lateral line joining an individual home to the main gravity sewer line.
- Water quality instrumentation ('Data Sonde') has provided insight into the ranges and variation of turbidity, chlorophyll, light, salinity, pH, dissolved oxygen, and tide stage within the creek, as well as interesting patterns and relationships between the parameters.
- Our research is confounded by, and we urge residents to stop detrimental behaviors such as the dumping of fish and (reported) alligator carcasses, pet waste, grass clippings, vegetation and other wastes into Jones Creek.

While we do not fully understand all the factors driving the high bacteria and turbidity issues in Jones Creek, we are building on our understanding of factors, and identifying key problem areas that we can focus on for water quality improvements. LRD will continue to monitor the water quality in Jones Creek and will proceed with the dry season sampling in this collaborative study with FDEP.

Background

FIB are used as an indicator of human waste in surface waters. Studies have linked high FIB concentrations to an increase in human-born illnesses/pathogens. Thus, the concentrations of FIB are a concern to any recreational waterway. Turbidity is a measure of water clarity, where particles (mineral or organic debris) remain suspended in the water column and this decreases water clarity. Turbidity can be a natural occurrence due to wind, waves and tides, or can be related to surface discharges, such as sediment/mineral or pollutant inputs upstream. The decrease in water clarity can be detrimental to organisms requiring light penetration on the seafloor and makes the water unappealing for recreational use.

Over the past several years, the LRD, in partnership with the Town of Jupiter, has conducted extensive water quality monitoring and thoroughly explored the watersheds to try and identify the potential source(s) of FIB and high turbidity. With no obvious source of the high FIB values, LRD and FDEP partnered to capitalize on FDEP's more sophisticated analytical methods to further investigate the potential sources of FIB. In addition, LRD deployed a pair of near-continuous water quality monitoring instruments in Jones Creek to explore the results and relationships between turbidity, chlorophyll, salinity, temperature, light, dissolved oxygen, pH and water level. This project includes twice monthly wet season monitoring from August through September, and dry season sampling to January 2020. These preliminary results summarize the wet season results of water quality samples collected through September 25th, 2019.

Wet Season Sampling & Results

Enterococci and fecal coliform are both FIB commonly used as an indicator of human waste when detected in high counts in surface waters. Enterococci exceedances in Jones Creek range from the 100+ to 5,000+ MPN/100mL, well above the Environmental Protection Agency's (EPA's) recommended Beach Action Value (BAV) of 71 MPN/100mL for recreational waters. This is a concern for the residents and environmental managers.

LRD has conducted extensive water quality monitoring and thoroughly explored the watershed to try and identify the potential source(s) of FIB. With no obvious source of the high FIB values, LRD is now collaborating with Florida Department of Environmental Protection (FDEP) experts to further investigate the potential sources of FIB.

Samples were collected from the locations indicated in Fig. 1; further described in Table 1. Each sample location is near a source of incoming water (e.g., creek, culvert or storm drain) and chosen to assist in the determination of a FIB source. In Jones Creek, sample location 75 reflects tidal inputs (75 is also directly upstream of a possible homeless encampment), PLE discharges through a slough (PLE is a Town of Jupiter natural area and possible homeless encampment), during extreme rains and high lake levels TPJ drains a golf course community to the south and JCU drains adjacent commercial/residential neighborhoods (flow in and out of JCU is restricted by vegetation and mangrove overgrowth). CALC is located in a shallow portion of Jones creek that forks off from the main tidal creek. Samples collected at CALC are collected from surface waters flowing underneath the Caloosahatchee Drive culvert bridge.

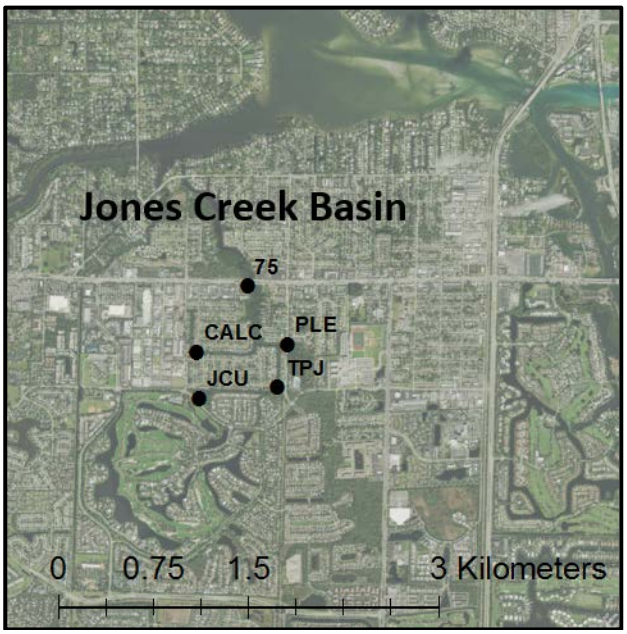


Figure 1. Map of sample locations in Jones Creek, a tributary into the Loxahatchee River in Jupiter, Florida.

Table 1. Description of water quality sampling locations

Site Name	Site ID	Description	Latitude	Longitude
Indiantown Rd Bridge	75	Deep mangrove lined channel.	26.933685	-80.113127
Caloosahatchee Culvert	CALC	Culvert bridge on Caloosahatchee Dr.; shallow mangrove creek with low sunlight.	26.929011	-80.117231
Toney Penna Jones Creek	TPJ	Toney Penna Foot Bridge; clearing in mangrove tidal creek.	26.926428	-80.110738
Jones Creek Upper	JCU	Culvert across from Jupiter Christian Academy; shaded, freshwater vegetation, flow often restricted.	26.925715	-80.116983
Pennock Lane East	PLE	Immediately upstream of weir structure draining natural area.	26.929480	-80.109928

All samples were collected by LRD's Wildpine laboratory staff. 5 samples were collected per sampling event at 0.3 m depth during an outgoing tide (preferably mid to end ebb). Wet season sampling included Aug 12, Aug 27, Sep 10, Sep 25, 2019. Samples were processed according to the standard/NELAC certified methods and/or using FDEP's pre-packaged 'kits' and sent on ice overnight to FDEP's Laboratory for confirmatory FIB and further analysis.

Environmental Parameters and Water Quality

During sample collection LRD staff collected environmental data including (methods in parenthesis): temperature (EPA 170.1), salinity (SM 2520 B), conductivity (EPA 120.1), pH (EPA 150.1), dissolved oxygen (mg/L EPA 360.1; percent FDEP FT1500), rainfall and tidal stage. After collection samples were processed for chlorophyll-a (SM 10200 H), turbidity (EPA 180.1), orthophosphorous (SM 4500-P F), total phosphorous (SM 4500-P E), nitrate and nitrite (EPA 353.2), total kjeldahl nitrogen (EPA 351.2), total nitrogen (calculation)), fecal coliform (Colilert-18/QT) and Enterococci (Enterolert/QT) at LRD's WildPine Laboratory.

Across the entire watershed average rainfall ranged from 13 inches in August to 4 inches in September (See https://loxahatcheeriver.org/river/rainfall/). In the Wet season temperatures ranged from 25.4°C (77.7°F) to 31.84°C (89.3°F). Both turbidity and chlorophyll-a (measure of algal biomass) increased as temperatue, pH and dissolved oxygen decreased (Fig. 2).

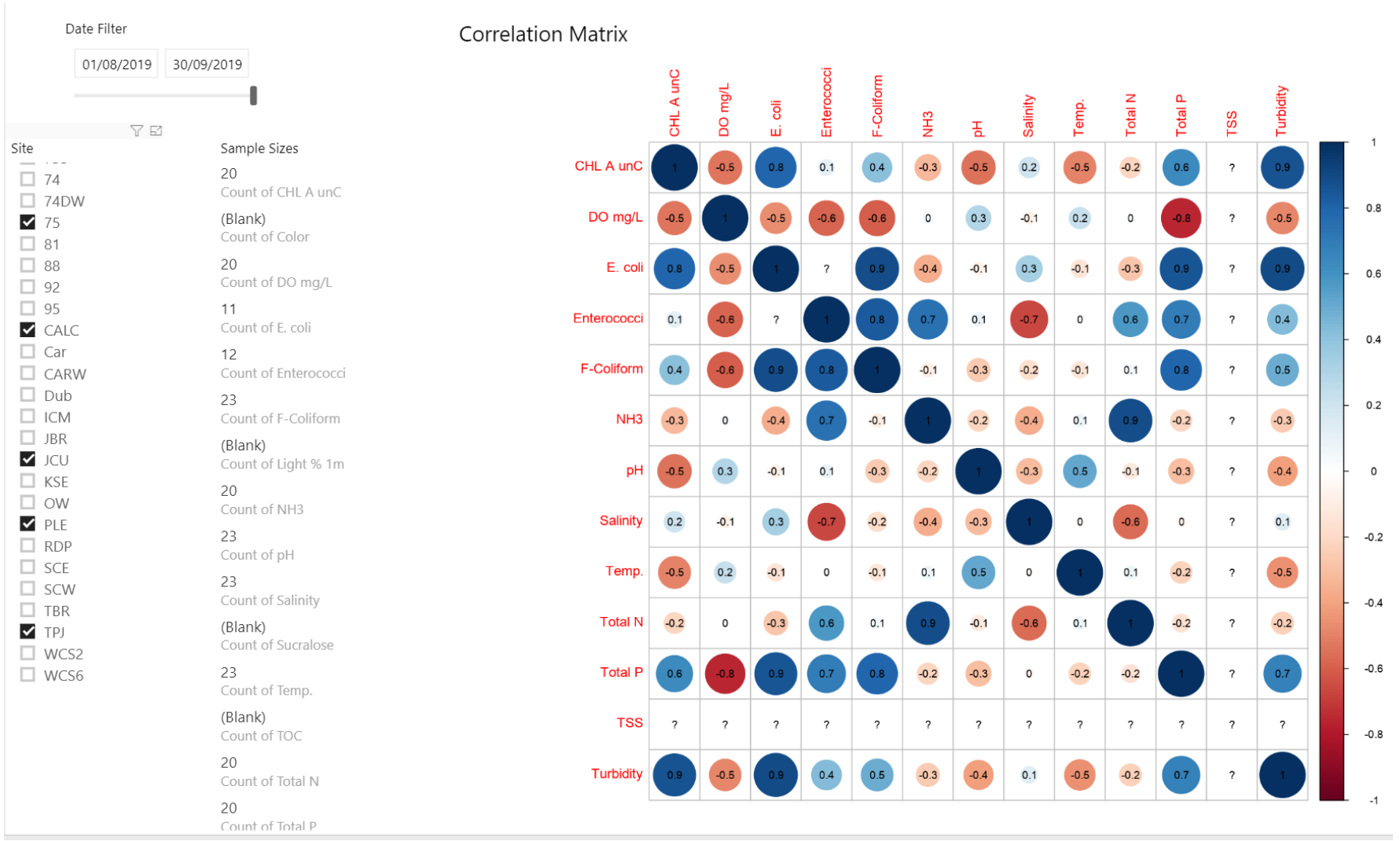


Figure 2. Correlation Matrix of water quality parameters measured in Jones Creek. Interactive version available at LRD's website: Loxahatcheeriver.org/river/river-keeper.

Chemical Indicators

Most humans ingest forms of chemicals that are not processed during digestion and can be detected in human waste material. Common chemicals include: Acetaminophen, Naproxen, Ibuprofen, hydrocodone and sucralose. All five chemical tracers were analyzed, however in the wet season in Jones Creek only sucralose (a sweetener found in treated and untreated human waste) was measured above the FDEP minimum detection limits. See https://fldeploc.dep.state.fl.us/sop

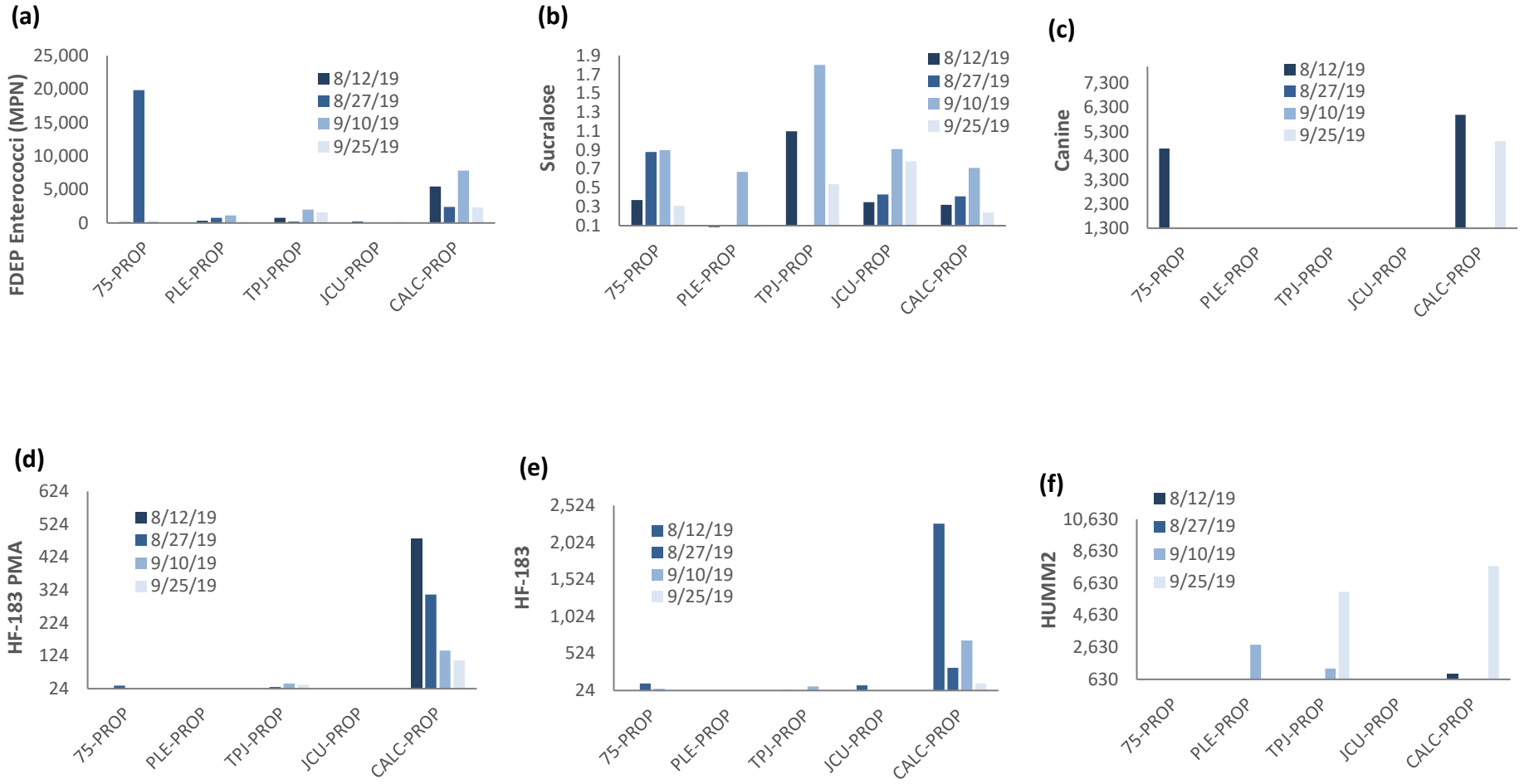
Genetic Markers

Quantitative polymerase chain reaction (qPCR) is a laboratory technique used in Microbial Source tracking (MST) studies to detect and quantify host-associated genetic markers. This project uses markers to detect DNA from bacteria that are commonly present in human or animal waste. Two human markers, HF183 and HumM2, were used to determine if DNA from human fecal bacteria were present at the time of sampling. The HF183 marker detects *Bacteroides* 16S rRNA gene targets, and the samples are treated with the chemical propidium monoazide (PMA) to differentiate between live and dead cells. This method provides two values, a measurement of the total amount of HF183 DNA and the amount of HF183 DNA coming from live bacteria (HF183 PMA). The other human marker, HumM2, detects a *Bacteroides* non-16S rRNA gene target. A separate marker was used to detect bacterial DNA from canine waste. Populations of raccoons and wading birds have been noted in this basin and can be a potential source of fecal bacteria. There is no current genetic marker available to determine the presence of raccoon waste, and bird markers were not tested. LRD collected samples and all qPCR analyses were conducted by FDEP at the FDEP Molecular Biology Laboratory following the designated standard operating procedures (SOPs) (https://floridadep.gov/dear/florida-dep-laboratory/content/molecular-biology).

Initial results indicate continued high levels of FIB in Jones Creek. The caloosahatchee culvert station (CALC-PROP) upstream in Jones Creek consistently had higher FIB (Fig. 3a), higher HF-183 PMA (Fig. 3d), and HF-183 (Fig. 3e) human marker, as well as the highest concentration of the canine marker (Fig. 3c). The sampling event on August 12th also had high FIB (Fig 3a) and canine marker (Fig. 3c) at station 75 – the closest monitoring station to the Loxahatchee River.

The presence of human waste markers with the absence of chemical tracer Acetaminophen is indicative of low concentrations of fecal pollution, which may point to a single household rather than broken wastewater infrastructure. These findings are leading us to adjust our monitoring locations to try and narrow in on those potential pollution sources such as a camper discharge, a homeless encampment, a residence still utilizing a septic system, or a broken sewer lateral line joining the home to the gravity sewer line.

Figure 3. Initial results for (a) enterococci FIB, (b) sucralose (chemical indicator of human waste), (c) qPCR canine marker, and qPCR Human genetic marker showing (d) Propidium monoazide (PMA) treated 'live' Bacteroides , (e) HF-183 total Bacteroides and (f) HUMM2 Bacteroidetes non-16S rRNA gene targets.

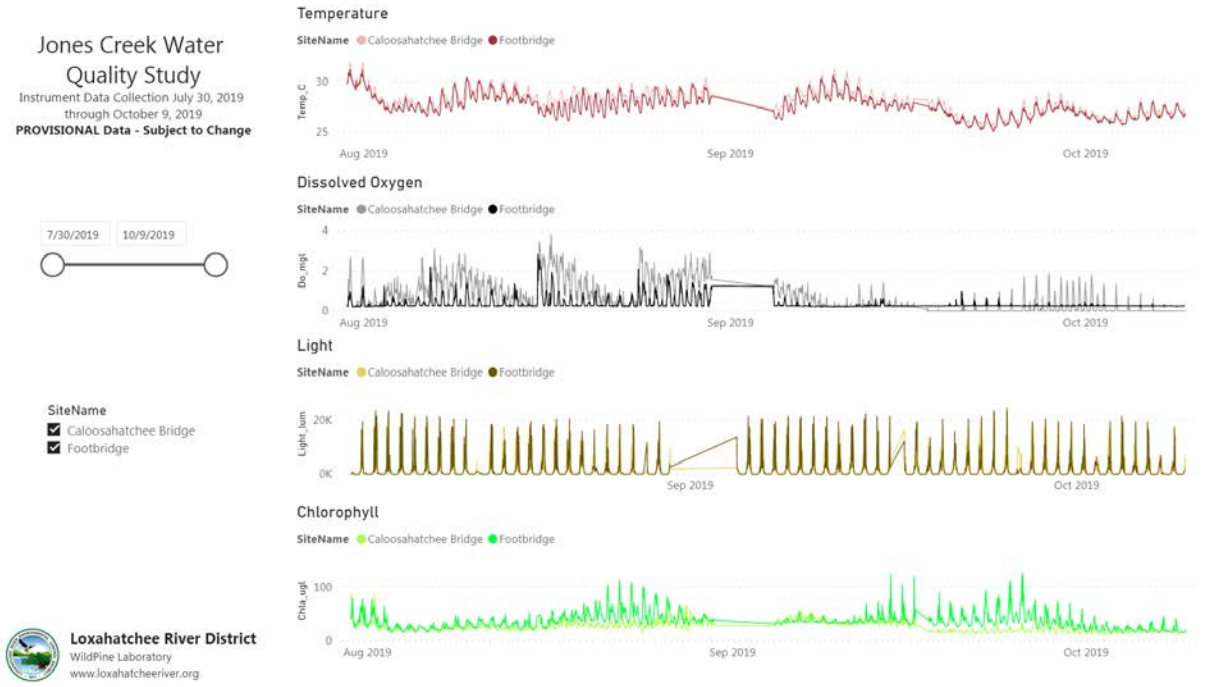


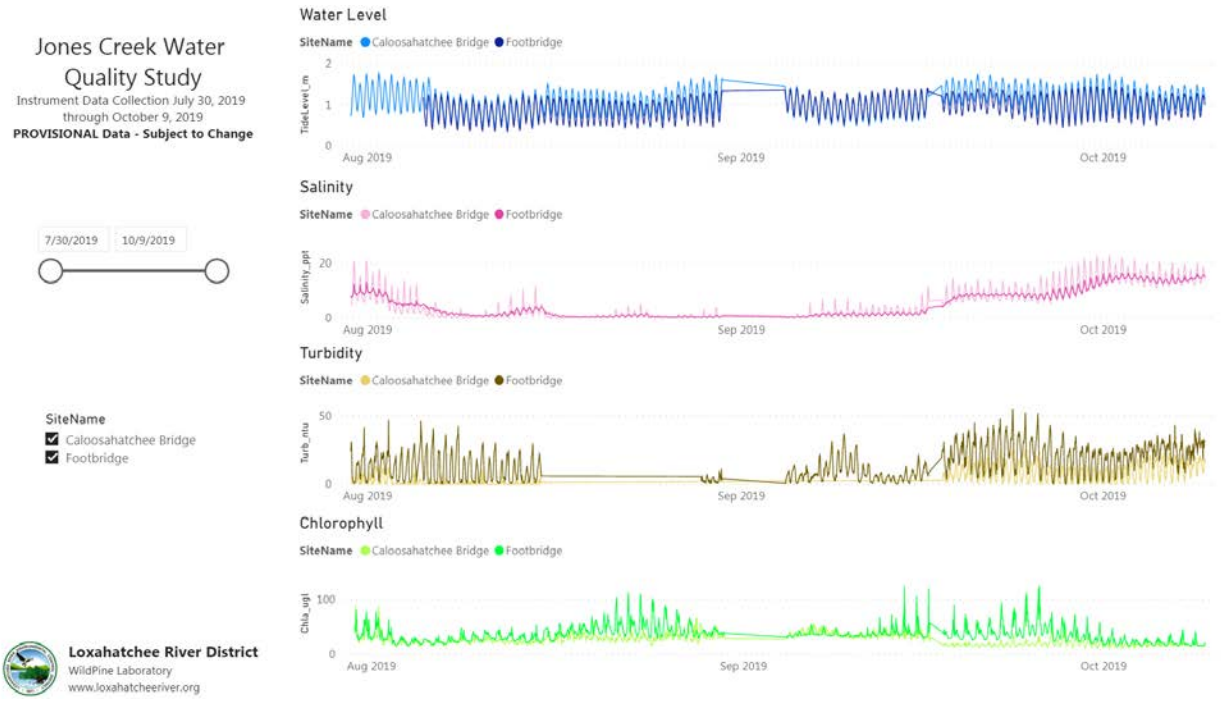
High Frequency Water Quality Data Collection – Data Sonde Instruments

In support of this special project, and to improve our understanding of the patterns and magnitude of changes in various water quality parameters, LRD deployed a pair of near-continuous water quality monitoring instruments ('Data Sondes') in Jones Creek. The instruments (Hydrolab DS5X) had sensors for turbidity, chlorophyll, salinity, temperature, dissolved oxygen, pH and water level set to record data every 15-minutes. The instruments were deployed from residential docks near the Caloosahatchee Bridge (near the CALC water quality monitoring station) and near the Footbridge (near the TPJ water quality monitoring station) from July 30, 2019 through October 9, 2019. The instruments were deployed for two weeks then brought back to the laboratory for data download, cleaning and calibration. Quality control (QC) measurements were made at the time of deployment, at one week out, then just prior to removal with a separate instrument and/or known calibration concentration. If the data for that deployment was glaringly wrong it was deleted from the dataset, though for this preliminary data review we were less aggressive with data filtering to preserve as much as the information as possible. Light sensors (Onset Computer Corp) were also deployed to assess diurnal patterns in water quality parameters. All instruments were removed on August 30 because a powerful hurricane (Dorian) was forecast to strike our area, then redeployed on September 4.

All of the Data Sonde data is presented in a multitude of interactive data visualizations available from the Jones Creek web page provided by LRD: www.loxahatcheeriver.org/JonesCreek. Not surprisingly water temperatures were high with some measurements over 31^{o}C (89^{o}F). Temperatures dipped to approximately 25^{o}C (77 ^{o}F) during a few early mornings. Dissolved oxygen (DO) levels were generally very low and hypoxic (<2 mg/L), common in mangrove tidal creeks. DO showed more variability during the period prior to the hurricane when there were more rain events compared to September when there was very little rain. Salinity ranged from near zero to over 22 psu and was highly influenced by the tide cycle. In general, salinity tended to decrease during periods of increased rainfall. The Caloosahatchee site showed more variability in salinity that the Footbridge site further upstream. Turbidity values varied with substantial diurnal fluctuations ranging from zero to near 50 NTU in each tide cycle. This common in shallow tidal regions, where sediments are easily resuspended by tidal currents. Unfortunately, the turbidity data did not pass QC for several deployments and was deleted (shown as gaps in Fig. 4), but the data indicated high variability and generally higher readings during periods of little rainfall. Lastly, chlorophyll values, a measure of algae productivity, were also high and variable ranging from the teens to over 100 ug/L. The chlorophyll values and light data confirmed the diurnal pattern with high chlorophyll concentrations during daylight hours. Like other parameters, the Caloosahatchee site showed greater variability and generally higher concentrations of chlorophyll. On the Jones Creek website page 7 of the visualizations shows the correlation matrix with some moderate positive and negative correlations between parameters, but some of these relationships are notably different between the two sites.

Figure 4. Sample screens of the interactive data visualization tools to explore the water quality data collected by instrumentation near the Caloosahatchee Bridge and the Footbridge in Jones Creek available on LRD's website: www.loxahatcheeriver.org/JonesCreek.





Conclusions

Neither the high FIB nor the high turbidity in Jones Creek can be attributed to an isolated timeframe, specific site/location, or related to any singular water quality measure. This suggests a combination of factors leading to decreased water quality in Jones Creek. LRD will continue to collaborate with FDEP to both isolate problem areas and develop potential solutions starting with priority site CALC.

During data collection we have noticed a several issues that can be addressed by the public. Some of these examples include finding fish, lobster, and alligator carcasses, pet waste bags and landscape vegetation floating and along the bridge banks of Jones Creek. Any dead and/or decaying matter is likely to harbor bacteria and will not improve water quality. We urge residents to refrain from discarding waste products into the creek.

Dry season sample collection is underway until January 2020. We intend to prepare a summary report once all of the results are finalized.