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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: 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. FSI’s SPRINGSWATCH volunteer citizen-science program has provided enhanced monitoring of the Santa Fe River and Springs system’s ecological health. The resulting data are provided in annual reports and via FSI’s SPRINGSWATCH website (https://floridaspringsinstitute.org/springswatch/) to inform the state’s environmental agencies and educate the public of the springs and river health.

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 ten stations: six spring stations (three in headspring boils and three in spring runs), and four stations on the Santa Fe River (Figure 1).
Section 2.0 Methods

Ecological monitoring was conducted on the Lower Santa Fe River from January 2020 to November 2020. 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 during 2020 by the Florida SPRINGSWATCH Volunteer Program with assistance from FSI environmental scientists. Throughout the year several monthly sampling trips were canceled due to circumstances surrounding the COVID-19 global pandemic. Some dissolved oxygen data has been excluded due to equipment malfunction (January 2020 and November 2020).

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>
<thead>
<tr>
<th>Month-Year</th>
<th>Water Quality</th>
<th>PAR</th>
<th>Vegetation</th>
<th>Secchi</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 12, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>February 9, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>June 14, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>July 14, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>September 13, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>October 11, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>November 8, 2020</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1. Lower Santa Fe River sampling events (January 2020-November 2020)

2.2 Water Quality

Surface water data were collected 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 ten monitoring stations along the Lower Santa Fe River measure temperature/dissolved oxygen, and specific conductance, respectively. Vertical Secchi disk readings were also taken 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 at the ten monitoring sites. Data were collected using a LI-COR brand LI-192 underwater quantum sensor to measure PAR energy reaching the water surface and at one foot intervals from the surface to a depth of two feet in the water column. Figure 2 provides an image of the LI-COR PAR light sensor. 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

![Image of a LI-COR PAR meter](image)

Figure 2. Image of a LI-COR PAR meter

2.4 Vegetation

Submerged Aquatic Vegetation (SAV) and algae percent cover was monitored at all ten 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 two plant cover estimates were averaged to provide the overall estimated percent plant cover 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 2020 to November 2020. 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 baseline 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

Florida SPRINGSWATCH Lower Santa Fe River Water Quality Figure 3 through Figure 6 present field parameter results collected from the ten stations along the Lower Santa Fe River and Springs as part of the Florida SPRINGSWATCH program from January 2020 to November 2020. 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 fluctuate 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 to 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 (μS/cm) field measurements.

Figure 5 presents data for temperature (°C) field measurements. Temperature in the Lower Santa Fe River spring remains relatively constant at about 22°C year-round. Temperatures at the river stations are more variable and respond more to changing air temperatures.

Figure 6 demonstrates the results for specific conductance (μS/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, phosphorus, and other pollutants. Higher specific conductance values suggest a higher concentration of these ions in the water. Specific Conductance was less variable at the spring stations. Greater variability at the river stations was likely due to the changing mix between surface and groundwater due to periodic high rainfall periods in the watershed (Figure 6).
Figure 3. Florida SPRINGSWATCH Program Lower Santa Fe River Dissolved Oxygen Percent Saturation (DO %) Measurements (January 2020-November 2020)

Figure 4. Florida SPRINGSWATCH Program Lower Santa Fe River Dissolved Oxygen Measurements (mg/L) (January 2020-November 2020)
**Figure 5.** Florida SPRINGSWATCH program Lower Santa Fe River Temperature Measurements (°C) (January 2020-November 2020)

**Figure 6.** Florida SPRINGSWATCH program Lower Santa Fe River Specific Conductance Measurements (uS/cm) (January 2020-November 2020)
3.1.1 Secchi Disk Visibility

Vertical Secchi disk visibility measurements were collected by SPRINGSWATCH volunteers at six river stations and two spring stations (Table 2, Figure 7). These measurements provide information concerning general water clarity. Depending on river levels on several occasions the Secchi disk was still visible when at the river bottom, indicating an underestimate of water clarity. The results from these instances are outlined in light blue in Table 2 and boxed in blue in Figure 7.

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Station ID</th>
<th>Secchi (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2020</td>
<td>SFR above Johnson</td>
<td>1.22</td>
</tr>
<tr>
<td></td>
<td>SFR below Gilchrist Blue</td>
<td>1.30</td>
</tr>
<tr>
<td></td>
<td>SFR Below Ginnie</td>
<td>1.37</td>
</tr>
<tr>
<td>Feb 2020</td>
<td>SFR above Johnson</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>SFR below Gilchrist Blue</td>
<td>2.12</td>
</tr>
<tr>
<td></td>
<td>SFR Below Ginnie</td>
<td>3.66</td>
</tr>
<tr>
<td>Jun 2020</td>
<td>SFR above Johnson</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>SFR below Gilchrist Blue</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>SFR Below Ginnie</td>
<td>1.12</td>
</tr>
<tr>
<td>Jul 2020</td>
<td>SFR above Johnson</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>SFR below Gilchrist Blue</td>
<td>1.83</td>
</tr>
<tr>
<td></td>
<td>SFR Below Ginnie</td>
<td>1.07</td>
</tr>
<tr>
<td>Oct 2020</td>
<td>SFR above Johnson</td>
<td>0.73</td>
</tr>
<tr>
<td>Nov 2020</td>
<td>SFR above Johnson</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Figure 7. Florida SPRINGSWATCH program Lower Santa Fe River Secchi Disk Measurements (m) (January 2020-December 2020)
3.1.2 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 2020 to November 2020. 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/lower percent transmittance values can indicate poor water clarity where light cannot pass as easily through the water column. This is 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 2020-November 2020)
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 2020 through November 2020 using underwater photographs taken at each station. Table 3 and Figure 9 summarize the average percent cover of vegetation and algae 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 2020-November 2020)

<table>
<thead>
<tr>
<th>Station ID</th>
<th>Algae</th>
<th>Bare Ground</th>
<th>Detritus</th>
<th>Eelgrass (Valisneria americana)</th>
<th>Pennywort</th>
<th>Southern Naiad</th>
<th>Watercress</th>
<th>Hygrophilla</th>
<th>Vegetation Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR above Johnson Spring Run</td>
<td>8%</td>
<td>40%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>45%</td>
<td>50%</td>
</tr>
<tr>
<td>Johnson Spring Run</td>
<td>4%</td>
<td>88%</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Rum Island Spring</td>
<td>12%</td>
<td>85%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Gilchrist Blue Spring Run</td>
<td>7%</td>
<td>52%</td>
<td>2%</td>
<td>7%</td>
<td>2%</td>
<td>0%</td>
<td>13%</td>
<td>0%</td>
<td>22%</td>
</tr>
<tr>
<td>SFR Below Gilchrist Blue</td>
<td>50%</td>
<td>48%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Devil’s Eye Spring</td>
<td>5%</td>
<td>55%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>July Spring</td>
<td>5%</td>
<td>18%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>13%</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>Ginnie Spring Run</td>
<td>0%</td>
<td>60%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>SFR Below Ginnie</td>
<td>0%</td>
<td>0.5</td>
<td>0.475</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0.025</td>
<td>0%</td>
<td>0.025</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 2020-November 2020)
Section 4.0 References
