STATEMENT OF WORK
For Springs Protection Initiative:
Springs Protection Initiative Science (SPIS)-BIOLOGY WORKGROUP

I. INTRODUCTION/BACKGROUND

Alterations in spring flow/current velocity and spring water quality are frequently manifest in biological responses, including changes to plant and animal communities. These could be shifts from submerged macrophytes to filamentous macroalgae, invasion by exotic plants or animals, or changes in animal community structure. In most cases, there exists very little or no historical biological data to evaluate ecological changes in springs and their spring runs (= spring run stream). Major "drivers" (forcing functions which drive biological changes) include:

- Changes in water flow/current velocity
- Changes in water quality
- Impacts from recreational activity
- Effects of aquatic plant management
- Effects of exotic species invasions
- Physical effects (shoreline hardening, downstream dams, etc.)

One component of this work plan will be to implement biological monitoring in multiple spring run streams to generate a consistently collected data set from multiple spring run stream ecosystems that can be used to better understand ecological status and condition in these streams. A second component of the work will be to identify, design and implement studies to address pertinent management questions. These will complement the monitoring and generate enhanced understanding of spring run stream ecology. A third component of the work will be to re-analyze fish monitoring data collected in the lower St. Johns River and estuary to evaluate effects of changes in flow of Silver Springs on fish populations in the estuary. A fourth component of the work will be to implement a second round of intensive biological monitoring in Volusia Blue Spring to support the adopted Minimum Flow Regime.

II. OBJECTIVES

1) Conduct field study of the biota of multiple spring-run streams to better understand variation among and within and relate to physical-chemical conditions in those streams

2) Conduct focused research studies, primarily in the Silver Springs/River ecosystem, to better define trophic relationships and biological interactions in spring-run streams.

3) Working with the Physicochemical and Hydrodynamic Work Groups, better understand important hydrologic and water quality drivers influencing biological community structure and function in spring run streams of the St. Johns River.

4) Re-analyzed Fisheries Independent Monitoring data collected in the lower St. Johns River and estuary through 2012 to assess effects of different flow scenarios from Silver Springs/River on fish populations in the estuary.

5) Conduct a second round of biological sampling/monitoring in Volusia Blue Spring to support the adopted Minimum Flow Regime.

6) Develop conceptual and empirical models relating drivers and biology from the above work.

7) Summarize data to provide information to inform management decisions and actions.

Field Study – Synoptic Biological Survey (by contractor for SJRWMD)

The lack of a long-term, continuous record of biological status or condition to complement flow and water quality monitoring hampers understanding of key drivers affecting spring run stream ecology. In order to gain a better understanding of the biological composition of spring-run streams and the variation within and among various spring types, a short-term, synoptic survey will be conducted across a broad range of spring-run streams in north and central Florida (list below). Key questions include:

- What is the composition (taxa richness, relative abundance, biomass, etc.) of the submerged macrophyte (SAV), attached and benthic algal, and macroinvertebrate communities of spring run streams?
- What seasonal changes occur in the composition of the SAV, algal, and macroinvertebrate communities in these streams?
- How does community structure relate to variation in flow and water quality?

This component of the work will also establish a "benchmark" of biological condition in these streams in the 2015 time frame, for comparison with future similar work.

Study Streams

a. Silver River – Sample at the "Mammoth Spring" head spring, the "3900' Station" (the location of the current US Geological Survey gauging station) and ~2 miles downstream at the new SJRWMD water quality sampling site (SILVERRIVERS5).

b. Wekiva River – Sample at the headspring (downstream of bridge) and upstream of SR 46 at the SJRWMD “WEKR18” SAV sampling site (Lat. 28° 48.514’/Long. 81° 25.073’).

c. Alexander Springs Creek – Sample at headspring and ~1 mile downstream of CR 445 at new SJRWMD water quality site (ALXSPRA8)..

d. Rock Springs Run – Sample at headspring and downstream at SJRWMD “RSR12” SAV sampling site (Lat. 28° 44.636’/Long. 81° 28.512’).

e. Juniper Creek – Sample at headspring and downstream at SJRWMD “JUNC06” SAV sampling site (Lat. 29° 11.112’/Long. 81° 42.687’).

f. Silver Glen Spring – Sample at one site downstream at SJRWMD “SGLR08” SAV site (Lat. 29° 14.859’/Long. 81° 38.280’) or a nearby site to be determined.

g. Volusia Blue Spring – Sample at one site ~300m downstream near swim area (upstream of), or at another site to be determined.

h. Ichetucknee River – Sample downstream of inflow of Blue Hole Spring (Jug Spring) and at a location between mid-point tube access and south take-out.

i. Wacissa River – Sample downstream of Big/Big Blue Spring and at Goose Pasture camp area.

j. Manatee Spring – Sample at one site downstream of head spring in the spring run, location to be determined.

k. Rainbow River – Sample at headspring and a downstream location to be determined.

l. Weeki Wachee River – Sample at headspring and downstream at a site above Hospital Hole or other location to be determined.

m. Gum Slough – Sample at headspring and at a downstream sampling site corresponding to “Transect 3” of King (2012).

n. Wakulla River – Sample at an upstream site just downstream of the headspring area and at a downstream location in the Wakulla River to be determined.

These 14 streams were chosen in part because all have reasonably long-term (10 years or more) data on flow and water chemistry. SJRWMD will obtain these data for use in data analysis.

Contracted Data Collection, Sample Processing, and Data Management

Data collection and taxa identification will be conducted by a contractor familiar with the standard methods required by the District, and District staff will approve all sampling locations and methods prior to the start of sampling. The proposed data collection includes sampling biological, field water quality, and physical parameters along transects within each spring system as specified in the list, above. Sampling will occur in the spring (April/May) and late summer (August/September) of 2015. The sampling design will allow for comprehensive statistical analyses of interactions among biological variables, and physical and chemical parameters (flow, DO, NO_x) currently monitored within each spring system. Samples will be collected from within SAV and algal communities and parameters will include:

a) SAV, macroalgae, and epiphytic algae cover (modified Braun-Blanquet scale)
b) SAV dry weight and morphometrics, including number of leaves per shoot, leaf length and width, intermodal distance, shoot dry weight, and root/rhizome dry weight
c) Benthic macroalgae dry weight, ash-free dry weight, chlorophyll *a*, and dominant taxa composition
d) Epiphytic algae dry weight, ash-free dry weight, chlorophyll *a*, and dominant taxa composition
e) Macroinvertebrate taxa richness, population density, diversity, evenness, and functional feeding group and life habitat categorization within each vegetative community (SAV and algae)

Water quality and physical parameter field measurements will be sampled concurrent with SAV, algal, and invertebrate sampling. Physical and chemical parameters will include water depth, depth to top of SAV canopy, tree canopy cover, current velocity, water temperature, specific conductance, pH, and DO.

When sampling such highly variable ecosystems such as springs and spring runs, strict adherence to field methods is required to preserve data quality. Expectations of Data Quality Objectives (DQO) are as follows:

1) Data collected under the contracted SOW must be comparable such that standard statistical methods (and assumptions) for the determination of correlation or covariance can be applied.
2) Standard methods employed must capture appropriate variability of characteristics being monitored. Sample n will be as large as feasible based on budget.
3) Samples will be collected within a short temporal period such that seasonal effects do not add interference to data analyses and interpretation.

All field derived data will be compiled by the contractor in a database designed by District staff to allow for smooth transfer into the District's biological database. The Synoptic Study database will be accompanied by a brief report summarizing field and laboratory methods and sampling events.

General

All data collected will be delivered to the District in specified electronic format. Measurements will be expressed in SI (metric) units. In some cases (e.g., flow) measurements will be expressed in SI (m^3/second or cms) with English flow added parenthetically (ft^3/second or cfs).

Data analysis shall compare physical/chemical measures with various biological measures (algae, macroinvertebrates, and fish) using linear comparisons (parametric or nonparametric correlation, regression, etc.) and multivariate methods (principal components analysis, Primer/BIOENV, etc.). Biological measures shall include taxa richness, abundance (as #/m^2), diversity indices, functional feeding group, life habit, etc. All shall be used in these comparisons. Comparisons shall also be made between various algal measures (AFDW, relative abundance of green algae, blue-green algae, etc.) and invertebrate measures.

Focused Research Studies (by University of Florida)

The objectives of the Biological Element of the Springs Protection Initiative Science work (SPIS) are:

1. Identify the major algal grazers and their consumers. Collect samples of vegetation (algae and macrophytes), dominant/common invertebrate species, dominant/common fish species, turtles and alligators. Analyze stable isotope composition of the collected material to delineate food webs.

2. Determine algal growth and grazing rates of small grazer species. Based on the results of Objective 1, samples of the dominant algal and grazer species will be collected live and set up in mesocosms in the laboratory to evaluate algal growth rates and grazing rates.

3. Assess the potential for top-down (consumer) control of key grazers in the ecosystem which were identified in Objectives 1 and 2. Manipulative experiments will be performed in the field to further assess grazing effects on algal populations and also to assess the influence of predators on those rates.

III. SCOPE OF WORK

1. Identify the major algal grazers and their consumers

UF will employ natural abundances of stable carbon and nitrogen isotopes ($\delta^{13}C$ and $\delta^{15}N$) as a tool to: (1) discriminate contributions to trophic webs for various primary producers in the Silver River and other targeted spring-fed systems; (2) identify potentially important grazers of nuisance, filamentous macroalgae; and (3) identify also predators of those grazers that are likely to exert some control on grazer abundance and distribution. Although emphasis has thus far been on carbon and nitrogen, the simultaneous use of sulfur and its naturally occurring stable isotopes ($\delta^{34}S$) is likely to enhance the ability to identify important trophic linkages and guide work carried out as part of Objective 2 and 3 below.

Floral and faunal samples for initial stable isotope analysis will be collected from the Silver River and other targeted spring-fed systems (e.g., Alexander, Ichetucknee, Wacissa, as well as others with approval of the District lead) within three months of approval of this work order. Various nets, sieves and traps will be used to collect invertebrates, fishes, turtles and alligators. Invertebrates and smaller fishes will be collected whole. Larger fishes, turtles, and alligators will have a tissue sample taken and will be released. Vegetation will be collected in quadrats.

In the laboratory, collected material will be dried and ground to a fine powder. Stable isotope analysis will be conducted on the samples for isotopes of carbon and nitrogen. A smaller set of samples will be analyzed for isotopes of sulfur.

2. Determine algal growth and grazing rates of small grazer species

UF will design and implement a suite of laboratory-based studies to assess potential small grazer impacts on filamentous macroalgae maintained at ambient and reduced nutrient (nitrate) levels. These will be small invertebrates such as amphipods, some snail species, or possibly some aquatic insect species. In years 1 and 2, work will focus on taxon-specific grazing rates on the dominant algae (e.g., *Lyngbya* and/or *Vaucheria*) maintained at ambient nutrient levels. In year 3, UF will specifically consider the effects of a simulated management intervention, i.e., reduced nutrients (nitrate specifically), on algal growth rates and the ability of macroinvertebrate grazers to control macroalgal growth and abundance. Year 1 may largely involve trial studies to evaluate what laboratory set-up is most effective and what species are amenable to growth studies in the laboratory. Year 2 would conduct more definitive experiments to collect data.

Preliminary work indicates that macroinvertebrates can be successfully introduced to flasks under laboratory conditions to assess grazing rates and an appropriate manipulation of grazer density should allow for estimation of equilibrium conditions, i.e., no net algal growth. Algae and invertebrates will be collected from the Silver River system initially.

3. *Assess the potential for top-down (consumer) control of key grazers in the ecosystem which were identified in Objectives 1 and 2*

UF will assess predation on grazers using a combination of techniques that are tailored to the idiosyncrasies of the organism(s) under investigation. Gastropods, for example, are certainly amenable to standard tethering techniques to assess predation potential whereas amphipods are not. Enclosure/exclosure experiments are likely to be used to quantify *in situ* grazing rates of both amphipods and gastropods and also to assess the influence of predators on those rates. Proper scaling is critical and there is not a “one type fits all” approach. These studies are an essential complement to the laboratory experiments proposed above (Objective 2) and those being carried out by the Nitrogen Dynamics and Metabolism workgroup [Element #3; leads M. Cohen and M. Coveney], because if properly designed they eliminate methodological artifacts and provide invaluable reference data.

During year 1 of the project UF will design and test (in the field) equipment and protocols to be employed as part of experiments carried out in years 2 and 3. At the end of year 1, in consultation with the District lead, Rob Mattson, UF will review the findings of the pilot efforts and propose a detailed scope of work for subsequent years that is commensurate with the funding allocated.

Re-evaluation of Fisheries Independent Monitoring (FIM) data through 2012 (by Florida Fish and Wildlife Research Institute)

Since 2001, the Florida Fish and Wildlife Research Institute (an agency of the Florida Fish and Wildlife Conservation Commission) has monitored populations of juvenile finfish and selected shellfish species in the lower St. Johns River and estuary as part of the statewide Fisheries Independent Monitoring (FIM) program. This effort employs multiple gear types in a stratified random sampling design. Samples are collected monthly, along with basic physical-chemical data (salinity, water temperature) and habitat observations.

These data were analyzed in conjunction with upstream river flow data from the Ocklawaha and St. Johns Rivers in the SJRWMD Water Supply Impact Study (WSIS) to assess the potential effects of upstream withdrawals of surface water from the St. Johns and/or Ocklawaha Rivers on fish and selected invertebrate populations in the estuary (Miller et al. 2012; Mattson et al. 2012). One conclusion from this work was that changes in flow of the Ocklawaha River have a strong effect on salinity regimes in the St. Johns River estuary, as much as or more so than changes in flow upstream on the St. Johns River.

Because the Silver River is a major contributor of flow to the lower Ocklawaha River, changes in the flow of the spring (due to climatic changes or due to excessive groundwater pumping) could ultimately have significant and possibly negative effects on fisheries in the St. Johns River estuary. Using the analytical tools developed in the WSIS, the FIM data collected up through 2012 will be re-analyzed to evaluate the effects of different Silver River flow conditions on fish populations in the lower St. Johns River and estuary.

Volusia Blue Spring Minimum Flow Regime Monitoring (by Stetson University and District)

In 2006, the SJRWMD adopted a Minimum Flow Regime (MFR) for Volusia Blue Spring. This MFR is primarily focused on providing adequate winter warm water refuge habitat for the population of Florida manatees in the St. Johns River. The adopted MFR increases minimum flows incrementally over time. The first increment allows a minimum long-term average spring flow of 133 cubic feet per second (cfs), which is less than the current long-term average flow of 157 cfs, until March 31, 2009. This minimum long-term average flow would be raised during each of four subsequent 5-year intervals to the following:

- 137 cfs (from April 1, 2009, through March 31, 2014)
- 142 cfs (from April 1, 2014, through March 31, 2019)
- 148 cfs (from April 1, 2019, through March 31, 2024)
- 157 cfs (after March 31, 2024)

Under the approved rule, after March 31, 2024, the minimum long-term average flow of the spring run will be the current long-term average flow of 157 cfs.

The District received numerous comments from individuals and other agencies regarding implementation of the Blue Spring MFR. A recurring comment was, given the phased structure of the rule, that the District may not be able to ensure the required flows will actually be achieved by the dates established in the flow regime. To address this, the Governing Board of SJRWMD authorized District staff to develop the comprehensive Volusia Blue Spring Minimum Flow Regime Action Plan that directs the implementation of a multifaceted approach to ensure, to the extent possible, that the increasing minimum flows required by the Blue Spring MFR will be met in the future.

The Action Plan was designed to adaptively manage implementation of the Blue Spring MFR. Monitoring is an integral part of the implementation process by providing the multifaceted data required to reduce uncertainties and to allow for modification of the Action Plan as needed to ensure that the Blue Spring MFR protects the springs resources and unique flora and fauna.

The Action Plan directed that a detailed Monitoring Plan be developed that includes the physical, chemical, and ecological data monitoring and analysis required for the periodic evaluation of the Blue Spring MFR. The Monitoring Plan was developed in partnership with DEP and FWC to cooperatively develop, fund, and implement the Monitoring Plan work elements. Continuing oversight will be provided by representatives of the Blue Spring Minimum Flow Interagency Work Group, the U.S. Geological Survey (USGS), and the USFWS. The Monitoring Plan is structured on a 5-year schedule, with one year of intensive biological monitoring being conducted, along with flow and water quality monitoring, followed by four years of flow and water quality monitoring. The cycle then repeats, with a year of more intensive biological monitoring.

The first intensive monitoring effort was conducted in 2007-08 and the data from this effort were summarized in Wetland Solutions, Inc. (2010). Relevant findings from that effort were:

- Water quality was linked to spring discharge, with higher concentrations of dissolved salts and minerals occurring at lower flows, possibly reflecting a greater relative fraction of “older” deeper groundwater contribution to spring flow. Nitrate concentrations were also lower at lower spring flows.
- The submerged plant community was dominated by benthic and filamentous algae. Algal abundance as mat thickness was higher in the upper and middle portions of the spring run.
- The benthic macroinvertebrate community was depauperate, probably due to very low dissolved oxygen DO levels in the spring discharge and high dissolved salt content. As indicated by the Stream Condition Index, a higher-quality invertebrate community was present at higher spring flows.
- The spring run supported a fairly diverse fish and turtle community.
- Spring ecosystem productivity is strongly related to solar input and appears to be lower than in other spring systems in the region and state, probably due to the exceptionally low DO in the spring discharge and lack of submerged aquatic vegetation.
- Manatee use of the spring run as a winter warm-water refuge continues to increase.

Implementation of the next intensive biological monitoring episode had to be delayed due to budget restrictions. Under the SJRWMD Springs Protection Initiative Science (SPIS), funding will be provided to conduct this monitoring in 2014-15.

The overall monitoring plan for Blue Spring is detailed in the 2013 Monitoring Plan prepared by the District (SJRWMD 2012). The following will be monitored in 2014-15:

1) Continuous flow measurements in the spring run. (USGS and SJRWMD)

2) Water quality monitoring at the head spring and a location in the spring run. (USGS and SJRWMD)

3) Monthly quantitative surveys of fish populations in the spring and spring run. (Stetson University)

4) Quarterly collections of snails for determination of density by species or lowest practical taxonomic level. (Stetson University)

5) Quarterly semi-quantitative surveys of benthic algae and submerged aquatic vegetation using the Braun-Blanquet cover scale. (Stetson University)

6) Quarterly collections of macroinvertebrates for determination of the Stream Condition Index. (SJRWMD and FDEP)

IV. BUDGET

The general contractual budget for the period 2014-2016 is shown in the table on the next page. Funding is budgeted under the SPIS overall budget. Detailed budgets and Scopes of Work for each of the work elements above are specified in the following:

Synoptic Survey – to be developed as part of the procurement and contracting process

Focused Research – found in Work Order No. 5 under SJRWMD Contract No. 27789 with University of Florida

Re-evaluation of FIM data – found in SJRWMD Contract No. 27882 with the Fish and Wildlife Conservation Commission.

Volusia Blue Spring Monitoring – found in SJRWMD Contract No. 27972 with Stetson University.

Field Study – Synoptic Biological Survey	2014	2015	2016
Quantitative SAV surveys		18,000	12,000
Quantitative attached algal surveys		70,000	20,000
Macroinvertebrate monitoring		140,000	30,000
Project and data management		12,000	18,000
TOTAL SYNOPTIC BIOLOGICAL SURVEY	0	240,000	80,000
Focused Research Studies			
Identify major algal grazers and their consumers	49,150	25,000	
Determine algal growth rates and grazing rates of small grazers	22,500	70,000	TBD
Assess potential for top-down (consumer) control of key grazers identified in prior work	15,000	45,000	TBD
TOTAL FOCUSED RESEARCH	86,650	140,000	68,186
Re-evaluation of FIM data through 2012	7,500	17,500	0
Volusia Blue Spring			
Monthly fish surveys	1,000	3,000	
Quantitative snail monitoring	700	1,000	
Semi-quantitative SAV monitoring	50	50	
Data analysis and report preparation			200
FDEP analysis of samples collected for SCI		3,000	3,000
TOTAL VOLUSIA BLUE SPRING	1,750	7,050	200
TOTAL BIOLOGY GROUP CONTRACTUAL BUDGET	95,900	404,550	TBD

V. SCHEDULE

Proposed work schedule, including fieldwork, data analysis, and deliverables, is shown in the table, below.

	Q3 14	Q4 14	Q1 15	Q2 15	Q3 15	Q4 15	Q1 16	Q2 16	Q3 16
Synoptic Biological Survey									
Fieldwork and sample analysis									
Data submittal									
Focused Research									
ID algal grazers									
Algal growth and grazing rates									
Potential for top-down control									
FIM Re-analysis									
Vol. Blue Spring Monitoring									

	Field sampling and/or lab work
	Data analysis
	Interim report
	Final report

VI. STAFFING/CONTRACTUAL SUPPORT

Biological Monitoring and Studies	2014	2015	2016
Robert Mattson (FTE)	0.5	0.5	0.5
John Stenberg (FTE)	0.05	0.05	0.05
Palmer Kinser (FTE)	0.05	0.05	0.05
Tiffany Trent (FTE)	0.10	0.10	0.10
Steve Miller (FTE)	0.05	0.05	0.05
Jodi Slater (FTE)	0.05	0.05	0.05
Synoptic Biological Survey (Contractual)		280,000	40,000
Focused Research (UF Contractual)	86,650	140,000	TBD
FIM data re-analysis (FWCC Contractual)	7,500	17,500	

Volusia Blue Spring Monitoring	2014	2015	2016
Robert Mattson (FTE)	0.1	0.1	0.1
Water Resources Investigation staff (FTE)		0.2	0.2
SCI sample processing (Contractual to FDEP)		3,000	3,000
Fish, snail and SAV monitoring (Stetson Contractual)	1,750	4,050	200

VII. LITERATURE CITED

Mattson, R.A., K.W. Cummins, R.W. Merritt, P.A. Montagna, et al. 2012. Benthic Macroinvertebrates. Chapter 11. St. Johns River Water Supply Impact Study. St. Johns River Water Management District Technical Publication SJ2012-1.

Miller, S.J., R.E. Brockmeyer, Jr., W. Tweedale, J. Shenker, et al. 2012. Fish. Chapter 12. St. Johns River Water Supply Impact Study. St. Johns River Water Management District Technical Publication SJ2012-1.

SJRWMD. 2012. Volusia Blue Spring Minimum Flow Regime. 2013 Monitoring Plan. St. Johns River Water Management District, Palatka, FL.