

Howard T. Odum Florida Springs Institute

BLUEPRINT FOR RESTORING SPRINGS ON THE SANTA FE RIVER



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SPRINGS
INSTITUTE**



Egret and turtles on the Santa Fe River, 2017. Photo by John Moran.

Contents

Summary.....	2
Overview.....	4
Status of the Resource.....	12
Restoration Goals.....	15
Blueprint for Springs Restoration.....	20
Implementation of Springs Restoration Blueprints.....	26
Concluding Remarks.....	28
References.....	29

Blueprint for Springs Restoration

Summary

Baseline

- Based on historic records, about 75 percent of the average flow in the Santa Fe River was provided by springs. This influx of pure groundwater-maintained flows in the river throughout multi-year droughts and nourished flourishing populations of aquatic plants and animals.

Problems

- Total spring flows to the Santa Fe River have declined on average by 20 percent compared to the earliest baseflow records. Extreme spring flow declines are greatest upstream at Worthington Spring,

Santa Fe Spring, River Rise, Hornsby Spring, and Poe Spring, with zero flow and flow reversals evident during low rainfall periods. Significant flow declines are also documented in downstream springs, including Gilchrist Blue, the Ginnie Springs Group, and the Ichetucknee Springs System.

- Long-term declining spring flow trends are the result of increasing groundwater extractions for urban and agricultural development. When rainfall variations are accounted for, the spring flow decline in the entire Santa Fe River is about 200 million gallons per day (MGD).
- Over the past 70 years of record, nitrate nitrogen concentrations in individual Santa Fe River springs have increased between 1,000 and 80,000 percent, and by an average of 2,600 percent in the Lower Santa Fe River. The current average nitrogen pollutant load in the river is about 1,900 tons per year with more than 95 percent coming into the river from spring flows.
- Natural spring and river plant communities have largely disappeared or been replaced by filamentous algae. With reduced cover of the native plants at the base of the aquatic food web, fish and other wildlife populations have also declined.
- Recreational use of the Santa Fe River springs has also increased over the past century with current use estimated over one million visitors per year.
- The combined effects of declining spring flows, increasing nitrogen pollution, and inadequately controlled recreation are evidenced by impaired ecological health of the Santa Fe River's many springs.

Solutions

- Three restoration benchmarks are recommended to restore the Santa Fe River springs: 1) restoration of 95 percent of historic flows, 2) river and spring-wide compliance with Florida's numeric nutrient standard for nitrate nitrogen in springs of 0.35 parts per million (ppm), and 3) implementation of protective recreational carrying capacities for all publicly-owned springs and surface waters along the Santa Fe River.
- Spring flow recovery will necessitate a local and regional combined reduction of groundwater pumping by about 150 MGD, or one third of current regional pumping levels.
- Compliance with the state's nitrate nitrogen pollution criterion will necessitate reducing existing fertilizer and wastewater nitrogen inputs to the groundwater by about 1,675 tons per year or about 80 percent of existing loads. This goal can be attained by converting about 135,000 acres of intensive agriculture to longleaf pine plantations.
- Science-based human-use carrying capacity limits need to be implemented for all public springs.

Implementation

- A variety of options exist in current law to make progress towards restoration of the springs feeding the Santa Fe River. Additional measures that would help these springs recover, as well as many of the other springs in the state, include capping groundwater extractions and nitrogen fertilizer use at sustainable levels, and enacting fees on all groundwater extractions and nutrient loads to the aquifer. Protective recreational carrying capacities need to be established and enforced by state and county agencies for all public-use springs and for the entire Santa Fe River.

Overview

Introduction to the Santa Fe River and Springs

The Santa Fe River stretches for 75 miles across North Florida, originating in Lake Santa Fe and the Santa Fe Swamp north of Melrose on the east, and discharging into the Suwannee River south of Branford on the west (Figure 1).

The Santa Fe River is naturally divided into two different hydrogeologic systems. The Upper (eastern) Santa Fe River is fed by a combination of rainfall and runoff into Lake Santa Fe and the blackwater swamps of the Florida Highlands which are underlain by a thick clay stratum (Hawthorn Formation) and disappears underground through River Sink, an ancient sinkhole just west of Interstate 75 at O’Leno State Park. The Lower Santa Fe River starts three miles south at River Rise - a resurgence spring that discharges a combination of the lost surface flows from River Sink in O’Leno State Park and clear groundwater from the surrounding Floridan Aquifer. The Lower Santa Fe River receives a blend of highly variable blackwater inflows from the upper river and relatively constant clear groundwater flows to the lower river from the springs draining the underlying Floridan Aquifer. More than 30 named and unnamed springs with a combined springshed area of 2,423 square miles discharge their groundwater flows into the Upper and Lower Santa Fe River¹.

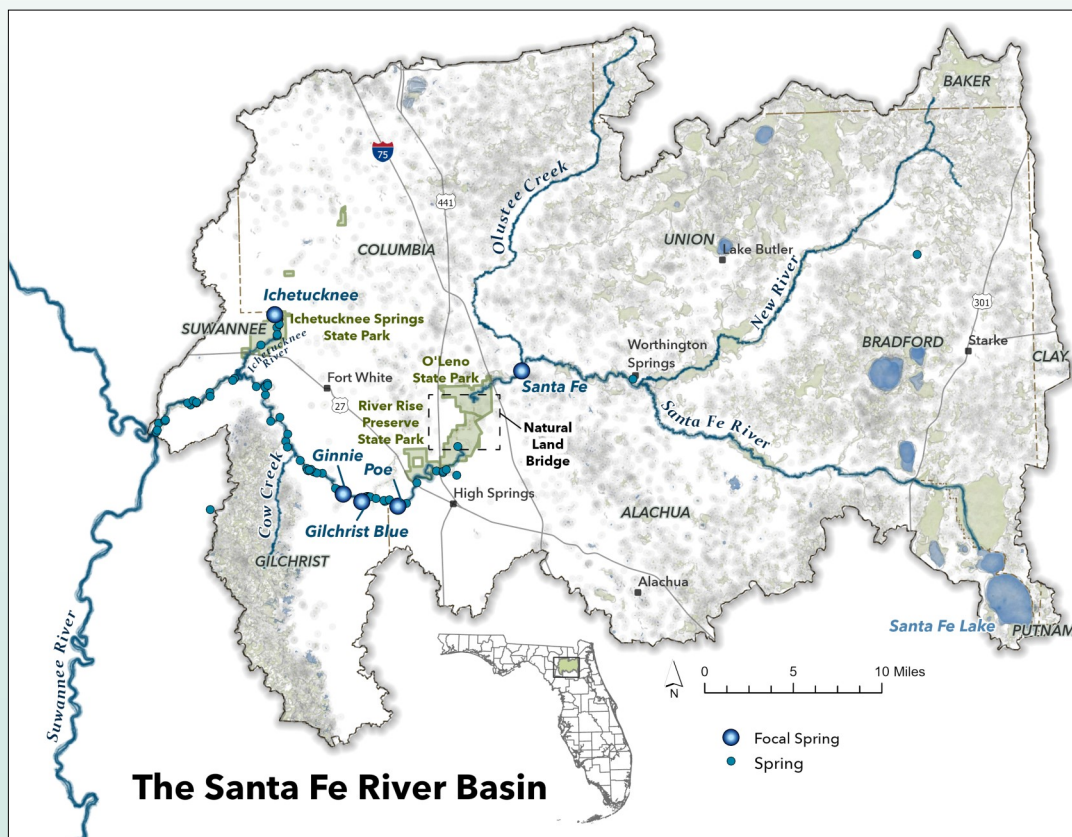


Figure 1. The Santa Fe River surface water basin includes about 1,384 square miles and extends from Clay and Putnam counties on the east to Suwannee and Gilchrist counties on the west.

¹ FSI 2012a, 2012b, 2017, 2020

The historic long-term average flow of the Santa Fe River at its confluence with the Suwannee River was about 2,200 cfs (1,400 million gallons per day [MGD]) . On average 75% of that average flow was derived from groundwater inputs, or about 1,630 cfs (1,050 MGD).

The surface watershed that feeds tannic water to the Upper Santa Fe River encompasses over 1,384 square miles of highlands and lowlands and includes two major tributaries to the Upper Santa Fe River. These are the New River just upstream from the town of Worthington Springs, and Olustee Creek, 9.3 miles downstream from Worthington Springs. While the Upper Santa Fe River is predominantly tannic in nature, there are two named springs upstream of the O'Leno River Sink and the Lower Santa Fe River.

The first named spring upstream is Worthington Spring where the upper river is crossed by SR 121. This historic second magnitude spring stopped flowing in the 1950s. The second named spring downstream is Santa Fe Spring (aka Graham Spring and COL61981), located about one mile upstream from I-75 and half a mile downstream of the Olustee Creek confluence. Formerly a first magnitude spring, Santa Fe Spring has a large and deep spring pool and continues to flow during wet climatic periods but stops flowing during droughts and reverses during ensuing floods.

Below River Rise the Lower Santa Fe River flows through the karst lowlands and is predominantly spring fed. Dozens of karst features, including springs, swallets, and surface water resurgences dictate the lower river's hydrology upstream of its confluence with the Suwannee River. Other than the river resurgence flow at River Rise, the next largest point inflow to the Lower Santa Fe River is the Ichetucknee River, about 7 miles upstream of the Suwannee River confluence. The majority of this inflow is derived from groundwater flowing out of eight named and numerous unnamed springs that feed the Ichetucknee River. Cow Creek provides a relatively small and intermittent surface water inflow to the Lower Santa Fe River, above its confluence with the Ichetucknee River.



FDOT Springs Protection Zone signage marks the boundaries of the river's springsheds. Photo by John Moran.

Evidence of Harm

The Santa Fe River was long one of the most pristine rivers in the state of Florida². Even today there are no permitted surface pollutant discharges from agricultural, municipal, or industrial pollution sources directly into the river. Neither are there any permitted surface water withdrawals from the Santa Fe River. The Santa Fe River and springs have a long history of human use for subsistence and sport fishing and more recently for water-based recreation such as paddle sports, tubing, and skin/scuba diving.

By the 1980s, increasing impairment was evident in the river as nitrate nitrogen concentrations increased and spring inflows declined. In response to this visible impairment, the entire Santa Fe River and its tributaries and springs were designated by the State as Outstanding Florida Waters (OFWs) in 1986, the highest water quality protection afforded by Florida's government to natural surface waters. At that time, it was already recognized that concentrations of nitrogen, mercury, and coliform bacteria in the Santa Fe River were above water quality standards³.

The Santa Fe River was placed on Florida's list of impaired waters based on these water quality impairments. A Total Maximum Daily Load (TMDL) was established for nitrogen, dissolved oxygen, and coliform bacteria concentrations in the Santa Fe River in 2008⁴. The first Basin Management Action Plan (BMAP) intended to correct these water quality violations was approved and implemented in 2012⁵. In light of continuing water quality degradation through the next five years the Santa Fe River and Springs BMAP was revised in 2018⁶, following designation of six springs on the Lower Santa Fe River as Outstanding Florida Springs (OFS) by the Florida Springs and Aquifer Protection Act of 2016. In conjunction with the earlier OFW status described above, the relatively recent OFS designation is the highest level of water quality protection for Florida's springs.

Through an administrative challenge the updated Santa Fe River and Springs BMAP was found to be inadequate to restore protective water quality in the river and springs in a timely manner. At the time of this writing the degraded water quality in the river and springs continues to worsen⁷.

The cessation of flow at Worthington Spring reported to have occurred in the 1950s was an early warning that spring baseflows into the Santa Fe River were declining. The Suwannee River Water Management District (SRWMD) staff recognized that flows in the Upper Santa Fe River were declining by the 1990s⁸. However, a regulatory limit on those flow reductions was not enacted until 2007 when the SRWMD adopted a regulatory Minimum Flow and Level (MFL) for the Upper Santa Fe River⁹. While that MFL did not call for recovery, in 2007 it was clear based on the data, that this limit on minimum flows was not being met at the time the rule became effective¹⁰.

By 2012, publication of the Howard T. Odum Florida Springs Institute's (FSI's) Santa Fe River Restoration Action Plan documented that flows in the entire river were below historic levels, primarily

² Suwannee Coalition 1983

³ FDEP 2008

⁴ Ibid

⁵ FDEP 2012

⁶ FDEP 2018

⁷ FSI 2020

⁸ Hornsby and Ceryak 1998

⁹ Grubbs and Crandall 2007, WRA 2006

¹⁰ FSI 2012a

as a result of declining spring groundwater baseflows¹¹. In 2015 the SRWMD in partnership with the St. Johns River Water Management District (SJRWMD) and the Florida Department of Environmental Protection (FDEP) adopted an MFL for the Lower Santa Fe River and Springs that declared that flow declines were already past the point of “significant harm”¹².

In 2015 the state agencies published a “Prevention and Recovery Strategy” for the Santa Fe River, its major tributary the Ichetucknee River, and the remaining springs¹³. The state’s prevention and recovery strategy recognized the effects of regional groundwater pumping (an average of 450 MGD in the counties surrounding the Santa Fe Springshed¹⁴) on the noted flow declines and led to development of a Regional Water Supply Assessment that called for restoring groundwater resources¹⁵. However, no efforts were made by the water management districts to limit or to stop issuance of new water use permits authorizing groundwater extractions throughout the region supplying flows to the springs of the Santa Fe and Ichetucknee rivers.

Data analysis by FSI and the District’s consultants presented to the state agencies in 2012 indicated that actual harmful flow reductions in the Santa Fe River and springs were greater than concluded by the state¹⁶. In fact, the documented flow regimes for the Upper and Lower Santa Fe River have consistently remained below the reduced flows allowed by the 2007 and 2015 MFLs. Efforts are currently underway by the SRWMD and FDEP to re-evaluate those MFLs and possibly to further lower the regulatory limit for minimum flows¹⁷. The irony is that even the draft new lower minimum flow will not be and has not been consistently achieved in more than 20 years.

While regulatory limits on maximum pollutant loads and minimum flows are intended to define harmful limits not to be exceeded, the reality is that the ecological systems supported by the Santa Fe River and associated springs have been suffering from harm for multiple decades. The last three years of focused studies by FSI, in ongoing consultation with a suite of state and federal agency scientists, confirms that the springs and spring runs are significantly harmed as evidenced by reduced water clarity, increased nuisance algae communities, lower food chain support, and diminished populations and productivity of wildlife and the plants they rely on for nourishment¹⁸.



Ichetucknee Headspring at Ichetucknee Springs State Park. Photo by Anne Barca.

¹¹ Ibid

¹² SRWMD 2013

¹³ SRWMD 2015

¹⁴ Marella 2015

¹⁵ FDEP and SJRWMD

¹⁶ FSI 2012a; Intera 2012

¹⁷ Dunn 2020

¹⁸ FSI 2020

Remedies

Effective, legal, and affordable remedies are available for all of these impairments. With governmental vision, leadership, and determination, the Santa Fe River and springs can recover much of their historic ecological structure and function. A Santa Fe Springs Restoration Blueprint and achievable restoration goals are described in the next section of this document for each of the stressors described above.

While different springs and segments of the Santa Fe River will require site specific actions to achieve restoration, the basic principles are similar or identical throughout the Santa Fe springshed. As a preview, general remedies that will restore and protect the Santa Fe River and springs include the following:

- Restoring lost spring flows will be accomplished by reducing local and regional groundwater extractions.
- Reducing nitrate nitrogen pollution will be achieved by limiting excessive springshed fertilizer inputs and by upgrading animal and human wastewater management practices.
- Limiting recreational impacts will be attained by establishing and enforcing human carrying capacity limits in all public waters.

Each of these necessary efforts can be implemented in a phased manner and accompanied by ongoing monitoring of the springs and river. Feedback from these reassessment efforts can be used to inform efficacy of specific actions and used to adaptively manage restoration and protection efforts. Successful protection and restoration of the Santa Fe River and springs will provide a blueprint template for other springs and water body restoration efforts statewide.

Descriptions of Representative Spring Groups

A quantitative, data-based blueprint for overall restoration and protection of the Santa Fe River and springs is provided below. In addition to the overview plan, site-specific blueprints are provided for three key spring systems of varying size that contribute flows and nutrients to the Santa Fe River. These individual contributing areas from upstream to downstream include Santa Fe Spring, the combined Poe-Gilchrist Blue-Ginnie Springs System, and the Ichetucknee Spring System. Each of these individual restoration units is described as follows. Finally, a blueprint for restoration of all of the springs feeding the Santa Fe River is outlined based on the same principles.

Santa Fe Spring

Santa Fe Spring is an historic first magnitude spring with a median measured flow greater than 100 to 150 cfs¹⁹. Under private ownership until 2019, Santa Fe Springs has received minimal recreational use. Flow monitoring has been spotty at Santa Fe Spring with a high flow of 150 cfs reported by the SRWMD in 1998 and a maximum flow reversal recorded in 2002 as negative 200 cfs²⁰. The number of flow records at Santa Fe Spring has increased since FSI began conducting routine monitoring three years ago²¹. During this recent period, outflows have been positive and averaged 93 cfs with a

¹⁹ Hornsby and Ceryak 1998, FGS 2004

²⁰ WRA 2006

²¹ FSI 2020

measured range between 53 and 113 cfs. Estimated and observed flow reversals at Santa Fe Spring have occurred with increasing frequency since 2001²². Historic water quality data for Santa Fe Spring are not available but recent nitrate concentrations average 0.46 mg/L and are about twice as high as nitrate concentrations in the adjacent river.

The water flowing out of Santa Fe Spring is tannic-colored with reduced clarity and the spring pool lacks submerged aquatic vegetation. Santa Fe Spring was acquired by Alachua Conservation Trust in 2019 and has been placed in a perpetual easement for conservation. It is likely that it will be opened for limited recreational use in the future.

Poe, Blue, Ginnie Springs System

Poe Spring

Poe Spring is a second magnitude spring owned and managed by Alachua County as a public recreation and nature study park. Poe Springs was historically utilized for recreation long before county acquisition in 2004²³. The earliest available flow records for Poe Spring indicate that it had an average discharge of 72 cfs for the period from 1917 to 1972²⁴. There is no record of flow cessation or reversal at Poe Spring before 2012 when flows at River Rise, Hornsby Spring, Treehouse Spring, Columbia Spring, and US 27 stopped and the upper half of the Lower Santa Fe River was stagnant, experienced a massive bloom of noxious algae, and loss of water clarity. In May 2012 Poe Springs' flow was measured as 2 cfs. Between June 24 and 26, 2012, Tropical Storm Debby delivered more than 11 inches of rainfall in Alachua County and the Santa Fe River stage increased by more than 14 feet within a week, backflowing into the Poe Spring vent and spreading tannic water through the underlying caves of the Floridan Aquifer. Although positive flows at Poe Spring had recovered within a few months, average flows have been 42 cfs over the past 2 years and water discharging from Poe Spring continues to be slightly tannic, imparting a yellow-brown to green tint to the water and reducing water clarity and primary productivity²⁵. Nitrate concentrations measured at Poe Spring were consistently declining from 1.76 in 1996 to a low of less than 0.1 mg/L in 2012. Since that time nitrate concentrations are demonstrating an increasing trend with a recent average of 0.30 mg/L during the past two years.

Gilchrist Blue Springs Group

The Gilchrist Blue Spring Group is currently owned by the State of Florida and is managed as the Ruth B. Kirby Gilchrist Blue Springs State Park. There are four named springs comprising this spring system, in order from highest to lowest flow: Gilchrist Blue Spring, Naked Spring, Little Blue Spring, and Johnson Spring. Prior to acquisition of this spring group and 402 acres by the Florida Park Service in October 2017, Gilchrist Blue Springs was a private commercial recreational site. The earliest recorded development of Gilchrist Blue Spring as a recreational site is in the 1950s. The earliest reported flow records for the Gilchrist Blue Spring run averaged 99 cfs in 1975²⁶. Average flows at this spring during the past ten years are 75 cfs for the entire springs group. Nitrate concentrations measured at Gilchrist Blue Spring were fairly constant at 1.7 mg/L between 1992 and 2004. Since 2004 nitrate concentrations at this spring have been consistently rising to the current average of 2.25 mg/L.

²² WRA 2006

²³ ACEPD 2004

²⁴ Rosenau et al. 1977

²⁵ FSI 2020

²⁶ Rosenau et al. 1977

Gilchrist Blue Spring and its 1,000-foot spring run to the Santa Fe River have been well vegetated during recent history and has accommodated large numbers of turtles and fish. Shortly after state acquisition in September 2017, Hurricane Irma delivered nearly a foot of rain over a two-day period and the Santa Fe River rose rapidly by about 18 feet at the upstream US 441 gauge. While this dark, tannic water did not create a reverse flow into the aquifer at Gilchrist Blue Spring, it did cover the spring and spring run for several months, killing off the majority of the rooted vegetation in the spring run. Heavy recreational use between that die off and initiation of a prohibition on wading in the spring run kept it largely unvegetated. Under current park management and very high public use, the head spring pool receives almost constant foot traffic and has very little vegetation and minimal wildlife use. The adjacent secondary spring, Naked Spring, has been placed off limits for recreation by the Florida Park Service. Native and exotic vegetation is rapidly recolonizing this spring and much of the spring run since these restrictions were imposed by the state. With returning vegetation in the spring run, FSI has documented increases in fish and other wildlife populations at the Gilchrist Blue Spring System²⁷.

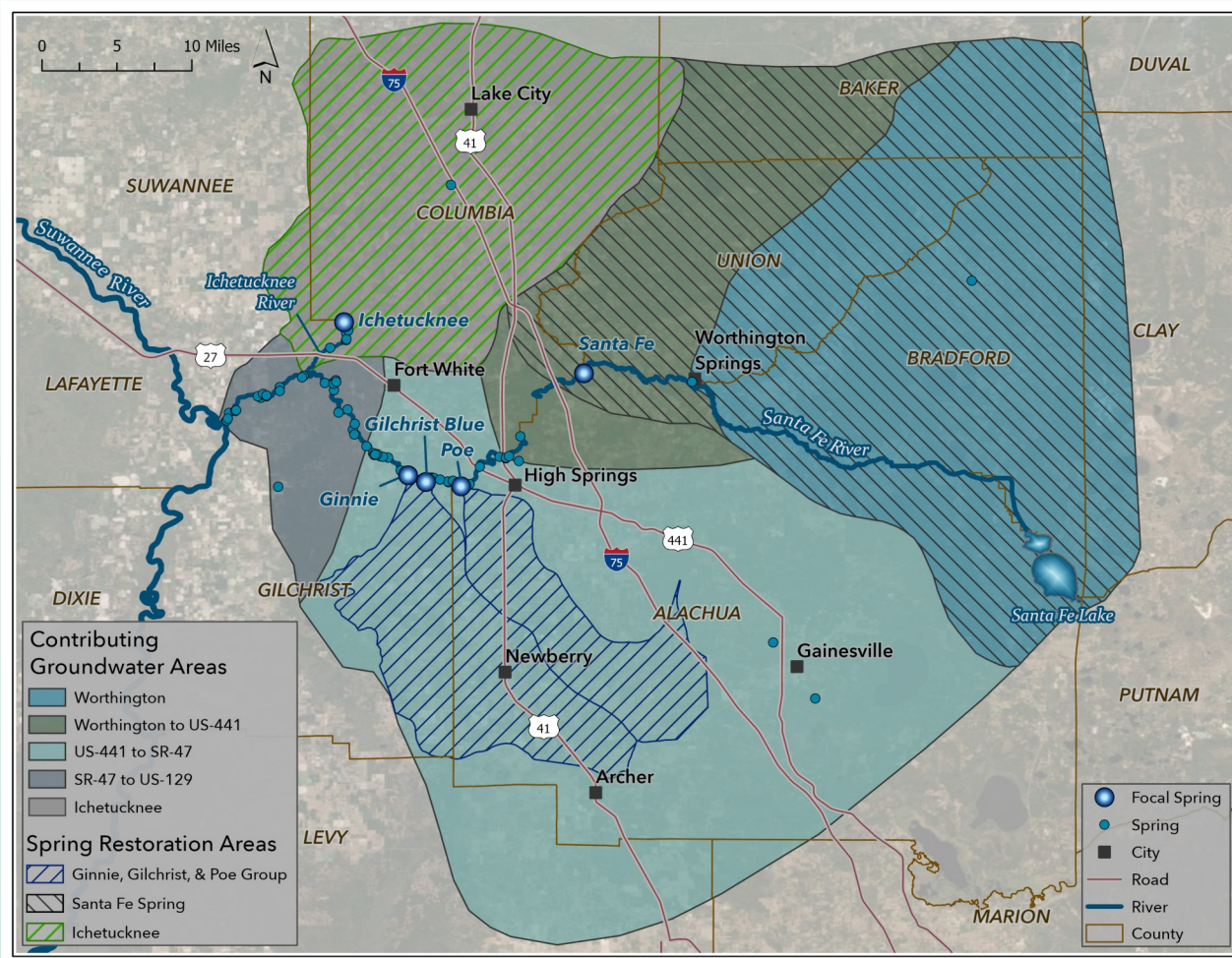


Figure 2. Maximum-extent springsheds feeding groundwater to the Santa Fe River and Springs. The combined springshed area that feeds the springs along the Santa Fe River encompasses about 2,423 square miles.

²⁷ FSI 2020

Ginnie Springs Group

Ginnie Springs Outdoors (GSO) is a privately-owned recreational park located downstream of Gilchrist Blue Spring State Park in the northeastern portion of Gilchrist County, approximately three miles west of the Alachua County line and 350 feet south of the Columbia County line. A total of seven named springs including Ginnie Spring, Devil's Eye, Devil's Ear, Little Devil, Dogwood Spring, Deer Spring, and Twin Spring are located on or adjacent to and immediately south of the Santa Fe River. The GSO park is one of the most popular private spring recreation sites in the State of Florida and is renowned for its cave diving opportunities. Camping is permitted on the property and facilities exist in each spring to facilitate access to the water via stairs to avoid erosion of the spring banks.

Devil's Ear Spring is located in the river channel and flows must be calculated by upstream-downstream difference. The combined flow of these seven springs was estimated by Karst Environmental Services as 243 cfs in the late 1980s. The flow from the remaining six named springs was reported as 98 cfs in the 1980s and more recently reported as 48.5 cfs in 2012-2013. During that period, the smaller springs in the group were found to have negative (reverse) flows during river flooding events. There is presently no record of full flow reversals in Ginnie and Devil's Springs. Measured nitrate concentrations in Ginnie Springs have increased from 1.24 mg/L in the mid-1990s to an average of 1.56 mg/L during the most recent period (2018 to 2020). All of the springs at GSO are seasonally impacted by recreational activities.

Ichetucknee Springs System

The Ichetucknee River and springs has a long history of human use with abundant evidence of prehistoric and historic cultural uses extending back at least 15,000 years before present²⁸. The upper half of the Ichetucknee River, eight named springs, and 2,669 acres of surrounding land was acquired by the State of Florida and established as Ichetucknee Springs State Park in 1970. Flows have been reported for the Ichetucknee River and springs for about 90 years. During that period, average flows have declined by an estimated 10 to 20%, independent of rainfall fluctuations. In 2011 a hydrologist with the U.S. Geological Survey concluded that the observed flow reduction was due in large part to regional groundwater pumping in northeast Florida and southeast Georgia²⁹. Based on continuing data analysis FSI has reached the same conclusion.

The record of nitrate nitrogen concentrations in the Ichetucknee River and springs starts in 1946 and continues through the present. Nitrate nitrogen concentrations have increased from less than 0.23 mg/L in 1946 to an average of 0.80 mg/L over the past two decades. Unlike many other Florida springs, nitrate levels in the Ichetucknee springs have been fairly consistent and appear to have leveled-off over the past 20 years, indicating that human nitrogen sources in the springshed have not changed greatly during this period. Ichetucknee Springs is the first Florida state park to have a recreational use carrying capacity. Tubers entering the river near the head spring have been limited to no more than 750 per day since May 1989 based on the findings of a research study conducted by a UF graduate student in the 1970s³⁰. While the Ichetucknee springs and river continue to be well-vegetated with native SAV plant species, there has been a marked decrease in the species diversity of those plants³¹.

²⁸ FSI 2012a

²⁹ Grubbs 2011

³⁰ DuToit 1979

³¹ FSI 2012b

Status of the Resource

Florida's agricultural, industrial, and urban development has been responsible for the ongoing depletion and pollution of the Floridan Aquifer^{32,33}. Groundwater extractions from the Floridan Aquifer average nearly 4 billion gallons each day, with much higher pumping rates during dry years³⁴. Compared to estimated pre-development conditions, aquifer levels have declined over much of its extent, resulting in an average decline in Florida spring flows by about one third³⁵.

Agricultural and urban nitrogen fertilizer and wastewater loads to the surface of the vulnerable lands overlying the underground aquifer exceed 340 million pounds each year³⁶. As a result of these controllable loads, nitrate nitrogen concentrations in the Floridan Aquifer and springs have risen from a natural background of about 0.05 mg/L to an average of nearly 1 mg/L, an average increase of 1,900 percent. Over 80 percent of Florida's 1,000+ springs are impaired by elevated concentrations of nitrate nitrogen as determined by FDEP's spring standard of 0.35 mg/L. As described below, the springs nourishing the Santa Fe River are no exception to this regional decline in Florida's aquatic and water resources environment.

An estimated 30 million visitors utilize Florida's springs each year. The estimated annual direct revenues generated by springs-related activities is \$1 billion, equivalent to a natural annual income-providing endowment of \$30 million³⁷. A university study of the economic importance of springs in the Santa Fe River Basin indicated that about 1 million people visit these local springs annually with a resulting economic impact of about \$94 million³⁸. As visitation at the Santa Fe River springs increases, the lack of limitations and guidance on sustainable human uses becomes more apparent. Science-based recreation carrying capacities need to be developed and implemented in all of the springs feeding the Santa Fe River.



Inner tubers with algae on the Ichetucknee River, 2014. Photo by John Moran.

³² FDEP 2000

³³ FSI 2018

³⁴ Bellino 2017

³⁵ Knight and Clark 2016

³⁶ Knight 2015

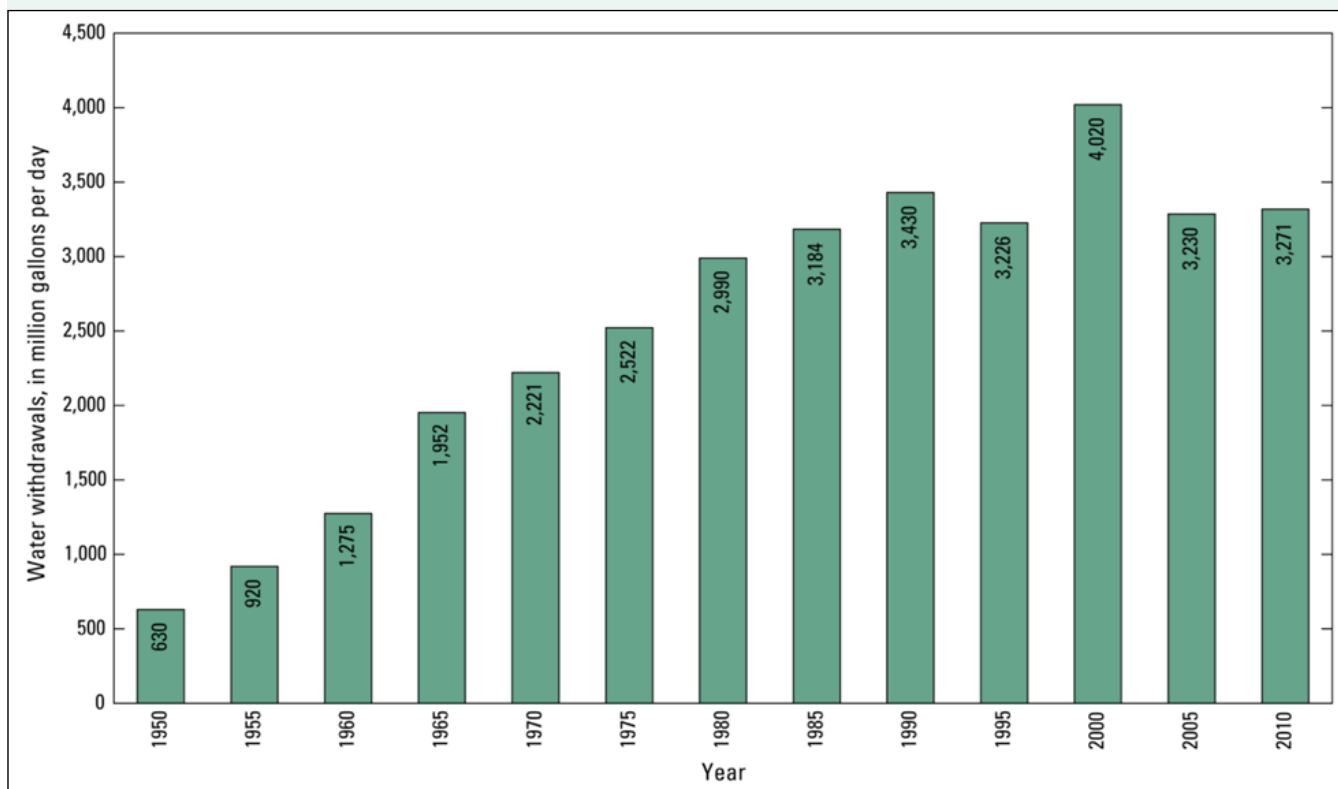
³⁷ Ibid

³⁸ Borosova et al. 2014

Historic Baseline

Reported flows in the Lower Santa Fe River at the US 47 gauging station upstream of the Ichetucknee Springs System input averaged 1,604 cfs between 1927 and 1960. Baseflow derived from groundwater inputs upstream of US 47 was estimated as 71 percent or about 1,145 cfs. Early flow data from individual spring systems is intermittent or in many cases non-existent. Average discharge reported at Poe Springs for the period from 1917 to 1972 was 72 cfs. Flows at Gilchrist Blue Spring, including Naked Spring flows, reported for 1975 to 1998 averaged 99 cfs. The principal springs in the Ginnie Springs Group had a combined average flow of 98 cfs. Santa Fe Springs was reported to be first magnitude (>100 cfs) historically based on a limited number of flow measurements. Data from 1998 indicated an average discharge of 150 cfs. Reported spring discharge in the Ichetucknee River at US 27 added another 364 cfs to the Lower Santa Fe River for the period from 1930 through 1960.

A few early nitrate-nitrogen concentrations are reported from the Santa Fe River springs. In their 1977 report, Rosenau et al. reported a nitrate nitrogen concentration at Worthington Springs of 0.06 mg/L³⁹. Based on nitrate nitrogen sampling conducted in 1946, Ferguson et al. reported nitrate at 0.11 mg/L from Poe Springs and a nitrate concentration at Ichetucknee Springs of 0.23 mg/L⁴⁰. From this data and similar sampling even earlier than 1910 in the Floridan Aquifer and artesian springs, FGS has concluded that the ambient nitrate nitrogen concentration in the Floridan Aquifer and the artesian springs it nourishes was about 0.05 mg/L. The earliest nitrate concentration reported from the Santa Fe River downstream was about 0.55 mg/L in 1988.



Total groundwater withdrawals from the Floridan Aquifer, 1950-2010 (USGS)

³⁹ Rosenau et al. 1977

⁴⁰ Ferguson et al. 1947

The Suwannee River Coalition 1983 report recommending state protection of the entire Santa Fe River and springs system with the legal designation as “Outstanding Florida Waters” indicated that:

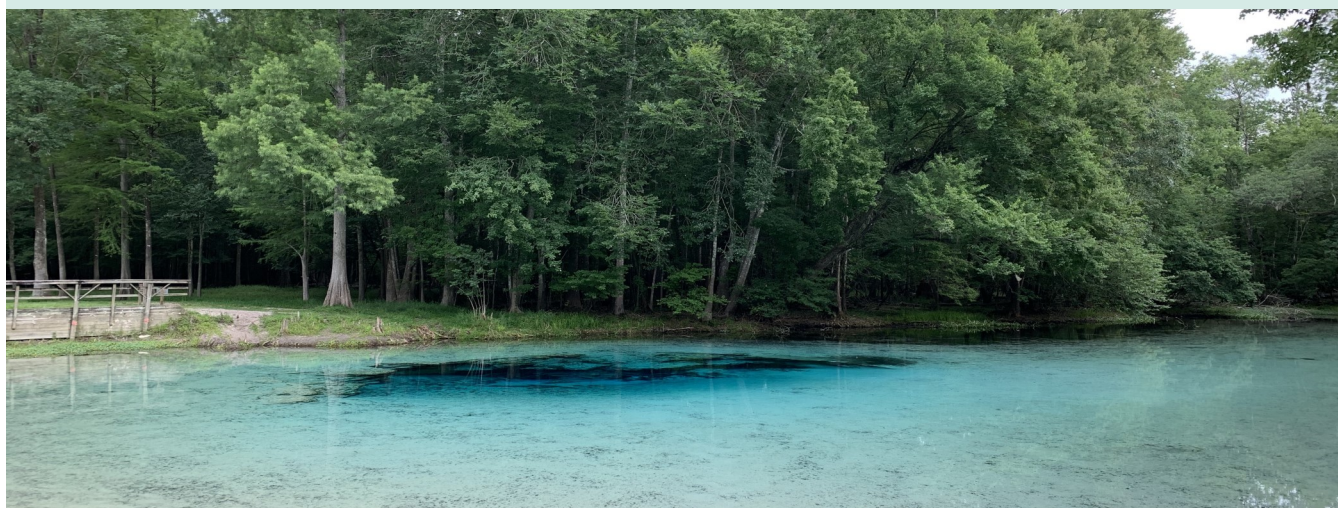
“...hundreds of thousands of people use the Santa Fe River system every year, ample testimony to the attractiveness of the river. Whether they visit to canoe, fish, sail, swim, snorkel, or dive, visitors to the river are there because of the clean and pure water that invites and surrounds them...There is no more refreshing place to be on a hot summer day than floating down the Santa Fe River. The clear cool water at the various springs invites swimming and snorkeling⁴¹.”

Anecdotal evidence indicates seasonal utilization of many of these springs for passive and active recreation throughout the historical period. For example, the Ichetucknee Head Spring has been accessible throughout the past century for limited water supply, fishing, and recreation, as has the Mission Springs Group (Roaring and Singing springs). There were documented springs changing and access pavilions at Worthington and Poe Springs by the 1930s. It is equally likely that similar access and human disturbance historically existed at Hornsby, Gilchrist Blue, Ginnie, Wilson, and several other of the larger springs along the Santa Fe River.

Current Conditions

Average total flows in the Lower Santa Fe River at SR 47 for the period between 2000 and 2019 averaged 1,142 cfs, a drop of about 462 cfs (298 MGD) or 29 percent. Groundwater inflows over this period are estimated as 865 cfs, for an estimated decline of 280 cfs (181 MGD) or 24 percent. The average discharge measured at Poe Springs for the 2000 to 2019 period was 20 cfs, a decline of about 52 cfs (34 MGD) or 72 percent. Average flows at the Gilchrist Blue Springs Group over the same time interval were 42 cfs (27 MGD) for an average reduction of 56 percent. Average discharge at Santa Fe Spring for the period from 2000 through 2019 was 93 cfs (60 MGD) for an average reduction of more than 57 cfs (37 MGD) or 38 percent. And for the Ichetucknee River at US 27 the average flow between 2000 and 2019 was 300 cfs for an average reduction of 70 cfs (45 MGD) or 19 percent.

During recorded history, water flows in the Upper Santa Fe River have always been dominated by surface runoff resulting from local rainfall. Nitrate nitrogen concentrations in this reach typically average between



Ruth B. Kirby Gilchrist Blue Springs State Park, 2020. Photo by Haley Moody.

⁴¹ Suwannee River Coalition 1983

0.1 and 0.2 mg/L with a range from <0.01 to about 0.5 mg/L. Nitrate concentrations measured at Santa Fe Spring have averaged 0.46 mg/L during the last two decades. Poe Springs nitrate concentrations were greater than 1.25 mg/L in the late 1990s and have declined to a current average of 0.30 mg/L and Gilchrist Blue Spring nitrate concentration was about 1.60 mg/L in the mid-1990s and has risen to 2.25 mg/L in recent years. The Ichetucknee Springs average nitrate nitrogen concentration is currently about 0.79 mg/L. Downstream nitrate concentrations in the Lower Santa Fe River averaged about 0.88 mg/L⁴².

A considerable inventory of recreational data exist for the springs feeding the Lower Santa Fe River over the past five decades. Ichetucknee Springs State Park has kept records of admissions since 1983 with annual averages between about 150,000 to 200,000 persons per year. About 70 percent of this activity is concentrated during the three summer months of highest use. Since becoming the state's newest state park in 2017, Gilchrist Blue Spring State Park has reported 129,682 visitors in 2018 and 135,507 in 2019. No official record exists for the nearby Ginnie Springs Group, but human use was estimated at about 300,000 people per year by UF. The 2014 study by UF⁴³ estimated a total recreational use of about one million persons per year for the Santa Fe and nearby Suwannee River springs. Even more important in terms of ecological impacts of recreation is the intensity of use or the number of people experiencing in-water activities such as wading, bathing, swimming, snorkeling, etc.. FSI documented peak human use intensities in 2019 of 5,829 people /ac-day at the Ichetucknee Head Spring, 5,243 at Gilchrist Blue Spring, 7,622 at Poe Spring, and 12,230 at Naked Spring. These human use intensities were observed to result in excessive turbidity with significant loss of water clarity and denudation of rooted plant communities.

Restoration Goals

Protection and restoration of Florida's springs has a long history. The first springs working group was convened by Jim Stevenson (formerly chief naturalist at the Florida Park Service) in 1993. Governor Jeb Bush and his FDEP secretary David Struhs initiated the Florida Springs Task Force and Florida Springs Initiative in 1999. By the early 2000's there were more than a dozen citizen/agency springs working groups focused on restoring major spring systems throughout the northern portion of the state⁴⁴. Since 2013 the Florida legislature has provided \$50 million each year to springs restoration projects. In 2016 the legislature enacted the Florida Springs and Aquifer Protection Act in an effort to accelerate completion of springs MFL limits and BMAPs.

Nevertheless, as evidenced by the summary above of historic and current conditions in these springs, these well-intentioned efforts have not been successful at restoring or recovering the Santa Fe River and springs. Current conditions continue to worsen, in terms of water flow reductions, degraded water quality, loss of ecological function, and aesthetics. A new approach is required to turn around the continuing degradation of the Santa Fe River and spring natural resources.

Target Groundwater and Spring Flows

All groundwater extractions lower aquifer pressures and the potentiometric surface of the aquifer and all pumping reduces spring flows. The fundamental springs management question is how much can historic flows be reduced while still assuring healthy springs? This allowable spring flow reduction dictates how much groundwater can be safely pumped.

⁴² FSI 2020

⁴³ Borosova 2014

⁴⁴ Knight 2015

Florida law requires that regulatory minimum flows and levels (MFLs) be established for springs, other surface water bodies, and the aquifer. The MFL law is clear that adequate spring flows and aquifer levels must be provided that do not result in significant harm to human and environmental water resources. At face-value the existing Florida spring MFLs indicate that historic spring flows cannot be reduced by more than from 3 to 15 percent, depending on the specific spring system. And yet, average flow reductions documented at hundreds of Florida’s springs range from 20 to 100 percent⁴⁵. The state water management district agency’s reliance on inaccurate groundwater flow models and incomplete implementation of the spring MFLs has led to continuing issuance of new groundwater use permits in spite of the unacceptable flow reductions documented in most springs.

Based on an overview of all of the spring MFL studies conducted by Florida’s water management districts, FSI proposes that groundwater pumping should be capped so that an average of 95 percent of historic spring flows be maintained (5 percent average long-term flow reduction), and that a minimum average of 90 percent of historic flows be maintained for any individual spring in a multi-spring system. This in-stream flow requirement is in general agreement with guidance from the U.S. Environmental Protection Agency and non-governmental environmental organizations⁴⁶.

Based on this recommended minimum of 95 percent of historic flows, Table 1 provides a summary of estimated restorative minimum spring flows for the entire Santa Fe River System as well as for the representative spring systems selected for restoration. The total average spring flow recovery needed in the entire Santa Fe River Springshed area is estimated as 230 cfs. This goal will require a reduction in total groundwater consumption of about 148 MGD. A much smaller recovery goal of about 20 MGD groundwater pumping reduction would restore about 95 percent of historic flows in the Ichetucknee River.

Target Spring	Historic Average Flow (cfs)	Current Average Flow (cfs)	Target Average Flow (cfs)	Average Flow Recovery Needed (cfs)	Average Flow Recovery Needed (MGD)
Santa Fe Spring	110	80	105	25	16
Poe Spring	72	39	68	29	59
Gilchrist Blue Spring Group	99	75	94	19	
Ginnie Springs Group	98	49	93	44	
Santa Fe River Base Flows at US 47	1122	865	1066	201	130
Ichetucknee Springs	364	310	346	36	23
Santa Fe River at Suwannee River	1630	1319	1549	230	148

Table 1. Anthropogenic base flow reductions at selected Santa Fe springs and river stations and estimated flow recovery goals to achieve restoration of 95 percent of historic average groundwater inflows.

⁴⁵ Ibid

⁴⁶ Baer and Ingle 2019, SIFN 2010

Target Quality of Ground and Surface Waters

Nitrate nitrogen continues to be the most problematic pollutant affecting Florida's artesian springs⁴⁷. The Florida statewide numeric nutrient standard for nitrate as nitrogen in springs is 0.35 mg/L⁴⁸. Lower site-specific limits for nitrate are in place for some springs (e.g., Wekiva and Kings Bay) but not for any of the Santa Fe River springs. Regulatory TMDLs and BMAPs for the Santa Fe springs all reference the goal of no more than 5 percent of water quality samples exceeding this 0.35 mg/L criterion. For this springs restoration blueprint FSI suggests a target average nitrate nitrogen concentration goal of 0.25 mg/L. Setting the goal for a long-term average of 0.25 mg/L provides a margin-of-safety that no more than 5 percent of monthly concentrations will exceed the state criterion of 0.35 mg/L. This goal is still more than five times higher than estimated springs and aquifer baseline concentrations and may ultimately need to be lowered more to be protective of springs health.

The existing groundwater nitrate nitrogen standard is 10 mg/L based on protection of human health. There is considerable concern worldwide that this standard is not low enough to protect vulnerable individuals from chronic ingestion of potable water with much lower nitrate levels⁴⁹. For example, the National Cancer Institute and other researchers have reported that the heightened risk of human carcinogenic and teratogenic effects are increased more than three-fold by chronic exposure to drinking water with nitrate concentrations as low as 2.5 mg/L⁵⁰. In either case, it is impossible to keep nitrate in springs at less than the numeric criterion of 0.35 mg/L while allowing nitrate concentrations up to 2.5 or 10 mg/L in the groundwater feeding those springs.

For this restoration blueprint we propose a target goal of no more than an average of 0.25 mg/L for nitrate



Poe Spring on the Santa Fe River, 2020. Photo by John Moran.

⁴⁷ FGS 2004, Knight 2015

⁴⁸ FDEP 2012

⁴⁹ EWG 2019

⁵⁰ Ward et al. 2005

nitrogen in the groundwater at any spring vent. Table 2 provides a summary of the current existing nitrate concentrations in the entire Santa Fe River system as well as target nitrogen mass reductions recommended in the representative springs selected for this restoration blueprint analysis.

Target Spring	Average Nitrate-N Goal (mg/L)	Current Average GW Nitrate-N (mg/L)	Target Nitrate-N Conc. Reduction (mg/L)	Target Restored Flow (cfs)	Target Nitrogen Mass Reduction to GW (tons/yr)
Santa Fe Spring	0.25	0.46	0.21	105	22
Poe Spring	0.25	0.30	0.05	68	3
Gilchrist Blue Springs Group	0.25	2.15	1.90	94	176
Ginnie Springs Group	0.25	1.56	1.31	93	120
Santa Fe River Springs at US 47	0.25	1.35	1.10	1066	1154
Ichetucknee Springs	0.25	0.80	0.55	346	187
Santa Fe River Springs at Suwannee River	0.25	1.35	1.10	1549	1677

Table 2. Current nitrate nitrogen concentrations and restoration goals in the representative Santa Fe River and springs. (Target nitrogen mass reduction is calculated as the target nitrate-N concentration multiplied by the desired target flow with appropriate conversion factors; GW = groundwater)

Target Human-Use Carrying Capacity

An acceptable human-use carrying capacity for spring’s protection is site specific and dependent on the adjacent landscape topography and land use, the spring depth, spring flows, and desired in-water recreational activities. Steep banks adjacent to a spring boil or spring run can result in excessive smothering of benthic plants and animals due to erosion. A well-vegetated upland cover adjacent to a spring may provide protection against both natural and human-caused erosion. Bank hardening and rip rap may allow higher human traffic while minimizing erosion but at the added expense of habitat loss.

In-water recreational activities have a greater impact on springs ecology than out-of-water activities. In-water activities in floating tubes and paddle craft are less likely to cause impacts to submerged aquatic vegetation (SAV), benthic wildlife populations, and water clarity. Shallow spring boils and runs are more susceptible to negative impacts from human wading, bathing, and paddling. Deeper springs and spring runs may be minimally impacted by boating activities.

Various options for specific spring carrying capacity limitations are available. A preliminary list of some example measures includes:

- Limiting human visitation overall, and for specific activities, in limited areas at levels that do not create significant harm to springs ecology.
- Limiting in-water uses such as wading in shallow vegetated areas.
- Prohibiting motorized vessels in spring heads and runs.

The goal of any spring human carrying capacity limitation is to retain a significant and sustainable fraction of the natural ecological structure and function. Some spring ecosystem structural and functional indices that should be considered when establishing an appropriate human use carrying capacity include⁵¹:

- Physical Attributes – water access, bank erosion, hardened structures
- Water Quality Attributes – water clarity affected by resuspension of sediments, human nitrogen inputs, sunscreen inputs, trash and micro-plastics
- Biological Attributes - plant community species composition and percent cover, faunal populations and diversity, ecological productivity

Until additional site-specific data are available, FSI recommends establishing generic carrying capacity goals of retaining or restoring at least 90 percent (less than a loss of 10 percent of structure/function) of the undisturbed baseline values for each of these important spring ecological attributes.

Blueprint for Springs Restoration

Four specific Spring Restoration Areas important for the overall health of the Santa Fe Spring System were selected to serve as a range of case histories for restoration. For each of these individual spring systems, from small to large, the maximum extent springshed area was approximately delineated based on a variety of potentiometric and watershed maps (see Figure 2). The maximum extent springshed is the specific land area that has the most potential to directly affect each spring's water quantity and quality.

FSI's Blue Water Audit (BWA) database was then used to estimate total groundwater use and nitrogen loading in those springsheds and is useful for prioritizing the individual land parcels and land uses for achieving the flow and load targets estimated above.

The second portion of each Spring Restoration Area Blueprint provides guidance on estimating the human carrying capacity compatible with the proposed goal of restoring and preserving 90 percent of the natural spring ecosystem structure and function.

Note that restoring the first three spring groups significantly reduces the additional restoration actions needed for restoring the entire Lower Santa Fe River Springs Group.

⁵¹ FSI 2018



Paddling at Rum Island Spring, 2017. Photo by John Moran.

Santa Fe Spring Restoration Area Blueprint

Responsible Entities: Alachua Conservation Trust with support from the SRWMD, SJRWMD, Columbia and Alachua Counties, FDEP, and Florida Fish and Wildlife Conservation Commission (FWC).

Flow Restoration: The Santa Fe Spring restoration goal is to increase average spring discharge to 95 percent of historic levels or about 105 cfs. This will require reduction of pumping in and around the existing springshed by about 16 MGD. Since total estimated groundwater pumping within the existing reduced springshed is only about 16 MGD, with a 50% reduction in local pumping to achieve an 8 MGD reduction, achieving the other 8 MGD will require a cutback of all existing regional water use permits by about 2 percent. The largest users affecting the supply of groundwater to Santa Fe Spring are the City of Gainesville, City of Jacksonville, regional sand and limerock mines, and about 15 smaller communities.

Water Quality Restoration: Water quality at Santa Fe Spring is almost twice as high as the target average N concentration of 0.25 mg/L. Reduced nitrogen loading to the aquifer of about 22 tons N/yr will be required to meet this goal. Water clarity, a physicochemical index of spring health, is not currently acceptable at Santa Fe Spring and needs to be restored. With flow restoration as described above, water clarity will also be improved by greatly reducing the frequency of flow reversals that transport tannic river water into the aquifer.

Biological Restoration: Santa Fe Spring currently has no SAV and moderate nuisance algal communities. Restoration of flow and water clarity described above will allow reestablishment of healthy SAV communities in this spring. Restoration of SAV and attached epiphytic algae will restore acceptable ecosystem productivity and serve as a basis for food chain support of normal healthy faunal populations.

Human Carrying Capacity: The existing Santa Fe Spring pool is relatively deep and suitable for swimming and limited paddle sports. A bathymetric map should be prepared for the spring pool and short spring run to help direct development of any public use facilities. Steep slopes surrounding the spring pool are vulnerable to significant erosion and should be off limits to most human activities. Swimming with improved entry/exit is a compatible use for the spring pool area. One or two relatively small access boardwalks and stairs leading from the surrounding high ground to the water and a floating swim platform will not significantly diminish the ecological structure and function of Santa Fe Spring. The short run should be cleaned of debris and possibly deepened to avoid wading impacts on any restored SAV. Total human capacity of this newly accessible spring needs to be limited to a reasonable permeable upland parking capacity that avoids loss of valuable upland habitat and creation of harmful stormwater runoff.

Poe/Gilchrist Blue/Ginnie Springs Restoration Area Blueprint

Responsible Entities: Alachua County, Florida Park Service, and GSO with support from the SRWMD and FWC.

Flow Restoration: The Poe Spring restoration goal is to increase average spring discharge to 95 percent of historic levels or about 68 cfs. Restoration of protective flows at Gilchrist Blue Springs will require a recovered average flow of 94 cfs and the Ginnie Springs Group needs a recovered average flow of 93 cfs. The combined flow recovery needed for these three critical spring groups is 59 MGD. Current estimated groundwater pumping in the combined springshed for these three spring systems is 25 MGD. The largest users affecting the supply of groundwater to these important recreational springs are the cities of Gainesville, Newberry, and Archer; hundreds of agricultural irrigation wells; thousands of private, self-supply wells; and various industrial users, including the Nestle water bottling facility. Assuming this existing average pumping rate can be reduced by half or 12 MGD, the remaining 47 MGD of groundwater flow recovery will require an estimated additional 10 percent reduction in all regional groundwater extractions throughout northeast Florida.

Water Quality Restoration: Nitrate concentrations at Poe Spring, the Gilchrist Blue Springs Group, and the Ginnie Springs Group are currently above acceptable limits. The combined nitrogen loading to the groundwater feeding these springs is about 400 tons N/yr. Necessary compliance with the numeric nutrient limit will require a nitrogen load reduction at the land surface of more than 2,670 tons N/yr (5.34 million pounds N/yr). Row crop agriculture and dairies are the predominant sources of this nitrogen loading and will need to be replaced by land uses that do not require fertilizer additions.

Water clarity, a physicochemical index of spring health, is not currently acceptable in Poe Springs and is increasingly threatened in Gilchrist Blue and Ginnie. With the flow restoration described above, water clarity will also be improved by reducing the frequency of flow cessation and reversed flows that transport tannic river water into the aquifer.

Biological Restoration: These three spring systems have little to no surviving SAV and seasonally high cover of nuisance algal communities. Restoration of flow and water clarity described above will



Paddleboarder and nuisance filamentous algae on Hornsby Spring run in 2019.

Photo by John Moran.

allow some reestablishment of healthy SAV communities in these springs. Restoration of SAV and attached epiphytic algae will increase ecosystem productivity to acceptable levels and serve as a basis for food chain support of recovered faunal populations.

With the recent addition of the Gilchrist Blue Spring System to the Florida Park Service, SAV restoration is already occurring in specific areas through removal of direct human recreational impacts. Naked Spring has been closed to all recreation and is naturally revegetating. The main spring run below Gilchrist Blue was denuded of vegetation following prolonged black out by tannic river waters after Hurricane Irma in 2017. The FPS has closed the spring run to foot traffic and SAV is recovering through natural recolonization. The head spring pool is a combination of a shallow area used for wading and bathing and a deeper area over the spring vent, historically used for jumping and diving. The jumping platform has been removed and this area is now only available for swimming and snorkeling. The wading area will remain unvegetated but the shallow shoreline areas on the west side of the spring pool should be protected and allowed to revegetate. The revegetating areas in Gilchrist Blue Springs Run and Naked Spring have an acceptable level of ecosystem productivity and serve as a basis for wildlife food chain support.

The most important biological restoration action needed at the Ginnie Springs Group is the enforcement of reasonable limits on recreational activities. Portions of the spring pools and spring runs should be delineated off limits and allowed to revegetate. This action will provide additional protective habitat and food chain support for aquatic wildlife.

Human Carrying Capacity: The existing spring pools at all three spring groups are relatively deep and suitable for swimming and limited paddle sports. However, their spring runs are generally shallow and susceptible to impacts caused by wading. Bathymetric maps should be prepared for the various spring pools and runs to help direct design of exclusion and allowed activity areas.

Extensive restoration and public access efforts have already been expended at Poe Spring. There is no need to modify the existing access stairs. Vegetated slopes around the spring should be fully fenced and noticed as prohibited areas. Swimming is a compatible use for the spring pool area. Installation of a relatively small floating swim platform will not significantly diminish the ecological structure and function of Poe Spring. A portion of the shallow spring run should be designated off-limits to wading to allow SAV revegetation and improved fish habitat. Total human capacity of this county park is already high and may need to be reduced.

The FPS has established a preliminary carrying capacity for Gilchrist Blue Spring State Park. This public

access limit is commonly reached on summer weekends. As indicated previously, SAV restoration areas have already been closed to human traffic. The next most important habitat restoration need at this new state park is the unvegetated sloping upland areas around the main spring pool. FPS is continuing to work on protecting those areas from additional erosion. Paddling sports are generally compatible with a healthy ecology at Gilchrist Blue Spring. Connection to the adjacent Santa Fe River canoe trail is critically important for passive use and access for these resources. To avoid renewed damage to the recovering SAV plant community in the spring run there needs to be some limit on this accessibility during high use periods.

While GSO legally controls access to the seven springs in the Ginnie Springs Group, they do not own the water in those springs. The public has the right to access springs up to the mean high water line without restriction or charge. As long as this access is by paddle craft, there is minimal damage to the spring ecological health. The biggest impact at these recreational springs is from the frequency and intensity of wading. Limits on the number of recreationalists in these springs and proposed exclusion areas along some of their shorelines would provide some partial restoration of wildlife habitat in these state waters.

Ichetucknee Spring System Restoration Area Blueprint

Responsible Entities: The Florida Department of Environmental Protection and Florida Park Service with support from the SRWMD, Columbia County, and FWC.

Flow Restoration: The Ichetucknee Spring System flow restoration goal is to increase average spring discharge to 95 percent of historic levels or about 346 cfs. This will require reduction of pumping in and surrounding the existing springshed by about 23 MGD. The BWA analysis indicates that the total estimated groundwater extraction in the current Ichetucknee springshed is about 10 MGD. The top 124 properties with estimated groundwater uses greater than 100,000 gallons per day (gpd) extract about 90 percent of this estimated groundwater use. The largest users affecting the supply of groundwater to Ichetucknee Springs are Lake City, as well as several hundred large agricultural irrigation wells.

Regional groundwater extractions affecting the Ichetucknee system are estimated as 450 MGD. Since total estimated groundwater pumping within the existing, reduced springshed is only about 10 MGD, and assuming that local pumping can be cut in half to about 5 MGD, achieving the 23 MGD pumping reduction goal needed for Ichetucknee Springs recovery and protection will require a regional cutback of all existing groundwater uses by about 15 MGD or 3 percent of the regional total. There is no cost to the general public by adjusting the existing water use permits in the region to sustainable quantities required by the Ichetucknee River minimum flows.

Water Quality Restoration: Water quality at the Ichetucknee springs is impaired by nitrate nitrogen concentrations averaging 0.80 mg/L. Fortunately for successful restoration, this is one of the lowest elevated nitrate concentrations in any of Florida's major spring systems. To consistently achieve the state's numeric nitrogen criterion of 0.35 mg/L in the Ichetucknee springs, it will be necessary to reduce this average existing concentration by about 0.55 mg/L for an estimated



Gilchrist Blue headspring, 2014. Photo by John Moran.

nitrogen mass reduction to the groundwater of 187 tons per year. The BWA for the Ichetucknee Springshed estimates a N loading to the groundwater of 269 tons N per year for the top 500 of the highest loading parcels. The land uses on these properties were mapped as row crop, cattle production, a golf course, and highly landscaped properties. Based on these data, the 187 tons N/yr required load reduction goal will require permanent conversion of an estimated 33,000 acres in the springshed to unfertilized land uses such as longleaf pine plantation.

Existing water clarity at the Ichetucknee Head Spring, Blue Hole, and other major springs is excellent. Downstream water clarity is markedly reduced, primarily due to sloughing of excessive filamentous algae upstream⁵². Reducing nitrate loads at the spring inflows will reduce this water clarity impairment. Reduced water clarity due to human recreation is detectable on high-use weekends but quickly dissipates during long intervals with lower human use. New limits on upstream tubing may also contribute to increased downstream water clarity.

Biological Restoration: Biologically diverse historic SAV communities in the Ichetucknee springs and river have been progressively altered as nitrate levels have increased and average flow has declined over the past three decades⁵³. The prevalence of floating aquatic plants, especially water lettuce, has also increased in

⁵² WSI 2011

⁵³ FSI 2012b

the Ichetucknee River during this same time period. Gross primary productivity measured in the Ichetucknee River is high and supports an abundant faunal community of invertebrates, turtles, fish, birds, and mammals. A gradual diversification of the existing SAV plant community and a reduction in the proliferation of floating aquatic plants is expected to occur in the Ichetucknee if the first two restoration actions described above are completed. No other biological restoration is essential.

Human Carrying Capacity: The FPS has established a human carrying capacity for the Ichetucknee Springs State Park. No more than 750 tubers per day can enter the river at the upstream tube launch point. For many years it has been observed that even this limited use intensity causes excessive damage to the upstream SAV plant community. Tubing from the Head Spring Tube Launch may be discontinued while paddle craft may be allowed. At Midpoint Landing the limit is 2,250 tubers per day. The only limit downstream at the Dampier Landing tubing launch is access to parking. Due to increased water depths, the very high use on peak visitation days does not appear to be responsible for any long-term harm to the aquatic resources of the Lower Ichetucknee River.

Lower Santa Fe River Springs Restoration Area Blueprint

Responsible Entities: The SRWMD with support from the surrounding counties (Alachua, Gilchrist, Columbia, Suwannee), FDEP, and FWC.

Flow Restoration: The overall Santa Fe River springs restoration goal is to increase the existing average spring discharge of 1,319 cfs to 95 percent of historic levels or about 1,549 cfs. This will require reduction of groundwater pumping in and around the existing Santa Fe River Springshed by about 150 MGD. Since total estimated groundwater pumping within the springshed is currently about 70 MGD, this will require a regional cutback of all existing water use permits by about 25 percent. The largest users affecting the supply of groundwater to the Lower Santa Fe River springs are the cities of Gainesville, Lake City, Jacksonville, many dozens of smaller communities, sand and limerock mines, dairies, thousands of agricultural irrigation wells, and water bottling facilities. Note that two thirds of this goal or about 100 MGD will be accomplished by restoring the three upstream spring groups (Santa Fe Spring, Poe/Blue/Ginnie, and Ichetucknee).

Water Quality Restoration: Water quality in the Floridan Aquifer artesian springs feeding the Lower Santa Fe River is impaired by elevated nitrate nitrogen with an average estimated groundwater concentration of 1.35 mg/L. This level will need to be reduced by about 1.10 mg/L to consistently achieve the state's goal of 0.35 mg/L. This equates to a mass reduction of the nitrogen load to the aquifer of about 1,677 tons of nitrogen per year. The current estimated nitrogen load to the aquifer in the springshed is 2,034 tons N/yr or about 13,560 tons N/yr to the land surface. This existing nitrogen load to the land surface will need to be reduced by about 82 percent to achieve water quality restoration. Note that nearly one third of this goal or 506 tons N/yr will be achieved by restoring the three upstream spring groups. In addition to the estimated reduction of intensive nitrogen fertilization on 33,000 acres above for the Ichetucknee water quality restoration goal, another 100,000 acres of intensive agricultural lands will need to be converted to unfertilized forestry practices to achieve this goal for the overall Lower Santa Fe River water quality restoration.

Biological Restoration:

Historically, the Lower Santa Fe River supported a high cover of native SAV, mainly tapegrass, eelgrass, and other macrophytic plants typical of healthy Florida spring runs. During prolonged floods that result in extended tannic surface waters from the Upper Santa Fe River, these plant communities would periodically die back. During subsequent periods of lower rainfall and drought, spring inflows would again dominate, resulting in high water clarity and a resurgence of these healthy SAV populations. Restoring a fair measure of the historic water quantity and quality in the Lower Santa Fe River will restore this very productive aquatic ecosystem and the wildlife it formerly supported.



Striped mullet swim on the Ichetucknee River, 2018. Photo by Bob Knight.

Human Carrying Capacity: The carrying capacity of the Lower Santa Fe River is currently set by the number and size of accessible points for launching tubes, paddle craft, and motorized boats. Public access points are located at the US 441 boat launch, the US 27 boat ramp, Rum Island County Park, Gilchrist Blue Spring State Park, SR 47 county park, and the US 129 boat ramp. In addition to those public access points, a number of private access points are available (e.g., Ginnie Springs Outdoors, Wilson Spring, Three Rivers Estates, etc.). While large power boats are causing significant erosional and aesthetic damage to the Lower Santa Fe River from SR 47 downstream to its confluence with the Suwannee River, rocky shoals discourage large boats farther upstream. With the proliferation of paddle craft on the river above SR 47 it is advisable to limit the size of outboard motors for the entire Lower Santa Fe River from US 129 upstream to River Rise.

Implementation of the Springs Restoration Blueprints

Restoration of springs water quantity and quality, combined with limitations on springs recreational uses, are essential for compliance with existing legal requirements and for protecting the public interest related to springs sustainability. This section briefly outlines the implementation of the Springs Restoration Blueprint provided above.

Springs Water Quantity

Based on the recognition that groundwater in the Floridan Aquifer is finite and is also the most pristine natural source of water available for human and natural systems, and that this water is owned in common by all residents of the state, existing law allows the water management districts to cap uses and to reduce existing uses as necessary to protect and sustain the public's best interests. Continuous monitoring and an extraction fee should be required for all groundwater uses in Florida's Springs Region. Implementation of the necessary groundwater extraction reductions outlined in this blueprint would still allow use of 5 percent of the annual average groundwater supply for human use, or about 500 MGD, over the entire Florida Springs Region. Achieving the goals outlined above will not limit the basic per capita indoors water use enjoyed by the majority of Floridians. Successful water quantity restoration entails no expenditure of public tax dollars. The only financial impacts are to individuals who profit from excessive but free water uses. All normal water uses beyond in-home per capita uses can be supplied by rainwater collection and storage at the expense of individuals who wish to use larger amounts of water for their businesses and personal living.

Springs Water Quality

Two fundamentally different options exist for achieving the overall Santa Fe Springshed water quality goal for nitrogen load reduction. The first option requires polluters to pay for their impacts to public waters. The second option is to use public funds to compensate land owners for reducing or eliminating their legal fertilizer uses and confined animal feeding operations.

The first option requires no public funding, and if accomplished by a tax on nitrogen loading, either directly on a per-acre basis or as a fee on nitrogen fertilizer, would actually generate revenue for ancillary groundwater/springs protection and public acquisition projects.

The second option compensates agricultural producers for lost profitability due to converting their productive land to lower value crops that are not fertilized. Longleaf pine plantation is one of the profitable land uses that could replace fertilizer-intensive farms and pastures that dominate the Santa Fe Springshed now. Estimated conversion costs in this area for a perpetual conservation easement and establishment of a longleaf pine forest is about \$2,500 per acre. Achieving the overall 1,677 tons N/yr load reduction goal for the entire Santa Fe Springshed might require the conversion of about 135,000 acres from intensive agriculture to longleaf pine for an estimated \$337.5 million buyout. This estimated area is equivalent to less than 10 percent of the springshed area and one half of the existing acres of intensively fertilized agricultural land.

Sustainable Recreation

All of Florida's springs-centered state and county parks should have a sustainable recreational carrying capacity. Also, all public waters should be subject to protection from excessive recreational and boating activities, even those waters adjacent to privately-owned uplands. There is no anticipated cost to the public to enact speed and watercraft limits on the Santa Fe River. Enforcement of stronger

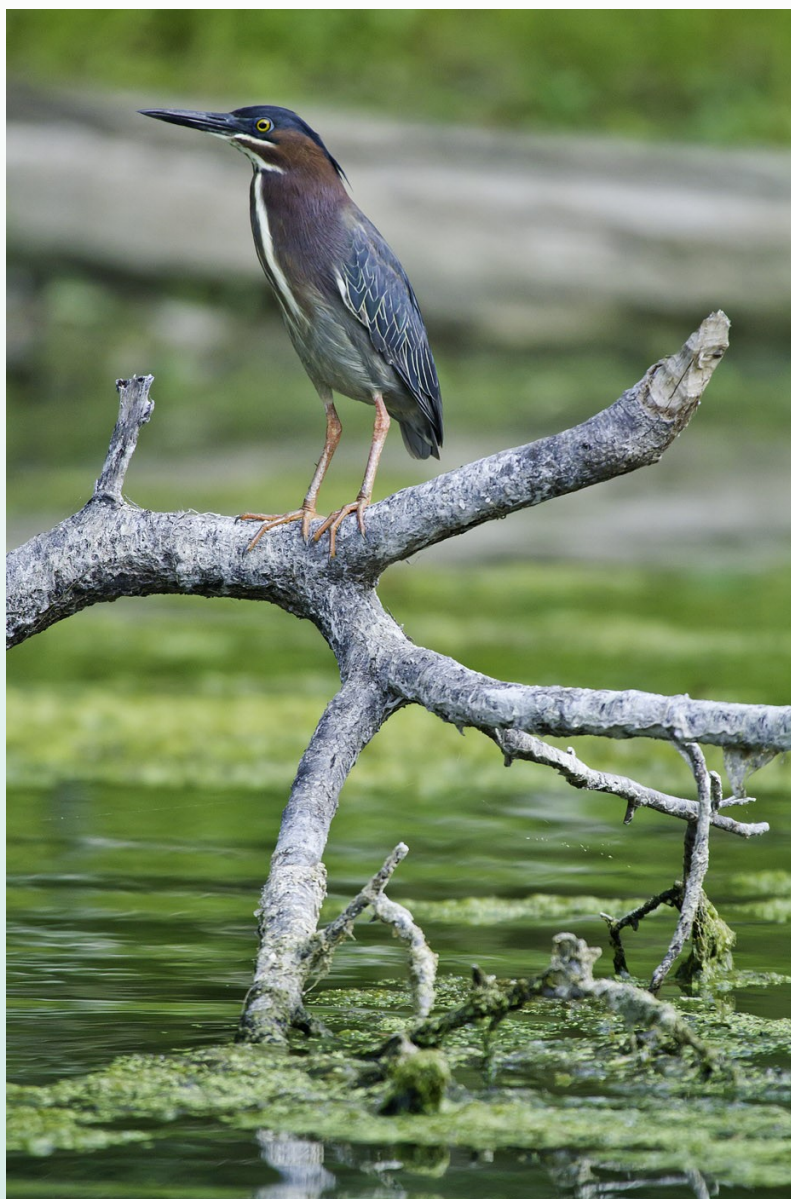
restrictions on boating, fishing, littering, shoreline conversion, filling, etc. is already the responsibility of state environmental agencies, game wardens, sheriff deputies, and park rangers. Some additional public dollars need to be allocated to help these agencies provide better protection of the Santa Fe River spring and water habitats.

Concluding Remarks

Quantitative restoration goals for the Santa Fe River and Springs are provided in this *Blueprint for Restoring Springs on the Santa Fe River*. Historic and recent scientific studies of the Santa Fe River, its springs, and the springshed and aquifer that nourish them have been used to provide data-based estimates of spring flow declines and increases in nitrate nitrogen loading. Observed impacts from excessive recreational activities have also been described. Due to these known stressors, the Santa Fe springs have experienced declining ecological and aesthetical health for more than thirty years.

Spring restoration goals have previously been established by state environmental agencies and are used in this blueprint for springs recovery. This document summarizes what must be done to achieve compliance with existing state water quantity and quality standards.

While meaningful restoration is not easy it does not have to be expensive for the public that owns and values these unique natural resources. Every year and decade of the state's inaction and delay makes springs restoration more expensive and more difficult. However, it is not too late to turn these problems around. The local and regional economy will not be harmed by implementing the restoration measures detailed in this plan. In fact, successful restoration and continuing protection of the Santa Fe River's springs will ensure a bright economic future for local and regional residents.



Green heron and algae on the Santa Fe River, 2012. Photo by John Moran.

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About FSI

The Florida Springs Institute is a 501(c)(3) non-profit organization dedicated to providing the highest quality springs science and education. We are devoted to developing restoration and management goals for Florida's 1,000+ artesian springs and promoting their protection.

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Cover photos: (Front) Gilchrist Blue Spring kayakers, 2017. (Back) Gilchrist Blue Spring underwater turtle, 2013.

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