SPRINGS WATCH

LOWER SANTA FE RIVER SPRINGSWATCH MONITORING SUMMARY

January 2023 – November 2023

PREPARED FOR
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF PARKS AND RECREATION

Howard T. Odum
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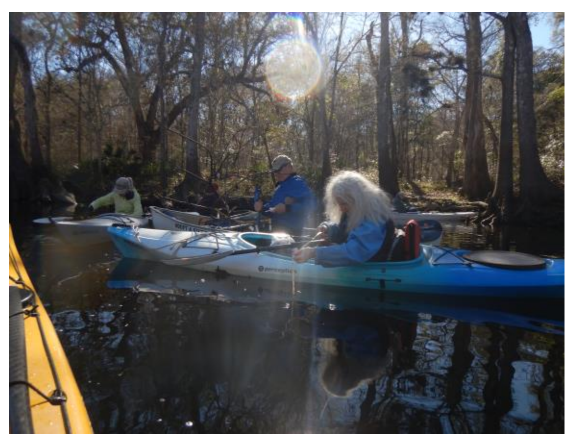
Photo by John Moran

Volunteer and Staff Acknowledgments

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 07012340.

Our Lower Santa Fe River SpringsWatch program would not be possible without the hard work of our team leader, Georgia Shemitz, and their dedicate team of volunteers: Maya Lahti, Terri Skiles, Nancy Watson, and Dan Roundtree. Together they put in 128 volunteer hours over 10 monitoring sessions in 2023. We would like to thank Isaac Szabo for his underwater fish photography utilized in this report.

We would like to thank FSI's SpringsWatch Coordinators, Emanuela Torres-Marquis, Shannon Letcher, and Jill Lingard, Environmental Scientist Bill Hawthorne, and Associate Director, Haley Moody for their contributions to this report; all who worked under the guidance of Executive Director, Dr. Emily Taylor. We also acknowledge the ongoing guidance from former Executive Director Dr. Robert Knight.



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, paddleboarding, tubing, swimming, snorkeling, scuba diving, and boating. Residents 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 (floridaspringsinstitute.org/springswatch) to inform the state's environmental agencies and educate the public about the springs and river health.

This report was prepared by the Howard T. Odum Florida Springs Institute (FSI) and is focused on ecological monitoring of the Lower Santa Fe River and springs conducted by SpringsWatch volunteers in 2023.

1.1 Monitoring Stations

SpringsWatch volunteers collected data at 10 stations: six spring stations (three in headspring boils and three in spring runs), and four stations on the Santa Fe River (Figure 1).

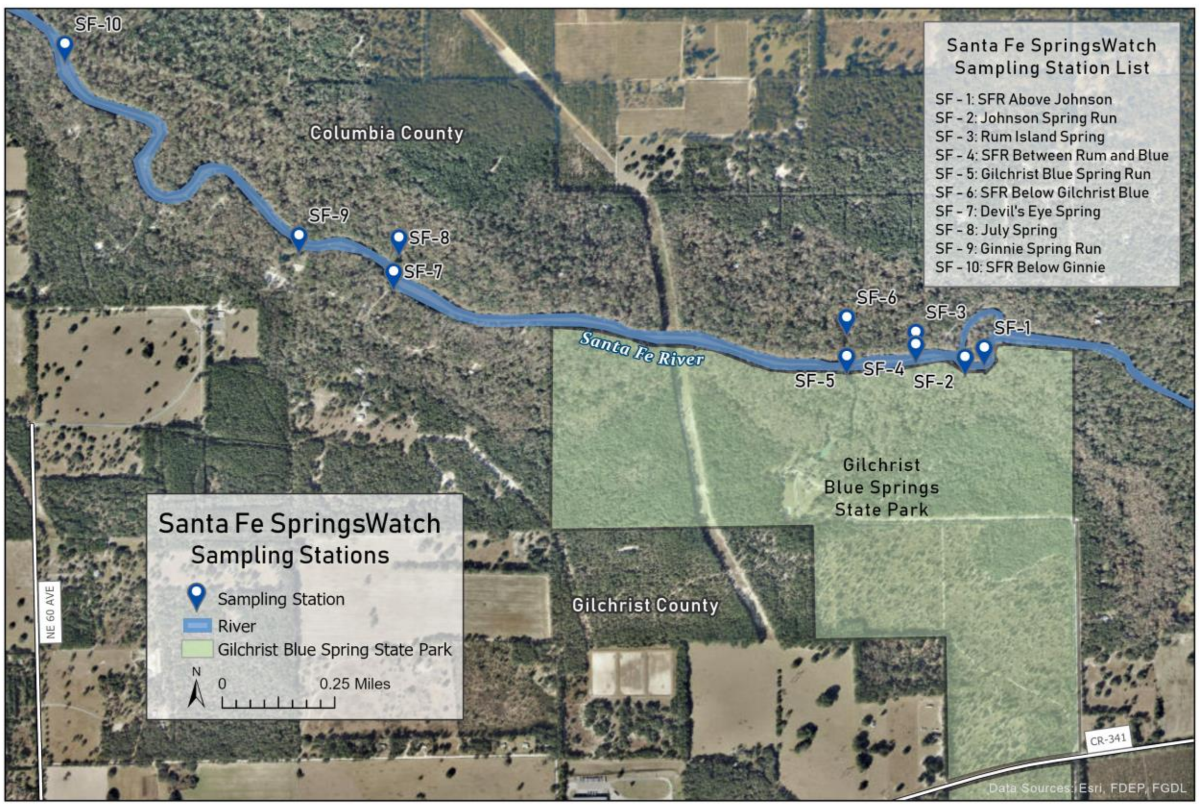


Figure 1. Lower Santa Fe River SpringsWatch monitoring stations.

Section 2.0 Methods

Ecological monitoring was conducted on the Lower Santa Fe River from January to December 2023. 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 eleven 2023 sampling events along the Lower Santa Fe River and springs conducted by SpringsWatch volunteers with assistance from FSI environmental scientists.

Volunteers collected the following data during each monitoring session:

- Water quality field parameters (temperature, dissolved oxygen, specific conductivity, and nitrate-nitrite)
- Vertical light attenuation
- Vertical Secchi disk measurements
- Submerged aquatic vegetation
- Staff gage reading

Table 1. Lower Santa Fe River SpringsWatch sampling events (January-December 2023).

Date	Temperature	Dissolved Oxygen	Specific Conductance	PAR	Secchi	Nitrate+Nitrite	Vegetation
1/11/2023	X	X	X	X	X		X
2/22/2023	X	X	X		X		X
3/22/2023	X	X	X	X	X	X	X
4/20/2023	X		X	X			X
5/24/2023	X	X	X	X			X
7/27/2023	X	X	X	X	X		X
8/24/2023	X	X	X	X	X		X
9/12/2023	X	X	X	X	X		X
10/26/2023	X	X	X	X	X		X
11/30/2023	X	X	X	X			X

2.2 Water Quality

SpringsWatch volunteers collected surface water data 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 to measure temperature, dissolved oxygen, and specific conductance. Vertical Secchi disk readings were also taken at each station to measure water clarity. Volunteers maintained water quality meters according to factory instructions and calibrated them before and after each sampling event.

2.2.1. Nitrate-Nitrite (NOx-N)

FSI staff collected Nitrate-nitrite (NOx-N) samples at stations SF-5 and SF-3 (Figure 1). Water samples were sent to a state-accredited laboratory (McGlynn Laboratories Inc.) for nitrogen as nitrate-nitrite (NOx-N) analysis. Preparation, storage, and analysis all followed FDEP Standard

Operating Procedures. Samples were hand collected from approximately 0.1m depth. Sample bottles were re-capped and sealed before being acidified with approximately 0.25mL of 50% sulfuric acid (H_2SO_4) and then stored on ice prior to transport. Water sampled were held in a refrigerator for <21days before being sent to a state-accredited laboratory (McGlynn Laboratories Inc.) for nitrate-nitrite (NOx-N) analysis. All analyses were conducted within a standard holding time of 28 days from sample collection.

2.3 Light Measurements

Photosynthetically Active Radiation (PAR) underwater light transmission and attenuation coefficients were measured monthly at the 10 monitoring sites. Volunteers used a LI-COR brand LI-250A underwater quantum photometer to measure PAR energy reaching the water surface and at depth intervals of one foot and two feet. Figure 2 provides an image of the LI-COR PAR light sensor.

Figure 2. LI-COR PAR

2.4 Secchi Disk Visibility

SpringsWatch volunteers took monthly vertical Secchi disk measurements at river stations SF-1, SF-6, and SF-10 (Figure 1) throughout the sampling period.

The Secchi disk (Figure 3) is a tool for measuring water clarity in aquatic ecosystems. It is a disk with alternating black and white quadrants that is lowered into the water until it is no longer visible. The depth at which the disk disappears is known as the Secchi depth and is used as an indicator of water quality. Secchi depth can be used to monitor changes in water clarity over time and can be used to identify problems such as algal blooms or pollution.

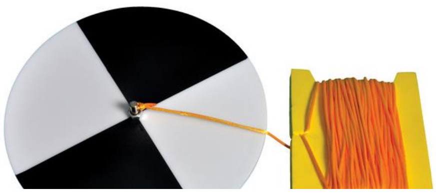


Figure 3. Secchi disk

2.5 Vegetation

Submerged aquatic vegetation (SAV) was monitored monthly at all 10 stations. SpringsWatch volunteers took two photographs at each station in two different locations, which they sent to FSI for analysis. This data presents an ongoing record of conditions in the river and spring and will be useful for comparison to future evaluations of the ecological health of the Santa Fe system.

Section 3.0 Results

This section summarizes field data collected as part of the ecosystem monitoring conducted by SpringsWatch volunteers along the Lower Santa Fe River from January to November 2023.

3.1 Water Quality

3.1.1 Dissolved Oxygen, Temperature, Specific Conductance, and Nitrate-Nitrite

Figure 4 through 8 present water quality results collected from the 10 stations along the Lower Santa Fe River from January to November 2023.

Figure 4 presents shows dissolved oxygen results measured in percent saturation (DO%) at each station. Figure 5 shows DO results measured in milligrams per liter (mg/L), or parts per million, at each river station.

DO levels fluctuated between spring and river stations primarily due to ground water versus 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. The higher DO levels seen at Gilchrist Blue and Johnson Spring Runs are likely due to an abundance of photosynthesizing aquatic vegetation in those locations.

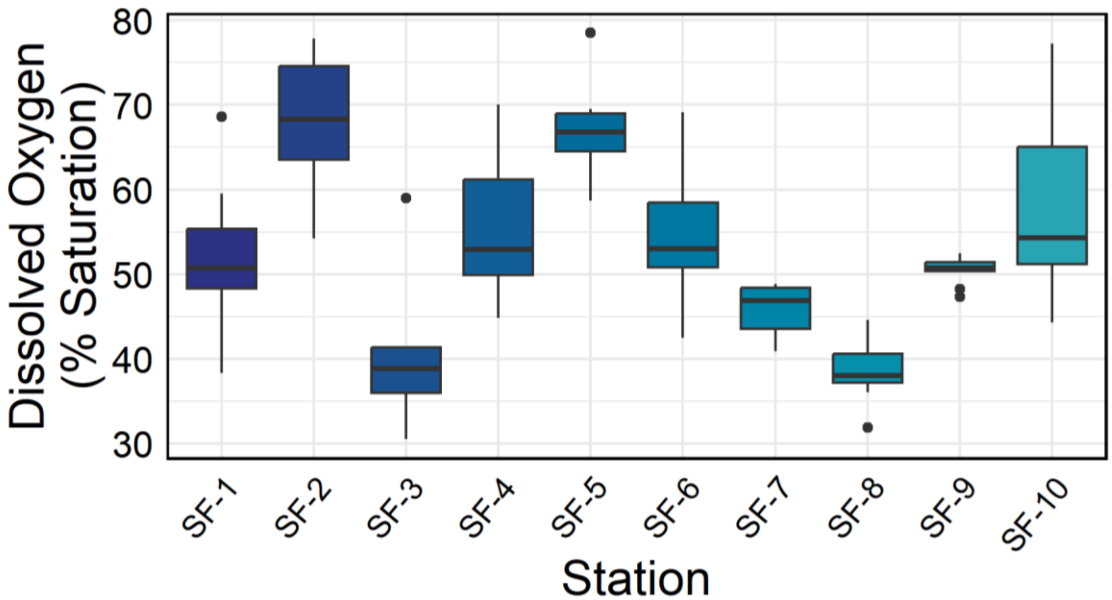


Figure 4. Dissolved Oxygen (% saturation) at Lower Santa Fe River SpringsWatch stations (January to November 2023)

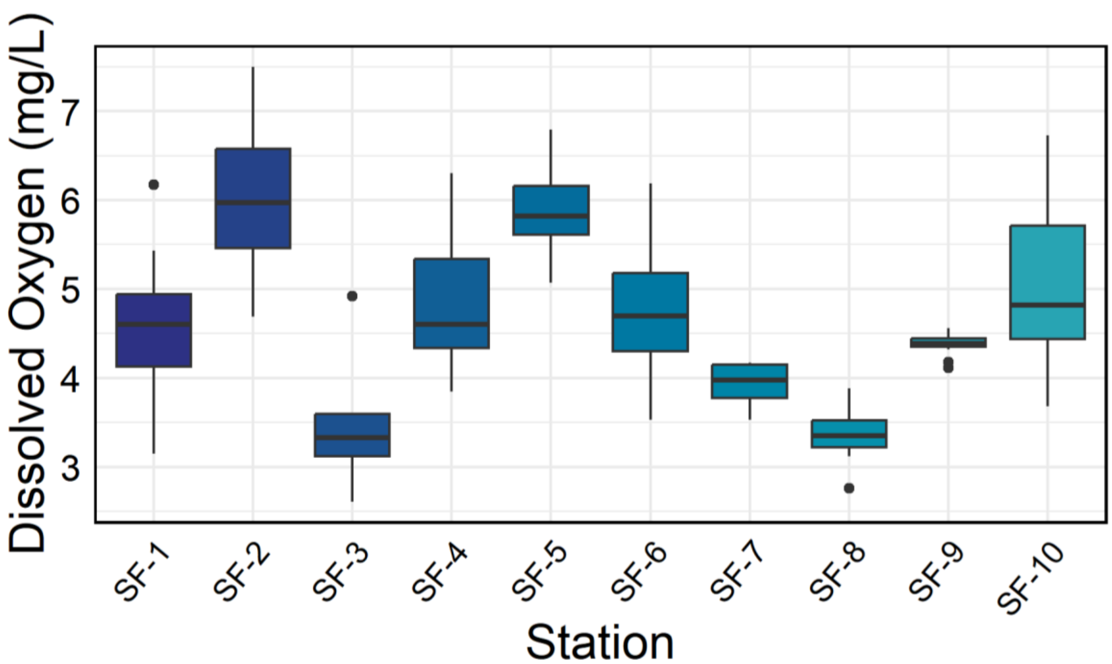


Figure 5. Dissolved oxygen (mg/L) at Lower Santa Fe River SpringsWatch stations (January to November 2023)

Figure 6 present data for water temperature (°C) field measurements for the Lower Santa Fe River SpringsWatch by monitoring stations.

Temperature in the Lower Santa Fe River springs remains relatively constant at about 22°C year-round. Temperatures at the river stations are more variable and respond more to changing air temperatures.

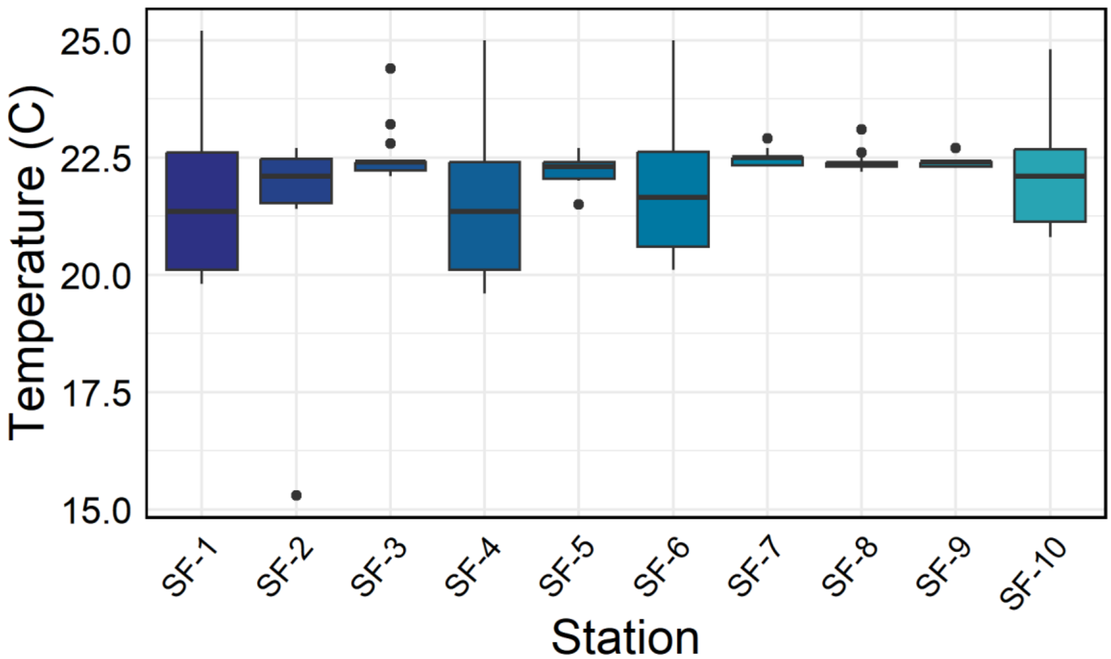


Figure 6. Water temperature (°C) by Santa Fe River SpringsWatch Station (January-November 2023).

Figure 7 show results for specific conductance field measurements for Santa Fe SpringsWatch stations.

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 high rainfall periods in the watershed.

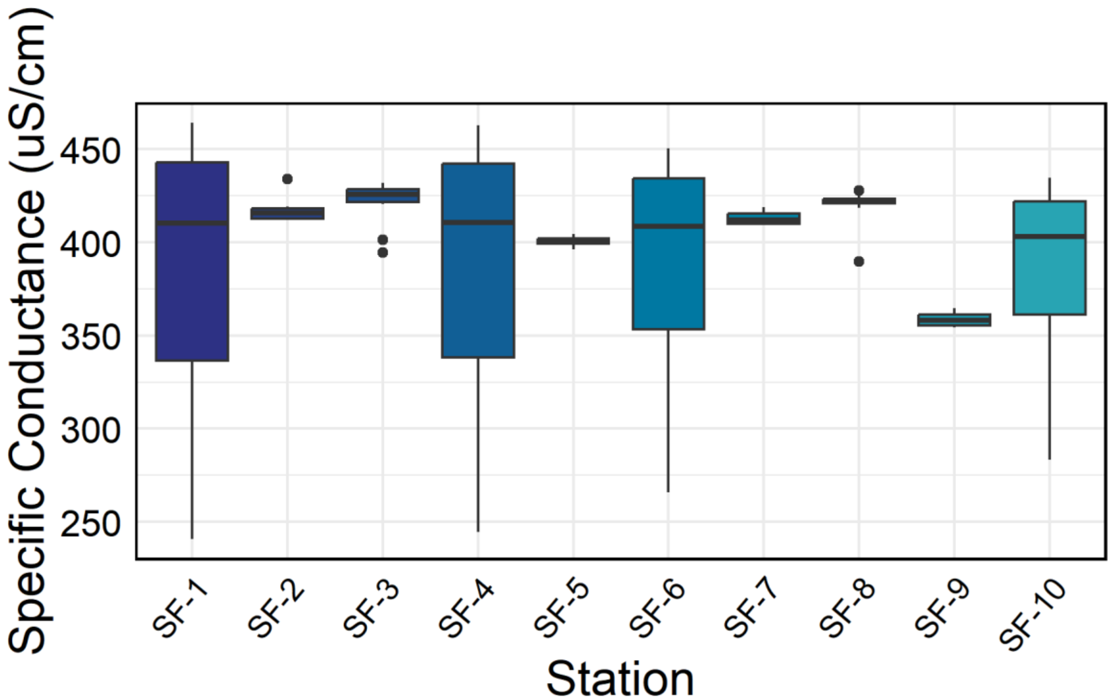


Figure 7. Specific Conductance (uS/m) by Lower SantaFe SpringsWatch group by SpringsWatch station

FSI staff collected Nitrate-nitrite (NOx-N) samples at station SF-3 and SF-5 during March 2023 (Figure 1). The springs impairment level set by the Florida Department of Environmental Protection is 0.35mg/L. NOx-N at station SF-3 was 2.209 mg/L, which is over 6 times greater than the FDEP threshold. NOx-N at station SF-5 was 1.213 mg/L, which is 3.5 times greater than then FDEP threshold. The average NOx-N concentration was 1.711 mg/L (Figure 8).

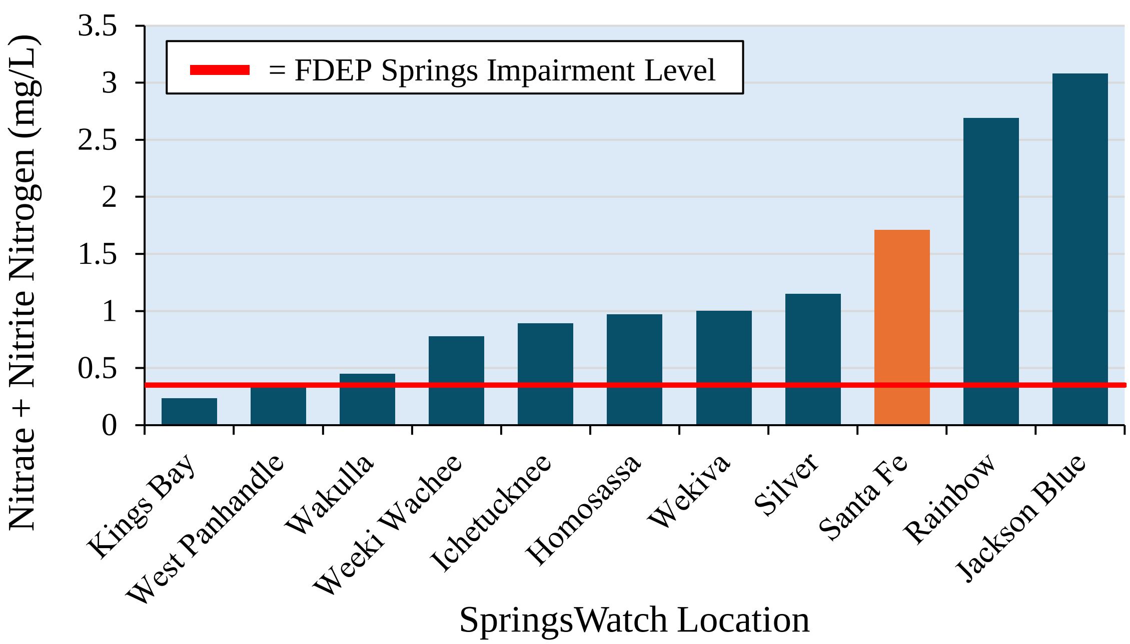


Figure 8. Nitrate-nitrite (NOx-N levels at SpringsWatch samples sites in 2023. Taken in April 2023, Homosassa is denoted by the orange bar.

3.2 Clarity and Light Measurements

3.2.1 Secchi Disk Visibility

SpringsWatch volunteers collected vertical Secchi disk visibility measurements at four river stations: SF-1, SF-4, SF-6, and SF-10 (Figure 1). Depending on river levels, on several occasions the Secchi disk was still visible when at the river bottom, indicating an underestimate of water clarity. Those data were removed from analyses. Figure 9 presents Secchi measurements for these four stations in 2023.

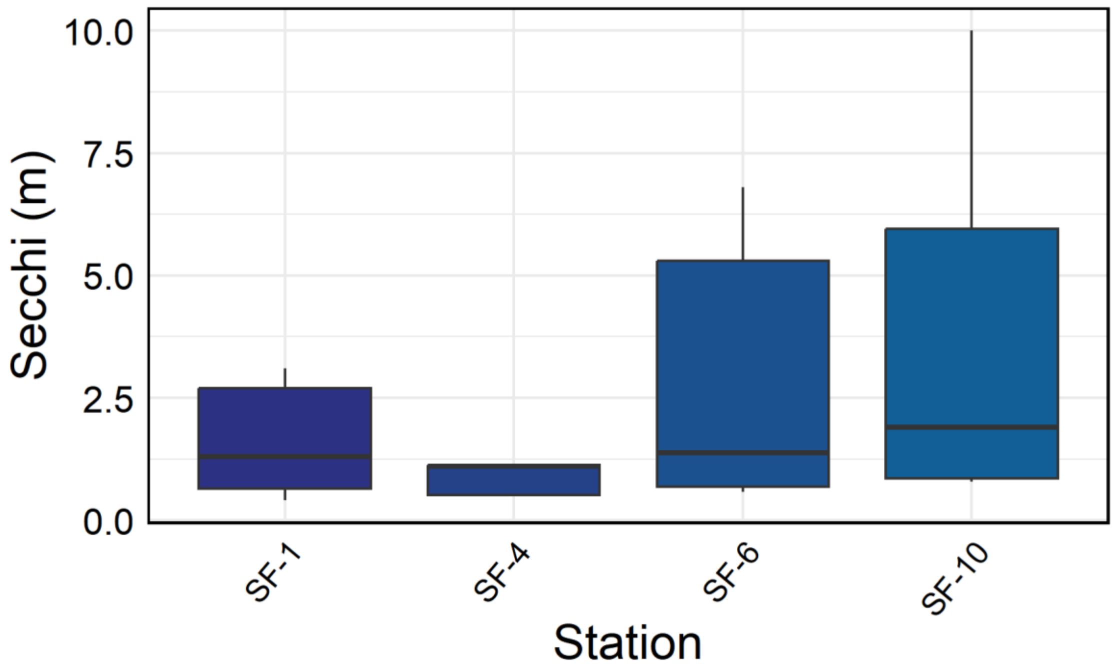


Figure 9. Secchi disk measurements at 7 Santa Fe River SpringsWatch stations (January-November 2023

3.2.2 Light Measurements

Figure 10 present the percent transmittance estimates collected by Santa Fe River SpringsWatch volunteers from January through November 2023.

Percent transmittance refers to the amount of light that is able to pass through the water column to a depth of 1 meter below the surface. Figure 11 presents the k (diffuse light attenuation) calculated average per Santa SpringsWatch monitoring session (January to November 2023). The diffuse attenuation coefficient (k) is the calculated via the Lambert-Beer equation (Wetzel 2001) to measure how readily light dissipates throughout the water column. Higher attenuation values correspond to less water clarity. 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 increases in dissolved substances such as tannins (color) and suspended solids (turbidity) in the water.

In aquatic ecosystems, the diffusion attenuation coefficient can have a significant impact on the biota that inhabit the water. For example, in shallow, clear water with a low diffusion attenuation coefficient and high percent transmittance, light can easily reach the bottom of the water column, enabling the growth of aquatic plants and phytoplankton. This, in turn, can support the entire food web, from primary producers to top predators. On the other hand, in deep, turbid water with a high diffusion attenuation coefficient and low percent transmittance, light is unable to penetrate as far, limiting the growth of aquatic plants and phytoplankton. This can have cascading effects on the entire ecosystem, potentially reducing the population size and diversity of biota that depend on these primary producers. Thus, the diffusion attenuation coefficient is an important factor to consider when evaluating the health and productivity of aquatic ecosystems.

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 differences in percent transmittance values in the river stations versus the spring stations.

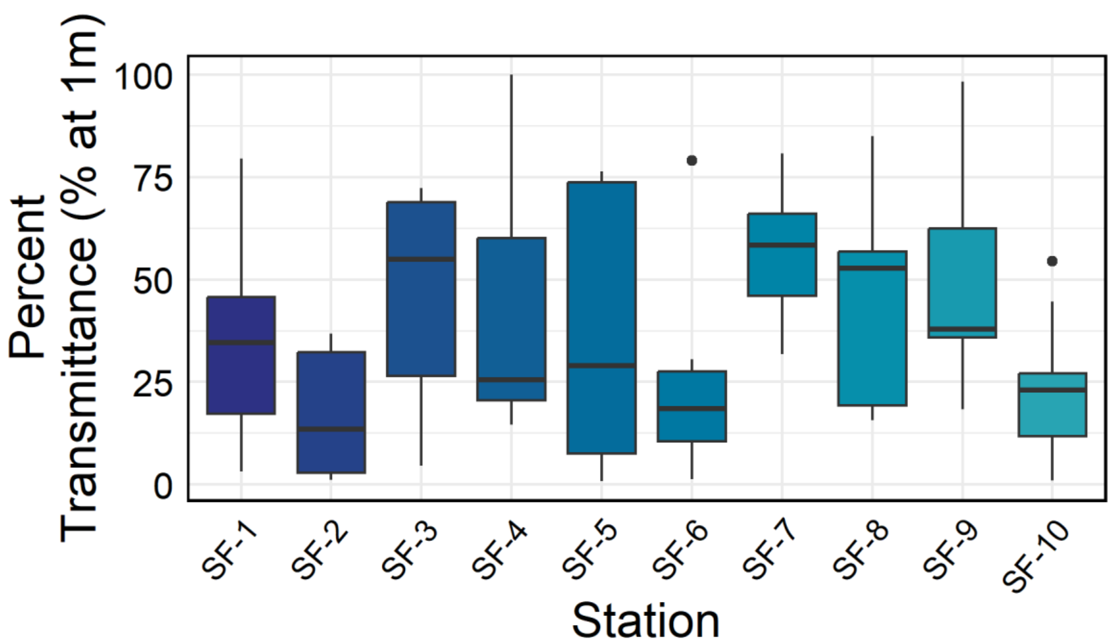


Figure 10. Percent transmittance (@1m) for Santa Fe River SpringsWatch (January–November 2023).

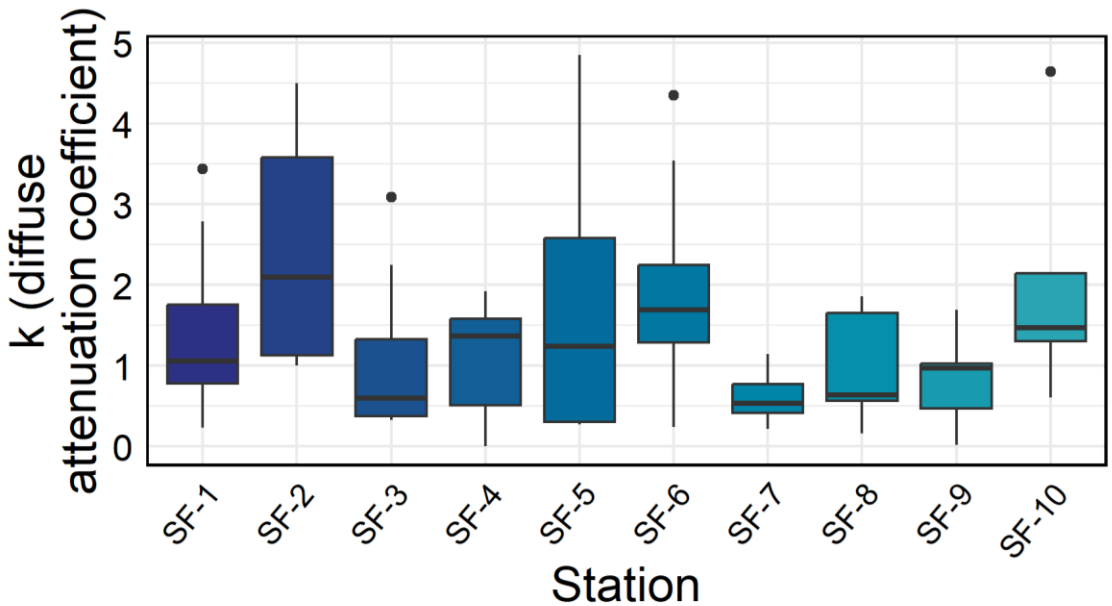


Figure 11. Average k (diffuse attenuation coefficient) per Lower Santa Fe SpringsWatch station (January to November 2023)

3.4 Aquatic Vegetation Survey

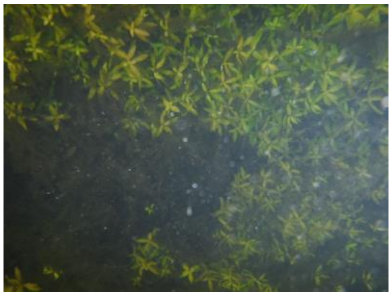
Submerged aquatic vegetation (SAV) plays an important ecological role within a springs system. It provides habitat and food for fish and other wildlife, increases water clarity, affects nutrient cycles, and stabilizes shorelines and sediments. This data presents an ongoing record of conditions in the river and spring and will be useful for comparison to future evaluations of the ecological health of the system.

Pictured below are river bottom photos taken by SpringsWatch volunteers in 2023 which feature the SAV in the river, springs, and spring runs.

SAV along the Lower Santa Fe River (stations SF-1, SF-4, SF-6, and SF-10):

SF-1 - Bare ground, detritus, and Hygrophila

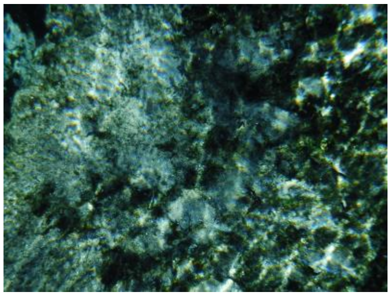
SF-4 – Sand and Hygrophila



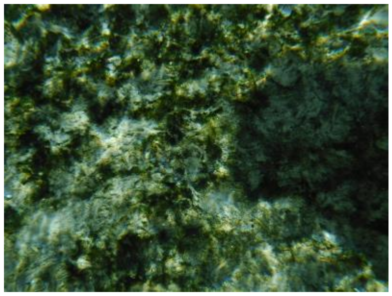
SF-6 – Bare ground and Hygrophila

SF-10 - Algae

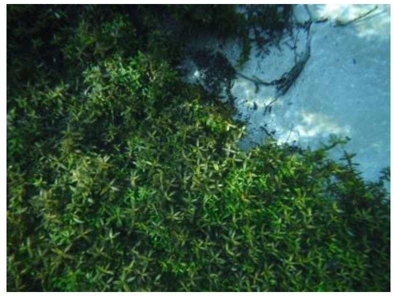
SAV at the Lower Santa Fe River springs (stations SF-3, SF-7, and SF-8):



SF-3 – Bare ground and algae



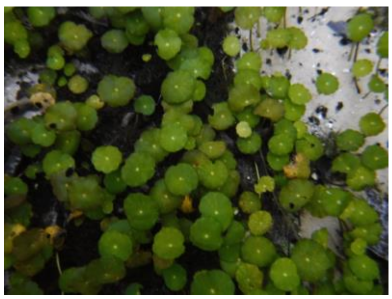
SF-7 - Bare ground and algae



SF-8 – Sand and Hygrophila

SAV at the Lower Santa Fe spring runs (stations SF-2, SF-5, and SF-9):

SF-2 – Sand, algae, and detritus



SF-5– Water pennywort and sand

SF-9 – Sand

Section 4.0 References

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Section 5.0 Appendix

Table A.1. Data collected during Lower Santa Fe SpringsWatch monitoring sessions (January to November 2023)

Station Name	Parameter Name	Average	Number of Samples	Maximum	Minimum	Standard Deviation
SF-1	k (diffuse attenuation coefficient)	1.4	13	3.4	0.2	1.0
	Temperature (°C)	21.7	14	25.2	19.8	1.9
	Dissolved Oxygen (%)	52.1	12	68.6	38.3	7.8
	Dissolved Oxygen (mg/L)	4.6	12	6.2	3.2	0.8
	Specific Conductance (µS/cm)	385.0	14	464.1	240.7	70.0
	Secchi (meters)	1.5	9	3.1	0.4	1.1
	Percent Transmittance (% at 1 meter)	36.5	13	79.5	3.2	25.3
SF-2	k (diffuse attenuation coefficient)	2.4	8	4.5	1.0	1.4
	Temperature (°C)	21.6	14	22.7	15.3	1.9
	Dissolved Oxygen (%)	68.4	12	77.8	54.2	7.6
	Dissolved Oxygen (mg/L)	6.0	12	7.5	4.7	0.8
	Specific Conductance (µS/cm)	416.5	14	434.0	411.9	5.7
	Percent Transmittance (% at 1 meter)	16.8	8	36.7	1.1	15.2
SF-3	k (diffuse attenuation coefficient)	1.0	13	3.1	0.3	0.8
	Temperature (°C)	22.6	14	24.4	22.1	0.6
	Dissolved Oxygen (%)	39.7	12	59.0	30.5	6.8
	Dissolved Oxygen (mg/L)	3.4	12	4.9	2.6	0.5
	Specific Conductance (µS/cm)	422.6	14	432.1	394.5	11.1
	Nitrate+Nitrite (mg/L)	2.2	1	2.2	2.2	NA
	Percent Transmittance (% at 1 meter)	45.4	13	72.3	4.5	23.2
SF-4	k (diffuse attenuation coefficient)	1.1	12	1.9	0.0	0.6
	Temperature (°C)	21.5	14	25.0	19.6	1.9
	Dissolved Oxygen (%)	54.8	12	70.0	44.8	7.5
	Dissolved Oxygen (mg/L)	4.8	12	6.3	3.9	0.7
	Specific Conductance (µS/cm)	385.9	14	462.9	244.5	68.3
	Secchi (meters)	0.9	5	1.1	0.5	0.3
	Percent Transmittance (% at 1 meter)	41.7	12	100.0	14.6	27.6
SF-5	k (diffuse attenuation coefficient)	1.7	13	4.9	0.3	1.6
	Temperature (°C)	22.2	14	22.7	21.5	0.4
	Dissolved Oxygen (%)	101.7	12	275.8	58.7	81.5
	Dissolved Oxygen (mg/L)	5.9	12	6.8	5.1	0.5
	Specific Conductance (µS/cm)	400.4	14	404.4	396.3	2.8
	Nitrate+Nitrite (mg/L)	1.2	1	1.2	1.2	NA
	Percent Transmittance (% at 1 meter)	37.0	13	76.4	0.8	32.0

Table A.1. Continued

Station Name	Parameter Name	Average	Number of Samples	Maximum	Minimum	Standard Deviation
SF-6	k (diffuse attenuation coefficient)	2.0	13	4.4	0.2	1.1
	Temperature (°C)	21.8	14	25.0	20.1	1.7
	Dissolved Oxygen (%)	54.9	12	69.1	42.5	7.1
	Dissolved Oxygen (mg/L)	4.8	12	6.2	3.5	0.7
	Specific Conductance (µS/cm)	388.1	14	450.4	266.0	56.5
	Secchi (meters)	2.8	9	6.8	0.6	2.7
	Percent Transmittance (% at 1 meter)	21.1	13	79.0	1.3	20.3
SF-7	k (diffuse attenuation coefficient)	0.6	12	1.1	0.2	0.3
	Temperature (°C)	22.5	14	22.9	22.3	0.2
	Dissolved Oxygen (%)	45.8	12	48.8	40.9	3.0
	Dissolved Oxygen (mg/L)	3.9	12	4.2	3.5	0.2
	Specific Conductance (µS/cm)	413.2	14	418.9	410.1	3.1
	Percent Transmittance (% at 1 meter)	56.2	12	80.7	31.8	13.2
SF-8	k (diffuse attenuation coefficient)	0.9	13	1.9	0.2	0.6
	Temperature (°C)	22.4	14	23.1	22.2	0.2
	Dissolved Oxygen (%)	38.8	12	44.6	31.9	3.5
	Dissolved Oxygen (mg/L)	3.4	12	3.9	2.8	0.3
	Specific Conductance (µS/cm)	420.3	14	427.7	389.8	9.1
	Staff (ft)	1.6	9	2.4	1.1	0.4
	Percent Transmittance (% at 1 meter)	47.8	13	85.0	15.6	25.3
SF-9	k (diffuse attenuation coefficient)	0.9	13	1.7	0.0	0.5
	Temperature (°C)	22.4	14	22.7	22.3	0.1
	Dissolved Oxygen (%)	50.6	12	52.5	47.3	1.6
	Dissolved Oxygen (mg/L)	4.4	12	4.6	4.1	0.1
	Specific Conductance (µS/cm)	358.4	14	364.7	354.4	3.4
	Percent Transmittance (% at 1 meter)	47.4	13	98.3	18.4	22.8
SF-10	k (diffuse attenuation coefficient)	1.9	13	4.6	0.6	1.3
	Temperature (°C)	22.2	14	24.8	20.8	1.4
	Dissolved Oxygen (%)	58.4	12	77.2	44.3	10.6
	Dissolved Oxygen (mg/L)	5.1	12	6.7	3.7	1.0
	Specific Conductance (µS/cm)	386.1	14	434.6	283.5	45.3
	Secchi (meters)	3.3	9	10.0	0.8	3.3
	Percent Transmittance (% at 1 meter)	22.7	13	54.5	1.0	15.2