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Our Lower Santa Fe River SPRINGSWATCH program would not be possible without the hard work of our volunteer team leader, Georgia Shemitz. We would also like to acknowledge the contribution and dedication of our other volunteers: Patrick Burke, Terri Skiles, Chislane Car, Michelle Friedline, Maya Lahti, and Dan Rountree.
Section 1.0 Introduction

The Santa Fe River is in the Springs Heartland of North Central Florida and is the discharge point for at least 36 named springs. Located in parts of Alachua, Columbia, and Gilchrist counties, the Lower Santa Fe River and springs offer significant recreational opportunities including kayaking, canoeing, paddle boarding, tubing, swimming, snorkeling, scuba diving, boating, and other water-related activities. The inhabitants of these counties depend on a healthy river and springs system for their water supply, livelihood, and recreational enjoyment. Through citizen science conducted via the SPRINGSWATCH volunteer program, FSI is able to enhance monitoring of the Santa Fe River and springs and use the resulting data to more accurately assess springs and river health 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 Lower Santa Fe River and springs.

1.1 Monitoring Stations

Data were collected by Florida SPRINGSWATCH volunteers at a total of 10 stations: 6 spring stations (three in headspring boils and three in spring runs), and four stations on the Santa Fe River (Figure 1).

![Figure 1. Lower Santa Fe River SPRINGSWATCH monitoring stations](image)
Section 2.0 Methods

Ecological monitoring was conducted on the Lower Santa Fe River from January 2019 to December 2019. Data collection included water quality field parameters, light measurements, vertical secchi disk readings, and aquatic vegetation surveys.

2.1 Sampling Events

Table 1 summarizes the sampling events along the Lower Santa Fe River and springs. Monitoring was conducted monthly during 2019 by the Florida SPRINGSWATCH Volunteer Program with assistance from FSI.

Lower Santa Fe River SPRINGSWATCH monitoring events included the following:
- Water quality field parameters (temperature, dissolved oxygen, and specific conductivity)
- Vertical light attenuation (PAR)
- Aquatic vegetation survey
- Vertical Secchi disk measurements

Table 1. Lower Santa Fe River sampling events (January 2019 – December 2019)

<table>
<thead>
<tr>
<th>Month-Year</th>
<th>Water Quality</th>
<th>PAR</th>
<th>Vegetation</th>
<th>Secchi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Feb-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mar-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Apr-19</td>
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<td>X</td>
<td>X</td>
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<td>Jun-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Jul-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aug-19</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Sep-19</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Oct-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Nov-19</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dec-19</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 Lower Santa Fe River with YSI water quality meters. Handheld YSI ProODO and YSI EcoSense EC300A meters were used at each of the 10 monitoring stations along the Lower Santa Fe 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 10 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](image)

2.4 **Vegetation**

Submerged Aquatic Vegetation (SAV) was monitored at all 10 stations (Figure 1) 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.


Section 3.0 Results

This section summarizes field data collected as part of the ecosystem monitoring conducted along the Lower Santa Fe River from January 2019 to December 2019. Data collected by Florida SPRINGSWATCH volunteers included water quality field parameters, light measurements, vertical secchi disk 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 Lower Santa Fe River/Springs system.

3.1 Water Quality

3.1.1 Florida SPRINGSWATCH Lower Santa Fe River Water Quality

Figures 3 through Figure 6 present field parameter results collected from the 10 stations along the Lower Santa Fe River and Springs as part of the Florida SPRINGSWATCH program from January 2019 to December 2019. 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. In contrast, river water has had a greater opportunity receive oxygen from atmospheric diffusion and from photosynthesizing SAV and algae resulting in higher DO concentrations. Figure 5 and Figure 6 present data for temperature (°C) and Specific Conductance (uS/cm) field measurements.

Figure 5 presents data for temperature (°C) field measurements. Temperature in the Lower Santa Fe River remains constant year-round since it is heavily influenced by spring water (typically 22° C).

Figure 6 demonstrates the results for Specific Conductance (uS/cm) 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, and other compounds. Higher specific conductance values suggest a higher concentration of these ions in the water. Specific Conductance results varied among stations (Figure 7). This could suggest variable levels of nitrate/nitrite influence on the water coming out of the springs, which them mixes with river water to influence conductance levels downstream (Figure 6).
Figure 3. Florida SPRINGSWATCH Program Lower Santa Fe River Dissolved Oxygen Percent Saturation (DO %) Measurements (January 2019-December 2019)

Figure 4. Florida SPRINGSWATCH Program Lower Santa Fe River Dissolved Oxygen Measurements (mg/L) (January 2019-December 2019)
Figure 5. Florida SPRINGSWATCH program Lower Santa Fe River Temperature Measurements (°C) (January 2019-December 2019)

Figure 6. Florida SPRINGSWATCH program Lower Santa Fe River Specific Conductance Measurements (μS/cm) (January 2019-December 2019)
3.1.2 Secchi Disk Visibility

Vertical Secchi disk visibility measurements were collected by SPRINGSWATCH volunteers at six river stations and two spring stations (Table 2, Figure 6). These measurements provide additional information concerning water clarity and the light attenuation properties of the spring run. Depending on river levels, full Secchi measurements were not possible for all sampling events. On several occasions the disk was still visible when it hit the river bottom, suggesting a higher level of water clarity than what was able to be measured at the time of sampling. The results from these instances are outlined in blue in Table 2 and boxed in blue in Figure 6.

Table 2. Vertical Secchi measurements (m) in the Lower Santa Fe River

<table>
<thead>
<tr>
<th>Row Labels</th>
<th>SFR above Johnson</th>
<th>Rum Island Spring</th>
<th>SFR between Rum and Blue</th>
<th>SFR below Gilchrist Blue</th>
<th>July Spring</th>
<th>SFR below Ginnie</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/6/2019</td>
<td>0.68</td>
<td>1.28</td>
<td>0.67</td>
<td>0.46</td>
<td>1.86</td>
<td>0.67</td>
</tr>
<tr>
<td>2/10/2019</td>
<td>0.7</td>
<td>1.4</td>
<td>0.61</td>
<td>0.91</td>
<td>0.82</td>
<td>1</td>
</tr>
<tr>
<td>3/7/2019</td>
<td>0.76</td>
<td>0.61</td>
<td>0.762</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/2/2019</td>
<td>2.26</td>
<td></td>
<td>1.65</td>
<td>2.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/12/2019</td>
<td>3.6</td>
<td></td>
<td>1.65</td>
<td>2.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/9/2019</td>
<td>1.6</td>
<td></td>
<td>0.91</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/14/2019</td>
<td>3.6</td>
<td></td>
<td>1.5</td>
<td>2.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/11/2019</td>
<td>0.91</td>
<td></td>
<td>0.91</td>
<td>0.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/8/2019</td>
<td>0.85</td>
<td></td>
<td>1.97</td>
<td>1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/6/2019</td>
<td>0.54</td>
<td></td>
<td>1.55</td>
<td>1.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/10/2019</td>
<td>0.64</td>
<td></td>
<td>1.29</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/15/2019</td>
<td>0.99</td>
<td></td>
<td>1.6</td>
<td>1.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7. Florida SPRINGSWATCH program Lower Santa Fe River Secchi Disk Measurements (m) (January 2019-December 2019)
3.1.3 Florida SPRINGSWATCH Lower Santa Fe River Light Measurements

Figure 8 displays the diffuse attenuation coefficient (k) and percent transmittance estimates collected by the Florida SPRINGSWATCH program along the Lower Santa Fe River from January 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. The Santa Fe River is a tannic system, dominated by dark water resulting from surface runoff containing tannins from leaf litter. This is the primary reason for the large differences in percent transmittance values in the river stations versus the spring stations (Figure 8). However, extremely low values of percent transmittance and high corresponding k values still suggest decreased water clarity/increased turbidity.

Figure 8. Lower Santa Fe River Diffuse Attenuation Coefficient (k) and Percent Transmittance Measurements (January 2019-December 2019)
3.2 Aquatic Vegetation Survey

3.2.1 Florida SPRINGSWATCH Lower Santa Fe River Springs Vegetation Survey

Vegetation cover was estimated at the Florida SPRINGSWATCH Lower Santa Fe River stations from January 2019 to December 2019 using underwater photographs taken at each station. 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.

Table 3. Average Percent Cover of Submerged Aquatic Vegetation (SAV), filamentous algae, detritus, and bare ground at Florida SPRINGSWATCH Lower Santa Fe River Springs Stations (January 2019 - December 2019)

<table>
<thead>
<tr>
<th>Station ID</th>
<th>Algae</th>
<th>Muskgrass</th>
<th>Sagittaria</th>
<th>Eelgrass</th>
<th>Hygrophila</th>
<th>Bare Ground</th>
<th>Detritus</th>
<th>Total SAV (non-algae)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR Above Johnson Spring Run</td>
<td>37%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>43%</td>
<td>51%</td>
<td>0%</td>
</tr>
<tr>
<td>Johnson Spring Run</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>73%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Rum Island Spring</td>
<td>16%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>77%</td>
<td>9%</td>
<td>0%</td>
</tr>
<tr>
<td>SFR between Blue &amp; Rum</td>
<td>19%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>54%</td>
<td>40%</td>
<td>0%</td>
</tr>
<tr>
<td>Gilchrist Blue Spring Run</td>
<td>28%</td>
<td>13%</td>
<td>1%</td>
<td>3%</td>
<td>2%</td>
<td>36%</td>
<td>16%</td>
<td>6%</td>
</tr>
<tr>
<td>SFR Below Gilchrist Blue</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>80%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>Devil’s Eye Spring</td>
<td>25%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>77%</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>July Spring</td>
<td>11%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>73%</td>
<td>12%</td>
<td>6%</td>
</tr>
<tr>
<td>Ginnie Spring Run</td>
<td>9%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>73%</td>
<td>3%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>SFR Below Ginnie</td>
<td>19%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>63%</td>
<td>18%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Figure 9. Average Percent Cover of Algae (filamentous and non-filamentous) and Submerged Aquatic Vegetation (SAV) at Florida SPRINGSWATCH Lower Santa Fe River Springs Stations (January 2019 - December 2019)
Section 4.0 References

