WAKULLA SPRINGS
MONITORING SUMMARY

January 2019 – December 2019

PREPARED FOR
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION,
DIVISION OF RECREATION AND PARKS
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This report was prepared by the Howard T. Odum Florida Springs Institute (FSI). Ecological monitoring was conducted by FSI and the Florida SPRINGSWATCH volunteers under the Florida Department of Environmental Protection (FDEP) Division of Recreation and Parks Research / Collection Permit Number 04261910. The establishment of the Florida SPRINGSWATCH Wakulla group was made possible by funds granted to the Florida Springs Institute by the Fish and Wildlife Foundation of Florida’s Protect Florida Springs Tag Grant program.

Our Wakulla SPRINGSWATCH program would not be possible without the hard work of our volunteer team leader, Sean McGlynn, and boat captain Bob Thompson. We would also like to acknowledge the contribution and dedication of our other volunteers: Julia McGlynn, Katy McGlynn, Carl Jameson, Sophie Wacoyne, and Bob Degle.
Section 1.0 Introduction

Located 16 miles south of Tallahassee, Wakulla Spring is one of the largest first-magnitude artesian springs in Florida as well as the United States. Wakulla Spring lies within the Edward Ball Wakulla Springs State Park, which has been listed on the Natural Register of Historic Places and is designated a National Natural Landmark. Wakulla Spring forms the headwaters of the Wakulla River which flows for nearly 11 miles before merging with the St. Marks River in St. Marks, Wakulla County. Wakulla springs is historically renown for its natural beauty, and has been a favorite recreational site, as well as potable water source, for residents of Leon, Wakulla, and surrounding counties. However, the Wakulla river and springs have not been immune to human impacts, demonstrating reductions/reversals in flow as well as increased growth of invasive hydrilla and filamentous algae, likely related to increased groundwater withdrawals for urban use. Through citizen science conducted via the SPRINGSWATCH volunteer program, FSI is able to enhance monitoring of the Wakulla River and springs. The resulting data will be used to more accurately assess the health of the river and springs and further educate the public.

This report was prepared by the Howard T. Odum Florida Springs Institute (FSI) and is focused on ecological monitoring currently being conducted by SPRINGSWATCH volunteers along the Wakulla River and springs.

1.1 Monitoring Stations

Data were collected by Florida SPRINGSWATCH volunteers at a total of 9 stations (Figure 1). WAK-HS represents the station at Wakulla headspring, with river/run stations WAK-1 through WAK-8.

Figure 1. Wakulla River SPRINGSWATCH monitoring stations
Section 2.0 Methods

Ecological monitoring was conducted on the Wakulla River from March 2019 to December 2019. Data collection included water quality field parameters, light measurements, and aquatic vegetation assessments.

2.1 Sampling Events

Table 1. Florida SPRINGSWATCH Wakulla sampling events (March 2019 – December 2019) summarizes the sampling events along the Wakulla River and springs. Monitoring was conducted monthly during 2019 by the Florida SPRINGSWATCH Volunteer Program with assistance from FSI. Months with missing DO or Specific Conductance data were the result of issues with calibration of the devices. These were resolved by October sampling.

Wakulla River SPRINGSWATCH monitoring events included the following:

- Water quality field parameters (temperature, dissolved oxygen, and specific conductivity)
- Vertical light attenuation (PAR)
- Aquatic vegetation assessments

Table 1. Florida SPRINGSWATCH Wakulla sampling events (March 2019 – December 2019)

<table>
<thead>
<tr>
<th>Sampling Date</th>
<th>DO</th>
<th>Specific Conductance</th>
<th>Temperature</th>
<th>Light Attenuation</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/28/2019</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>4/25/2019</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6/27/2019</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>7/25/2019</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>8/22/2019</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>9/26/2019</td>
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<td></td>
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<td>x</td>
<td>x</td>
</tr>
<tr>
<td>10/31/2019</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>12/26/2019</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

2.2 Water Quality

Surface water data were collected monthly at each station along the Wakulla River with YSI water quality meters. Handheld YSI ProODO and YSI EcoSense EC300A meters were used at each of the 9 monitoring stations along the Wakulla River to collect measurements of temperature/dissolved oxygen, and specific conductance respectively. Vertical Secchi disk readings were also taken monthly at each station to measure water clarity. Calibration and maintenance of water quality meters was conducted according to factory instructions. Instruments were calibrated before and after each sampling event.
2.3 Light Measurements

Photosynthetically Active Radiation (PAR) underwater light transmission and attenuation coefficients were measured monthly at the 9 monitoring sites during comprehensive ecological assessments. Data were collected using a LI-COR brand LI-192 underwater quantum sensor to measure PAR energy reaching the water surface and at 1-foot intervals from the surface to a depth of 2 feet in the water column. Figure 2 provides a typical light sensor installation. Light extinction (attenuation) coefficients were calculated from these data using the Lambert-Beer equation (Wetzel 2001):

\[ I_z = I_o (e^{-kz}) \]

Where:

- \( I_z \) = PAR at depth \( z \)
- \( I_o \) = PAR at the water surface
- \( k \) = diffuse attenuation coefficient, m\(^{-1}\)
- \( z \) = water depth, m

Figure 2. Image of a LI-COR PAR meter

2.4 Vegetation

Submerged Aquatic Vegetation (SAV) was monitored at 8 of the 9 stations during each sampling event. Two photographs were taken at each station in two different locations which were sent to FSI for vegetation identification and percent coverage estimations. The average between the two photographs was used to provide the overall average percent plant coverage at each station. Photos were not taken at the headspring (WAK-HS) due to its depth.
Section 3.0 Results

This section summarizes field data collected as part of the ecosystem monitoring conducted along the Wakulla River from March 2019 to December 2019. Data collected by Florida SPRINGSWATCH volunteers included water quality field parameters, light measurements, and aquatic vegetation assessments. These data provide a quantitative record of existing conditions in the river and springs and will be useful for comparison to future evaluations of the ecological health of the Wakulla River/Springs system.

3.1 Water Quality

3.1.1 Florida SPRINGSWATCH Water Quality

Figure 3. Florida SPRINGSWATCH Program Wakulla River Dissolved Oxygen Percent Saturation (DO %) Measurements (March 2019-December 2019) through Figure 6 present field parameter results collected from the 9 stations along the Wakulla River as part of the Florida SPRINGSWATCH program from March 2019 to December 2019, these are arranged graphically in upstream to downstream order (Figure 1). Figure 3 presents dissolved oxygen (DO) data measured in percent saturation (%), and Figure 4 presents DO results measured in milligrams per liter (mg/L), or parts per million (ppm). DO levels fluctuated between spring and river stations primarily due to ground water vs surface water influence. Spring stations tend to exhibit lower DO values than river stations since emerging groundwater typically contains less free oxygen, depending on the duration of time the water has been underground before reaching a spring vent. The WAK-HS and WAK-7 were closest to the Wakulla Spring vent (Figure 1) and exhibited the lowest DO concentration measurements (Figure 3, Figure 4). As water moves downstream its potential to receive oxygen from atmospheric diffusion and from photosynthesizing SAV and algae increases, resulting in higher DO concentrations. The WAK-6, WAK-8, and WAK-5 stations all had higher percentages of SAV cover (Table 2, Figure 8), and exhibited higher levels of DO saturation (Figure 3, Figure 4). WAK-4 also exhibited a higher DO concentration measurement (Figure 3, Figure 4), but exhibited lower vegetation cover at our sampling site (Table 2, Figure 8), which may be explained by potential SAV outside the photographed sampling area, or respiration from benthic algae.

Figure 5 presents data for temperature (°C) field measurements. Temperature in the Wakulla River ranged from 21-23°C throughout the year but averaged at roughly 22°C since it is fed largely in part by spring water (typically 22°C).

Figure 6 demonstrates the results for Specific Conductance field measurements. Specific Conductance can be influenced by naturally occurring ions present in spring water, but also from ions present due to higher levels of nitrate/nitrite, phosphorous, saltwater, and other compounds. Higher specific conductance values suggest a higher concentration of these ions in the water. The headspring station, WAK-HS, exhibited the highest Specific Conductance values, where WAK-1 through WAK-7 exhibited varied levels of Specific Conductance (Figure 6). Influence from runoff may explain the fluctuations in Specific Conductance of stations downstream of Wakulla headspring.
Figure 3. Florida SPRINGSWATCH Program Wakulla River Dissolved Oxygen Percent Saturation (DO %) Measurements (March 2019-December 2019)

Figure 4. Florida SPRINGSWATCH Program Wakulla Dissolved Oxygen Measurements (mg/L) (March 2019-December 2019)
Figure 5. Florida SPRINGSWATCH program Wakulla River Temperature Measurements (°C) (March 2019-December 2019)

Figure 6. Florida SPRINGSWATCH program Wakulla Specific Conductance Measurements (uS/cm) (March 2019-December 2019)
3.1.2 Florida SPRINGSWATCH Wakulla Light Measurements

Figure 7 displays the diffuse attenuation coefficient (k) and percent transmittance estimates collected by the Florida SPRINGSWATCH program along the Wakulla River from March 2019 to December 2019. Percent transmittance refers to the amount of light that is able to pass through the water column. The diffuse attenuation coefficient (k) is calculated via the Lambert-Beer equation (Wetzel 2001) to measure how readily light dissipates throughout the water column. Higher values of percent transmittance tend to correspond with lower values of coefficient k. Higher k values, or lower percent transmittance values, can indicate poor water clarity since light cannot pass as easily through the water column, often due to an increase in suspended solids (turbidity) in the water. WAK-6 exhibited the lowest percent transmittance and highest corresponding k value (Figure 7). This suggests that there may be increased turbidity at this station.

Figure 7. Florida SPRINGSWATCH Wakulla Diffuse Attenuation Coefficient (k) and Percent Transmittance Measurements (March 2019-December 2019)
3.2 Aquatic Vegetation Survey

3.2.1 Florida SPRINGSWATCH Wakulla River Springs Vegetation Survey

Submerged aquatic vegetation (SAV) cover was estimated at the Florida SPRINGSWATCH Wakulla River stations from March 2019 to December 2019 using underwater photographs taken at each station. Algae includes filamentous and non-filamentous (Chara sp.) varieties. Algae percentage may result in a total coverage greater than 100%, accounting for a percentage of vegetation cover (typically Sagittaria or Eelgrass) that is also covered in algae. Table 3 represents the average percent cover of vegetation at each station over the period of study. Vegetation was not surveyed at Wakulla headspring (WAK-HS) as the bottom of the spring was too deep to photograph.

Table 2. Average Percent Cover of SAV, algae, and bare ground at Florida SPRINGSWATCH Wakulla River Springs Stations (March 2019 - December 2019)

<table>
<thead>
<tr>
<th>Station</th>
<th>Algae</th>
<th>Sagittaria</th>
<th>Eelgrass</th>
<th>Hydrilla</th>
<th>Bare Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAK-1</td>
<td>40%</td>
<td>6%</td>
<td>0%</td>
<td>1%</td>
<td>55%</td>
</tr>
<tr>
<td>WAK-2</td>
<td>17%</td>
<td>6%</td>
<td>6%</td>
<td>0%</td>
<td>71%</td>
</tr>
<tr>
<td>WAK-3</td>
<td>29%</td>
<td>22%</td>
<td>0%</td>
<td>0%</td>
<td>58%</td>
</tr>
<tr>
<td>WAK-4</td>
<td>22%</td>
<td>0%</td>
<td>0%</td>
<td>9%</td>
<td>70%</td>
</tr>
<tr>
<td>WAK-5</td>
<td>13%</td>
<td>92%</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
</tr>
<tr>
<td>WAK-6</td>
<td>14%</td>
<td>87%</td>
<td>0%</td>
<td>2%</td>
<td>11%</td>
</tr>
<tr>
<td>WAK-7</td>
<td>58%</td>
<td>5%</td>
<td>10%</td>
<td>0%</td>
<td>27%</td>
</tr>
<tr>
<td>WAK-8</td>
<td>0%</td>
<td>13%</td>
<td>0%</td>
<td>46%</td>
<td>41%</td>
</tr>
</tbody>
</table>

Figure 8. Average Percent Cover of SAV, algae, and bare ground at Florida SPRINGSWATCH Wakulla River Springs Stations (March 2019 - December 2019)
Section 4.0 References

