

BIG BEND WILDLIFE MANAGEMENT AREA SPRING CREEK UNIT

SPRINGS INVENTORY PILOT PROJECT

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Cover photograph- Taylor County coast looking north up Big Spring Creek. Photo taken by Mark Long on January 29, 2016.

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EXECUTIVE SUMMARY

Under contract with the Florida Fish and Wildlife Conservation Commission (FWC), the Florida Geological Survey (FGS) conducted a springs inventory pilot project on the Spring Creek Unit of FWC's Big Bend Wildlife Management Area. In addition to cataloging new springs, a methodology for locating springs in coastal settings was developed.

Fifty "Points of Interest (POI)" (i.e. thermal hotspots) were identified using ESRI® ArcGIS® ArcMap™ 10.3.1 software and the FGS's 2003 Taylor County coast thermography data. Thirty-seven POI were identified within the boundaries of the Spring Creek Unit. The FGS visited thirty-three of these sites, by boat or foot, and confirmed twelve springs (four previously cataloged). Using aerial photography and field observation, another eleven unknown springs/seeps were cataloged in areas without thermography data. Using video and photographs acquired with a drone, eight additional springs were identified, but not visited (one was a POI). In total, twenty-seven new springs and spring groups were cataloged on the Spring Creek Unit. The term spring group is used to define locations that contain multiple vents in close proximity (Copeland, 2003).

At each spring location, field observations were made, general descriptions, estimates of discharge, and photographs were obtained. Field water quality parameters (dissolved oxygen, pH, specific conductance, and temperature) and water samples were obtained at eight springs. The water quality data show half the sampled springs have a saline influence and are discharging a mix of fresh and marine waters. Two attempts were made to sample TAY616991 ("Pittman") and Oyster Bar Spring, which are located near shore in the Gulf of Mexico. A decline in discharge at these springs precluded obtaining representative samples even at negative tidal cycles. Additionally, Oyster Bar Spring, was twice observed to not be flowing between January and May 2017.

Limited tidal and water quality data were obtained with In-Situ Trolls (datalogger with a pressure transducer and multiple water quality probes) that were deployed in a stilling well in TAY77044 ("La Bella Spring"). These data suggest that under certain hydrologic conditions (during significant high/low tide cycles and decreased potentiometric surface elevations), marine water may invade some of the spring conduits.

Based on observations made during the project, there are likely many springs that were not discovered due to difficulty of access and spring discharge fluctuations with changes in hydrological conditions and tidal influences.

INTRODUCTION

The FWC Big Bend Wildlife Management Area is approximately 72,000 acres of pine plantations, flatwoods, floodplain forest and swamps, and extensive coastal marsh between the Aucilla River and Horseshoe Beach, Florida. This wildlife management area consists of five separate units: Snipe Island, Hickory Mound, Spring Creek, and Tide Swamp in Taylor County, and Jena in Dixie County (Figure 1).

Very little documentation of the spring resources within the Big Bend Wildlife Management Area exists. As a result, in August 2016 the FWC contracted with the FGS to conduct a pilot project to inventory springs in the 14,600-acre Spring Creek Unit. This study area was chosen for the pilot project because the FGS previously located several uncataloged springs in the area using thermography data it acquired for prior ground and surface water interaction studies.

The FGS compiled data on the cataloged springs and utilized aerial and a Light Detection and Ranging (LiDAR) derived digital elevation model (DEM), thermography data, potentiometric surface maps, and ArcMap™ 10.3.1 software to identify potential spring target sites in the study area. Field verification of selected targets was used to inventory new, uncataloged springs. At confirmed springs, a field description, Global Positioning System (GPS) location, photographs, and estimates of discharge were obtained. Field water quality parameters (dissolved oxygen, pH, temperature, and specific conductance) and water samples were collected at select sites. In addition, a methodology for cataloging springs in the study area was established that can be applied to other wildlife management units.

PURPOSE

The purpose of this pilot project was to inventory previously uncataloged springs in the Spring Creek Unit of the Big Bend Wildlife Management Area and to develop a methodology to locate and inventory springs in coastal floodplain forests, swamps, and marshes.

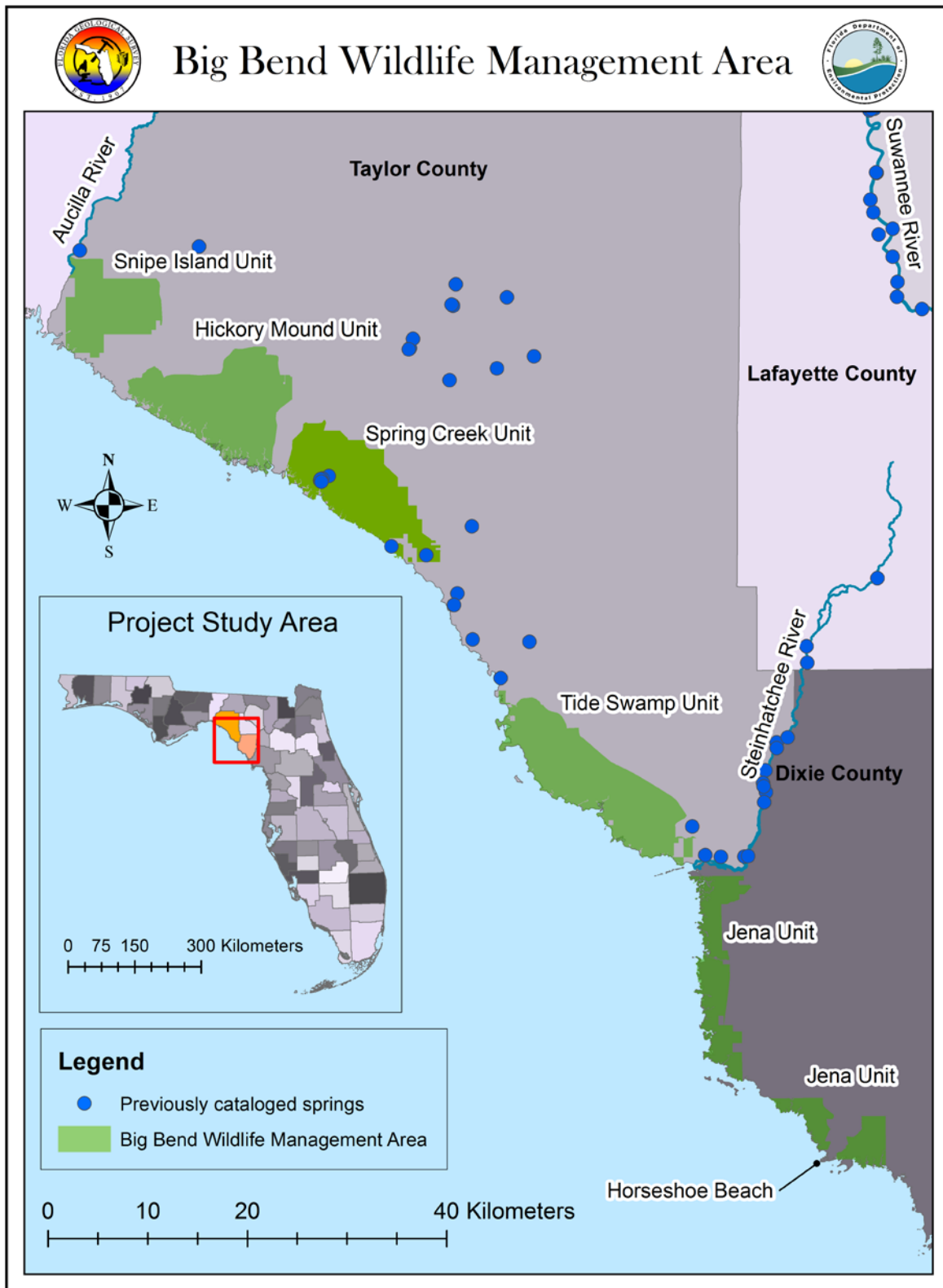


Figure 1. Big Bend Wildlife Management Area.

PREVIOUSLY CATALOGED SPRINGS

The Big Bend Wildlife Management Area was formerly owned and managed by timber companies. Due to low population density, the area's remoteness, and vast portions of the coast being in private ownership, very few springs in this area have been formally cataloged.

The Suwannee River Water Management District (SRWMD) cataloged several springs (Big Spring, TAY66991, TAY66992, TAY616991, and TAY616992) in the Spring Creek Unit in 1999 (Hornsby, 2000). Additional springs (TAY77041, TAY77042, TAY77043, and TAY77044) were cataloged by Hornsby after 2000 (personal communication).

In 2009, the FGS documented several springs in and near Big Spring Creek within the study area while researching offshore springs (DEP, 2010). The FGS designated these springs: Big Spring Creek 1, 2, 3, 4, 5, and 6, Oyster Bar Spring, and Kat Holland Spring. Upon further investigation, the FGS realized several of the springs they documented had been previously cataloged by the SRWMD. Table 1 shows the FGS alternate designations for several of the springs that were previously documented by the SRWMD.

When the FGS projected the GPS locational data for the previously documented springs, it was apparent that there were discrepancies in their locations. To eliminate these discrepancies, it would be useful to conduct a Geographic Information Systems (GIS) desktop comparison of locations and field verification of the numerous springs in Big Spring Creek proper.

Table 1. Previously Cataloged Springs

Spring Name	Alternate Designation	Date Cataloged
Big Spring		SRWMD 6/6/1999
TAY66991		SRWMD 6/6/1999
TAY66992		SRWMD 6/6/1999
TAY616991	FGS "Pittman Spring"	SRWMD 6/16/1999
TAY616992	FGS "Oman"	SRWMD 6/16/1999
TAY77041		SRWMD 7/7/2004
TAY77042		SRWMD 7/7/2004
TAY77043		SRWMD 7/7/2004
TAY77044	FGS "La Bella Spring"	SRWMD 7/7/2004
Big Spring Creek 1		FGS 1/10/2009
Big Spring Creek 2		FGS 1/10/2009
Big Spring Creek 3		FGS 1/10/2009
Big Spring Creek 4	SRWMD "TAY69992"	FGS 1/10/2009
Big Spring Creek 5		FGS 1/10/2009
Big Spring Creek 6	SRWMD "TAY69991"	FGS 1/10/2009
Oyster Bar Spring		FGS 1/10/2009
Kat Holland		FGS 1/10/2009

METHODS FOR LOCATING SPRINGS

Prior to conducting field work, project staff compiled data on previously cataloged springs, assembled aerial imagery, created a LiDAR DEM, thermography data, and potentiometric surface maps for use with ESRI® ArcGIS® ArcMap™ 10.3.1 software. The LiDAR data available to the FGS for the Taylor County coast has poor resolution and is of limited use for identifying potential springs in the flat terrain of the swamps and coastal marshes of the Spring Creek Unit. Potentiometric surface maps for Taylor County are coarse, have very few control points, and are of little use to determine potential groundwater flow paths in the project area.

The FGS thermography dataset for the Taylor County coast extending approximately two miles inland was acquired in February 2003 by SenSyTech, Inc. Imaging Group. SenSyTech was contracted by the FGS to collect high-resolution thermal imagery using their Airborne Multispectral Scanner (AMS Model 3600) for use in an investigation of surface and groundwater interaction. By displaying the temperature differences detected by the multispectral scanner within defined ranges and symbolized using color ramps in ArcMap™ 10.3.1 software, fifty potential spring target locations (“hotspots” or POI) were identified (see Figure 2.). Thirty-seven of these POI were within the study area boundary. A shapefile of the POI, aerial imagery, LiDAR DEM, and thermography data were transferred to a laptop containing ArcPad© 10.2 and ArcGIS© for use in the field. Custom forms were created in ArcPad Studio© for collecting different types of data observed in the field. Field reconnaissance of the POI was performed by connecting ArcPad© to a Garmin (GPS 18x USB) GPS receiver and physically visiting the POI by hiking, boating, and/or by drone.

Field observations and aerial imagery were employed to locate potential spring sites in areas where the FGS did not have thermography data. During reconnaissance of the study area’s road system, culvert crossings and ditches that contained clear, continuous water flow or rust colored iron-reducing bacterial concentrations were documented. From experience, and direct observation in the study area, it was determined that iron-reducing bacteria were present at locations of groundwater discharge (springs). Differences in tree species, vegetation types, and drainage seen on aerial imagery, or in the field, provided additional sites and/or areas that might contain springs. These sites were investigated by hiking up creeks, across forests and swamps, and through marshes.



Points of Interest Selected from Thermography Data

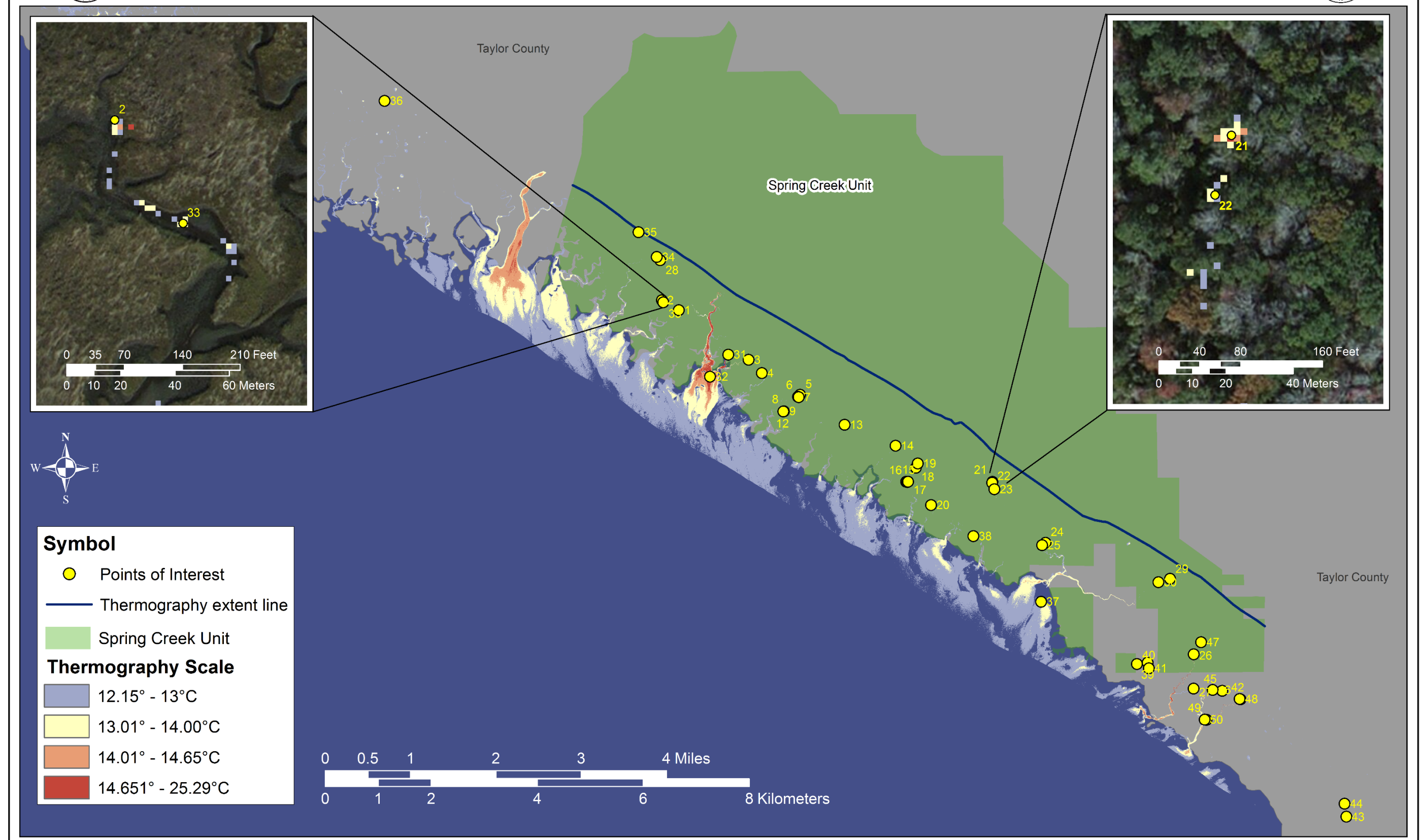


Figure 2. Points of Interests Selected from Thermography Data

A DJI Phantom 4 drone was used to do reconnaissance and to collect photographs and video of known and suspected springs. The drone allowed rapid reconnaissance and field verification of locations that would have been extremely challenging to physically access safely.

The FGS began fieldwork on December 1, 2016. A vehicular survey of the Spring Creek Unit was conducted. It included a track log of the roads driven, the locations of gates, and other access nuances. Since that date, FGS staff spent thirty-eight days in the field area. The last field day was May 26, 2016, when a stilling well and In-Situ Troll (a field instrument that records water depth, temperature, specific conductivity, and other parameters) were retrieved. Brief summaries of each of the field days' activities are provided in Appendix 1.

A portion of twelve days was spent traveling to or from the field area. On those days, field staff traveled to the Spring Warrior Fish Camp in the late afternoon and spent the night to facilitate an early start the next day. Thirteen days were spent hiking to POI or investigating potential springs in areas without thermography data. A jon boat was used on eleven days to access POI in tidal creeks or in marsh areas adjacent to tidal creeks. The field staff boated and hiked one day, flew and hiked another day, and one day was devoted solely to drone flights.

FINDINGS

In total, twenty-seven new springs/spring groups were cataloged in the study area. Twelve POI were verified as springs, eight of these were “new” springs or spring groups and four were previously cataloged (Oyster Bar, Kat Holland, TAY616991 (“Pittman”), and TAY 616992 (“Oman”). One of the twelve POI was on private land and was confirmed to be a spring (“Marie”) when the field crew attempted to locate the property owner on-site.

Twenty-nine non-POI springs were cataloged. Nineteen were “new” uncataloged springs or spring groups, and ten were previously cataloged: Big Spring, TAY66991 (“Big Spring Creek 6”), TAY66992 (“Big Spring Creek 4”), TAY77041, TAY77042 (“Big Spring Creek 3”), TAY77043 (“Boat Ramp”), TAY77044 (“La Bella”), Big Spring Creek 1, Big Spring Creek 2, and Big Spring Creek 5. Seven of the nineteen new springs were identified from drone footage, but were not visited. Figure 3 shows the locations of the new springs and spring groups in the study area. Appendix 2 has photographs and basic information for each of these springs.



New Springs

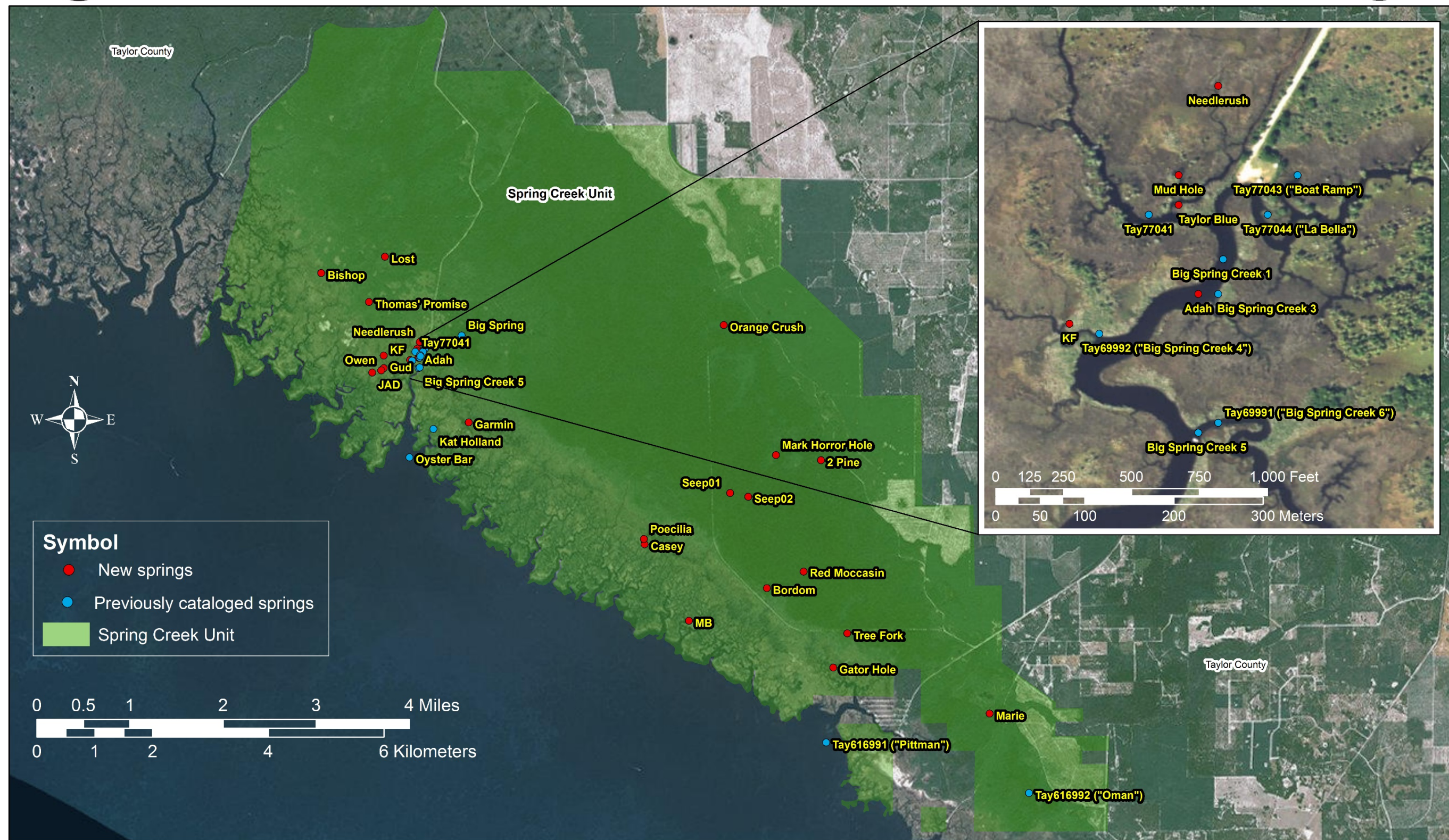


Figure 3. New Springs

SAMPLING

The FGS conducted the water quality sampling in accordance with the DEP's Standard Operation Procedures (DEP, 2014) utilizing laboratory pre-packaged sample kits. Field water quality parameters (dissolved oxygen, pH, temperature, and specific conductance) were obtained with a Yellow Springs Instrument (YSI) 6920 multi-parameter water quality sonde. Prior to collecting water samples, the YSI 6920 was deployed in or as close as possible to the spring vent and allowed to stabilize before recording field water quality parameter readings. Using the direct grab method, water quality samples were collected from the spring vent directly into sample containers. Ortho-phosphate samples were collected using a syringe with an attached 0.45-micron filter. Samples were preserved in the field and packed in ice for transport to the lab.

Field water quality parameters and water samples were collected at eight springs and from the well at the Spring Warrior Fish Camp. Water sampling was conducted at selected sites to reserve some sample kits for the end of the project, in case significant springs were discovered. Two attempts were made to sample Pittman (TAY616991) and Oyster Bar Springs on negative tides. On the morning of March 9, 2017, the samplers walked to Pittman Spring and observed it discharging clear water. But, within minutes before samples could be obtained, the water turned turbid and the decision was made not to collect samples. On the night of April 26, 2017, samplers again walked to Pittman Spring only to observe minimal discharge of turbid water. On the night of March 29, 2017, an attempt to sample Oyster Bar Spring was made, but its discharge was not sufficient to clear the vent of rolling grass, red algal clusters, and other organic debris. On the night of April 27, 2017, no discharge was observed coming from the spring vent during the negative tide. As a result, no water samples were collected at Oyster Bar Spring.

The laboratory analytical results and field parameters for water samples collected are presented in Table 2. The analytes selected are the same as those being monitored by the DEP in other springs around the State. The FGS added some metals to the analyte list to establish a baseline.

Table 2. Analytical Data from Sampled Sites.

SAMPLE NAME	BSC01	BSC02	BSC-06	Kat Holland	TAY616992	ORANGE	SWFC	TAY77043	Big Spring	S050615002
Date Sampled	01/25/17	01/25/17	01/26/17	02/01/17	04/12/17	04/12/17	04/27/17	04/27/17	04/27/17	03/22/17
Analytical Parameters										
Ammonia-N (mg/L)	0	0.078	0	0.22	0.093	0.057	0.17	0.076	0.093	-
Arsenic (ug/L)	0.12	0.84	1.49	1.84	NA	NA	0.21	0.98	1.27	-
Boron (ug/L)	30.2	309	428	1770	16.1	14	74.7	256	23.4	-
Calcium (mg/L)	87.5	98.9	106	217	45.9	64.2	95.1	94	74.4	48.4
Chloride (mg/L)	81	1400	2000	6600	6.4	5.5	370	1100	44	7
Color true (PCU)	33	9.2	13	20	150	64	110	16	23	-
Fluoride (mg/L)	0.14	0.24	0.25	0.47	0.12	0.13	0.13	0.22	0.16	0.098
Iron (ug/L)	1180	250	700	790	NA	NA	2550	480	920	0.004
Kjeldahl Nitrogen (mg/L)	0.26	0.17	0.37	0.42	0.6	0.22	0.39	0.19	0.21	0.043
Magnesium (mg/L)	24.8	113	144	458	15.4	21.4	41.4	98.7	28.9	15.18
Manganese (ug/L)	37	48.4	53.2	83	NA	NA	79	51	44.2	-
NO2NO3-N (mg/L)	0.004	0.004	0.009	0.005	0.004	0.004	0.004	0.004	0.004	-
O-Phosphate-P (mg/L)	0.071	0.028	0.035	0.052	0.033	0.05	0.087	0.029	0.037	-
Organic Carbon (mg/L)	2.4	1.6	3.4	3.4	16	2	5.3	2.3	2.5	1.07
Potassium (mg/L)	1.5	25.6	36	131	0.3	0.3	5.2	21.3	1	0.324
Sodium (mg/L)	44.2	709	969	3560	3.8	3.6	199	589	24.9	4.61
Sulfate (mg/L)	72	280	340	1000	0.97	29	59	240	72	30
TDS (mg/L)	464	2660	3890	12500	190	230	822	2140	418	222
Total Alkalinity (mg/L)	228	206	200	182	163	211	254	208	211	134
HCO3 (calc. Alkalinity*1.22)	278	251	244	222	199	257	310	254	257	164
Total-P (mg/L)	0.067	0.029	0.045	0.06	0.082	0.061	0.098	0.034	0.042	0.029
TSS (mg/L)	4	5	6	3	3	7	2	2	2	-
Turbidity (NTU)	9.9	1.3	3	3.2	5.8	13	14	0.95	2.2	-
Uranium (ug/L)	0.081	0.377	0.286	0.502	NA	NA	0.101	0.349	0.204	-
Field Parameters										-
Temperature °C	21	21	21	21	21	22	22	21	21	23.3
pH	6.89	6.92	6.94	7	6.72	7.06	6.79	6.91	7.03	7.6
Dissolved O2 (mg/L)	0.18	0.25	0.46	2.42	0.58	0.69	2.14	0.97	0.91	1.1
Specific Conductance (umhos/cm)	795	4830	6514	19874	310	443	1693	4182	652	361
Spring Names for BSC01 is "Bordom"; BSC02 is "Thomas' Promise"; BSC-06 is TAY69991; TAY616992 is "Oman"; ORANGE is "Orange Crush".										
SWFC is well at Spring Warrior Fish Camp. TAY77043 is "Boat Ramp". NA-not analyzed										

Stiff diagrams are graphs of the major ions detected in a water sample and allow one to visually compare the water quality of samples. Stiff diagrams, shown in Figure 4, were generated for each sample collected and for the March 22, 2017 water quality data from Suwannee River Water Management District's monitoring well (S050615002) located at the Taylor Correctional Institute. The water quality in this well is assumed to be consistent with water quality in the Upper Floridan aquifer for the local area. The chloride and sulfate concentrations in this well were estimated using concentrations previously detected in water samples from the well. The diagrams that look like "T's" have high concentrations of sodium (Na), potassium (K) and chloride (Cl), relative to other major ions, and reflect water with a saline influence. The diagrams with high concentrations of calcium (Ca) and bicarbonate (HCO₃), relative to the other major ions, are freshwater and are representative of Upper Floridan aquifer water. Samples BSC02 ("Thomas' Promise"), BSC-06 ("TAY69991"), Kat Holland, and TAY77043 ("Boat Ramp") have a clear saline influence. Four springs: BSC01 ("Bordom"), TAY61992 ("Oman"), Orange Crush, and Big Spring are "freshwater" springs. The Spring Warrior Fish Camp well data indicate the water in the aquifer at the Fish Camp is slightly saline.



Stiff Diagrams for Sampled Sites

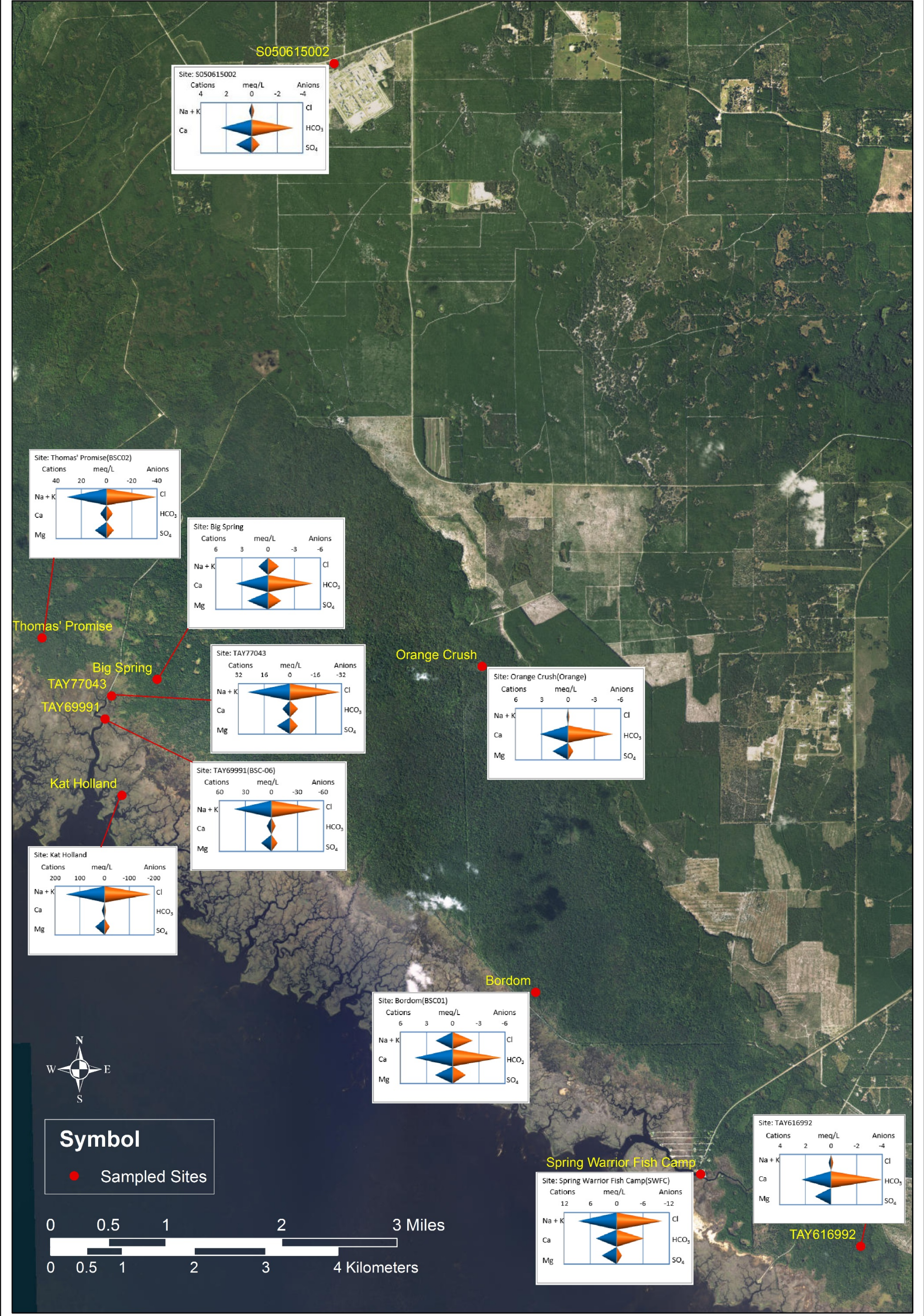


Figure 4. Stiff Diagrams for Sample Sites

TIDAL AND WATER QUALITY DATA FROM LA BELLA SPRING

Two In-Situ Troll data loggers were deployed in the vent of TAY77044 (“La Bella Spring”) by placing them in a stilling well. Stilling wells are a means of damping disruptions (waves, turbulence, foam) when collecting waterlevel and water quality data via dataloggers. The FGS utilized a six-foot section of 2-inch PVC pipe with 7/16 inch holes drilled on 6 inch centers for two feet up from the capped bottom of the pipe as the stilling well. This well was attached to a metal “T”-post with stainless steel hose clamps. The datalogger was suspended in the well via a coated wire that was attached to a bolt in the PVC cap on the top of the well. The T-post was manually driven into the sediment in the spring vent area. The datalogger was suspended near the bottom of the well. The PVC cap was secured with duct tape. A picture of the stilling well in TAY77044 (“La Bella Spring”) is provided in Figure 5. On April 20, 2017, an Aqua Troll 100 was deployed. It collected specific conductivity and temperature data every fifteen minutes, until it was retrieved on May 17, 2017. An Aqua Troll 200 was deployed on May 18, 2017 and recovered on May 26, 2017. It collected specific conductivity, temperature, and pressure as water level (tidal fluctuations) in fifteen minute intervals.

The data from these two loggers were combined and a graph of the specific conductivity, temperature, and pressure as water level are shown on Figure 6. The data show that during significant high/low tidal cycles, water discharging from La Bella Spring has a significant increase in specific conductance. Given the specific conductance remains elevated in the spring discharge during the low tide cycle, it is apparent that marine water is being mixed with the aquifer water during these events.



Figure 5. Stilling Well in TAY77043 ("La Bella Spring")

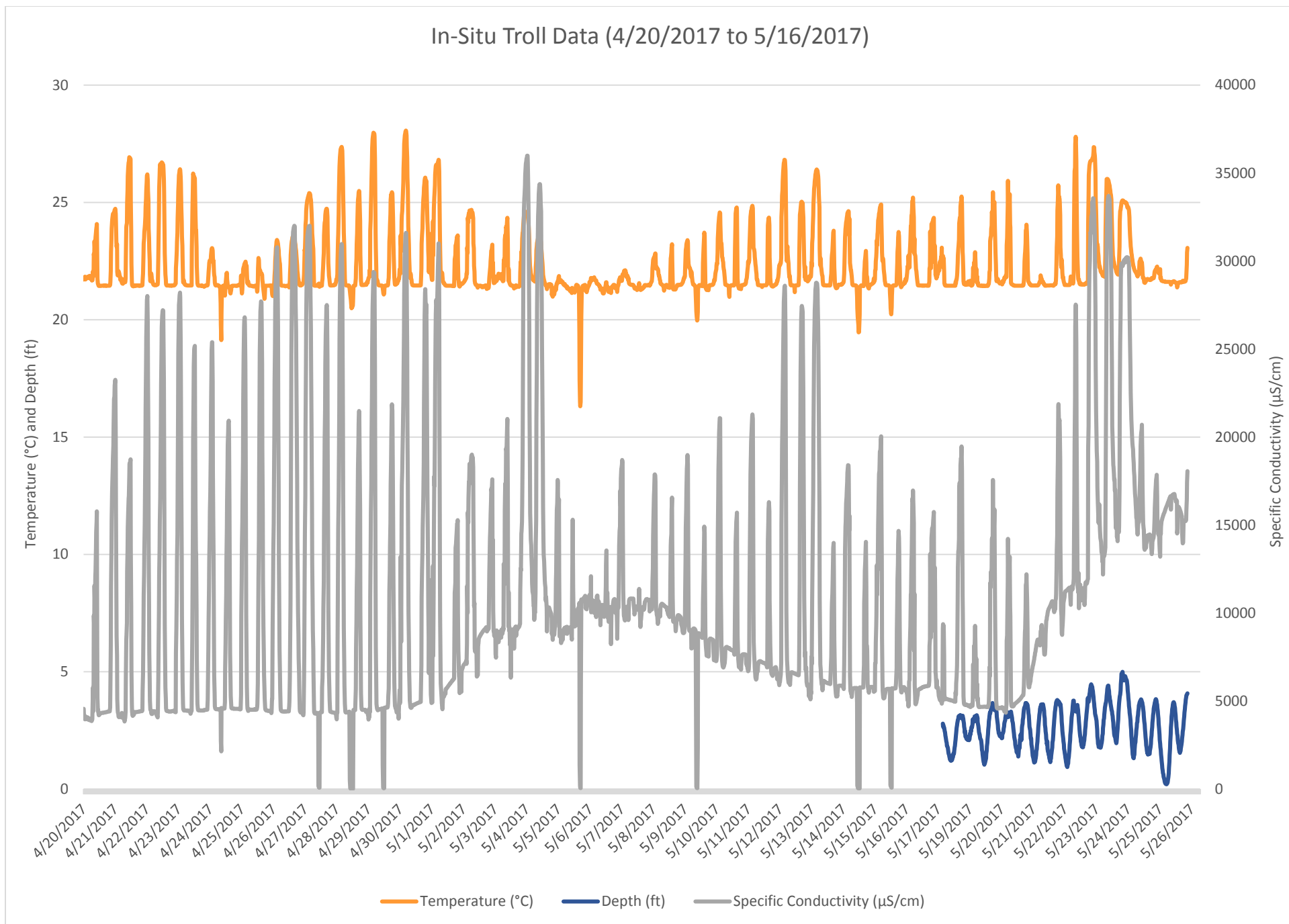


Figure 6. In-Situ Troll Data (4/20/17 to 5/26/17)

SUGGESTED METHODOLOGY FOR INVENTORYING SPRINGS

The most effective means found for identifying potential spring discharge in a large, remote area with difficult terrain, like the Spring Creek Unit, is analysis of thermography data. Traditional classification of the thermography raster data (Natural Break, Quantile, Equal-Interval, etc.) did not yield acceptable visual representations. For this project, temperatures above 15°C were classified manually to generate easily discernable visual thermal hot-spots or POI. After some field verification experience, and further refining the temperature range for thermal anomalies, one should be able to select springs with approximately ninety percent accuracy. If available, coupling thermography with high-resolution aerial imagery and LiDAR DEMs could increase one's confidence and accuracy. Verifying all potential spring targets will require physically visiting the site or, if open to the sky, drone verification.

Inland thermal points of interest were usually located in floodplain forest/swamps and required waterproof hip or rubber boots to access these sites. In rough areas, snake chaps were worn over the boots to minimize punctures and tears. The added protection from snake bites was a bonus. POI in tidal creeks or in the coastal marsh were accessed using either a shallow water operating jon boat equipped with a tiller steer outboard or by hiking. For most POI, a laptop containing ArcPad© 10.2 with an attached GPS receiver was used to navigate to and from POI. A custom digital form created in ArcPad Studio© on the laptop facilitated collecting different types of field data. For redundancy, it is recommended that an additional GPS receiver (hand-held), batteries, field book, and a hard copy field data sheet also be carried. To facilitate the collection of field water quality parameters at all springs, a small portable datalogger that can be carried in one's backpack is recommended.

A Yellow Springs Instrument (YSI) 6920 multi-parameter water quality sonde was used to collect the field water quality parameters (dissolved oxygen, pH, temperature, and specific conductance). Water sampling and transport were conducted in accordance with DEP's Standard Operation Procedures (DEP, 2014) utilizing laboratory pre-packaged sample kits.

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APPENDIX 1: SUMMARY OF FIELD WORK DAY ACTIVITIES

Appendix1: Summary of field work days.

Date	Staff	Method	Points of Interest	Notes
1/29/2016	Tom, Karlee, Cindy	Drone		Flew the drone from the boat ramp out to Oyster Bar, and just up the road from the boat ramp to Big Spring.
12/1/2016	Tom, Karlee	Vehicle		Drove the roads from Rock Road to Spring Warrior to test out ArcPad and get our bearings. Mapped road accessibility.
12/8/2016	Tom, Seth, Karlee	Foot	28, 34, 35	Parked at the end of Spring Creek Island Tram and walked out to POIs 28, 34, 35. Found a third magnitude spring at 35(Bishop), nothing of note found at 28, or 34. Located an additional spring (Thomas' Promise) approximately 1200' east of POI 34.
12/15/2016	Scott, Karlee	Foot	21,22, 23	Parked by the culverts on Mule Wallow Spur, crossed the ditch on the north side of the road and followed creek flow upstream. Took the branch to the left, to investigate POIs 21, 22, 23. Found a complex of five spring vents at 21 (Bordom), nothing of note at 22, or 23.
12/21/2017	Tom, Karlee			Arrived late afternoon to Spring Warrior Fish Camp.
12/22/2016	Tom, Karlee	Foot		Stopped along southernmost stretch of Mule Wallow Spur to investigate heavy iron deposits. Found a spring vent in between the limbs of a fallen tree in the ditch (Tree Fork). Crossed the ditch at the big culverts on Mule Wallow Spur to investigate the other branch in creek. Found two small vents (Red Moccasin).
12/27/2016	Tom, Karlee			Arrive late afternoon to Spring Warrior Fish Camp.
12/28/2016	Tom, Karlee	Boat	4, 31	Put the boat in at Spring Creek, took GPS points for the previously cataloged springs near the boat ramp as well as an additional uncataloged spring (Adah). Continued down towards creek mouth and visited Kat Holland (4). Went to POI 31, found no evidence of a spring at high tide. Oyster Bar was not visibly flowing.
12/29/2016	Tom, Karlee	Foot		Walked through the area north and east of the bend in Mule Wallow Spur. Walked along flowing creek but only found seeps, and one tiny vent (Seep 01, Seep 02), no notable springs. Observed a very large honey locust tree.

Appendix1: Summary of field work days.

1/4/2017	Tom, Karlee			Arrive late afternoon to Spring Warrior Fish Camp.
1/5/2017	Tom, Karlee	Foot		Walked east of most northern culvert in Mule Wallow Spur. Several inches of fresh water covering much of the ground with iron staining. Found a deeper portion with flow, which led to a vent (Orange Crush). Walked in south of Grantham Grade. Found clear spring flow (Two Pines), no visible vents.
1/6/2017	Tom, Karlee	Foot	29	Drove the Spring Creek Unit roads east of Spring Warrior Fish Camp. Found an open gate with fresh tire tracks going into the 40-acre private block. Walked in but could not locate land owner. Did observe a boiling spring at POI 29 (Marie).
1/19/2017	Tom, Karlee	Boat	24, 25, 37, 38	Put the boat in at Spring Warrior. Went up Clay Creek to POI 24 and 25 and located a spring full of baby gators (Gator Hole). Took the boat out of Spring Warrior Creek to POI 37 and located Pittman which had a visible boil. Went up the second creek west of Spring Warrior Creek to POI 38 and found no evidence of a spring.
1/24/2017	Tom, Karlee, Scott, Cindy	Boat		Arrived in the afternoon and went up stream just west of Spring Warrior Creek., tide too low to continue.
1/25/2017	Tom, Karlee, Scott, Cindy	Foot		Sampled Bordon and Thomas' Promise. Found fourth magnitude spring walking out of the woods just south of Spring Creek Island Tram(Lost).
1/26/2017	Tom, Karlee	Boat		Sampled Big Spring Creek 6.
1/31/2017	Tom, Karlee			Arrive late afternoon to Spring Warrior Fish Camp.
2/1/2017	Tom, Karlee	Boat	5, 6, 7, 8, 9, 10, 11, 12, 32	Oyster Bar flowing, sampled Kat Holland. Went up fourth creek east of Big Spring Creek but didn't find any definite springs at high tide.

Appendix1: Summary of field work days.

2/2/2017	Tom, Mary Beth	Boat	15, 16, 17, 20	Went up fourth creek west of Spring Warrior Creek. Found a spring (MB) at POI 20.
2/8/2017	Tom, Karlee	Walk		Walked down tram to edge of salt marsh to a large creek. No springs found.
2/15/2017	Tom, Karlee, Clint			Arrive late afternoon to Spring Warrior Fish Camp.
2/16/2017	Tom, Karlee, Clint	Foot		Walked out to salt marsh, no springs located although flow was noted.
2/17/2017	Tom, Casey	Foot	14	Walked southwest of bend in Mule Wallow Spur. Two springs found at POI 14.
2/22/2017	Tom, Karlee			Arrive late afternoon to Spring Warrior Fish Camp.
2/23/2017	Tom, Karlee	Drone		Flew drone west of the boat ramp, down Big Spring Creek, over Orange Crush, Mark Horror Hole, and Gator Hole.
3/3/2017	Tom, Karlee	Drone Walk		Flew drone north of Tree Fork, over Casey, Poecilia, Mark Horror Hole, and north of Mark Horror Hole. Hiked into Mark Horror Hole.
3/8/2017	Tom, Karlee			Arrive late afternoon to Spring Warrior Fish Camp.
3/9/2017	Tom, Karlee	Boat	2, 33	Put boat in at Spring Warrior Fish Camp. Pittman boiling clear, but not long enough to sample. Took boat to Spring Creek and found a spring at POI 2. Nothing found at POI 33.
3/16/2017	Tom, Karlee	Foot	26, 47	Walked into eastern block of Spring Creek Unit. Confirmed location of TAY616991 at POI 47, no spring found at POI 26.
3/29/2017	Tom, Karlee	Boat		Attempted to sample Oyster Bar, flow was insufficient.
3/30/2017	Tom, Karlee	Boat		Returned to Poster Child and walked some of the salt marsh around there. No additional springs found.

Appendix1: Summary of field work days.

3/31/2017	Tom, Karlee			Saw pygmy rattlesnake driving out of the WMA.
4/12/2017	Tom, Karlee	Foot		Sampled TAY616992, and Orange Crush.
4/19/2017	Tom, Karlee			Arrive late afternoon to Spring Warrior Fish Camp.
4/20/2017	Tom, Karlee	Boat	3	Deployed In-Situ Aqua Troll 100 at TAY77044. Went up creek next to Kat Holland to check out POI 3. Nothing found there, but we located a spring upstream(Garmin). Walked from Garmin to a big cypress.
4/26/2017	Tom, Karlee	Boat		Attempted to sample Pitman but flow was insufficient.
4/27/2017	Tom, Karlee, Alan	Walk Boat		Sampled TAY77043 and Big Spring. Attempted to sample Oyster Bar again but flow was still insufficient.
4/28/2017	Tom, Alan			Return.
5/17/2017	Tom, Karlee	Foot		Collect In-Situ Aqua Troll 100 from TAY77044.
5/18/2017	Tom, Karlee	Foot		Redeploy In-Situ Aqua Troll 200 in TAY77044.
5/26/2017	Tom, Karlee	Foot		Collect In-Situ Aqua Troll 200 from TAY77044.

APPENDIX 2: SPRING CREEK UNIT INVENTORIED SPRING

Bishop



Location – Lat. 29° 58' 57.36" N, Long. 83° 45' 38.52" W.

Cataloged – December 8, 2016.

Sampled – No.

Description – Visited on December 8, 2016. Water temperature of 69.1°F measured with an infrared thermometer. Discernable flow out of the north side of pool.

Estimated Discharge – Less than 0.5 ft³/s.

Historical Data – No.

Thomas' Promise



Location – Lat. 29° 58' 43.32" N, Long. 83°45' 11.88" W.

Cataloged – December 8, 2016.

Sampled – Sampled by FGS on January 25, 2017. Sample ID is "BSC02".

Description – Spring pool of approximately 45' by 70'. Visited on December 8, 2016 at which point the water temperature was 73.4° F when measured with an infrared thermometer.

Estimated Discharge – 10 ft³/s.

Historical Data – No.

Bordom



Location – Lat. 29° 56' 24.72" N, Long. 83° 41' 29.40" W.

Cataloged – December 15, 2016.

Sampled – Sampled by FGS on January 25, 2017. Sample ID is "BSC01".

Description – Three-lobed spring pool containing five small vents, the largest of which is in the middle. The pool is shallow and clear with abundant iron staining concentrated around the vents. Iron staining decreases as you go downstream the run.

Estimated Discharge – 5 ft³/s.

Historical Data – No.

Tree Fork



Location – Lat. 29° 56' 02.76" N, Long. 83° 40' 44.40" W.

Cataloged – December 22, 2016.

Sampled – No.

Description – Small visible boil visible in the fork of a fallen tree in the ditch on the south side of Mule Wallow Road. Flow going in both directions of ditch, and steam coming off of the boil when visited on December 22, 2016.

Estimated Discharge – Estimated flow of 1 ft³/s.

Historical Data – No.

Red Moccasin



Location – Lat. 29 56' 32.64" N, Long. 83 41' 08.88" W.

Cataloged – December 22, 2016.

Sampled – No.

Description – Two small visible boils located in spring run, multiple fallen trees in run could be obscuring others. Abundant iron staining observed as well as a large water moccasin also stained red by iron oxide.

Estimated Discharge – Estimated flow of 3 ft³/s in the run between the two visible vents.

Historical Data – No.

Adah



Location – Lat. 29° 58' 16.32" N, Long. 83° 44' 44.16" W.

Cataloged – December 28, 2016.

Sampled – No.

Description – Located in the middle of Big Spring Creek. There is a single small vent of approximately 12" diameter with a small boil.

Estimated Discharge – 3 ft³/s.

Historical Data – No.

Seep 01



Location – Lat. 29° 57' 10.80" N, Long. 83° 41' 49.92" W.

Date Cataloged – December 29th, 2017.

Sampled – No.

Description – No point of discrete discharge occurring, however visible flow emanates from area.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

Seep 02

Location – Lat. 29° 57' 09.00" N, Long. 83° 41' 39.84" W.

Cataloged – December 29th, 2017.

Sampled – No.

Description – No photograph taken. Creek run had estimated 3-5 ft³/s flow, observed abundant iron staining and very small vent (about one quarter inch in diameter) found in the bank. .

Estimated Discharge – 0.1 ft³/s.

Historical Data – No.

2 Pines

Location – Lat. 29° 57' 26.64" N, Long. 83° 40' 59.16" W.

Date Cataloged – January 5th, 2017.

Sampled – No.

Description – No photograph taken. About 0.5 ft³/s cold freshwater flow observed in a small creek by two pine trees. No central vent.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

Orange Crush



Location – Lat. 29° 58' 32.16" N, Long. 83° 41' 53.52" W.

Cataloged – January 5, 2017.

Sampled – Sampled by FGS on April 12, 2017. Sample ID is “Orange”.

Description – Located about 800 feet east of the northern most culvert on Mule Wallow Spur. The spring pool is about 30 feet across with a single vent that runs into a shallow, ill-defined run. Iron staining is extremely plentiful. On our first visit on January 1st, 2017, the run had spilled into the surrounding area. When we returned on April 12th, 2017, flow was confined to the run.

Estimated Discharge – 5 ft³/s.

Historical Data – No.

Marie

Location – Lat. 29° 55 23.88” N, Long. 83° 41’ 39.84” W.

Cataloged – January 5, 2017

Sampled – No.

Description – No photograph taken. Walked in through an open gate in hopes of speaking to the land owner. The spring had a single boil located on the left near the middle of the creek. No contact was made with the land owner.

Estimated Discharge – 3 ft³/s.

Historical Data – No.

Gator Hole



Location – Lat. 29° 58' 43.32" N, Long. 83° 45' 11.88" W.

Date Cataloged – January 19th, 2017.

Sampled – No.

Description – Located upstream in Clay Creek, a tributary of Spring Warrior Creek. There is a single boil in a small pool at the head of a creek surrounded by a few live palms and dead cedar tree. A small boil was visible with somewhat turbid water. Numerous baby alligators were sighted as we approached the spring on January 19th, 2017. The baby gators were visible on drone footage taken a month later on February 23rd, 2017.

Estimated Discharge – 4 ft³/s.

Historical Data – No.

Lost

Location – Lat. 29° 59' 05.28" N, Long. 83° 45' 02.88" W.

Cataloged – January 25th, 2017.

Sampled – No.

Description – Located about 200 feet south of Spring Creek Island Tram. The spring consists of a single small vent with no visible boil but perceptible fourth magnitude flow.

Estimated Discharge – 0.25 ft³/s.

Historical Data – No.

Poster Child



Location – Lat. 29° 58' 15.24" N, Long. 83° 45' 22.68" W.

Cataloged – March 9th, 2017.

Sampled – No.

Description – The boil on this spring is barely discernable on normal high tide when accessed by boat. At low tide, the drone footage shows a small clear spring with visible discharge creating a run.

Estimated Discharge – 2 ft³/s.

Historical Data – No.

Garmin



Location – Lat. 29° 57' 45.72" N, Long. 83° 44' 16.08" W.

Cataloged – April 20th, 2017.

Sampled – No.

Description – There is a single small vent in the middle of the creek with a palm trunk going into it.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

MB



Location – Lat. 29° 56' 08.88" N, Long. 83° 42' 12.96" W.

Cataloged – February 2nd, 2017.

Sampled – No.

Description – Located upstream of a tidal creek in between Big Spring Creek and Spring Warrior Creek. There is a single small boil visible at high tide. Accessible by boat.

Estimated Discharge – 2 ft³/s.

Historical Data – No.

Casey



Location – Lat. 29° 56' 45.96" N, Long. 83° 42' 38.88" W.

Cataloged – February 17th, 2017.

Sampled – No.

Description – Located about two thirds of a mile west of the bend in Mule Wallow Spur, and accessible by foot. The spring is at the confluence of a small spring run with a tidal creek next to an oyster bar. There are two vents and discharging water appeared to be creating a halocline in creek.

Estimated Discharge – 3 ft³/s.

Historical Data – No.

Poecilia



Location – Lat. 29° 56' 47.40" N, Long. 83° 42' 38.16 " W.

Cataloged – February 17th, 2017.

Sampled – No.

Description – Located upstream of a small spring run. There is a single vent in a small pool of just a few feet in diameter at low tide. The spring harbored several *Poecilia latipinna* at low tide.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

Mark Horror Hole



Location – Lat. 29° 57' 29.17" N, 83° 41' 24.36" W.

Cataloged – March 3rd, 2017.

Sampled – No.

Description – Located approximately a mile south from Grantham Grade. Accessibly by foot if you stay on the tram that runs north from the spring to Grantham Grade, otherwise extremely difficult to reach. There is a single vent in a pool of about 30 feet in diameter, surrounded by an area of low brush and organic muck swamp of about 375 feet in diameter.

Estimated Discharge – 5 ft³/s.

Historical Data – No.

Needlerush



Location – Lat. 29° 53' 23.88" N, Long. 83° 44' 43.44" W.

Cataloged – January 29th, 2016.

Sampled – No.

Description – Spring and run can easily be seen in drone footage. Run goes nearly parallel with the road and spring is around 250 feet from the road. Needle Rush is plentiful in the area and surrounds the spring.

Estimated Discharge – 0.25 ft³/s.

Historical Data – No.

Mud Hole



Location – Lat. 29° 58' 20.64" N, Long. 83° 44' 44.88" W.

Cataloged – January 29th, 2016.

Sampled – No.

Description – Small and muddy spring identified from drone footage. Mixed vegetation in the area with obvious clearing where spring is located. Located approximately about 225 feet west of the Big Spring Creek boat ramp.

Estimated Discharge – 0.25 ft³/s.

Historical Data – No.

Taylor Blue



Location – Lat. 29° 58' 19.56" N, Long. 83° 44' 44.88" W.

Cataloged – January 29th, 2016.

Sampled – No.

Description – Spring located along the bank of a run that comes off the Big Spring Creek and was identified from drone footage. Spring vent area can be seen at base of Sabal palm at the center of the bottom of the photograph.

Estimated Discharge – 2 ft³/s.

Historical Data – No.

KF



Location – Lat. 29° 58' 15.24" N, Long. 83° 44' 48.84" W.

Cataloged – January 29th, 2016.

Sampled – No.

Description – Spring identified from drone footage. The spring is in a run that connects to Big Spring Creek. The spring sits in an inlet just off the run. It is probably one of the vents that supplies flow to this unnamed tributary to Big Spring Creek. It is believed this could be previously cataloged by the SRWMD as TAY69992 and FGS as Big Spring Creek 4.

Estimated Discharge – 3ft³/s.

Historical Data – No.

Skid



Location – Lat. 29° 58' 17.40" N, Long. 83° 45' 03.60" W.

Cataloged – February 23rd, 2017.

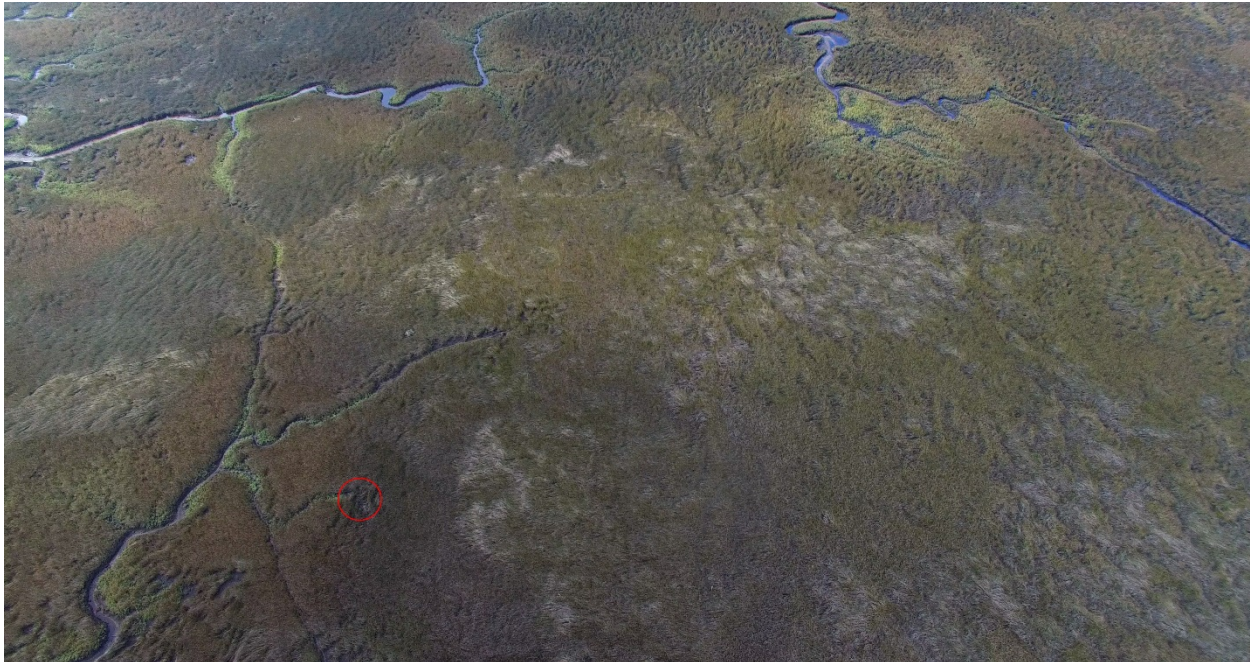
Sampled – No.

Description – Spring identified from drone footage. Evidence of flow and displacement of muck can be clearly seen.

Estimated Discharge – 1 ft³/s.

Historical Data – No.

Gud



Location – Lat. 29° 58' 11.28" N, Long. 83° 45' 03.60" W.

Cataloged – February 23rd, 2017.

Sampled – No.

Description – Spring identified from drone footage.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

Owen



Location – Lat. 29° 58' 10.20" N, Long. 83° 45' 05.04" W.

Cataloged – February 23rd, 2017.

Sampled – No.

Description – Spring identified from drone footage.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

JAD



Location – Lat. 29° 58' 09.12" N, Long. 83° 45' 10.08" W.

Cataloged – February 23rd, 2017.

Sampled – No.

Description – Spring identified from drone footage. Evidence of flow and displacement of muck can be seen in the run that leads towards the larger waterway. Two, maybe three vents exist in this area. The area is muddy and mucky.

Estimated Discharge – 0.5 ft³/s.

Historical Data – No.

Big Spring



Location – Lat. 29° 58' 27.15" N, Long. 83° 44' 20.11" W.

Cataloged – June 6, 1999.

Sampled – Sampled by FGS on April 27, 2017. Sample ID is “Big Spring”.

Description – Head spring of Big Spring Creek. Located east of Spring Creek Road and south of Loughridge Grade. Large spring pool of approximately 60' by 80' with spring run exiting to the east before turning south, then south west. Accessible by foot and difficult by kayak or canoe due to tree debris in run.

Estimated Discharge – 15 ft³/s.

Historical Data – Yes.

TAY77043 (“Boat Ramp”)



Location – Lat. 29° 58' 20.64" N, Long. 83° 44' 40.56" W.

Cataloged –July 7, 2004.

Sampled – Sampled by FGS on April 27, 2017. Sample ID is “TAY77043”.

Description – Located directly east of the parking lot area at the boat ramp, approximately 70 feet east of the pavilion. A single vent discharges clear water into a run of approximately 150 feet in length where it conflues Big Spring Creek. Easily accessed by a small footpath at the boat ramp parking area.

Estimated Discharge – 6 ft³/s.

Historical Data – Yes.

TAY77044 (“La Bella”)



Location – Lat. 29° 58’ 19.21” N, Long. 83° 44’ 41.66” W.

Cataloged –July 7, 2004.

Sampled – No.

Description – Located approximately 100 feet upstream from the boat ramp, and easily accessed by a small footpath at the boat ramp parking area. The spring is approximately 8 feet across and flows from a single small vent. There is a palm tree log lodged into the vent. FGS deployed an In-Situ Aqua Troll Data Logger from April 20th, 2017 to May 26th, 2017.

Estimated Discharge – 3 ft³/s.

Historical Data – Yes.

TAY77041



Location – Lat. 29° 58' 19.21" N, Long. 83° 44' 45.99 W.

Cataloged – July 7, 2004.

Sampled – No.

Description – Located approximately 300 feet southwest of the boat ramp. The spring is a small vent incised into the bank of the first tributary to Big Spring Creek downstream of the boat ramp. Accessible by boat.

Estimated Discharge – 1.5 ft³/s.

Historical Data – Yes.

Big Spring Creek 1



Location – Lat. 29° 58' 17.75" N, Long. 83° 44' 43.55" W.

Cataloged –January 10, 2009.

Sampled – No.

Description – The spring is a single small vent located in the west bank of Big Spring Creek. Approximately 250 feet downstream of the boat ramp.

Estimated Discharge – 0.5 ft³/s.

Historical Data – Yes.

Big Spring Creek 2



Location – Lat. 29° 58' 17.04" N, Long. 83° 44' 43.08" W.

Cataloged – January 10, 2009.

Sampled – No.

Description – The spring is a single boil located in the middle of Big Spring Creek, immediately downstream of Big Spring Creek 2.

Estimated Discharge – 3 ft³/s.

Historical Data – Yes.

TAY77042 ("Big Spring Creek 3")



Location – Lat. 29° 58' 16.32" N, Long. 83° 44' 43.44" W.

Cataloged – July 7, 2004.

Sampled – No.

Description – Located in the eastern bank of Big Spring Creek, approximately 400 feet downstream of the boat ramp. Discharge can be seen during low tide.

Estimated Discharge – 0.5 ft³/s.

Historical Data – Yes.

Big Spring Creek 5



Location – Lat. 29° 58' 11.28" N, Long. 83° 44' 44.44" W.

Cataloged –January 10, 2009.

Sampled – No.

Description – One of two springs located approximately 1500' downstream of the boat ramp in the mouth of a small tributary to Big Spring Creek. There is a capsized boat at the confluence with Big Spring Creek. Big Spring Creek 05 is in the middle of the creek immediately before it runs into Big Spring Creek proper.

Estimated Discharge – 5 ft³/s.

Historical Data – Yes.

TAY69991 (“Big Spring Creek 6”)



Location – Lat. 29° 58' 11.66" N, 83° 44' 43.43" W.

Cataloged – June 9, 1991.

Sampled – Sampled by FGS on January 26, 2017. Sample ID is “BSC-06”.

Description – One of two springs located approximately 1500’ downstream of the boat ramp in the mouth of a small tributary to Big Spring Creek. There is a capsized boat at the confluence with Big Spring Creek. Big Spring Creek 6 is located about 75 feet upstream the tributary from its confluence with Big Spring Creek. There is a single vent incised in the bank with a vigorous boil.

Estimated Discharge – 4 ft³/s.

Historical Data – Yes.

TAY69992 (“Big Spring Creek 4”)



Location – Lat. 29° 58' 14.88" N, Long. 83° 44' 47.76" W.

Cataloged – June 9, 1999.

Sampled – No.

Description – Clear spring flow observed in unnamed tributary running into Big Spring Creek, previously documented by both Suwannee River Water Management and FGS at the confluence with Big Spring Creek. One spring vent identified at above location using drone footage and named KF spring.

Estimated Discharge – 5 ft³/s.

Historical Data – Yes.

Kat Holland



Location – Lat. 29° 57' 41.76" N, Long. 83° 44' 35.88" W.

Cataloged – January 10, 2009.

Sampled – Sampled by FGS on February 1, 2017. Sample ID is “Kat Holland”.

Description – Located on the side of a small tidal creek that feeds into Big Spring Creek. There are three vents with a small bar alongside them visible at low tide. Two of the vents are in very close proximity to each other with a septum of less than a foot in width separating them.

Estimated Discharge – 3 ft³/s.

Historical Data – Yes.

Oyster Bar



Location – Lat. 29° 57' 28.08" N, Long. 83° 44' 49.20" W.

Cataloged – January 10, 2009.

Sampled – No.

Description – Located in between two oyster bars in the mouth of Big Spring Creek. Flow was not observed during multiple visits in December and January 2017. The above picture was taken on February 1, 2017, when Oyster Bar was first observed flowing. Since then flow has been intermittent, ranging between no visible flow to third magnitude flow and occasionally even second magnitude flow. Two attempts to sample Oyster Bar were unsuccessful due to insufficient flow.

Estimated Discharge – highly variable 8 ft³/s to no flow.

Historical Data – Yes.

TAY616991(“Pittman”)



Location – Lat. 29° 55' 09.84" N, Long, 83° 40' 56.28" W.

Cataloged – June 16, 1999.

Sampled – No.

Description – Located just outside the mouth of Spring Warrior Creek. There is a single boil that was observed to have intermittent flow ranging from almost imperceptible to third magnitude discharge. Two attempts to sample this spring were unsuccessful due to insufficient flow. Spring vent was observed to be clear for a few minutes before going turbid on a negative tide.

Estimated Discharge – 0.25 to 3 ft³/s.

Historical Data – Yes.

TAY616992 (Oman")



Location – Lat. 29° 54' 45.62" N, Long. 83° 39' 03.65" W.

Cataloged– June 16, 1999.

Sampled – Sampled by FGS on April 12, 2017. Sample ID is “TAY 616992”

Description – Located in the eastern portion of the Spring Creek Unit, south of Little Spring Road. There is a large spring pool of approximately 50 feet in diameter with four visible boils. Water was tinged slightly green. Just downstream of the spring pool the run braids into three runs that eventually merge back together. On the day, the FGS sampled it was tannin and slightly turbid.

Estimated Discharge – 25 ft³/s.

Historical Data – Yes.