

2020 Annual Monitoring Report

Madison Blue Spring

January 28, 2021



Contact Information

Cardno
3905 Crescent Park Drive
Riverview, FL, 33578, USA
Telephone: +1 813 664 4500
www.cardno.com

Document Information



NORTH AMERICA

Nestlé Waters North America Inc.
Deer Park Bottling Plant, 690 NE
Hawthorn Avenue, Lee, FL 32059 USA

Author(s)

Sheri A Huelster

Sheri Huelster
Senior Project Scientist

Prepared for

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Approved By

Richard W. Cantrell

Richard W. Cantrell
Senior Consultant

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Acronyms

CFS	Cubic feet per second
DO	Dissolved Oxygen
EMP	Environmental Monitoring Plan
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
IWR	Impaired Waters Rule
MDL	Minimum Detection Limit
MGD	million gallons per day
NELAC	National Environmental Laboratory Accreditation Conference
SRWMD	Suwannee River Water Management District
SCI	Stream Condition Index
SOP	Standard Operating Procedure
USGS	United States Geological Survey

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1 Introduction

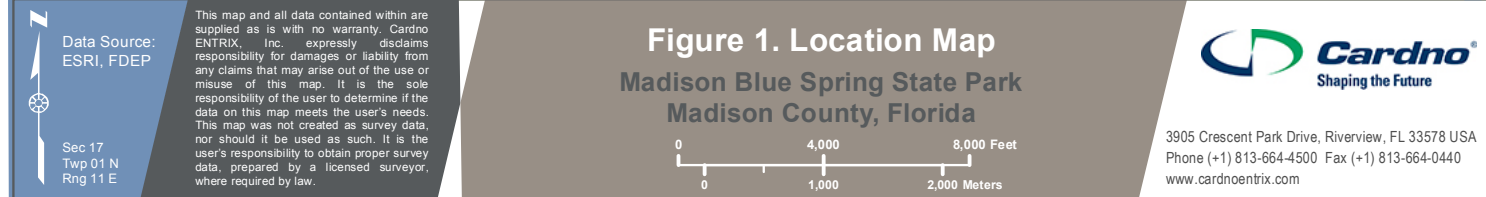
Madison Blue Spring is one of Florida's 33 First Magnitude Springs, discharging more than 100 cubic feet per second (cfs) or 64 million gallons of water a day (MGD) on average (Hornsby and Ceryak, 1998). The spring is located on the west bank of the Withlacoochee River within Madison Blue Spring State Park, which is approximately 10 miles (16 km) east of Madison Florida, off of State Highway 6 (Figures 1 and 2). Madison Blue Spring proper, and almost 39 acres surrounding the spring, was purchased by the State of Florida in late 2000 and was designated as a state park in the fall of 2002. Prior to state ownership, Madison Blue Spring was managed by Madison County. Madison Blue Spring State Park currently offers swimming, picnicking, and cavern diving, and is surrounded by hardwood and pine forests within a karst terrain typical to this region of northern Florida/southern Georgia. The spring discharges to the Withlacoochee River via a short spring run stream.

Madison Blue Spring discharges upwards on a 45° angle from the bottom of the spring pool (<http://www.floridastateparks.org/madisonbluespring/default.cfm>). The average spring discharge is 120 cfs (Hornsby and Ceryak, 1998). However, this discharge can sometimes be impeded or even reversed during short periods when the Withlacoochee River exceeds specific flood stages (SRWMD 2004). The diameter of the spring pool varies from 22 m (72 feet) to 25 m (82 feet), with surrounding limestone bluffs that rise to about 7 m (20 feet) above the water level. A single spring vent issues from a large, horizontal cavern entrance at the south end of the pool, which is about 7.3 m (24 feet) deep. The bottom of the spring pool slopes upwards from the cavern entrance and is predominantly of a sandy composition. The spring run, emanating from the northeastern corner of the spring pool, is approximately 150 m (500 feet) long and discharges over a rock and cobble-strewn bed directly to the Withlacoochee River.

Nestlé Waters North America Inc. (Nestlé Waters) holds a Water Use Permit (No. 2-079-218544-8) issued by the Suwannee River Water Management District (SRWMD) for the withdrawal of groundwater in the vicinity of Madison Blue Spring in Madison County, Florida. Cardno was retained by Nestlé Waters to conduct biological monitoring required by Condition No. 21 of the Environmental Monitoring Plan (EMP) that is part of the water use permit. The EMP has been revised multiple times since its original issuance in 2003, most recently in November 2014. The overall EMP includes surface water, groundwater, rain gauge, and biological monitoring.

The biological monitoring component of the EMP focuses on two distinct aquatic habitats: the Withlacoochee River upstream and downstream of the spring run, and the Madison Blue Spring pool (Figure 3). The monitoring is intended to detect potential ecological responses to changes in spring discharge. The biological monitoring component utilizes the aquatic benthic macroinvertebrate community to provide a cost-effective and successful assessment tool of overall system health as identified by Florida Department of Environmental Protection (FDEP) Bureau of Laboratories, particularly when the studies also include water quality measurements.

This annual report presents results from the biological monitoring event conducted at Madison Blue Spring on 30 November 2020 and compares them to previous monitoring results from 2003 to 2019 (monitoring event for 2018 occurred in May 2019 because of high water levels in the Withlacoochee River preventing sampling until that time). Baseline conditions for the permit monitoring were established through monitoring events conducted on 18 November 2003, 4 May 2004, and 26 May 2005, prior to permitted withdrawal of groundwater. Twenty-four monitoring events have been conducted since the permitted withdrawal of groundwater began in July 2005 (November 2005 to November 2020).





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Figure 2. Aerial Map of Monitoring Area

Madison Blue Spring State Park Madison County, Florida

0100200 Feet

03060 Meters



3905 Crescent Park Drive, Riverview, FL 33578 USA
Phone (+1) 813-664-4500 Fax (+1) 813-664-0440
www.cardnoentrix.com

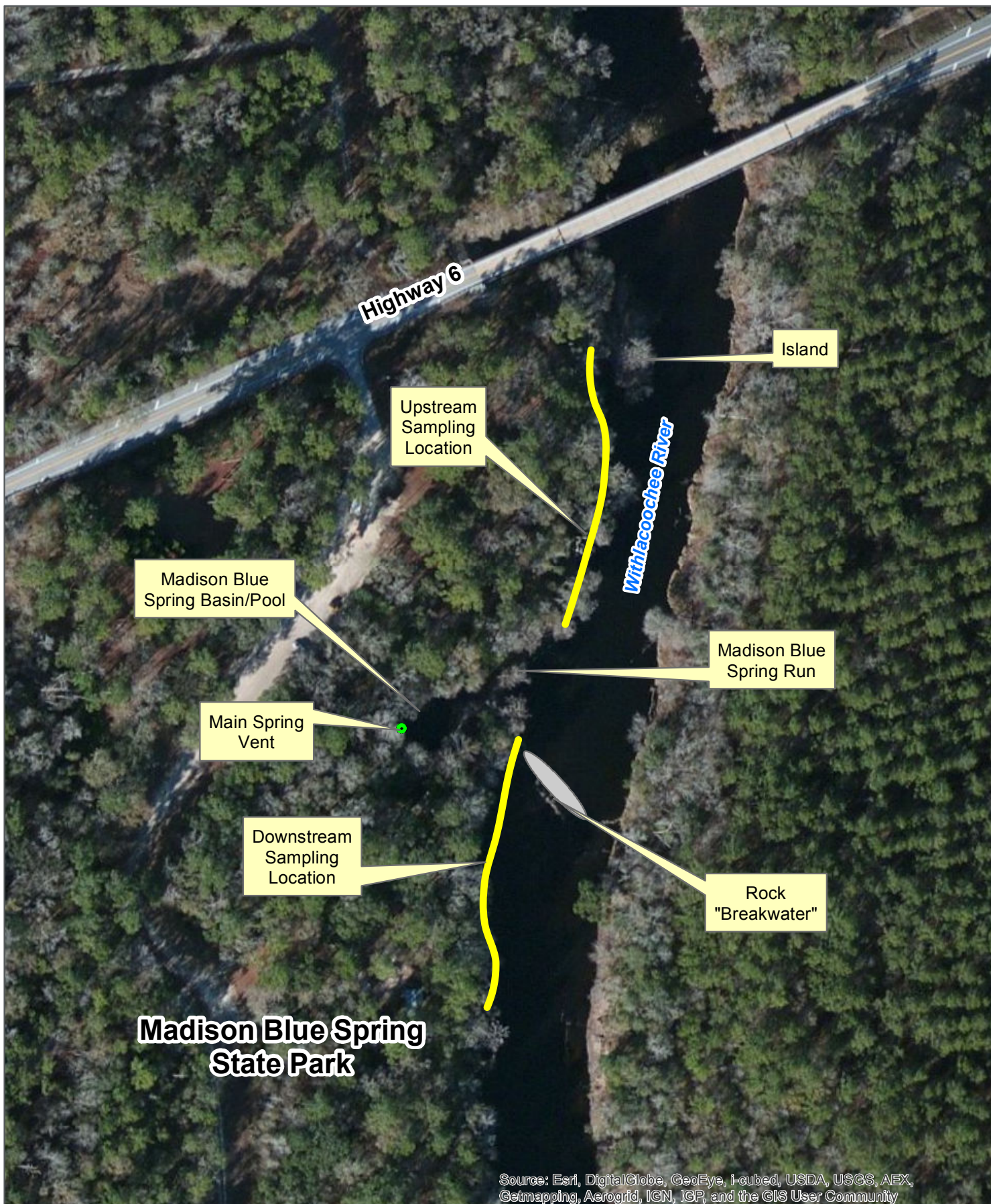
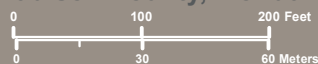


Figure 3. Biological Monitoring Sites

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2 Methods

Sampling methods and procedures described below are included in the EMP and are part of SRWMD Water Use Permit No. 2-079-218544-8. The most recent modifications to the biological monitoring component of the EMP were proposed by Nestlé Waters and approved by the SRWMD in November 2014. The approved modifications are as follows: 1) reduction of the monitoring requirements to once per year (November); 2) elimination of the solution channel monitoring; and 3) elimination of the biological sampling in the Spring Run. These changes are reflected in the methods described below.

Monitoring was conducted under FDEP, Division of Recreation and Parks Research/Collecting Permit No. 10152012.

2.1 Monitoring of Madison Blue Spring Pool

Benthic macroinvertebrate communities in the spring pool were sampled during November 2020 by a team of certified open water divers and ecologists, using snorkel equipment and a modified version of FDEP's Stream Condition Index (SCI) protocol. The modification to the standard SCI method involves the substitution of a Surber sampler for the standard D-frame dipnet when collecting the samples, as the Surber device is better at sampling the limestone substrate in the spring pool (Figure 4). The Surber samplers cover an area of 0.1 m² and have a net mesh size of 500 microns, while D-frame dipnets have a net mesh size of 590 microns and sample an area of 0.16 m².



Figure 4. Cardno ecologists used a modified SCI methodology to sample at the benthic macroinvertebrate community in Madison Blue Spring Pool (photo courtesy of D. Hammond, 29 November 2010, 11:11 a.m.).

One set of 20 Surber samples was collected from the spring pool by the ecologists at representative locations, depths, and substrate types, during the November 2020 monitoring event (Figure 5). The depth and substrate type were recorded for each of the individual samples collected in the spring pool.

The following field measurements were taken in the spring pool using an YSI ProDSS sonde and a Hach Turbidimeter Model 2100P: temperature, pH, dissolved oxygen, specific conductance, and turbidity. A surface water grab sample was collected and appropriately preserved from the spring pool and transported to the laboratory for quantitative analysis of alkalinity, calcium, chloride, potassium,

magnesium, sulfate, ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, orthophosphate, total organic carbon, and color. Chain of custody (COC) was maintained for all water quality samples submitted to Benchmark EnviroAnalytical, Inc. (Lab submission #20120175). Due to lab error, some of the parameters with short hold times (color, nitrate, nitrite, and orthophosphate) were analyzed out of hold and were reported with a “Q” code.

In 2014, a continuous recording instrument was installed in the spring pool by USGS (with joint funding by Nestlé Waters) that provides measurements of dissolved oxygen, temperature, specific conductivity, pH, and nitrate-nitrite concentrations; data collection began in July 2014. Daily average graphs for each parameter are presented in this report for January through December 2020.



Figure 5. Madison Blue Spring Pool overview and sampling on 30 November 2020 (photos courtesy of S. Huelster, 30 November 2020).

2.2 Monitoring of the Withlacoochee River Upstream and Downstream of Madison Blue Spring

The following field measurements were made at each Withlacoochee River monitoring site using an YSI ProDSS sonde and a Hach Turbidimeter Model 2100P: temperature, pH, dissolved oxygen, specific conductance, and turbidity. A surface water grab sample was collected and appropriately preserved at each site and transported to the laboratory for quantitative analysis of alkalinity, calcium, chloride, potassium, magnesium, sulfate, ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, orthophosphate, total organic carbon, and color. Chain of custody was maintained for all water quality samples submitted to Benchmark EnviroAnalytical, Inc. (Lab submission #20120175). Due to lab error, some of the parameters with short hold times (color, nitrate, nitrite, and orthophosphate) were analyzed out of hold and were reported with a “Q” code.

Macroinvertebrate sampling was performed according to the SCI protocol developed by the FDEP (DEP-SOP-003/11, SCI 1000) by personnel with training and experience in the SCI protocol and who have successfully passed FDEP audits for the protocol, or are under the supervision of personnel who have successfully passed FDEP audits. The SCI is a standardized macroinvertebrate sampling methodology that accounts for the various microhabitats available (e.g. leaf packs, snags, aquatic vegetation, roots/undercut banks) within a 100-meter segment of stream. Utilizing this methodology, 20 half meter D-frame dip net sweeps are performed within a 100-meter segment of the stream. The number and quality of benthic macroinvertebrate microhabitats present during the sampling event determines the number of sweeps performed within each microhabitat type.

Benthic macroinvertebrate communities were sampled by a team of Cardno ecologists on 30 November 2020 (Figure 6) in the Withlacoochee River extending approximately 100-meters upstream of the spring run near the State Highway 6 bridge and in the Withlacoochee River extending approximately 100-meters downstream of the confluence of the spring run with the river (see Figure 3), using FDEP’s standard SCI protocol (DEP-SOP-003/11, SCI 1000). Dipnet samples were collected along the western bank of the river by wading and reaching from the bank. One set of 20 samples was collected at each Withlacoochee River monitoring site. Each set of 20 macroinvertebrate samples was composited in a gallon plastic container and preserved. Consistent with FDEP protocols, each benthic macroinvertebrate sample was processed and taxonomically analyzed.



Figure 6. Representative conditions of the Withlacoochee River Upstream (left) and Downstream (right) of the Madison Blue Spring Run on 30 November 2020 (photos courtesy of S. Huelster, 30 November 2020).

At each Withlacoochee River station, stream Habitat Assessments (DEP-SOP-001/01, FT3100, Form FD 9000-5) were performed, and a Physical/Chemical Characterization Field Sheet (FT3001, Form FD 9000-3) was completed. The habitat assessment is comprised of a variety of physical criteria that are independently evaluated on a numerical scale, and the component values are summed to provide a quantitative rating for a stream segment that is presumed to be proportional to the quality of the stream for native macroinvertebrates. The Physical/Chemical form records a variety of other information and

also provides for the delineation of various microhabitats in the stream into categories to allow for sampling of such microhabitats in general proportion to their abundance.

In 2007, the FDEP SCI protocol was revised to include provisions for the taxonomic analysis of two aliquots for every SCI sample collected to account for variation in sample sorting. Under the current protocol, the SCI score for each sample is the arithmetic mean of the SCI scores of the two aliquots. Again in 2012, FDEP revised their protocols to divide the state into four regions. Under this division, Madison Blue Spring lies within the Big Bend region instead of the Panhandle where it was previously classified. In addition to the change in aliquots in 2007, the new 2012 protocol also utilizes a slightly different calculation of SCI scores (Table 1). Scores from the 2004 version of the SCI (November 2003 to May 2006) may not be directly comparable to the 2012 version of the SCI (November 2006 to November 2020), given the differences in protocol and how scores were calculated. For this reason, only data collected from November 2006 (two vial method) was used in statistical analysis; data collected in November 2003 and November 2005 were not used in analysis of SCI scores or metrics in this report.

Table 1. Equations for calculating SCI metrics for Big Bend Florida (range from 0-10) using the SCI-2012.

SCI Metric	Big Bend Score
Total Taxa	$10^{*(X-17)/23}$
Ephemeroptera Taxa	$10^{*X/5}$
Trichoptera Taxa	$10^{*X/7}$
Percent Collector-Filterer Taxa	$10^{*(X-1)/53}$
Long-lived Taxa	$10^{*X/3}$
Clinger Taxa	$10^{*X/8}$
Percent Dominant Taxa	$10^{-(10^{*[(X-12.5)/54]})}$
Percent Tanytarsini	$10^{*[\ln(X+1)/3.1]}$
Sensitive Taxa	$10^{*X/10}$
Percent Very Tolerant Taxa	$10^{-(10^{*[\ln(X+1)-0.6]/3.6]})}$

Note: In each equation, "X" equals the number representing the count or percentage listed in the corresponding row of the left column. For calculated values greater than ten, the score is set to ten; for values calculated less than zero, the score is set to zero. The metric scores are summed then divided by 0.9 to get overall SCI score.

2.3 Invertebrate Sample Processing and Tracking

At Cardno's Water Resources Laboratory, each composited benthic macroinvertebrate sample was sorted according to FDEP's SCI protocols by trained technicians who have passed the FDEP lab audit. Samples were logged into an internal sample log and custody was maintained throughout the process of sampling to identification. Sorted samples were sent to Dr. John Epler, a consulting expert in macroinvertebrate taxonomy, for identification accompanied by the COC along with a letter informing of the monitoring date, station, and number of sample jars sent. Chain of custody was maintained for all benthic macroinvertebrate samples that were sorted and then shipped to Dr. Epler for identification (#SAH11302020). Taxonomic identification was performed on two replicate samples from each site, and the sorted samples were returned to Cardno with the monitoring results. Two sets of benthic macroinvertebrate indices, as per the SCI methodology, were calculated for each site.

2.4 Quality Assurance/Quality Control (QA/QC)

The SCI sampling and assessment methodologies used by Cardno ecologists in the biological monitoring program followed the appropriate provisions in Chapter 62-160, Florida Administrative Code (F.A.C), and the FDEP's Standard Operating Procedures (SOPs) for Field and Laboratory Activities (DEP-SOP-003/11, SCI 1000). In addition, all ecologists who conducted the biological monitoring have either

received training from FDEP in the SCI process or successfully passed FDEP audits for SCI sampling. Water samples were collected by trained ecologists following the appropriate provisions in Chapter 62-160, F.A.C., and the FDEP's SOP for Field Activities (DEP-SOP-001/01, FS 2100). Laboratory analytical procedures for water samples were performed by a facility meeting National Environmental Laboratory Accreditation Conference (NELAC) Standards.

The instruments used in the field to collect measurements were the following: YSI ProDSS (water temperature, dissolved oxygen, specific conductivity, and pH) and a Hach Turbidimeter Model 2100P (turbidity). The specifications for each instrument are listed in Table 2. Field instruments are calibrated prior to each monitoring event and continuing calibration verifications are made following each monitoring event to ensure data validity.

Table 2. Performance specifications for instruments used in Madison Blue Spring Monitoring.

Parameter	Range	Accuracy	Resolution
YSI ProDSS			
Temperature	-5 to 70 °C	± 0.2 °C	0.1 °C
Dissolved Oxygen	0 to 500% <u>or</u> 0 to 50 mg/L	$\pm 1\%$ of reading or 1%, whichever is greater <u>or</u> ± 0.1 mg/L or 1% of reading, whichever is greater	0.01 mg/L and 0.1%
Specific Conductivity	0 to 200 mmhos/cm	0-100 mmhos/cm: $\pm 0.5\%$ of reading <u>or</u> 0.001 mmhos/cm, whichever is greater 100-200 mmhos: $\pm 1.0\%$ of reading	0.001, 0.01, 0.1 mmhos/cm
pH	0 to 14 pH units	± 0.2 pH units	0.01 pH units
Hach Turbidimeter Model 2100P			
Turbidity	0-1,000 NTU*	$\pm 2\%$	0.01 NTU

*NTU – Nephelometric turbidity units

2.5 Data Analysis

Data were analyzed using STATISTICA 12 (StatSoft, Inc.). To determine any trends in water quality, water quantity, and benthic macroinvertebrate data, the non-parametric Kendall Tau correlation procedure was used for data collected in the fall (November data from 2003 to 2020 for water quality and November 2006 to 2020 for benthic macroinvertebrates). Previous reports looked at spring, fall, and annual time periods, but with the change in monitoring frequency beginning in 2015, only fall data could be analyzed over time. The Kendall Tau correlation procedure evaluates data over time for increasing or decreasing monotonic trends. Observed trends were determined to be statistically significant at a p value of less than 0.05.

3 Results

The results of the biological monitoring events of Madison Blue Spring conducted on 30 November 2020 are presented below. Cardno followed all FDEP SOPs for sampling to ensure proper data collection and consistency with previous monitoring events. It had rained a few days before sampling along with in the morning prior to the sampling event. As the day went on, water levels were rising slowly within the Withlacoochee River. Weather conditions during the monitoring event on 30 November 2020 were fair with temperatures starting in the low 60's decreasing to the 50's, with cloudy skies clearing up to sunny skies, and a constant breeze.

For parameters with a statistically significant trend, the fall (November or December) results were plotted to better illustrate the increasing or decreasing trend and are provided in Appendix A. Monitoring events conducted on 18 November 2003, 4 May 2004, and 26 May 2005 represent baseline conditions because they occurred before the permitted withdrawal of groundwater began.

3.1 Gauge Height and Discharge Data

Stream gauge data for 2020 was reported in NAVD-1988 (NGVD-1929 still available) based on updated survey information provided on the USGS website in 2015. Figure 7 below reflects that change in survey elevation compared to previous reports. The actual gauge readings have remained the same, only the correction factor to NAVD for each station have been updated. Both the Withlacoochee River and Madison Blue Spring gauge height tracks similarly over time from 2003 to 2020 (Figure 7). Stream discharge of the Withlacoochee River is variable, with flows generally below 1,000 cfs. However, during the typical wet seasons of late winter to early spring and summer or when water levels rise rapidly after heavy rain events, the discharge has increased to as much as 57,300 cfs (Figure 8). During 2020, there were multiple discharge peaks for the Withlacoochee River. The largest increases in water levels occurred from early-February to a peak in mid-March and then from mid-April to a peak in May; there were multiple smaller peaks in flow during mid-June, mid-July, September, October, November, and the end of December 2020 (Figure 10).

Compared to the Withlacoochee River, the discharge from Madison Blue Spring has not varied much from 2003 to 2020; peak discharge occurred in July 2005 while negative discharge occurs when the Withlacoochee River flood events cause the stage to be high enough to create reverse flow conditions in the spring (Figure 9). Negative discharge in Madison Blue Spring generally has occurred during the first quarter of the year coincident with the typical winter wet season (Figure 9). During 2020, there was backflow in Madison Blue Spring for 33 days from mid-February to mid-March and for eight days at the end of April. Additionally, there was discharge above 100 cfs for 65 percent of the year, mainly during January and May and from late June through October (Figure 10). From 2010 to 2020 water withdrawn by Nestlé Waters has been fairly uniform averaging 0.67 MGD or around 1.03 cfs; this amount of water withdrawn from Madison Blue Spring, which makes up <1% of the average spring output, is negligible considering the average daily discharge of the spring (100.8 cfs from 2003 to 2020).

From 2003 to 2020, there has been no increasing or decreasing trend in annual averages of discharge or gauge height in Madison Blue Spring (Kendall Tau, $p > 0.05$). Similarly, when using the average discharge and gauge height during the month of monitoring (November) there have been no increasing or decreasing trends over time (Kendall Tau, $p > 0.05$).

During the 30 November 2020 monitoring event, the Madison Blue Spring gauge averaged 8.34 feet (water level of 40.62 ft NAVD) with a mean discharge of 93.4 cfs on the day of monitoring (Figures 7-10). The Pinetta gauge station (Withlacoochee River) averaged 6.89 feet (water level of 53.39 ft NAVD), with a mean discharge of 320 cfs during the November monitoring event (Figures 7-10).

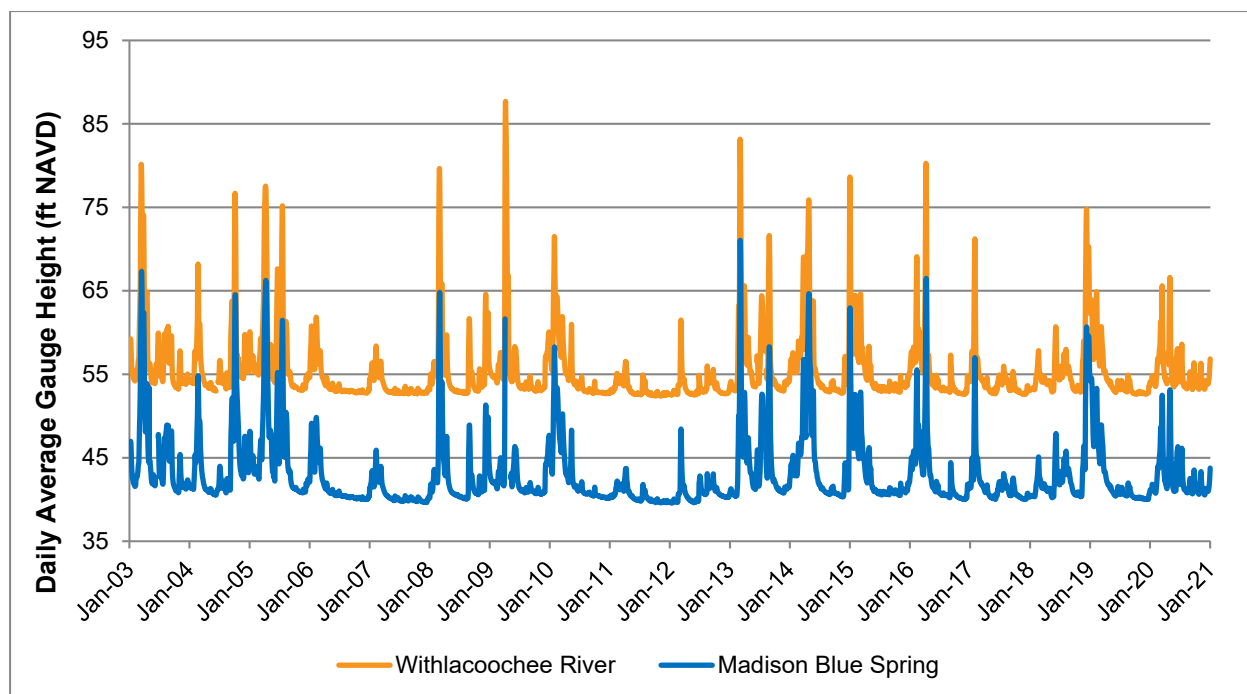


Figure 7. Daily average gauge height (ft NAVD) at the USGS Withlacoochee River near Pinetta and Madison Blue Spring monitoring stations from 2003 to 2020 (data from 3/30/2020 for the Madison Blue Spring and 6/3/2020 for the Withlacoochee River to present are provisional).

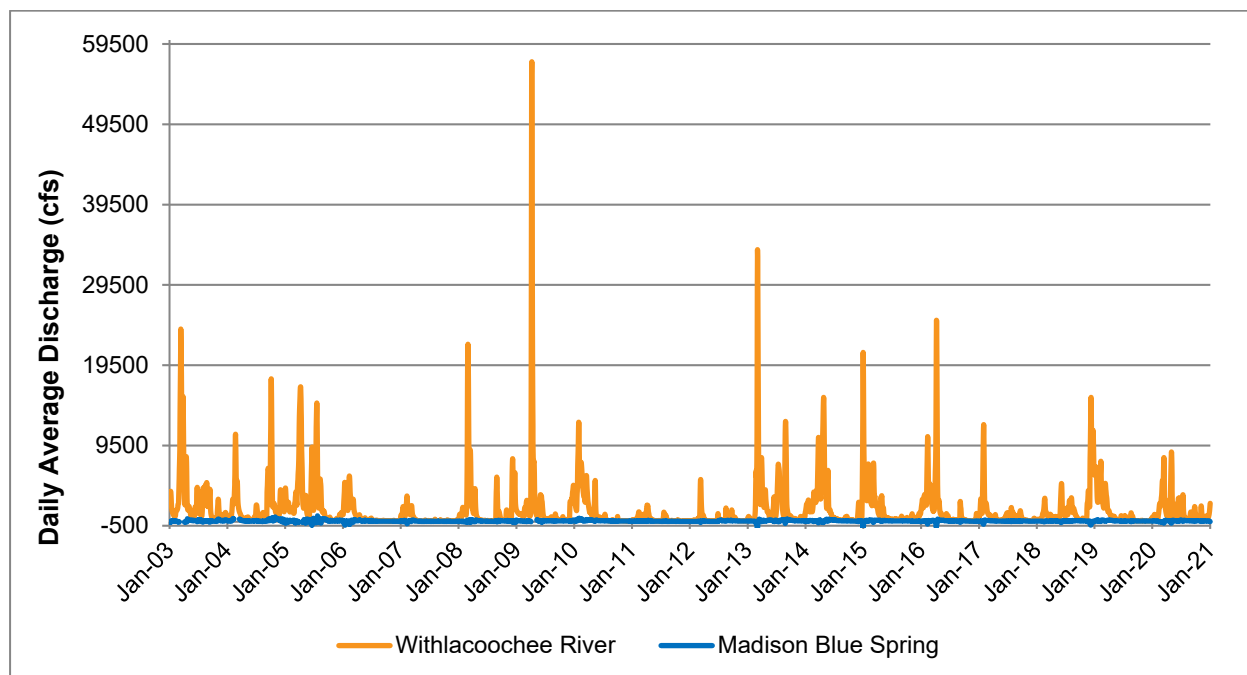


Figure 8. Daily average discharge (cfs) at the USGS Withlacoochee River near Pinetta and Madison Blue Spring monitoring stations from 2003 to 2020 (data from 3/30/2020 for Madison Blue Spring and 6/3/2020 for the Withlacoochee River to present is provisional).

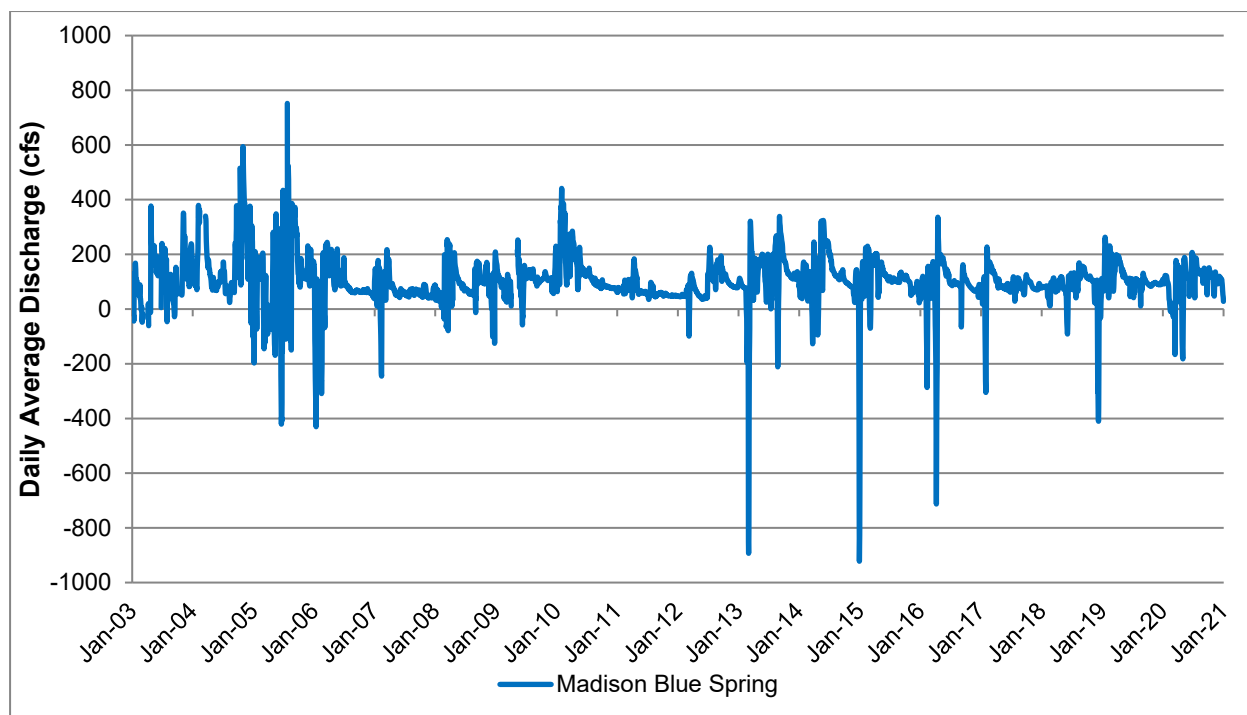


Figure 9. Daily average discharge (cfs) at the USGS Madison Blue Spring monitoring station from 2003 to 2020 (data from 3/30/2020 to present is provisional).

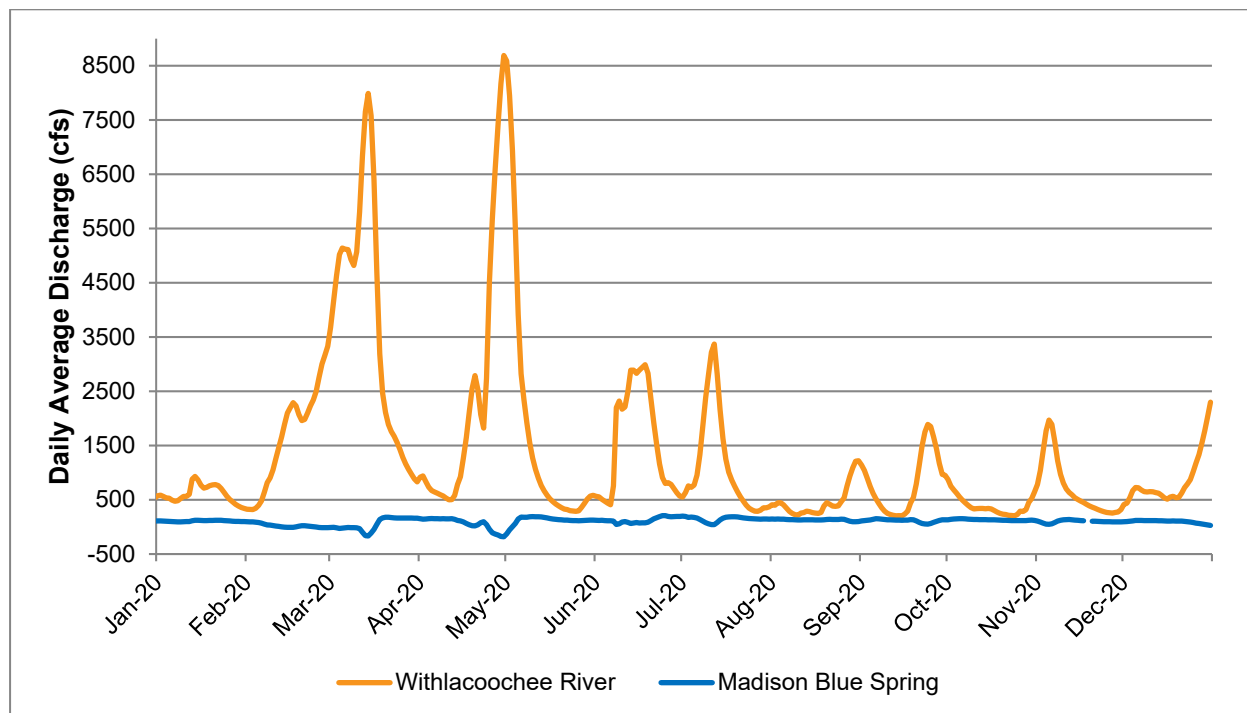


Figure 10. Daily average discharge (cfs) at the USGS Withlacoochee River near Pinetta and Madison Blue Spring monitoring stations for 2020 (data from 3/30/2020 for Madison Blue Spring and 6/3/2020 for the Withlacoochee River to present is provisional).

3.2 Water Quality

3.2.1 Field Measurements

Table 3 presents the field measurements collected at all stations (Spring Pool and the Withlacoochee River Upstream and Downstream of Madison Blue Spring) during the 30 November 2020 monitoring event. Figures 11 to 16 present all field water quality data collected during the monitoring program (2003 to 2020) from the Spring Pool and Withlacoochee River Upstream and Downstream of the spring.

Table 3. Field measurements from November 2020 monitoring event.

Parameter	Units	Class III Surface Water Standards	Spring Pool	Withlacoochee Upstream	Withlacoochee Downstream
Dissolved Oxygen	mg/L	See Rule 62-302.533 (1)(c) F.A.C.	1.94	7.50	5.06
Dissolved Oxygen	% Saturation	Pool: >34% daily avg. River: No more than 10% below 54.9; no more than 50% below 68.2	21.8	81.3	55.8
pH	SU	$6 \leq \text{pH} \leq 8.5$	7.77	7.70	7.72
Specific Conductivity	$\mu\text{mhos/cm}$	$< 1,275$	302	362	332
Temperature	°C	None	21.09	19.19	20.22
Turbidity	NTU	≤ 29	0.36	2.22	1.10

Previously, the Class III dissolved oxygen (DO) standard stated “DO shall not be less than 5.0 mg/L.” In 2013, the FDEP implemented a new standard for DO. This new standard states the DO daily average percent saturation for the Big Bend bioregion (which includes Madison Blue Spring) shall not be less than 34 percent. However, the Withlacoochee River is considered habitat for young of the year Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and more protective measures for DO are in place. FDEP utilized data in the Impaired Waters Rule (IWR) database, where data collected from 1991 through 2011 (baseline) were sufficient to have temporal variability and covered a period where the Gulf sturgeon population was stable or increasing. Based on this baseline data, DO should not be below the 10th percentile (54.9 percent saturation) for 10 percent of the measurements or have 50 percent of the measurements below the median (68.2 percent saturation).

During the 30 November 2020 monitoring event, DO percent saturations were above baseline 10th percentile at both river stations and the upstream river station was above the baseline median criterion. The Spring Pool was below the time of day translation of the daily average for the Big Bend bioregion of 34 percent. In the past, some of the Spring Pool or Withlacoochee Downstream measurements have been below the standard, and FDEP recognizes that spring systems, along with streams downstream of spring runs, typically exhibit lower DO concentrations and percent saturations (FDEP 2013). The low DO levels observed in many springs are caused by long residence times of ground water where DO becomes depleted prior to discharge (FDEP 2013). Figures 11 and 12 plot all of the DO measurements collected at the Spring Pool, Withlacoochee Upstream, and Withlacoochee Downstream monitoring stations to date (2003 to 2020). No stations exhibited a statistically significant increasing or decreasing trend for DO over the 2003 to 2020 fall monitoring period (Kendall Tau, $p > 0.05$).

No station exceeded the Class III water quality standard for pH ($6.0 \leq \text{pH} \leq 8.5$), specific conductivity (1,275 $\mu\text{mhos/cm}$), or turbidity (29 NTU). Additionally, no station exhibited a statistically significant increasing or decreasing trend for pH, temperature, or turbidity when results from the fall 2003 to 2020 were analyzed (Kendall Tau, $p > 0.05$).

However, the Spring Pool had a slight increasing trend in specific conductivity, with a slope of 0.80 $\mu\text{mhos/cm/yr}$, during the fall monitoring events from 2003 to 2020 (Kendall Tau = 0.43, $p < 0.05$, Figure A-

1). The trend in specific conductivity is not considered ecologically significant and should be of no concern at this time. This trend will continue to be monitored in the future. No increasing or decreasing trends in specific conductivity was observed at either Withlacoochee River station during fall monitoring events (Kendall Tau, $p > 0.05$).

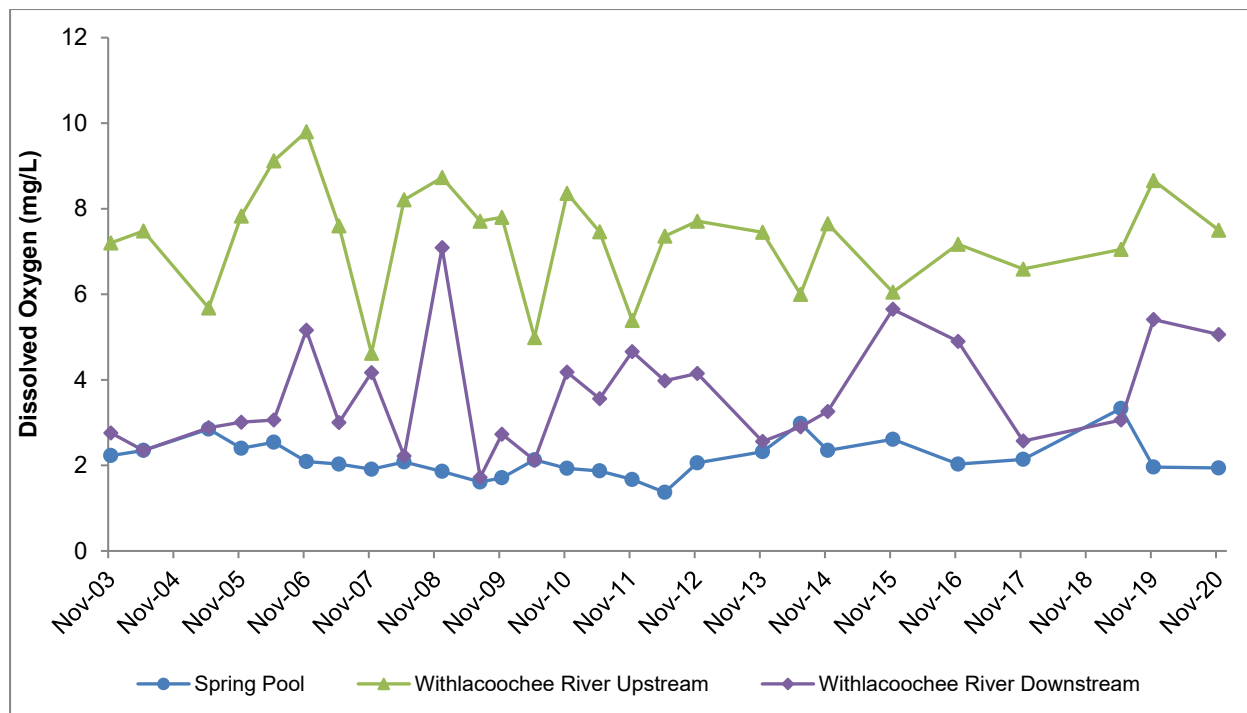


Figure 11. Dissolved oxygen concentration measurements at the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

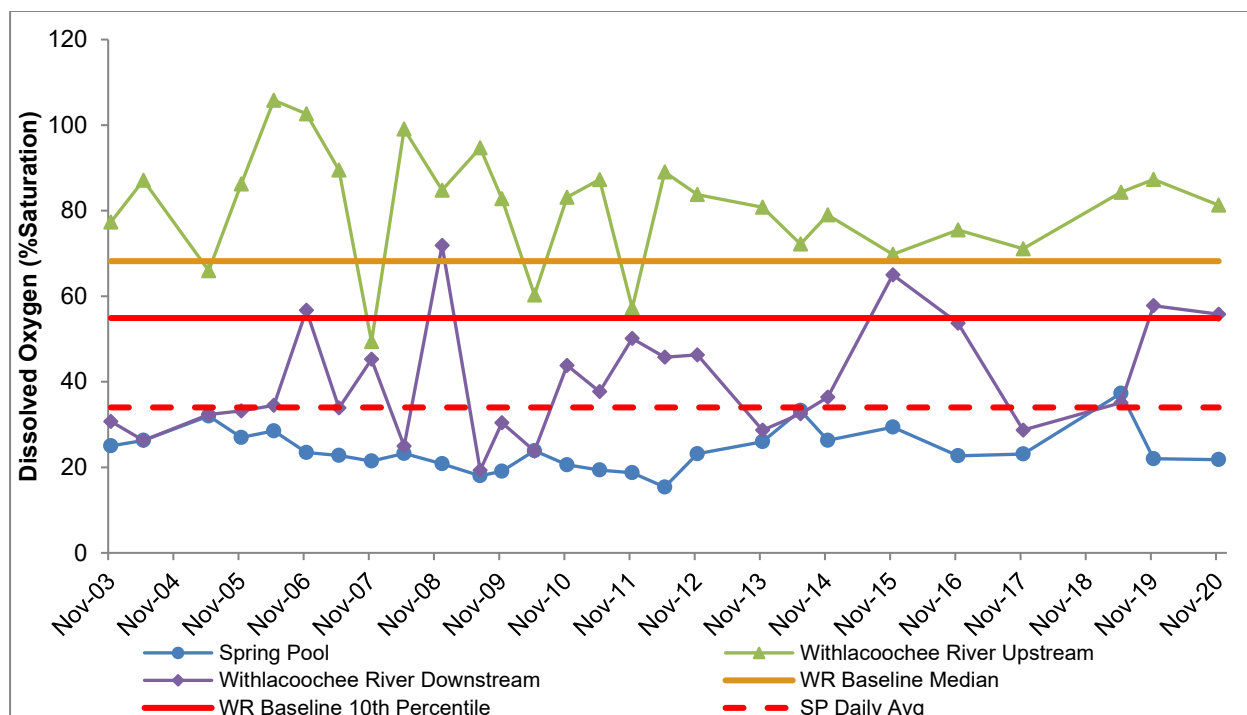


Figure 12. Dissolved oxygen saturation measurements at the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

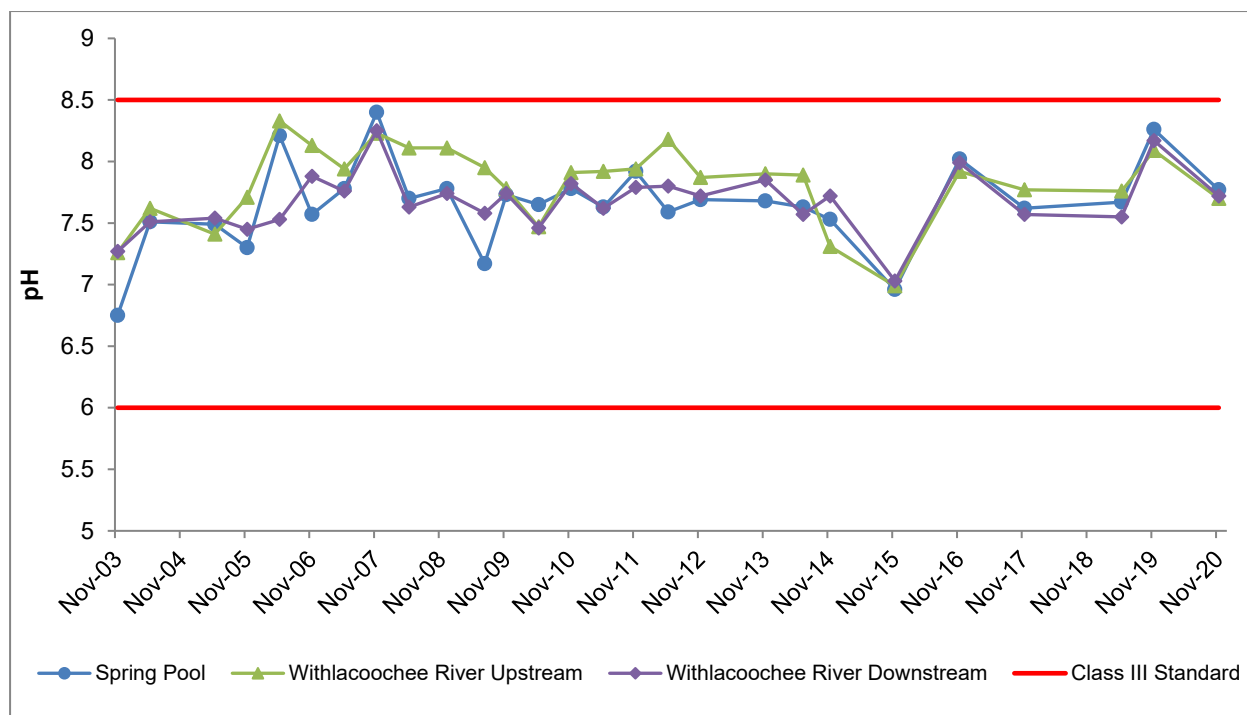


Figure 13. Measured pH recorded at the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

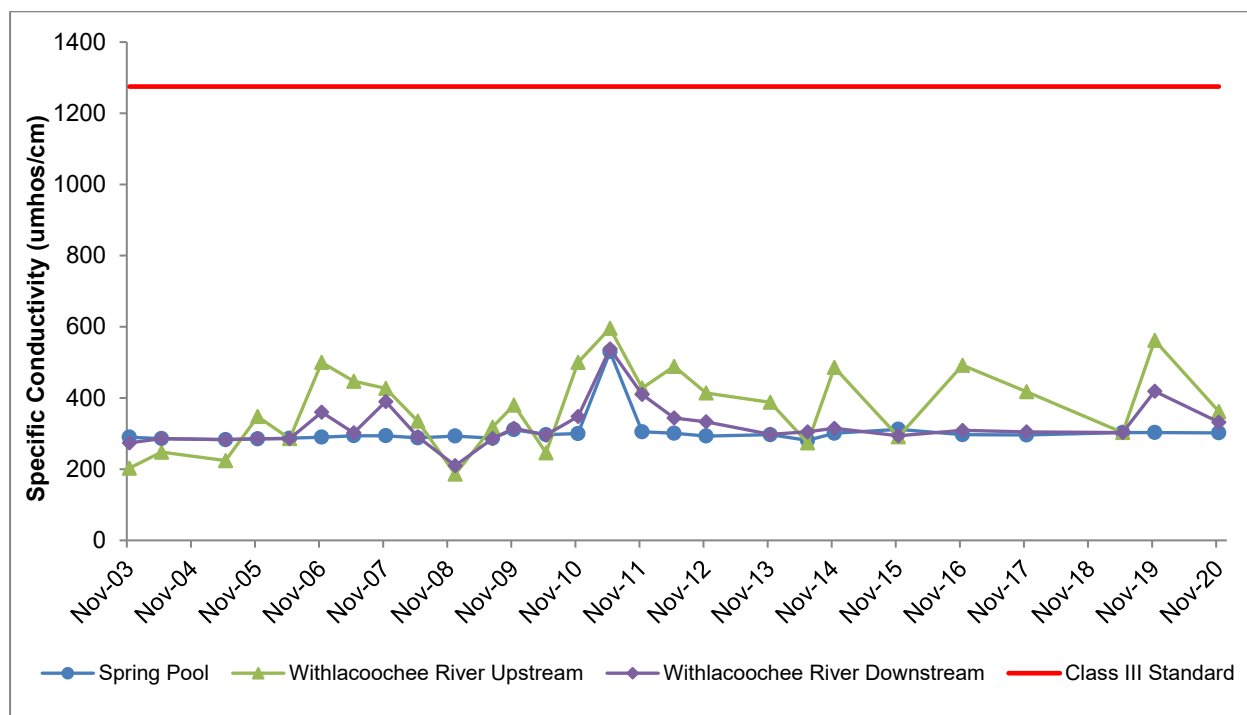


Figure 14. Specific conductivity measurements at the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

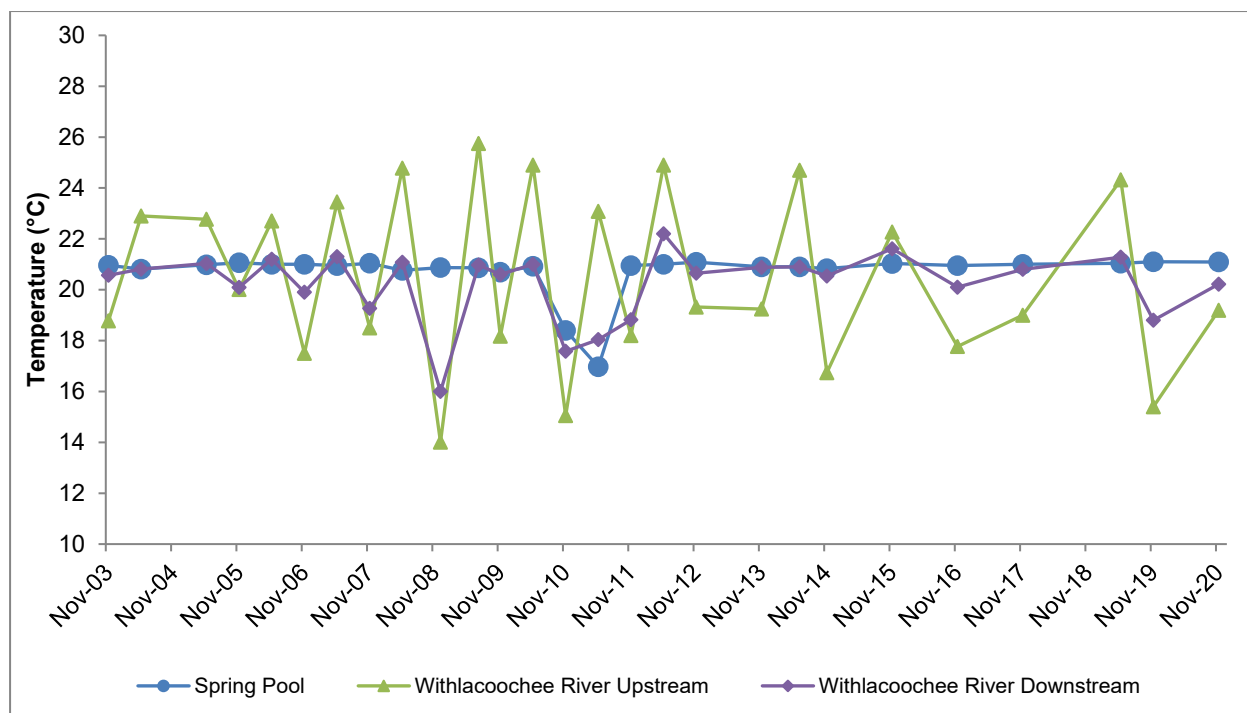


Figure 15. Water temperature measurements at the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

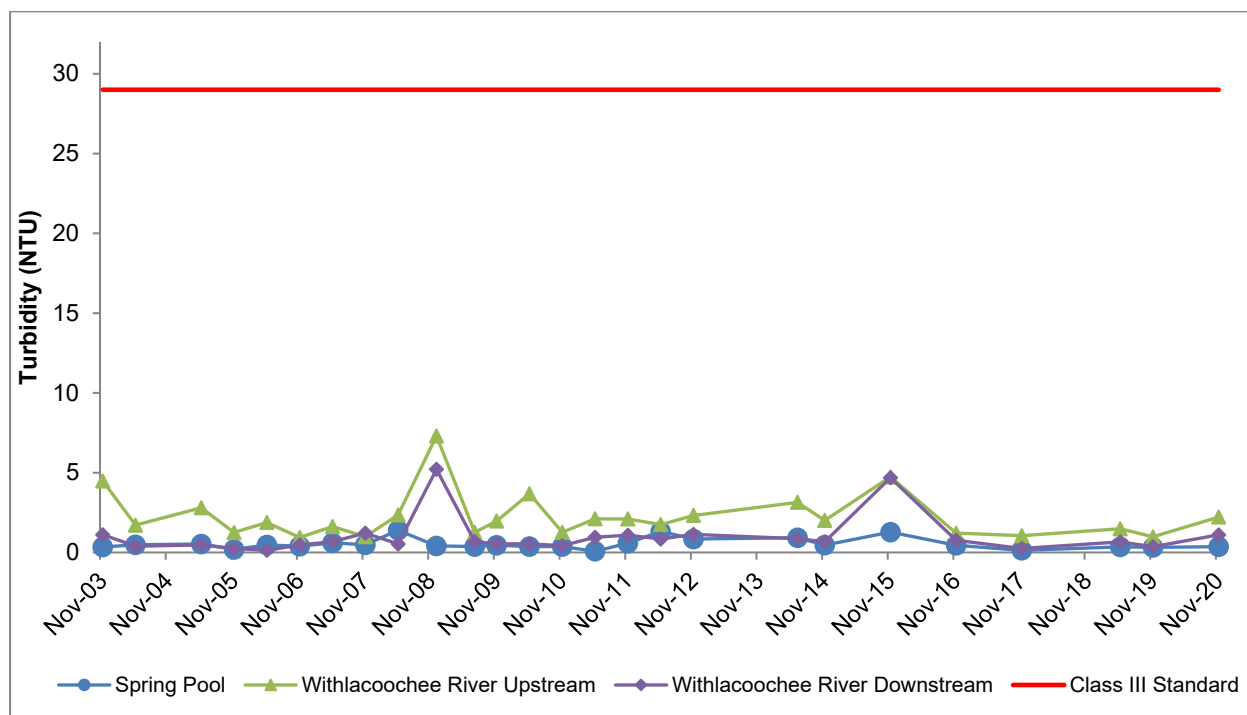


Figure 16. Turbidity measurements at the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

3.2.2 Water Quality Laboratory Analysis

Table 4 presents the results of laboratory analysis on water quality samples collected at the Spring Pool, Withlacoochee Upstream, and Withlacoochee Downstream stations on 30 November 2020. Due to lab error, some of the parameters with short hold times (color, nitrate, nitrite, and orthophosphate) were analyzed out of hold and were reported with a "Q" code. Figures 17 to 28 present all lab water quality data collected during the monitoring program (2003 to 2020) from the Spring Pool and Withlacoochee River Upstream and Downstream of the spring. Ammonia and nitrite results were graphed with the minimum detection limit (MDL) because of the large number of undetected results. For data analysis, results for ammonia and nitrite were censored to the highest reported MDL for each parameter (0.04 mg/L for ammonia and 0.05 mg/L for nitrite); all results at or below the highest MDLs (detected or undetected) were replaced with that value to make the MDL consistent over time. This truncation of the dataset is appropriate for the purposes of the statistical test, but does result in a loss in some statistical power for detecting trends.

Table 4. Laboratory water quality results from November 2020 monitoring event.

Parameter	Units	Class III Surface Water Standards	Spring Pool	Withlacoochee Upstream	Withlacoochee Downstream
Alkalinity as CaCO ₃	mg/L	> 20	124	91	121
Ammonia Nitrogen	mg/L	None	U (0.008)	U (0.008)	U (0.008)
Calcium	mg/L	None	44.3	33.4	44.5
Chloride	mg/L	None	3.83	8.24	4.0
Color	PCU	None	UQ (2.5)	70 Q	UQ (2.5)
Magnesium	mg/L	None	8.94	6.78	8.81
Nitrate Nitrogen	mg/L	None	1.8 Q	0.279 Q	1.79 Q
Nitrite Nitrogen	mg/L	None	UQ (0.02)	UQ (0.02)	UQ (0.02)
Orthophosphate	mg/L	None	0.076 Q	0.131 Q	0.065 Q
Potassium	mg/L	None	0.669 I	4.24	0.421 I
Sulfate	mg/L	None	10.2	56	10.3
Total Organic Carbon	mg/L	None	1.06 I	7.53	0.974 I

U - Undetected. Value listed is the Method Detection Limit (MDL)

I - Reported value is between the laboratory Method Detection Limit (MDL) and the Practical Quantification Limit (PQL)

Q - Sample held beyond the accepted holding time.

With the exception of alkalinity, there are no Class III surface water quality standards for the lab parameters measured. For alkalinity, no exceedances of the Class III Standard (shall not be depressed below 20 mg/L) were observed at any station in November 2020 (Table 4).

There were no statistically significant increasing or decreasing trends for alkalinity, ammonia, calcium, color, magnesium, nitrate, nitrite, orthophosphate, potassium, or total organic carbon observed at any station when the 2003 to 2020 fall data was analyzed (Kendall Tau, $p > 0.05$). While potassium, sulfate, and total organic carbon have been higher at the Withlacoochee River Upstream station compared to the other two stations, there were no trends observed in the fall potassium or total organic carbon data during the 2003 to 2020 time frame. However, there was a statistically significant increasing trend for sulfate from 2003 to 2020 during fall events at the Withlacoochee River Upstream station (Kendall Tau = 0.43, $p < 0.05$, slope 2.38 mg/L/yr, Figure A-2). While there was an increasing trend observed upstream, there were no increasing or decreasing trends at the Spring Pool or the Withlacoochee Downstream stations (Kendall Tau, $p > 0.05$). This trend will be monitored in the future, but currently indicates no impact from spring withdrawals.

There was also a statistically significant decrease in chloride (slope of -0.11 mg/L/yr) at the Spring Pool station over time during fall monitoring events (Kendall Tau = -0.47, $p < 0.05$, Figure A-3). No statistically significant trends for chloride were observed in the Withlacoochee River Upstream or Downstream data during fall events (Kendall Tau, $p > 0.05$). None of these trends are considered ecologically significant and are not a concern at this time.

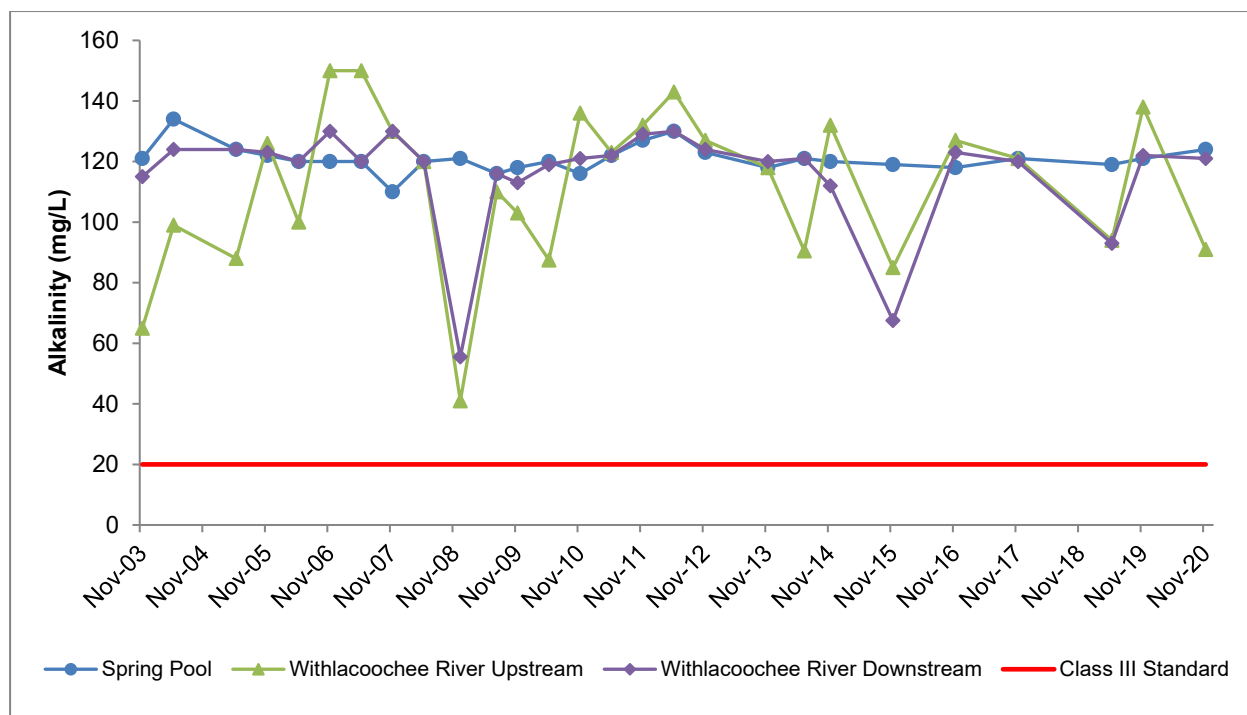


Figure 17. Alkalinity concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

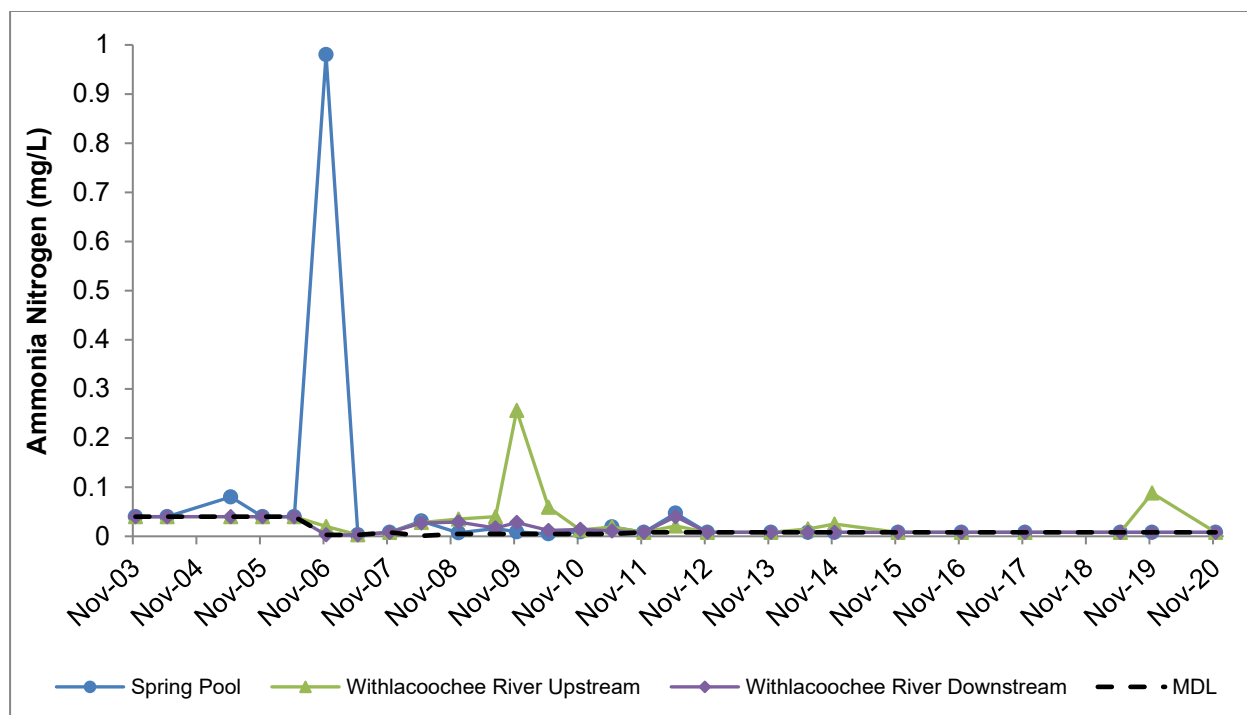


Figure 18. Ammonia concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

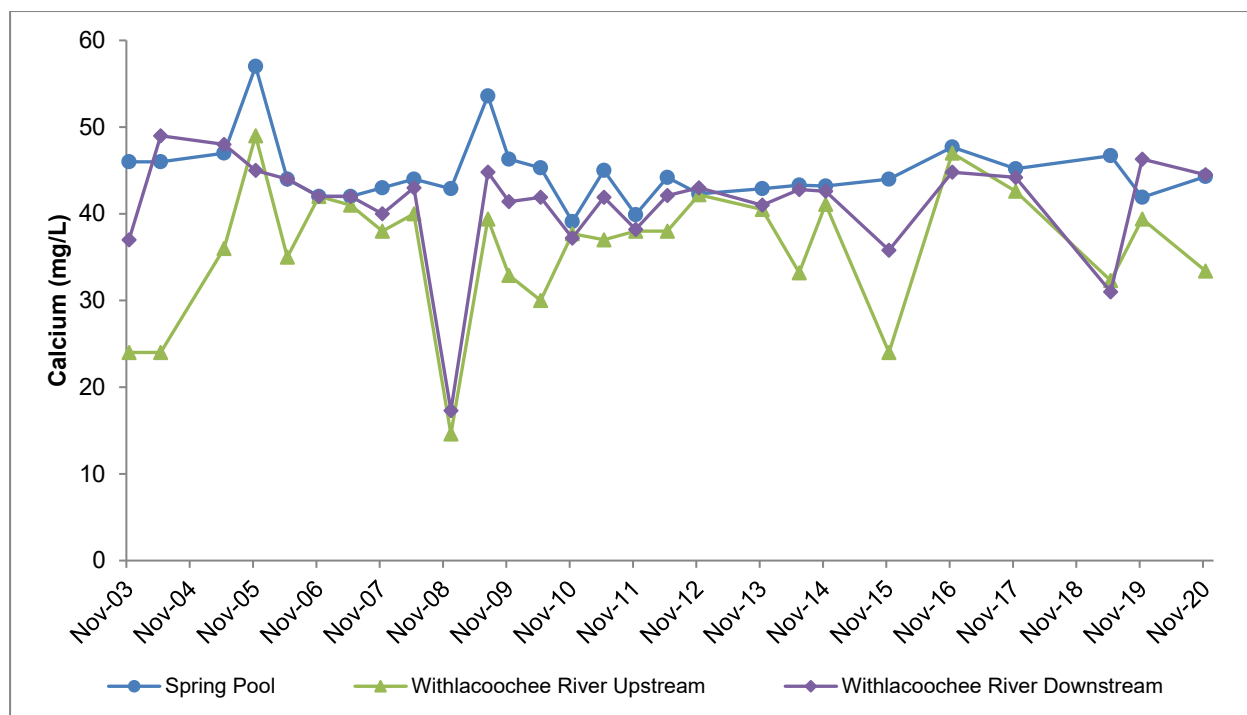


Figure 19. Calcium concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

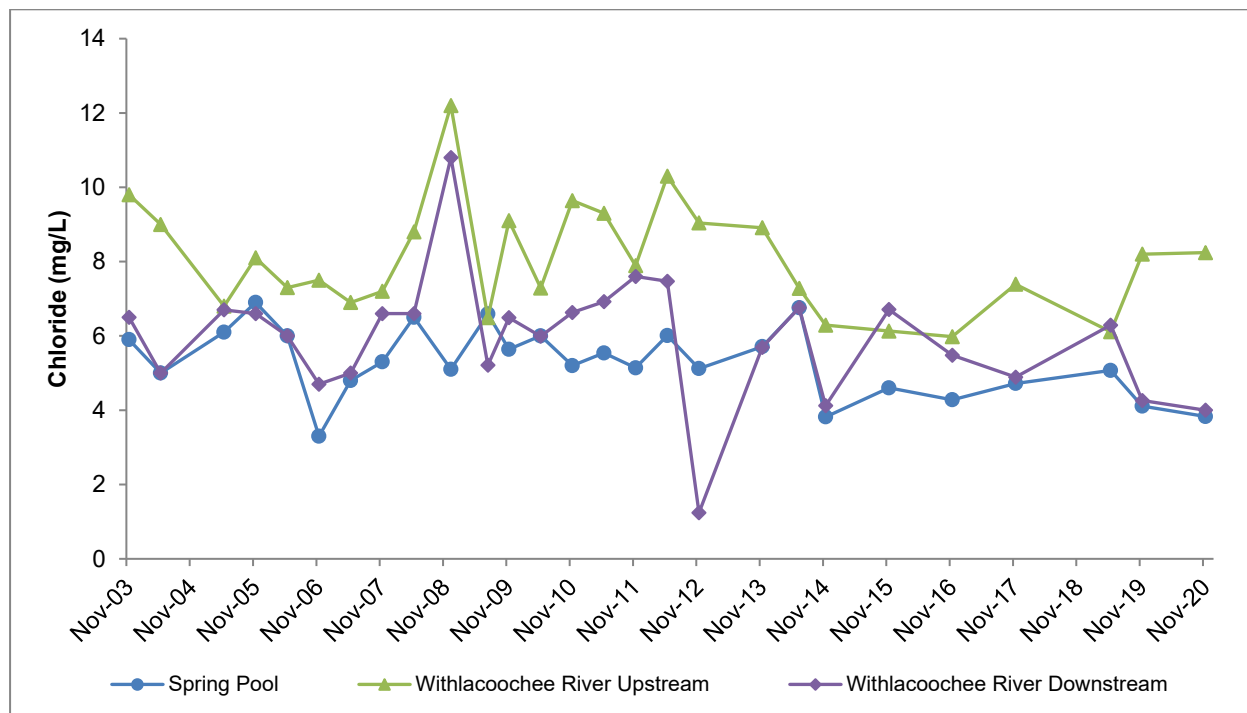


Figure 20. Chloride concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

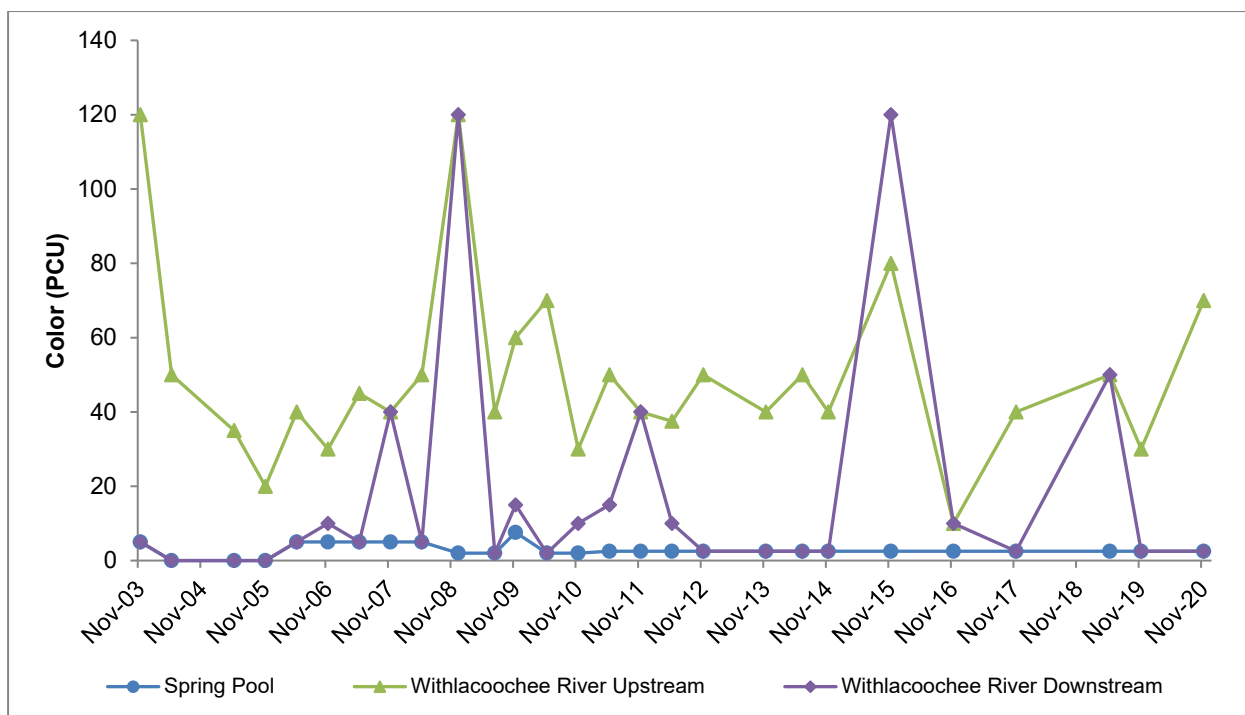


Figure 21. Color measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

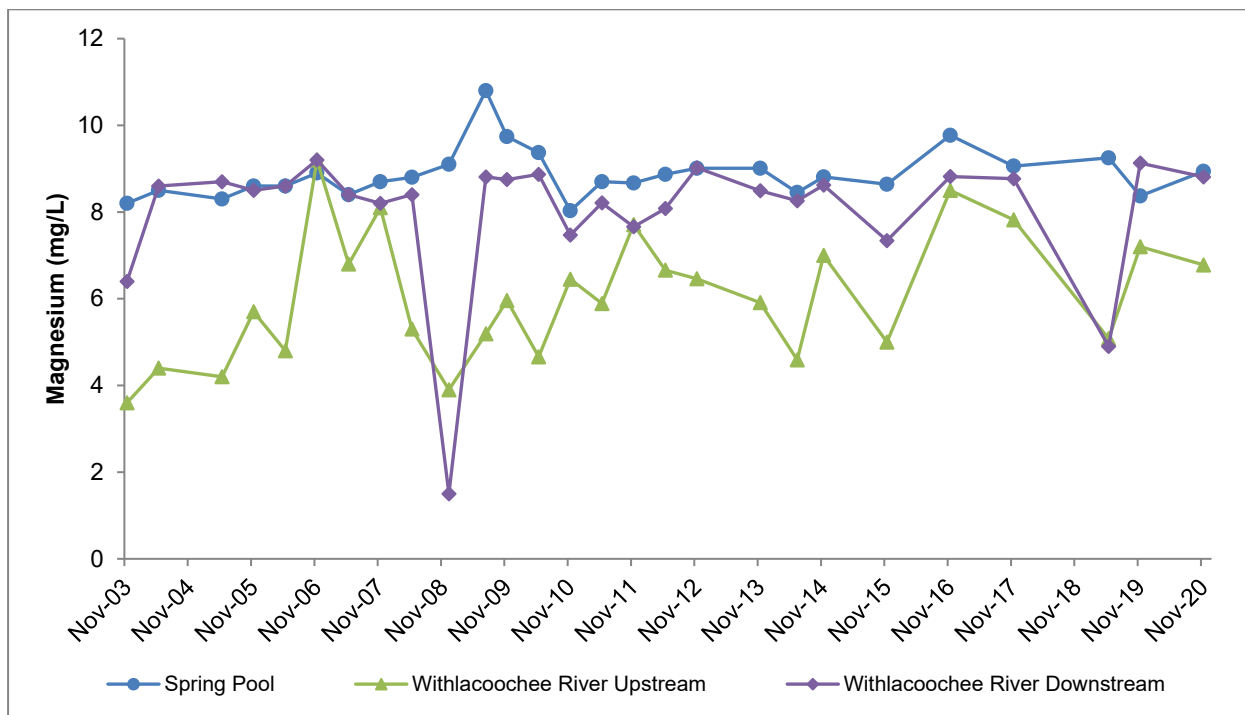


Figure 22. Magnesium concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

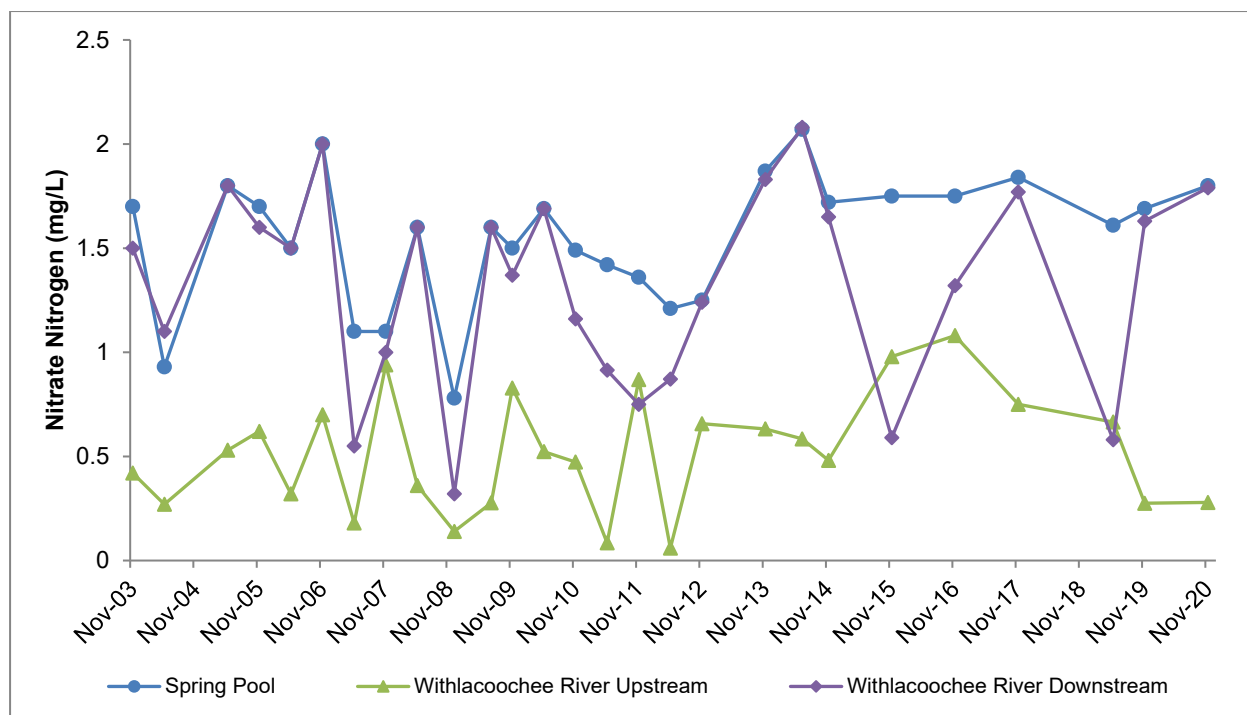


Figure 23. Nitrate nitrogen concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

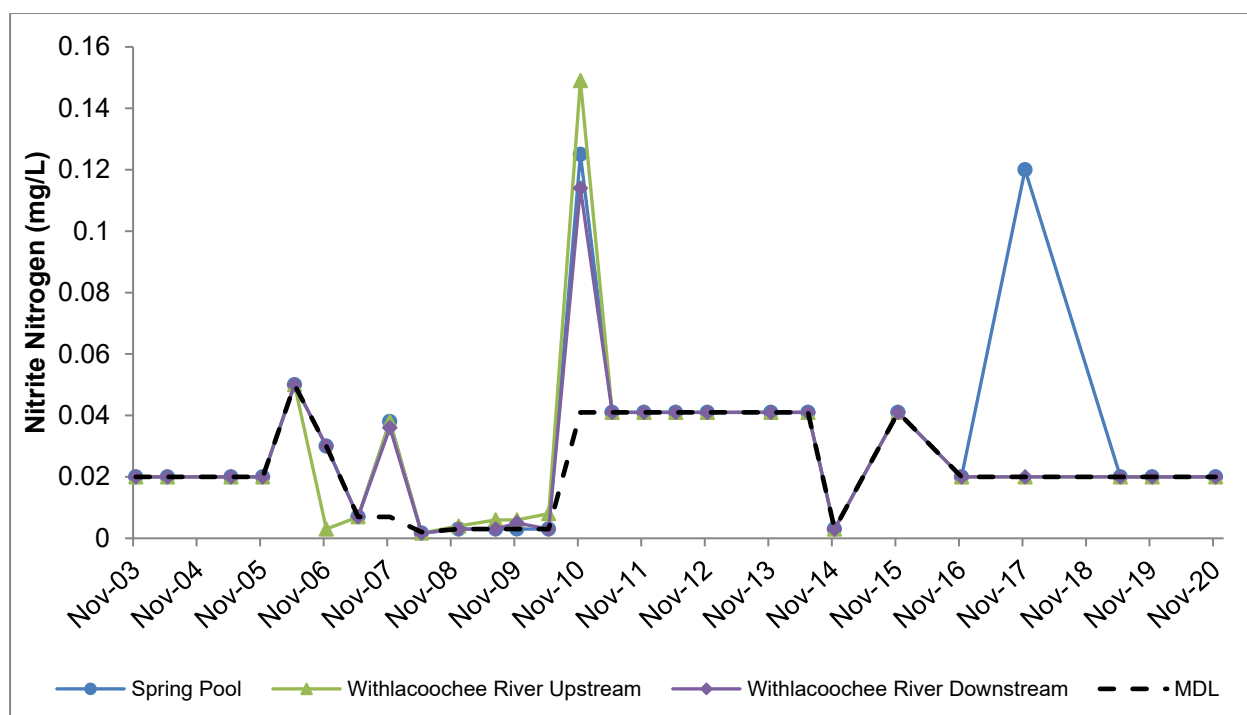


Figure 24. Nitrite nitrogen concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

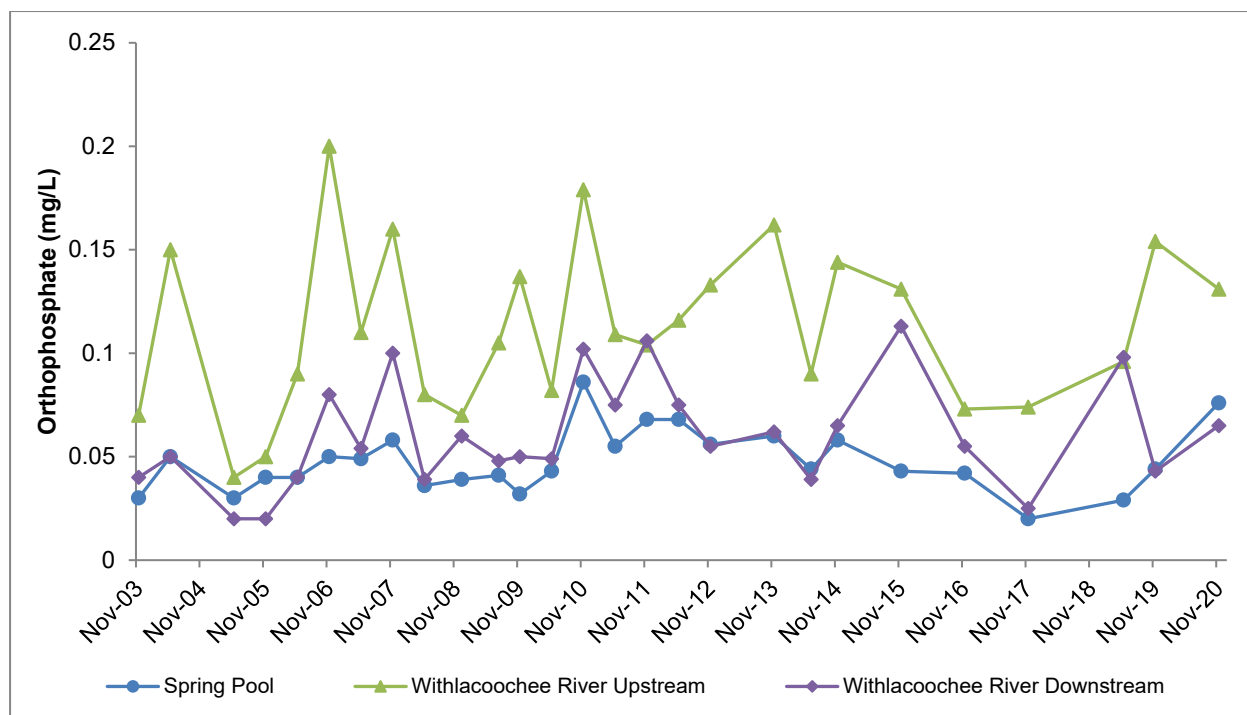


Figure 25. Orthophosphate concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

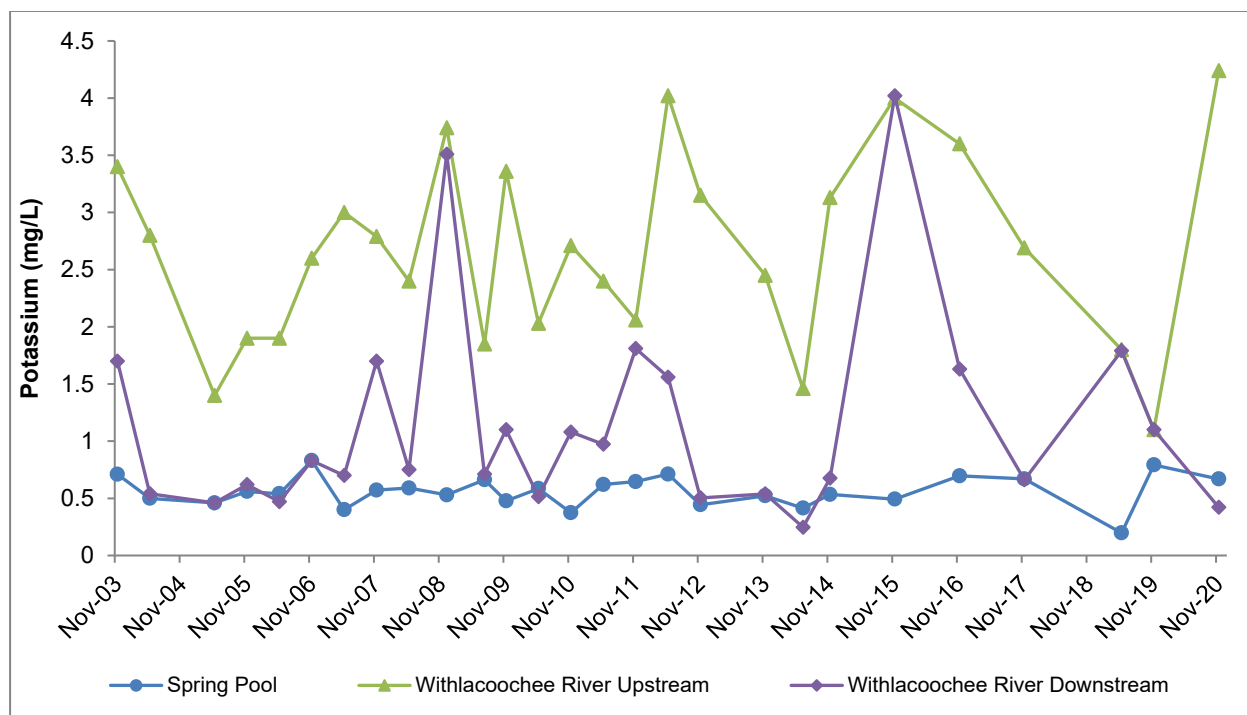


Figure 26. Potassium concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

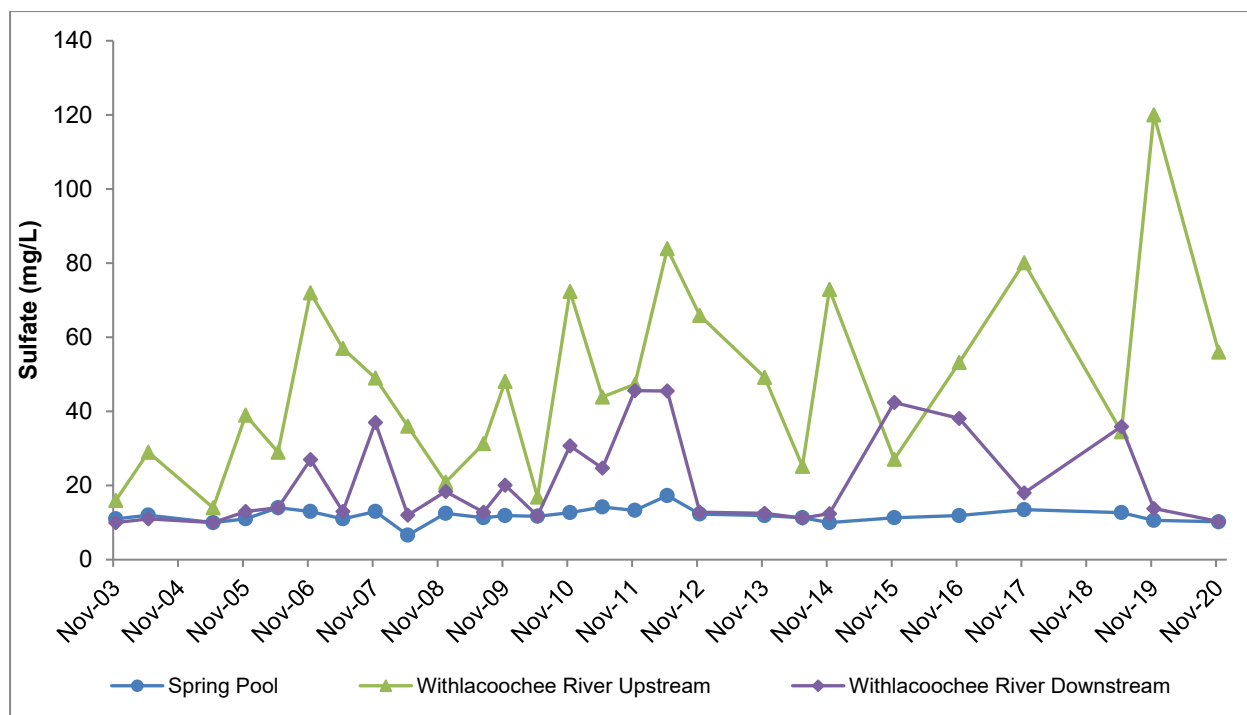


Figure 27. Sulfate concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

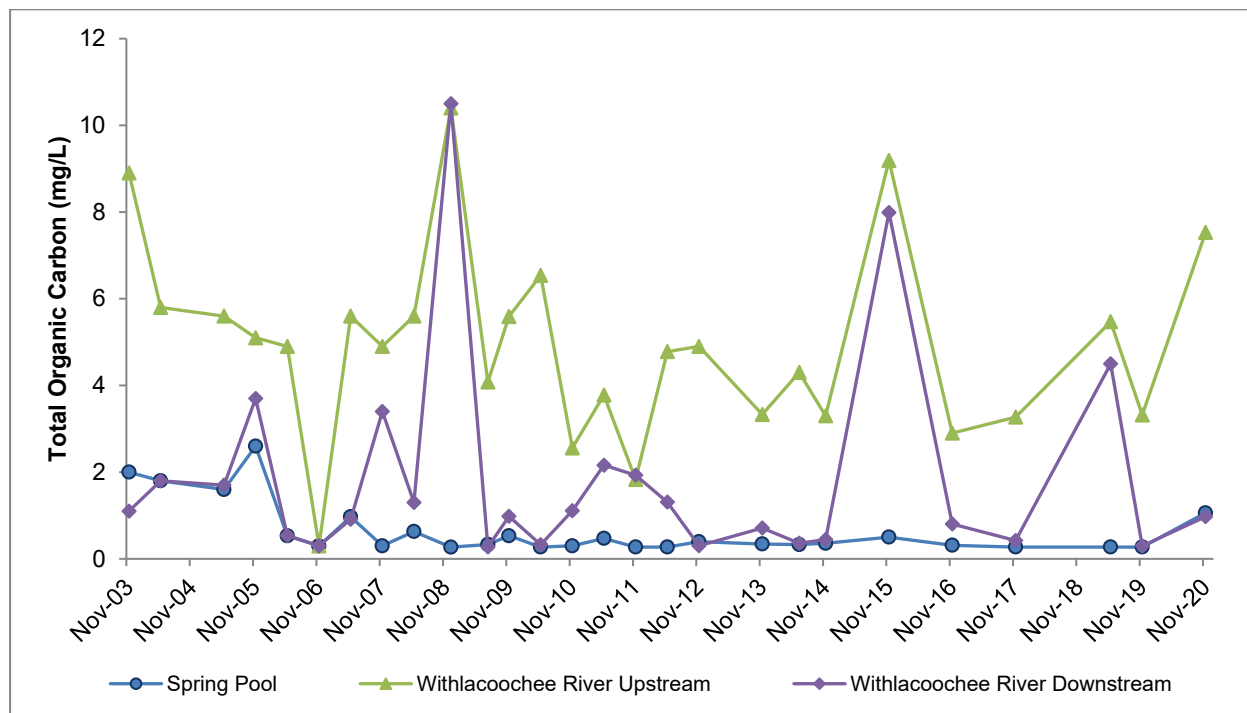


Figure 28. Total organic carbon concentrations measured at the Madison Blue Spring Pool, Withlacoochee River Upstream and Withlacoochee River Downstream stations from 2003 to 2020.

3.2.3 Continuous Recorder Monitoring Results

In 2014, USGS installed (with joint funding by Nestlé Waters) a continuous recording instrument in the spring pool to assist in establishing potential relationships between water withdrawal and water quality in the spring. Data were first available online through the USGS website in July 2014. Measurements of temperature, DO concentration (mg/L), pH, specific conductivity, and nitrate-nitrite were collected continuously (reading every 15 minutes). Data were also summarized in the form of daily average, minimum, and maximum on the USGS website. The daily average results are presented for each parameter below from January to December 2020 (Figures 29 to 33).

Like typical spring systems, temperature remained fairly stable throughout the year, with most measurements around 21°C; during periods of higher Withlacoochee River flow and subsequent backflow from the river for the period of mid-February through mid-March 2020 and the end of December 2020, water temperatures were much lower (Figure 29). DO concentrations showed an inverse pattern as temperature with higher concentrations during times of potential backflow (2.5 to 8.8 mg/L). During the remainder of the year when river discharges were lower, the daily average DO concentrations were generally between 1.4 and 2.4 mg/L (Figure 30). Values of pH ranged from 6.0 to 7.8 during the 2020 time frame; lower pH values were recorded during periods of potential backflow (Figure 31). When spring flow dominated, the daily average specific conductivity ranged from 279 to 304 $\mu\text{mhos/cm}$; when there were periods of river backflow, the specific conductivity decreased to 72 $\mu\text{mhos/cm}$ (Figure 32). Daily average nitrate-nitrite concentrations were variable and ranged from 0.81 to 2.65 mg/L over the year with higher concentrations during periods of normal spring discharge (Figure 33). During 2020, there were multiple periods with missing nitrate-nitrite measurements (Figure 33). Based on the individual surface water grab samples collected over time, the nitrate-nitrite daily average concentrations are dominated by nitrate (see Figure 23 for nitrate results).

When the November surface water grab sample data from 2014 through 2020 were compared to the continuous recorder daily averages, most values were within five percent of each other. There was a greater variance with the November 2014 nitrate-nitrate concentration (1.77 mg/L grab compared to 1.54 mg/L daily average), November 2015 pH (7.0 grab compared to 7.8 daily average), DO (2.61 mg/L grab compared to 2.38 mg/L daily average), and specific conductivity (312 $\mu\text{mhos/cm}$ grab compared to 291 $\mu\text{mhos/cm}$ daily average), November 2017 DO (2.14 mg/L grab compared to 1.82 mg/L daily average) and nitrate-nitrite concentration (1.96 mg/L grab compared to 1.77 mg/L daily average), and November 2019 pH (8.26 grab compared to 7.69 daily average) and nitrate-nitrite (1.69 mg/L grab compared to 1.95 mg/L daily average). The May 2019 data (2018 monitoring event) was more variable for DO concentration (3.33 mg/L grab compared to 1.94 mg/L daily average), pH (7.67 grab compared to 7.54 daily average), and nitrate-nitrite concentration (0.67 mg/L grab compared to 1.98 mg/L daily average).

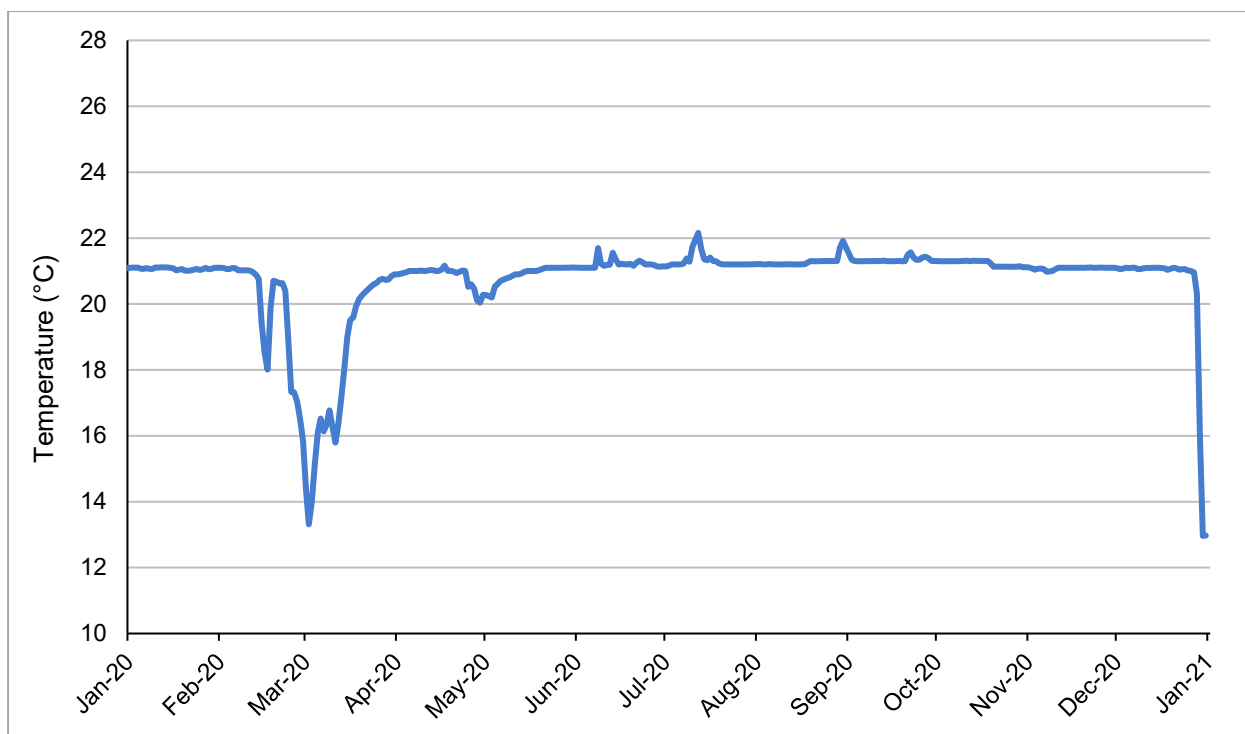


Figure 29. Daily average temperature collected at the Madison Blue Spring Pool from the continuous recorder from January to December 2020.

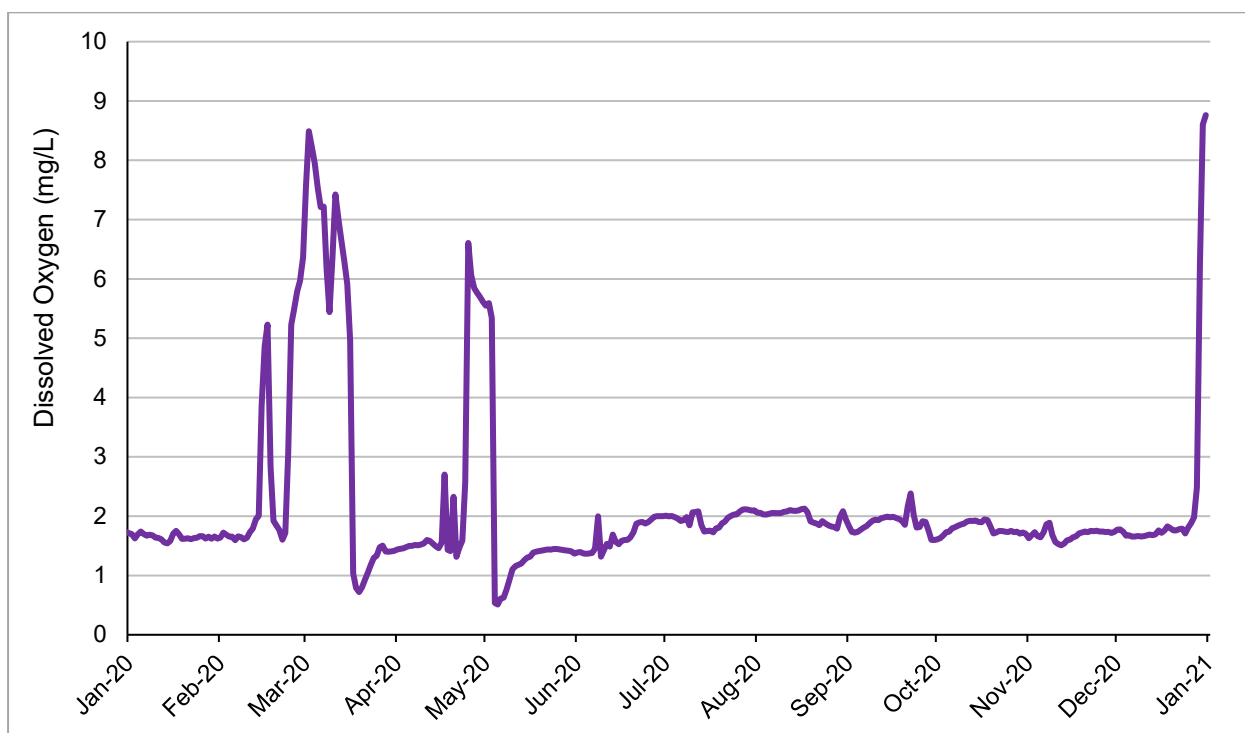


Figure 30. Daily average dissolved oxygen concentration collected at the Madison Blue Spring Pool from the continuous recorder from January to December 2020.

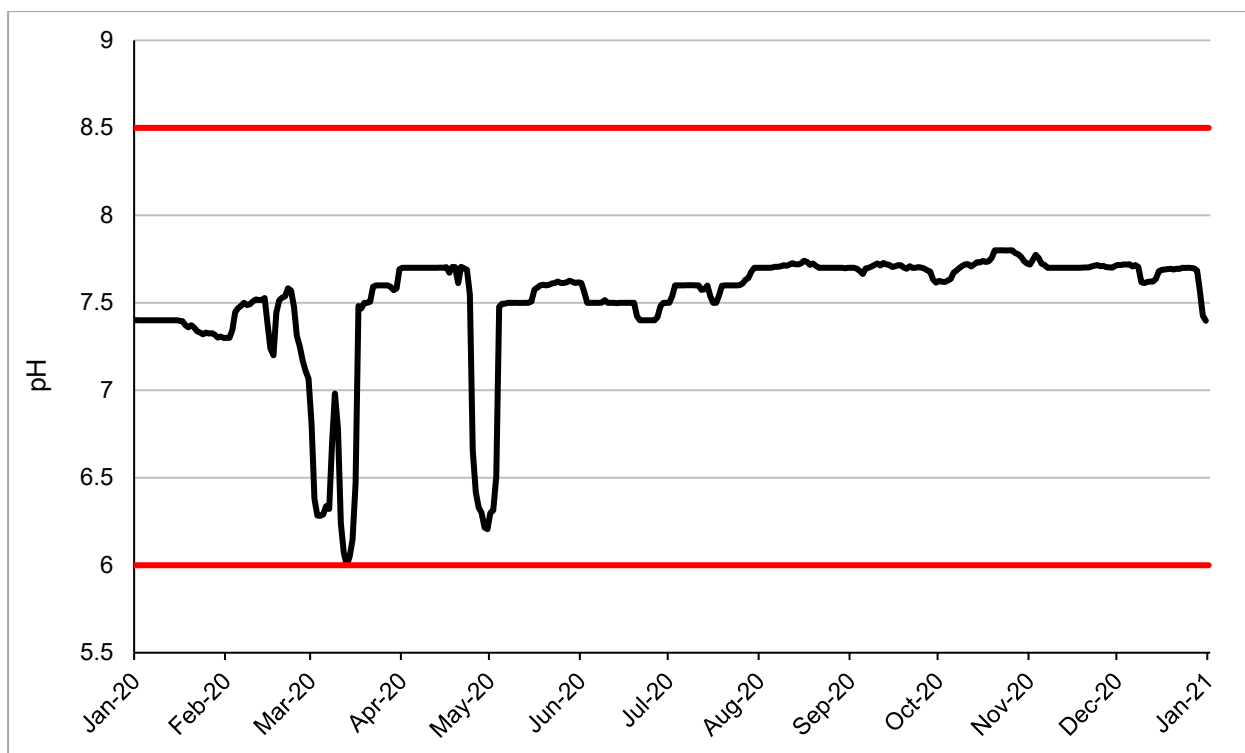


Figure 31. Daily average pH collected at the Madison Blue Spring Pool from the continuous recorder from January to December 2020.

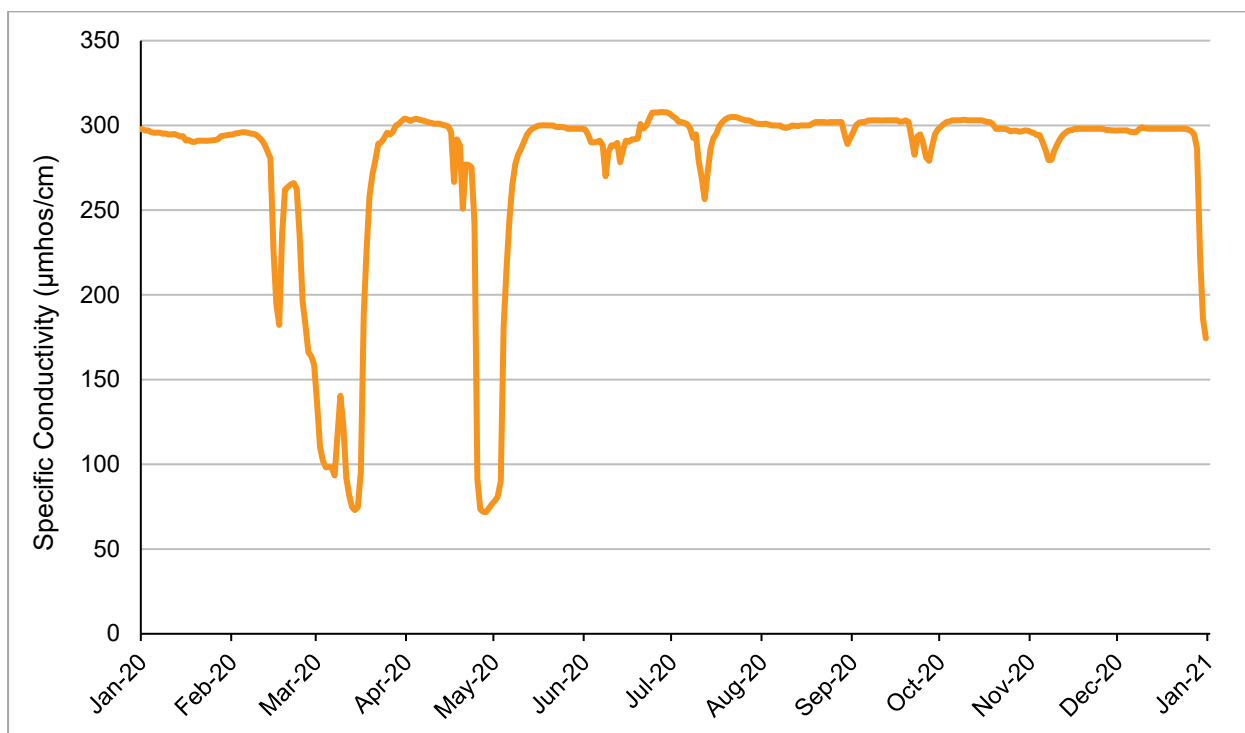


Figure 32. Daily average specific conductivity collected at the Madison Blue Spring Pool from the continuous recorder from January to December 2020.

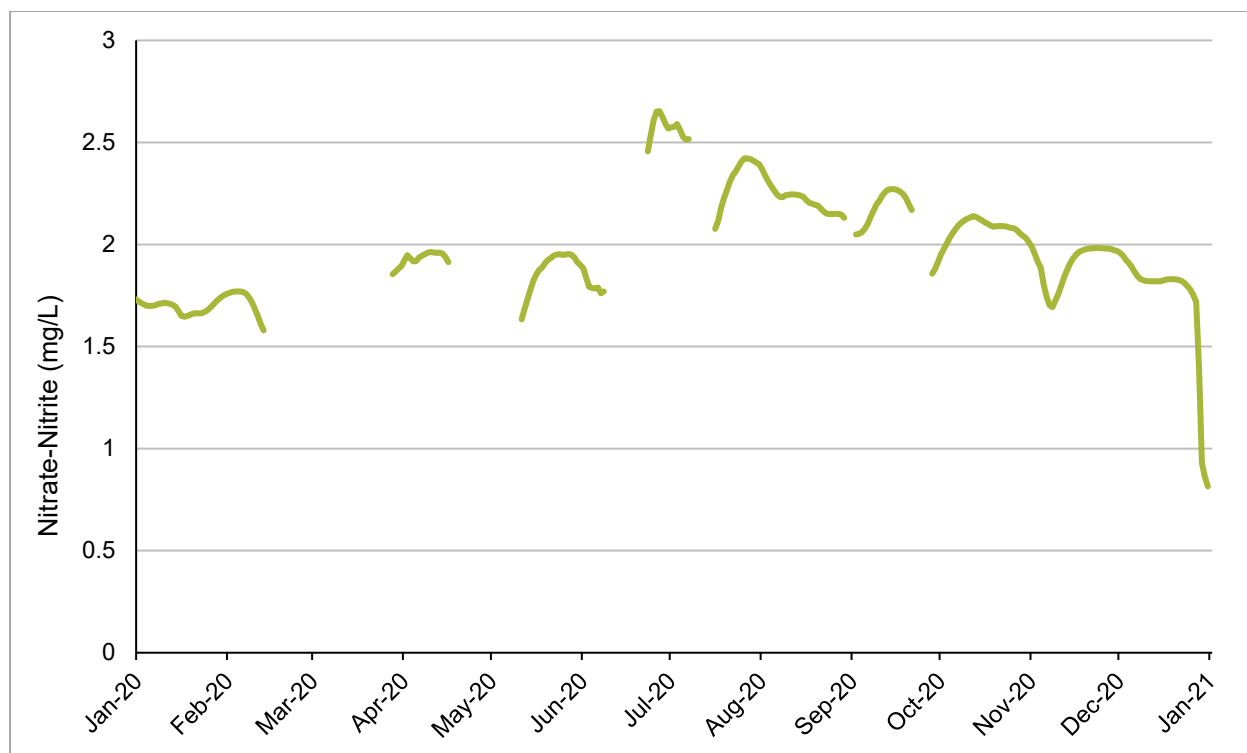


Figure 33. Daily average nitrate-nitrite collected at the Madison Blue Spring Pool from the continuous recorder from January to December 2020.

3.3 Biological Monitoring

3.3.1 Benthic Macroinvertebrate Monitoring

The substrate type and depth for each of the 20 individual benthic macroinvertebrate samples collected from the Spring Pool on 30 November 2020 are listed in Table 5. The majority of the samples were collected from rock or sand substrate with minor contributions of snags, root, leaves and algae; macroinvertebrates were collected at depths ranging from 2 to 25 feet. In November 2020, there was algae of varying lengths on rocks in the spring pool and good flow from the spring vent. Water levels were similar to previous November events.

Table 5. Madison Blue Spring Pool benthic macroinvertebrate samples from November 2020 monitoring event.

Sample No.	Substrate Type	Depth (feet)
1	snag/algae	5.5
2	algae/rock	5
3	sand/algae	13.5
4	rock/algae	20
5	sand	6
6	rock	25
7	algae/sand	14
8	sand/algae	10
9	algae/leaves/sand	9
10	leaves/sand	5
11	sand/algae	5.5
12	rock	3
13	rock/algae	4
14	rock	3.5
15	algae/rock	3
16	rock/sand/algae	6
17	sand/algae	3
18	rock	2
19	rock/algae	5.5
20	rock/algae	4.5

SCI scores were calculated for macroinvertebrate samples from the Spring Pool, Withlacoochee Upstream, and Withlacoochee Downstream stations. Table 6 presents the results of the SCI for each station during the November 2020 monitoring event.

SCI scores from samples collected during November 2020 at the Spring Pool were categorized as “Impaired,” according to the FDEP SCI protocol. The Withlacoochee River Upstream and Downstream SCI scores were categorized as “Healthy”. It is important to note that Florida’s SCI protocol is intended for streams and not springs, therefore an “Impaired” SCI score for the Spring Pool as recorded in 2020 and previous years refers to a low quality macroinvertebrate community assemblage when compared to what would be expected in a stream and is not a violation of any water quality standard.

The total number of invertebrate taxa (richness) collected during each monitoring event at each station is presented in Figure 34. Since the beginning of the biological monitoring program, the Spring Pool has generally exhibited the lowest taxa richness for each sampling event. Taxa richness was typically greatest at the Withlacoochee River Upstream station. Figure 34 indicates a drop in total taxa between November 2003 and May 2005 at most stations, prior to the beginning of permitted withdrawals by Nestlé Waters.

Figure 35 presents the overall SCI scores calculated at each station since the monitoring began in 2003. Prior to November 2006, the target number of invertebrates collected (100-120) and number of vials (single vial per sample) was different than the current protocol (140-160 invertebrates and two vials). After November 2006, the FDEP SCI-2012 protocol is used, and the raw scores used to calculate the metrics are an average of two replicate samples. Only those SCI scores collected under the FDEP SCI-2012 protocol are used in the analysis, because samples collected prior to November 2006 are not comparable.

SCI scores at the Spring Pool have remained relatively constant since monitoring began, with almost all scores within the “Impaired” category (below 34) during every event, including events that occurred before the permitted withdrawal of water by Nestlé Waters began. The first and only “Healthy” score obtained for the Spring Pool occurred in May 2019 (considered the 2018 monitoring event). It is important to note the SCI scores from the Spring Pool should only be compared to each other over time. The Spring Pool SCI scores should not be compared to scores from the river stations because the habitat characteristics and water quality (especially DO) of the Spring Pool differ greatly from the river, and the SCI methodology was modified to accommodate spring conditions. Differing SCI scores between the spring and river do not indicate a problem with spring biological integrity, but rather reflect the natural differences in habitat availability and structure between the two environments.

Table 6. SCI-2012 scores for the Madison Blue Spring Pool, Withlacoochee River Upstream and Downstream from the November 2020 monitoring event.

SCI Metric	Spring Pool		Withlacoochee River Upstream		Withlacoochee River Downstream	
	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score
Total Taxa	11.5	0	43.5	10	27.5	4.57
Ephemeroptera Taxa	0	0	1.5	3.0	2.5	5.0
Trichoptera Taxa	0.5	0.7	2.5	3.57	5.0	7.14
% Filter Feeder	0.96	0	7.48	1.22	4.56	0.67
Long-lived Taxa	0	0	2.0	6.67	0	0
Clinger Taxa	0	0	4.5	5.63	4.5	5.63
% Dominance	58.45	1.49	14.33	9.65	26.38	7.43
% Tanytarsini	0.64	0.80	16.27	8.93	4.21	5.28
Sensitive Taxa	1.5	1.5	3.0	3.0	3.0	3.0
% Very Tolerant	7.69	7.83	8.46	5.48	9.14	5.24
SCI Overall Score	14		64		49	
Evaluation	Impaired		Healthy		Healthy	
Total Individuals	150		154		154	

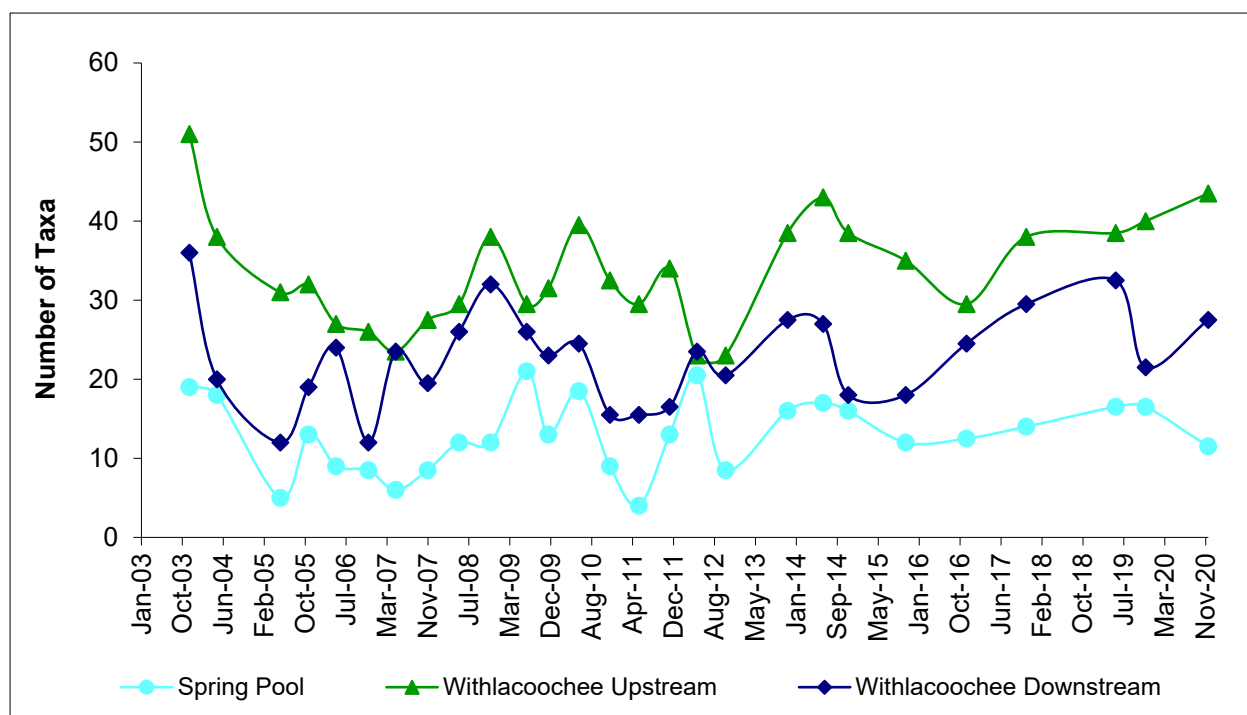


Figure 34. Number of benthic macroinvertebrate taxa found during SCI-2012 sampling in the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

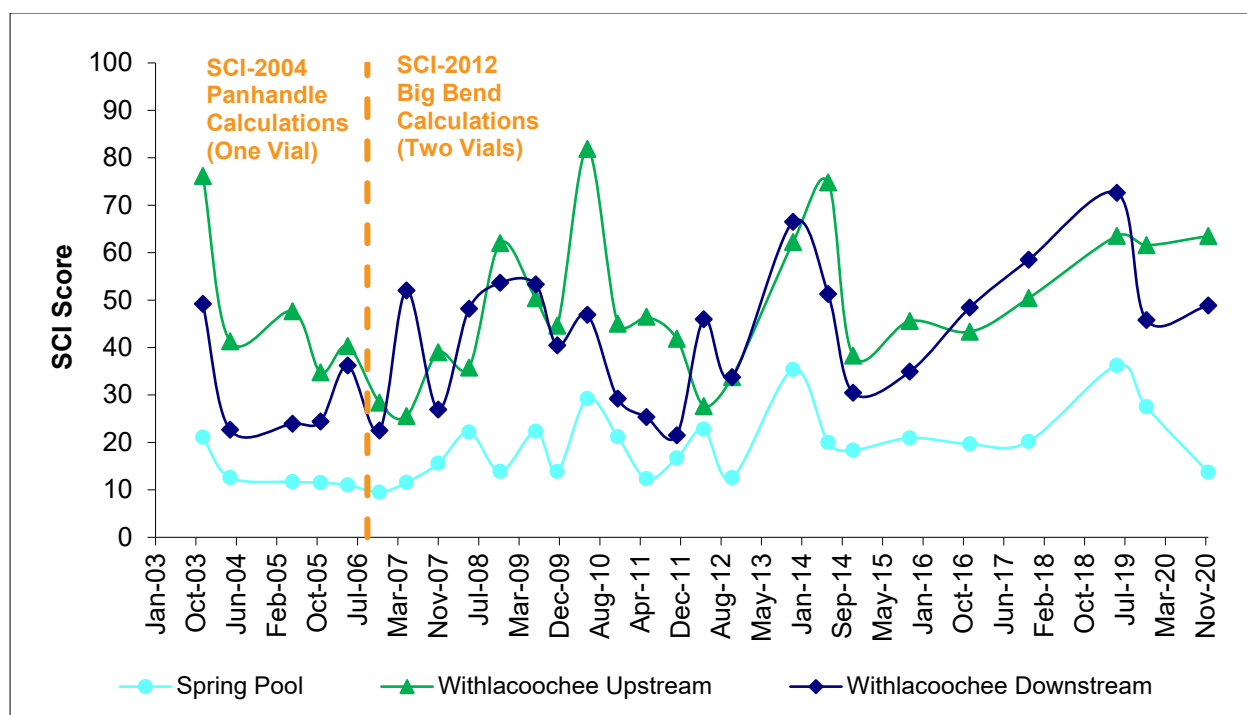


Figure 35. Overall SCI-2012 scores calculated for the Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream stations from 2003 to 2020.

When the November SCI scores at each station from 2006 to 2020 were analyzed, there were no statistically significant increasing or decreasing trend observed in SCI scores in the Spring Pool (Kendall Tau, $p > 0.05$). However, there was a statistically significant increasing trend in SCI scores at the Withlacoochee River Upstream and Downstream monitoring stations (Tau = 0.41, $p < 0.05$, Figures A-4 and A-5).

In addition to overall SCI scores, the individual metrics that make up the SCI were analyzed for trends at each station for November events. For the total taxa metric, the raw values (actual taxa count) were utilized for analysis. There was an increasing trend in total taxa collected at the Spring Pool (Tau = 0.41, $p < 0.05$, Figure A-6) and the Withlacoochee River Upstream (Tau = 0.52, $p < 0.05$, Figure A-7). At the Withlacoochee River Downstream station, there was an increasing trend in the metric scores for Trichoptera taxa (Kendall Tau = 0.66, $p < 0.05$, Figure A-8) and clinger taxa (Kendall Tau = 0.51, $p < 0.05$, Figure A-9) over time, indicating that more of the above listed taxa were present during more recent monitoring events. At the Withlacoochee River Upstream station, there was a significant increasing trend in the metric score for Trichoptera taxa (Kendall Tau = 0.44, $p < 0.05$, Figure A-10), indicating there were more Trichoptera taxa present during more recent monitoring events.

No other increasing or decreasing trends in individual SCI metrics were observed in the Spring Pool (Kendall Tau, $p > 0.05$). The stability of SCI scores and increasing trend in the 2020 analysis and lack of decreasing trends in individual metrics in the Spring Pool indicates that the withdrawals by Nestlé Waters are not impacting the macroinvertebrate community in the spring over the period of record. In considering all stations, the fact that there are either no changes in individual metrics or actual increases in scores shows that the spring output quantities (including during withdrawals by Nestlé Waters) or water quality do not appear to be impacting downstream waters.

To further determine if there were any potential impacts of Madison Blue Spring discharge on the biology in the Spring Pool and Withlacoochee River Downstream, SCI scores and individual metrics were compared to both spring and river discharge 30, 60, and 90 days prior to sampling for both the fall and spring monitoring periods. In the dataset of November monitoring events, when the discharge data from Madison Blue Spring and the Withlacoochee River were compared, there was a positive correlation between both discharges at 30, 60, and 90-day intervals (Spearman's Rank Correlation, $0.82 < r_s < 0.92$, $p < 0.05$).

When comparing the overall SCI score and individual metric scores in the Spring Pool during November events with average daily Madison Blue Spring and Withlacoochee River discharge, there were positive correlations in Trichoptera taxa and sensitive taxa (Spearman's Rank Correlation, $p < 0.05$, Table 7, Figures 13 and 15).

At the Withlacoochee River Downstream station, there were only statistically significant positive correlations between SCI scores and individual metrics and spring and river discharge during November events. When the Withlacoochee River Downstream SCI scores and individual metrics were compared to Madison Blue Spring discharge prior to sampling, there were positive correlations with SCI score, total taxa, Ephemeroptera taxa, Trichoptera taxa, clinger taxa, sensitive taxa, and percent dominance and various measures of discharge; (Spearman's Rank Correlation, $p < 0.05$, Table 7, Figures A-11 to A-17). Withlacoochee River Downstream SCI scores and individual metrics including total taxa, Ephemeroptera taxa, Trichoptera taxa, clinger taxa, percent dominance, and sensitive taxa had positive correlations with Withlacoochee River discharge over various lags (Figures A-11 to A-17). At the Withlacoochee River Upstream station, there were positive correlations between long-lived taxa and Madison Blue Spring discharge, while Ephemeroptera taxa, clinger taxa, percent dominance, sensitive taxa, and SCI scores were positively correlated with both Madison Blue Spring and Withlacoochee River discharge (Spearman's Rank Correlation, $p < 0.05$, Table 7).

The correlations between the Withlacoochee River Upstream SCI scores or individual metrics and Madison Blue Spring discharge is not of concern because the spring discharge is not directly affecting this station; the correlations are most likely driven by the flow quantities not the source.

Table 7. Results of Spearman's Rank Correlation between SCI metrics at Madison Blue Spring Pool, Withlacoochee River Upstream, and Withlacoochee River Downstream and lagged Madison Blue Spring or Withlacoochee River Discharge during fall monitoring events.

SCI Metrics	Madison Blue Spring Pool					
	MBS Discharge			WR Discharge		
	30-days	60-days	90-days	30-days	60-days	90-days
Total Taxa	0.23	0.10	0.12	-0.05	0.01	0.15
Ephemeroptera Taxa	0.45	0.45	0.45	0.10	0.24	0.45
Trichoptera Taxa	0.61	0.61	0.61	0.39	0.49	0.56
Filter Feeder	-0.05	-0.24	-0.21	-0.35	-0.41	-0.31
Long Lived Taxa	0.20	0.15	0.15	0.00	0.05	0.15
Clinger Taxa	0.20	0.15	0.15	0.00	0.05	0.15
Dominance Score	0.40	0.40	0.37	0.28	0.21	0.33
Tanytarsini Taxa	-0.13	-0.31	-0.33	-0.45	-0.42	-0.29
Sensitive Taxa	0.61	0.61	0.61	0.41	0.51	0.56
Tolerant Taxa	0.07	0.20	0.13	0.21	0.34	0.29
SCI Score	0.06	-0.02	-0.05	-0.13	-0.12	0.02
SCI Metrics	Withlacoochee River Downstream					
	MBS Discharge			WR Discharge		
	30-days	60-days	90-days	30-days	60-days	90-days
Total Taxa	0.65	0.68	0.62	0.58	0.70	0.82
Ephemeroptera Taxa	0.82	0.81	0.76	0.68	0.71	0.74
Trichoptera Taxa	0.61	0.64	0.57	0.52	0.66	0.74
Filter Feeder	0.22	0.16	0.19	0.02	0.01	0.18
Long Lived Taxa	0.11	0.29	0.25	0.02	0.10	0.34
Clinger Taxa	0.54	0.55	0.52	0.36	0.57	0.73
Dominance Score	0.52	0.61	0.52	0.40	0.52	0.71
Tanytarsini Taxa	0.02	-0.01	-0.02	-0.07	-0.16	-0.05
Sensitive Taxa	0.66	0.75	0.71	0.67	0.81	0.88
Tolerant Taxa	-0.09	-0.12	-0.20	-0.08	0.002	-0.046
SCI Score	0.73	0.76	0.71	0.62	0.75	0.88
SCI Metrics	Withlacoochee River Upstream					
	MBS Discharge			WR Discharge		
	30-days	60-days	90-days	30-days	60-days	90-days
Total Taxa	0.46	0.29	0.35	0.34	0.37	0.35
Ephemeroptera Taxa	0.57	0.58	0.51	0.46	0.52	0.57
Trichoptera Taxa	0.27	0.23	0.12	0.03	0.13	0.22
Filter Feeder	-0.25	-0.37	-0.41	-0.34	-0.31	-0.19
Long Lived Taxa	0.61	0.48	0.49	0.53	0.52	0.49
Clinger Taxa	0.55	0.59	0.52	0.57	0.60	0.65
Dominance Score	0.47	0.49	0.57	0.50	0.48	0.53
Tanytarsini Taxa	-0.18	-0.25	-0.31	-0.36	-0.32	-0.20
Sensitive Taxa	0.92	0.88	0.86	0.84	0.81	0.82
Tolerant Taxa	-0.01	-0.06	-0.09	-0.04	0.04	-0.04
SCI Score	0.64	0.55	0.49	0.54	0.55	0.59

Note: All correlations in **bold** are statistically significant at $p < 0.05$.

4 Summary and Interpretation

Cardno was retained by Nestlé Waters to conduct the biological monitoring component of the EMP developed as a special limiting condition (Condition No. 21) of the revised Nestlé Waters Water Use Permit No. 2-079-218544-8 issued by the SRWMD in 2014. The biological monitoring component of the EMP addresses two distinct aquatic habitats: the Withlacoochee River, both upstream and downstream of the spring run, and Madison Blue Spring proper. The monitoring is intended to detect potential ecological responses to changes in spring discharge. This annual report presents results of biological monitoring that occurred on 30 November 2020.

As part of the EMP, water quality data is also collected during each biological monitoring event and evaluated against results from previous years to identify any trends. There were no exceedances of Class III water quality standards during the November 2020 monitoring event except for dissolved oxygen within the Spring Pool. The Withlacoochee River Upstream station exhibited a statistically significant increasing trend in sulfate during fall events. The Spring Pool station showed a statistically significant increasing trend in specific conductivity and a statistically significant decreasing trend in chloride during fall monitoring events. The increasing trend observed at the Spring Pool station is very slight (slope of 0.80 $\mu\text{mhos/cm/year}$) and the direction of the trend in chloride is favorable; neither trend raises concern with respect to the Nestlé Waters permitted withdrawal near Madison Blue Spring.

Macroinvertebrate communities are evaluated in the Spring Pool, as well as the Withlacoochee River upstream and downstream of Madison Blue Spring using FDEP's SCI protocol. Biological monitoring that occurred before the permitted withdrawal of groundwater began (18 November 2003, 4 May 2004, and 26 May 2005) represent baseline conditions. Results from the November 2020 monitoring were evaluated against previous monitoring events to detect ecological responses to changes in spring discharge. The taxa richness decreased at almost all stations between November 2003 and May 2005, prior to the permitted withdrawal of groundwater near Madison Blue Spring. This is likely the result of high water levels and flows that occurred in 2004 resulting from rainfall associated with Hurricanes Charley, Frances, Ivan, and Jeanne (which prevented the occurrence of a fall 2004 monitoring event). Since 2005, the taxa richness has fluctuated, showing periodic increases and decreases at each station, and exhibiting an increasing trend in both the Spring Pool and Withlacoochee River Upstream from November 2006 through 2020.

Similar to the number of total taxa, overall SCI scores decreased at all stations between November 2003 and May 2005, prior to permitted withdrawals by Nestlé Waters (using the SCI-2004 calculations). In fact, the Withlacoochee River Upstream station SCI score decreased relatively consistently between November 2003 and May 2007. While overall SCI scores have remained relatively stable at the Spring Pool station, scores at the Withlacoochee River stations have increased since the 2007 monitoring, and decreased slightly in 2009, which may be attributed to flood conditions during early 2009. Additionally, there were slight increasing trends during fall monitoring events in individual metrics of the SCI at the Withlacoochee River Upstream or Downstream stations.

There was no correlation between SCI scores in the Spring Pool and average daily discharge in Madison Blue Spring 30-days, 60-days, or 90-days prior to the November monitoring events indicating there have been no changes in scores in either direction with relatively stable spring discharges. However, there were positive correlations between Madison Blue Spring discharge and Trichoptera and sensitive taxa metrics in the Spring Pool. Additionally, there were positive correlations at both Withlacoochee River stations between SCI scores and individual metrics (total taxa, Ephemeroptera, Trichoptera, clinger, dominant, and sensitive taxa) with both Madison Blue Spring and Withlacoochee River discharge (higher flows are correlated with higher flows), although the discharge lags may not have been equal.

5 Findings

The results to date indicate Madison Blue Spring discharge is not affecting the ecology of Madison Blue Spring Pool or the Withlacoochee River downstream of the spring run. Because there are positive relationships with Madison Blue Spring discharge or increases in ecological metrics over time, there is no evidence that groundwater withdrawals (which make up <1% of the average spring output) are having adverse effects on the ecology in the Spring Pool or Withlacoochee River Downstream. Spring discharge also shows no statistically significant negative relationship with biological community health (SCI score or individual metrics) in the Madison Blue Spring.

6 Changes/Improvements to the Biological Monitoring

Modifications to the biological monitoring component of the EMP were proposed by Nestlé Waters and approved by the SRWMD in November 2014. The approved modifications are as follows: 1) reduction of the monitoring requirements to once per year (November); 2) elimination of the solution channel monitoring; and 3) elimination of the biological sampling in the Spring Run. Monitoring in November 2020 was the sixth year using the modified conditions.

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Madison Blue Spring

APPENDIX

A

INVESTIGATION OF STATISTICALLY
SIGNIFICANT WATER QUALITY AND
BIOLOGICAL TRENDS

Appendix A

Investigation of Statistically Significant Water Quality and Biological Trends

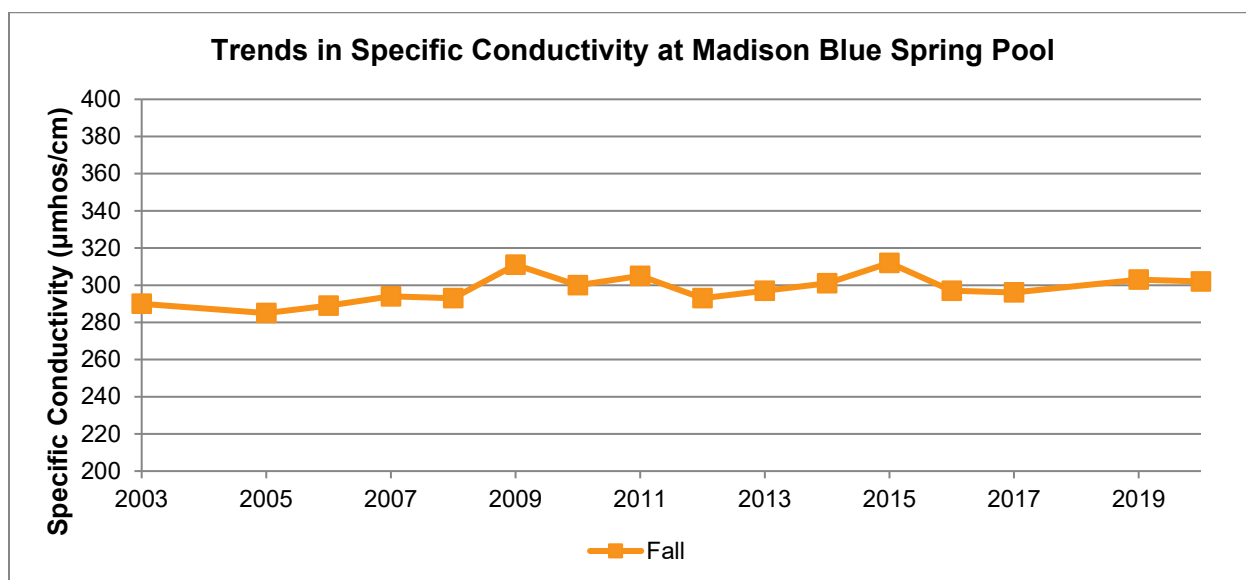


Figure A-1. Specific conductivity from 2003 to 2020 at the Spring Pool using fall values with a statistically significant increasing trend (Kendall Tau = 0.43, $p < 0.05$, slope = 0.80 µmhos/cm/yr).

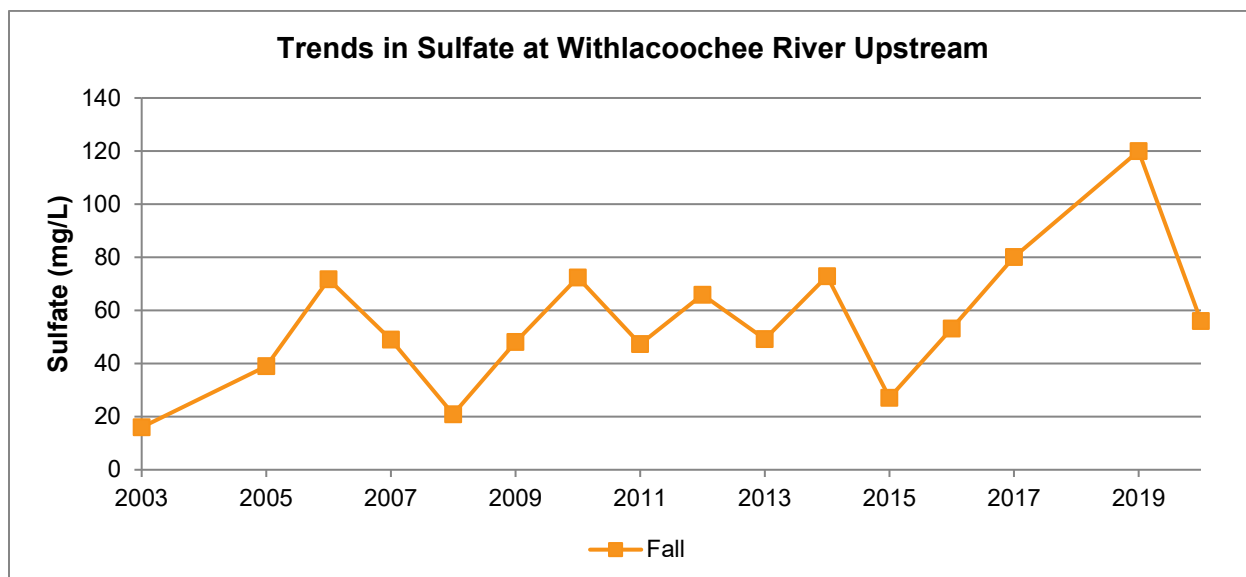


Figure A-2. Sulfate from 2003 to 2020 at Withlacoochee River Upstream using fall values with a statistically significant increasing trend (Kendall Tau = 0.43, $p < 0.05$, slope = 2.38 mg/L/yr).

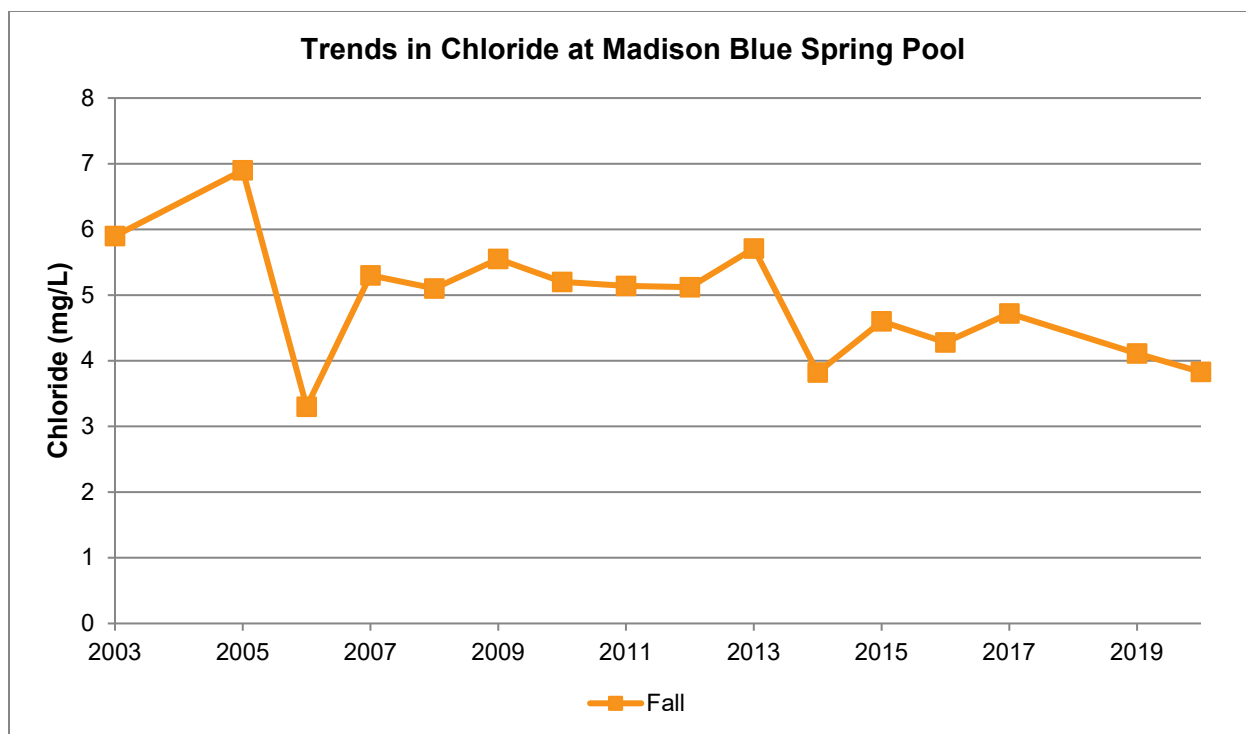


Figure A-3. Chloride from 2003 to 2020 at the Spring Pool using fall values with a statistically significant decreasing trend (Kendall Tau = -0.47, $p < 0.05$, slope = -0.11 mg/L/yr).

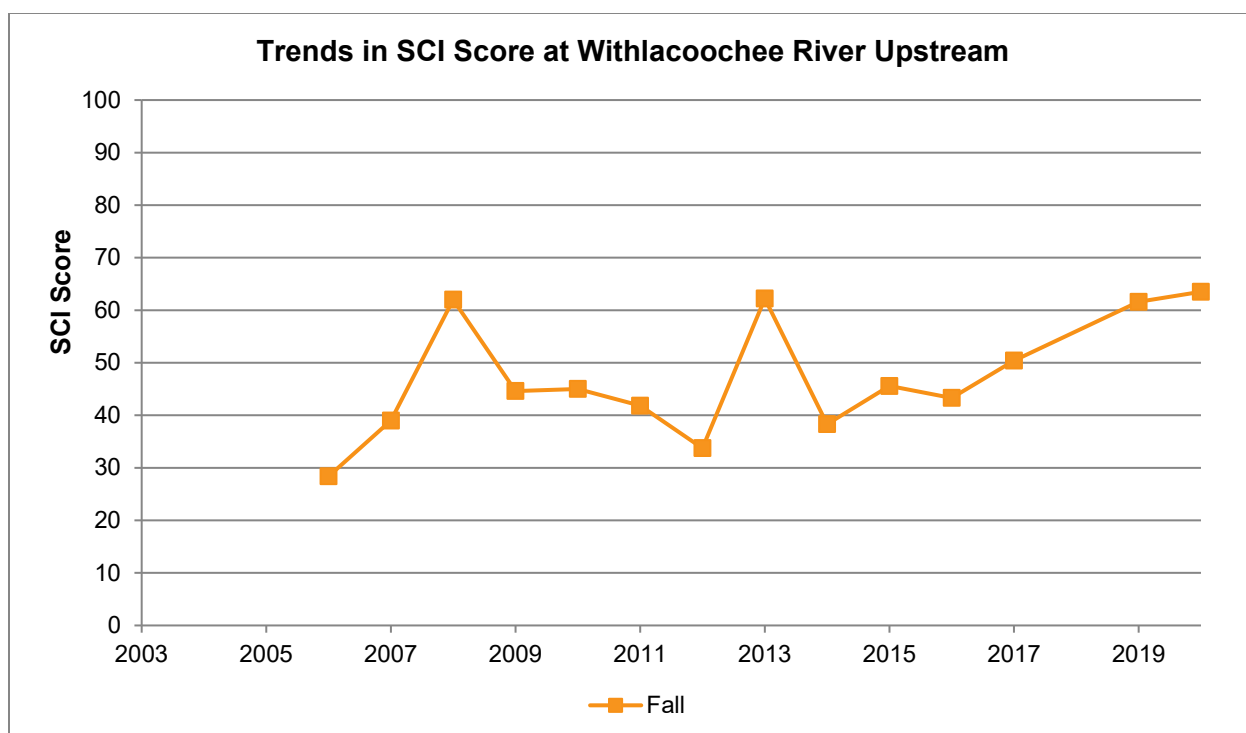


Figure A-4. SCI scores from 2006 to 2020 at Withlacoochee River Upstream using fall values with a statistically increasing trend.

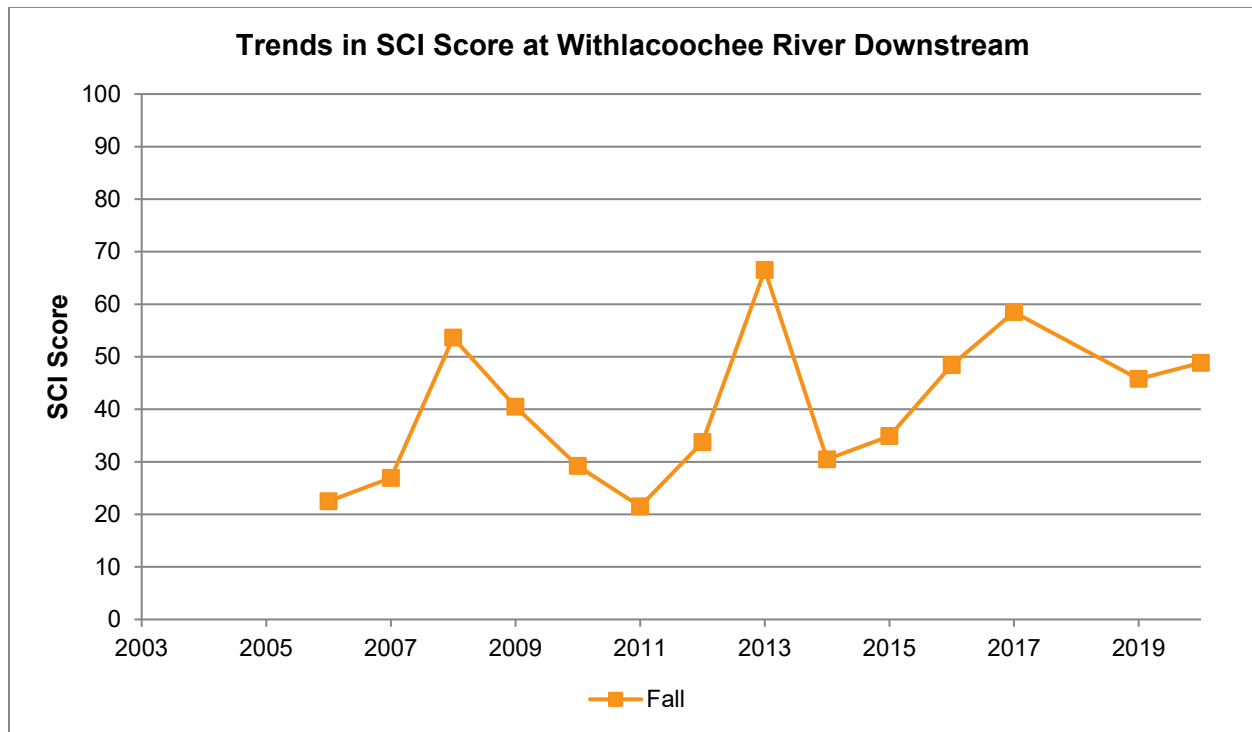


Figure A-5. SCI scores from 2006 to 2020 at Withlacoochee River Downstream using fall values with a statistically increasing trend.

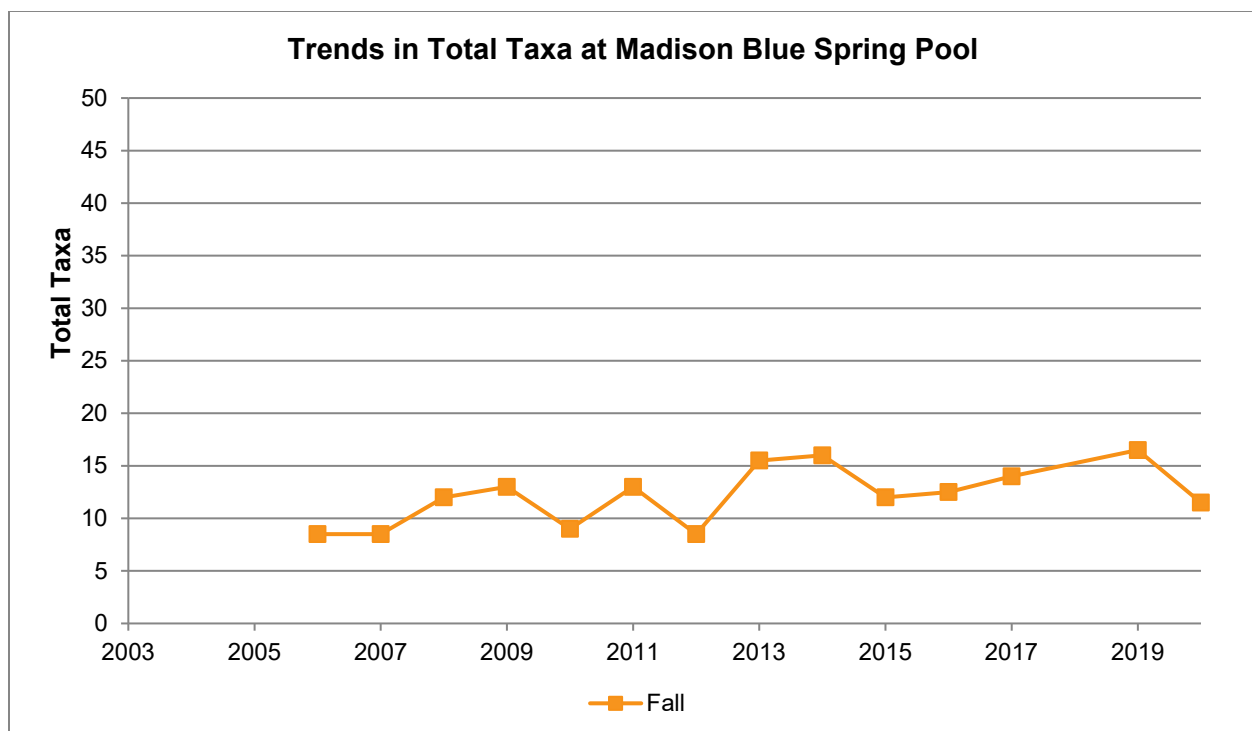


Figure A-6. Total taxa from 2006 to 2020 at the Spring Pool using fall values with a statistically increasing trend.

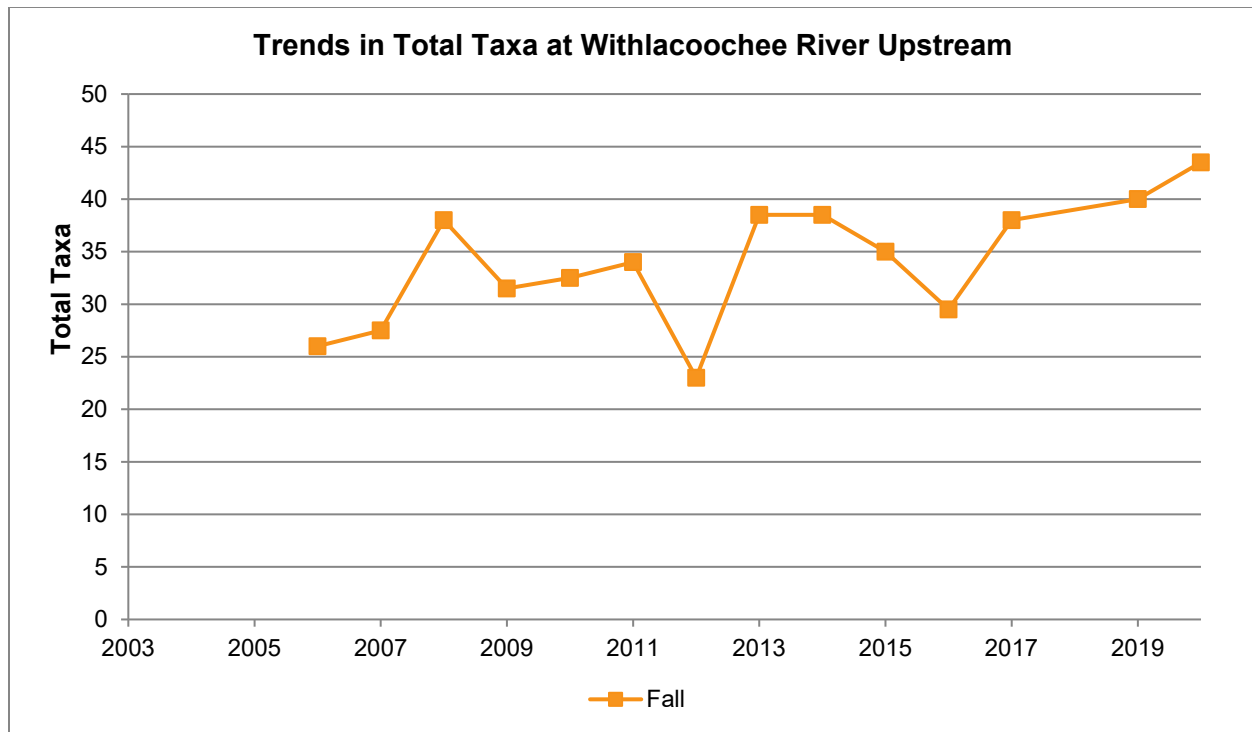


Figure A-7. Total taxa from 2006 to 2020 at Withlacoochee River Upstream using fall values with a statistically increasing trend.

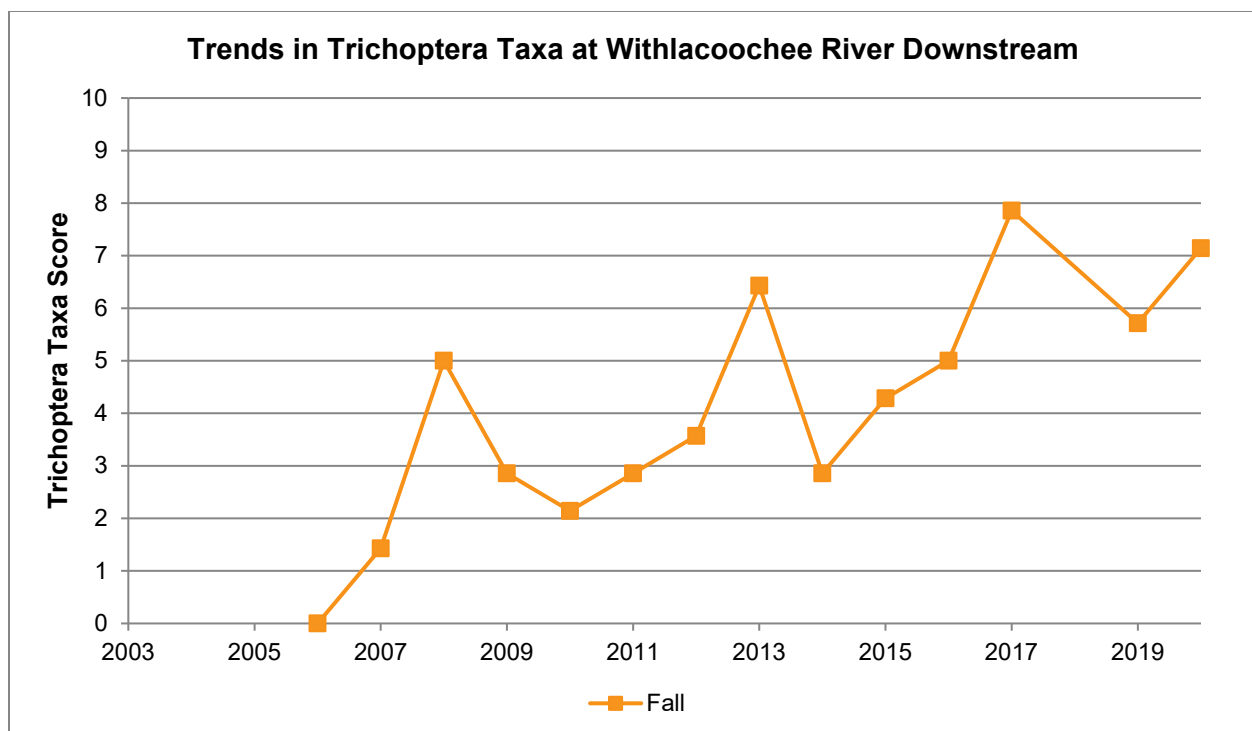


Figure A-8. Trichoptera taxa from 2006 to 2020 at the Withlacoochee River Downstream using fall values with a statistically significant increasing trend.

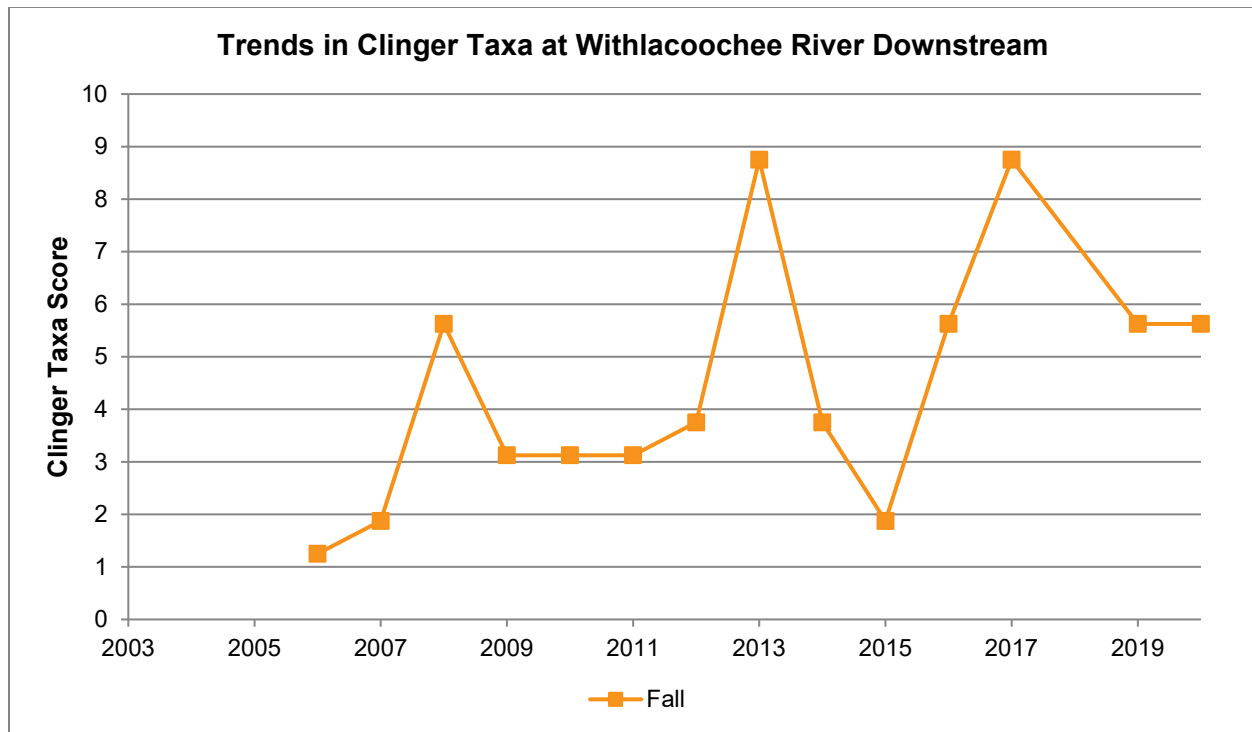


Figure A-9. Clinger taxa from 2006 to 2020 at the Withlacoochee River Downstream using fall values with a statistically significant increasing trend.

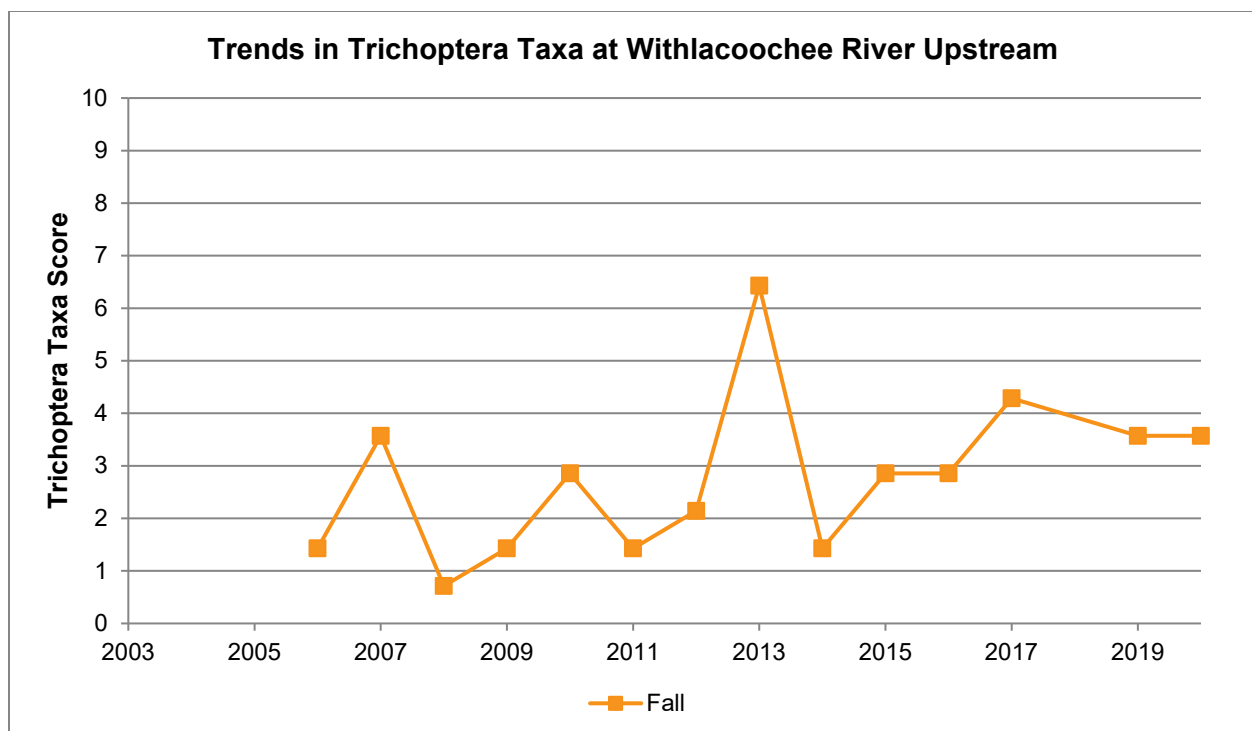


Figure A-10. Trichoptera taxa from 2006 to 2020 at Withlacoochee River Upstream using fall values with a statistically significant increasing trend.

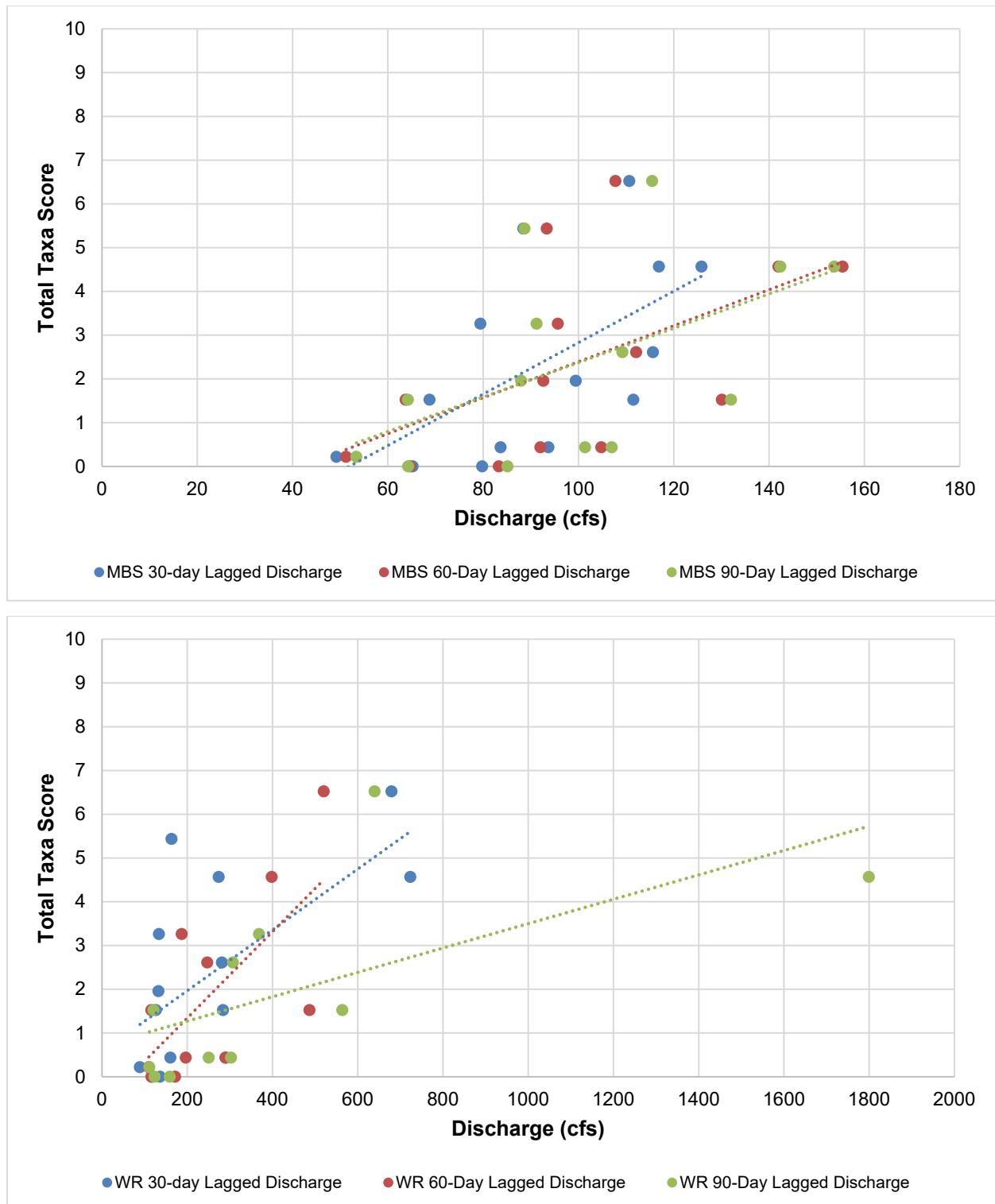


Figure A-11. Scatterplot of Withlacoochee River Downstream total taxa score and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

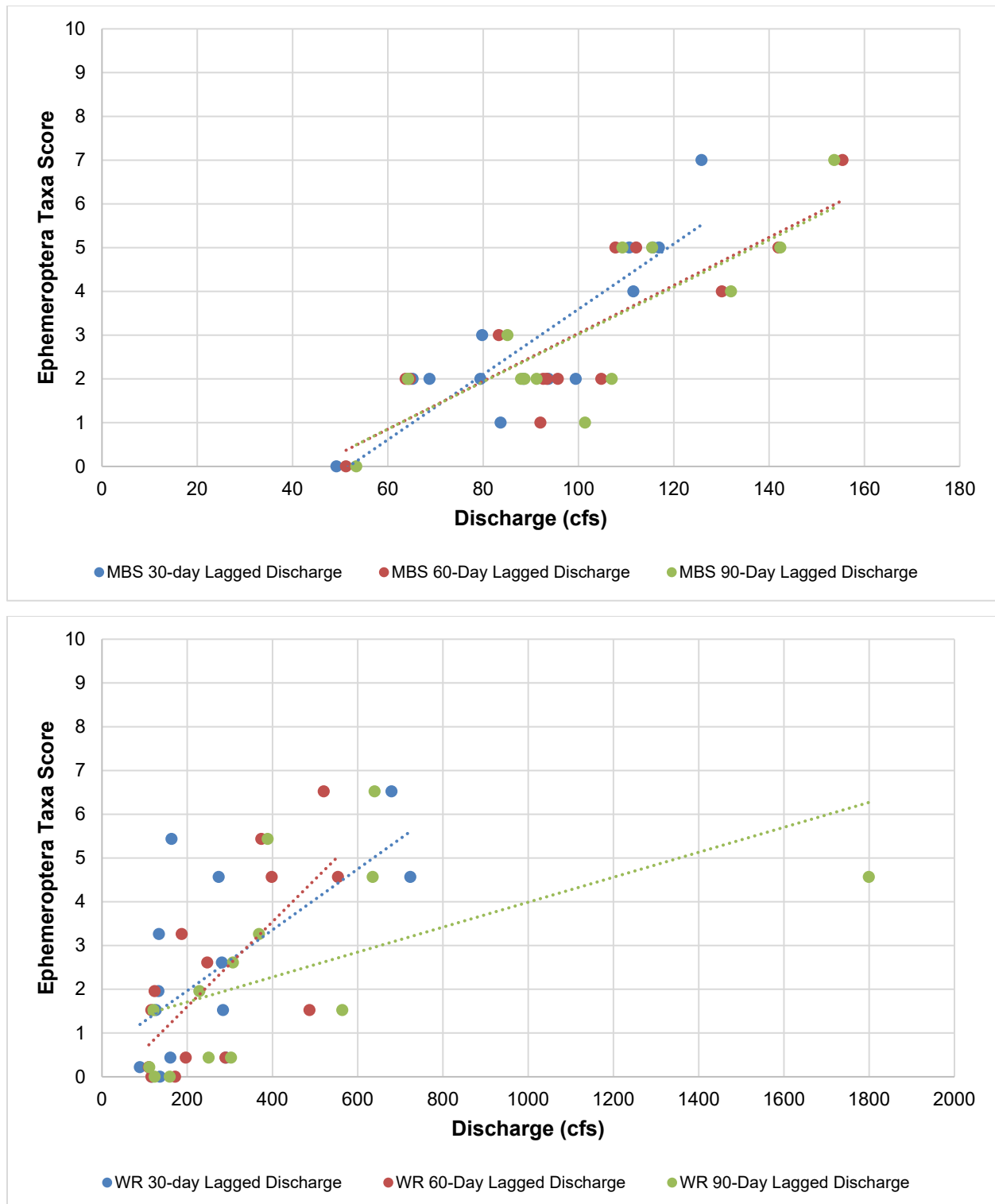


Figure A-12. Scatterplot of Withlacoochee River Downstream Ephemeroptera taxa scores and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

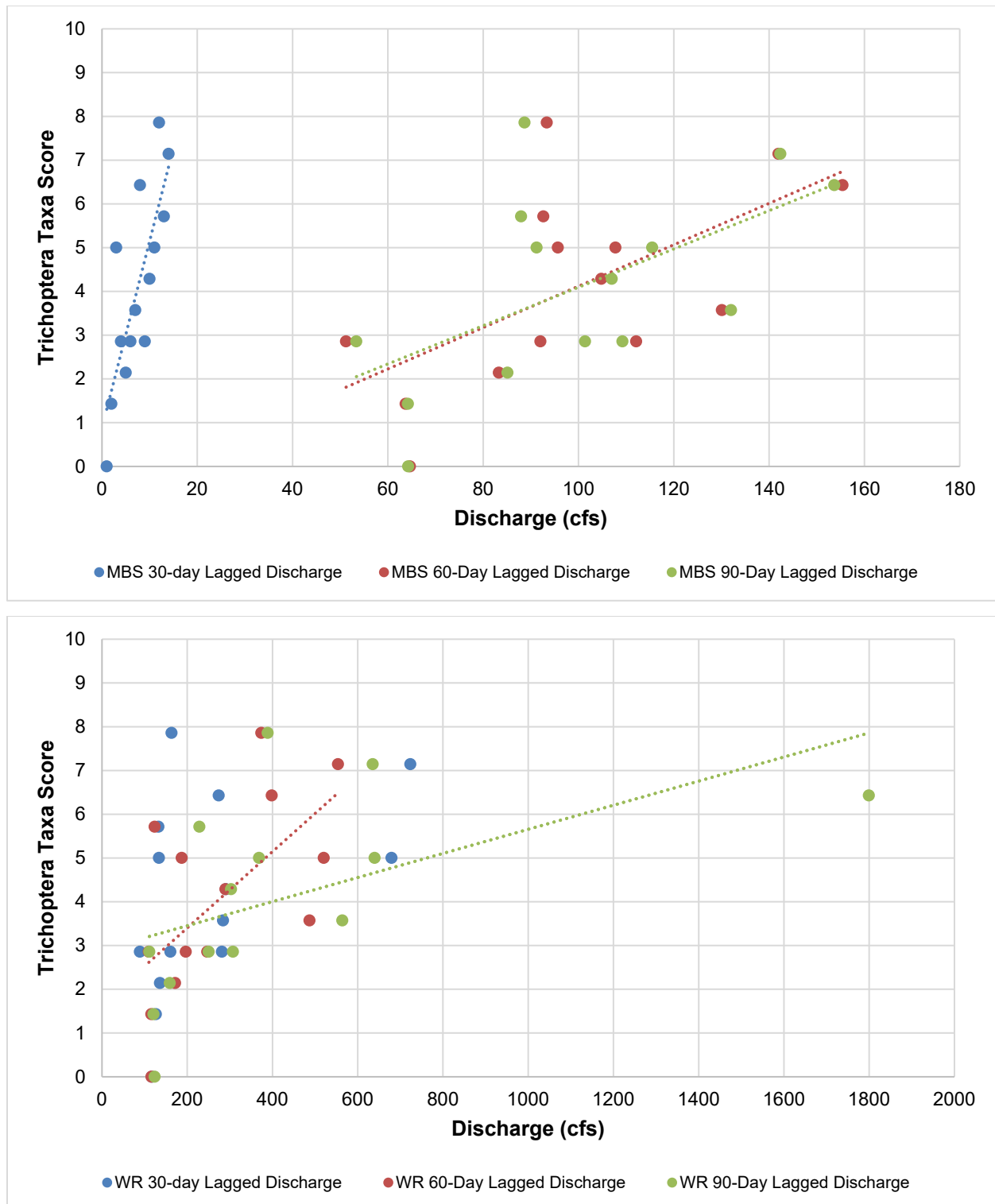


Figure A-13. Scatterplot of Withlacoochee River Downstream Trichoptera taxa scores and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

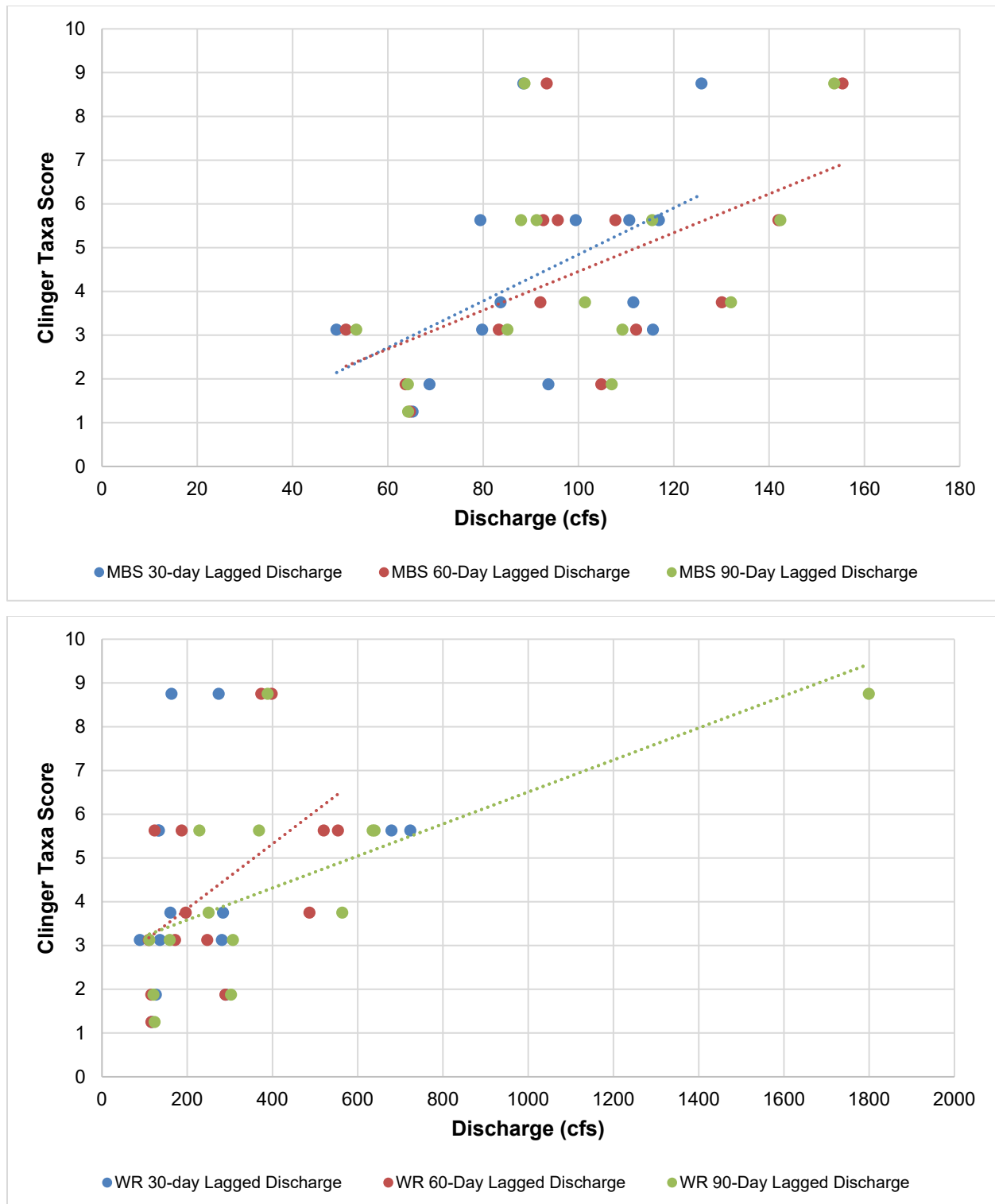


Figure A-14. Scatterplot of Withlacoochee River Downstream clinger taxa scores and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

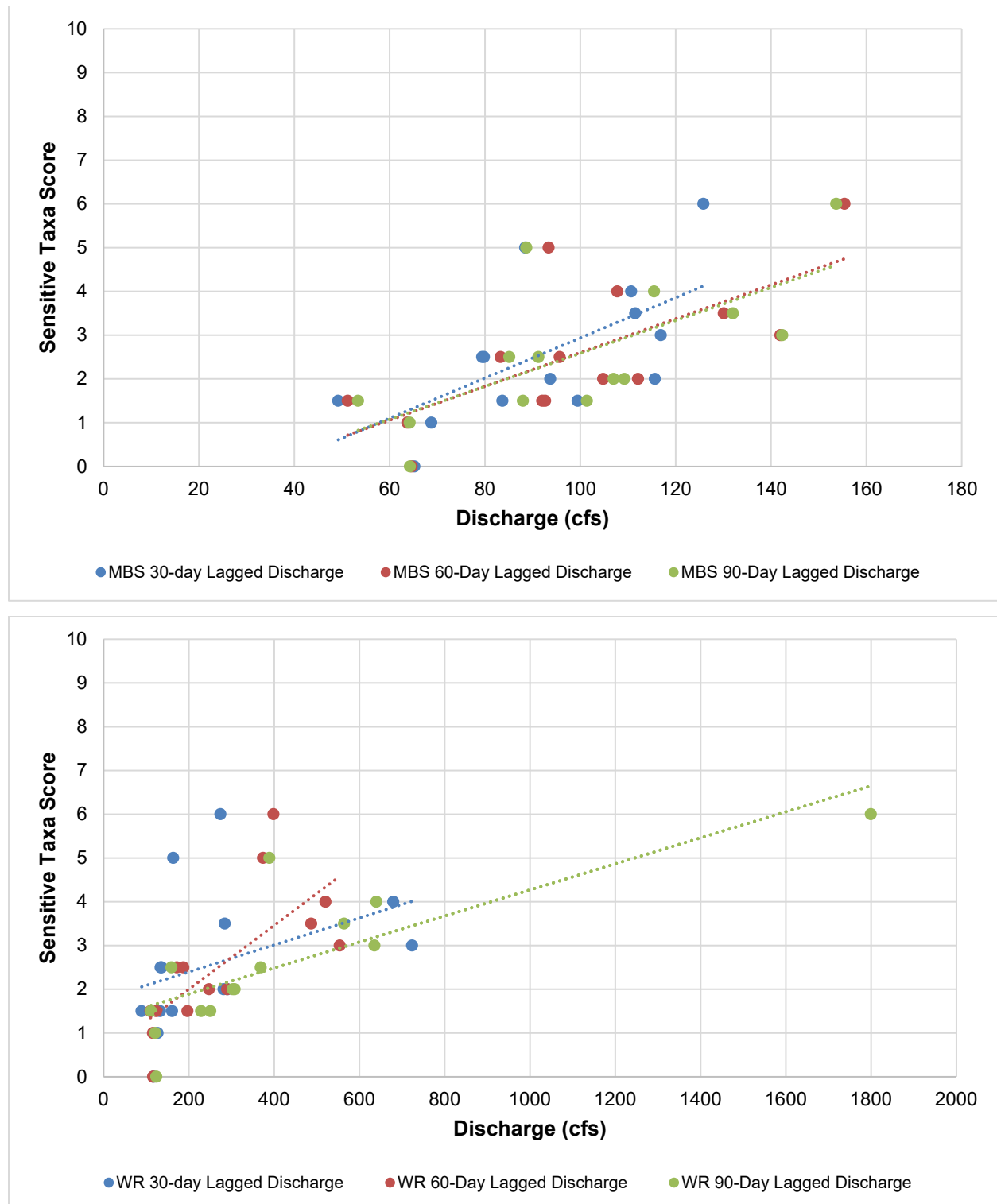


Figure A-15. Scatterplot of Withlacoochee River Downstream sensitive taxa scores and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

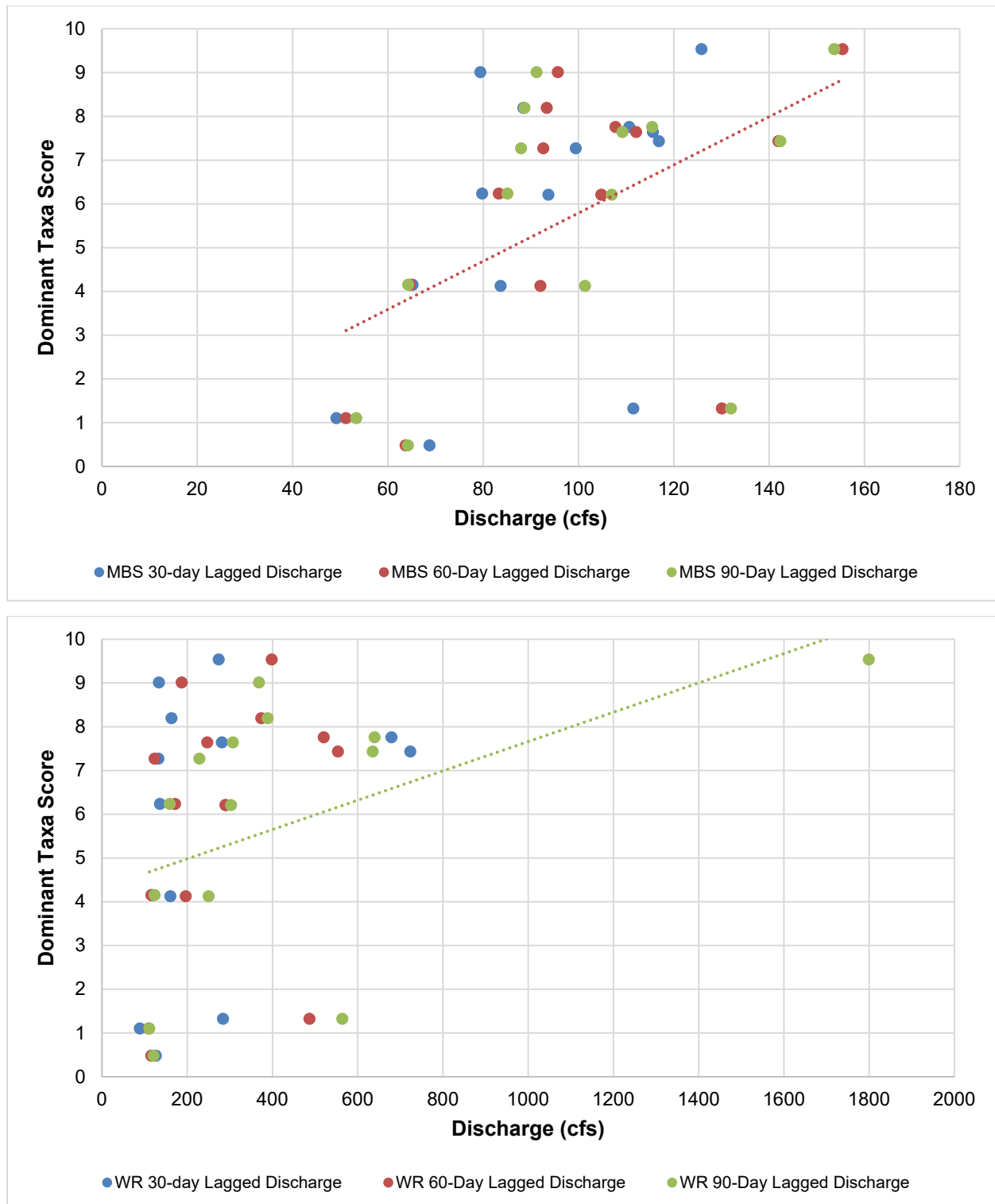


Figure A-16. Scatterplot of Withlacoochee River Downstream percent dominance scores and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

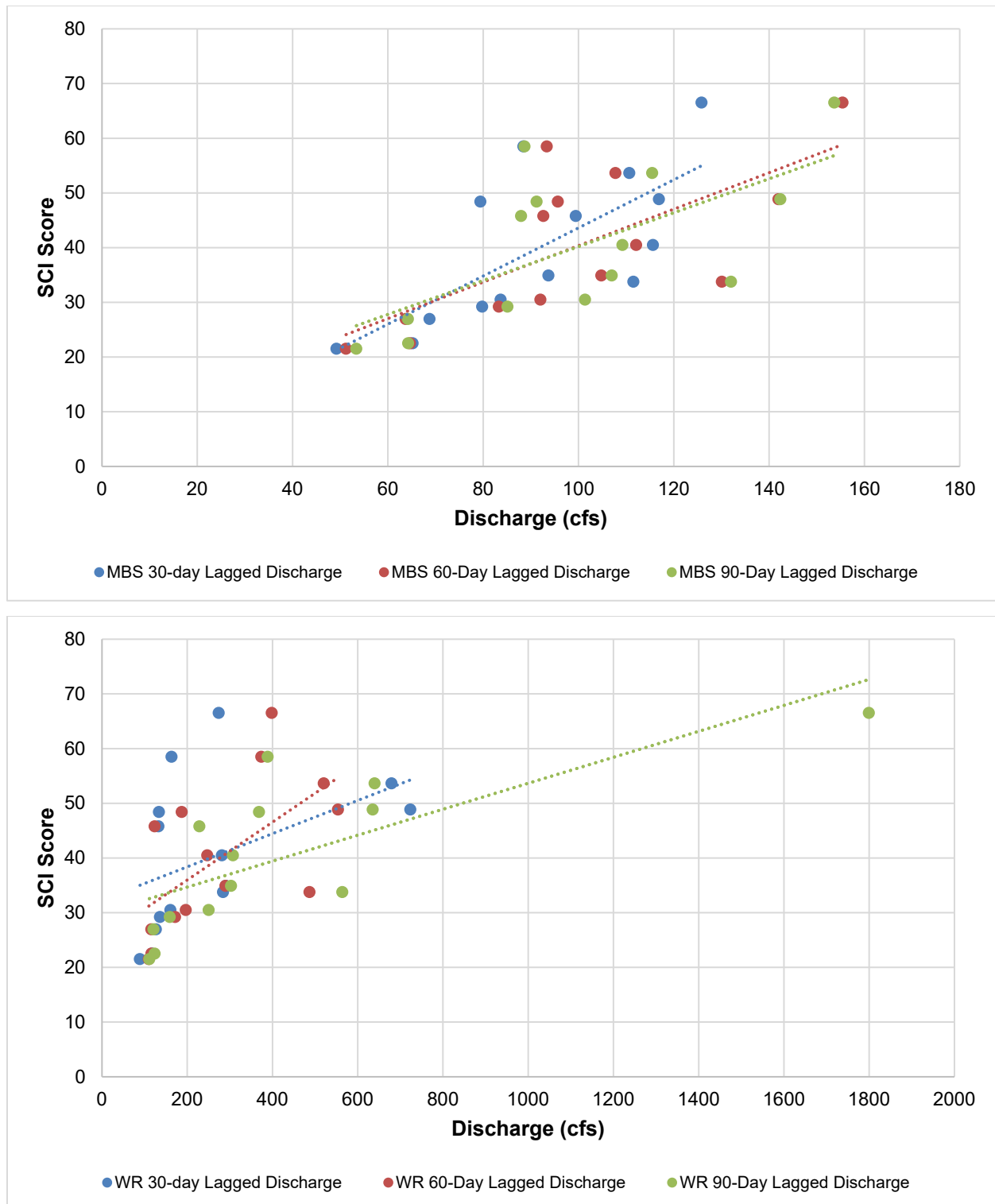


Figure A-17. Scatterplot of Withlacoochee River Downstream SCI scores and lagged Madison Blue Spring (top) and Withlacoochee River (bottom) discharge. Linear relationships are displayed as approximations for parameters with significant Spearman's Correlations.

About Cardno

Cardno is an ASX-200 professional infrastructure and environmental services company, with expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage, and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD].

Cardno Zero Harm

Cardno
ZERO
HARM
EVERY JOB. EVERY DAY.

At Cardno, our primary concern is to develop and maintain safe and healthy conditions for anyone involved at our project worksites. We require full compliance with our Health and Safety Policy Manual and established work procedures and expect the same protocol from our subcontractors. We are committed to achieving our Zero Harm goal by continually improving our safety systems, education, and vigilance at the workplace and in the field. Safety is a Cardno core value and through strong leadership and active employee participation, we seek to implement and reinforce these leading actions on every job, every day.