

# Economic Contributions and Ecosystem Services of Springs in the Lower Suwannee and Santa Fe River Basins of North-Central Florida

Tatiana Borisova, Alan W. Hodges, and Thomas J. Stevens



Manatees in Manatee Springs  
*Credit: Mark Long*

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## **Acknowledgements**

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## **Introduction and Objectives**

A significant proportion of the Florida economy is attributed to the tourism industry, and Florida's springs are a primary destination for many in-state and out-of-state visitors. Springs-based tourism serves as an economic engine generating revenues for local businesses and creating jobs. The variety of services provided by nature to human society (including recreation) is referred to as ecosystem services. Along with tourism and recreation, springs provide such ecosystem services as intellectual and spiritual inspiration; support for the natural cycles of nutrients and water; and habitat for wildlife, including endangered and threatened species that have a significant value to society (Figure 1).



Figure 1. Ichetucknee Springs

*Source: Ichetucknee Springs State Park Website*

Periodic droughts, groundwater pumping to satisfy residential, agricultural, and industrial water demands, and groundwater pollution (from urban and agricultural lands) are impacting Florida's spring systems. Water flow in many of Florida's springs has been declining, while nutrient loading to the springs has been growing, affecting the condition of aquatic ecosystems and water clarity in the springs and downstream bodies of water. Changes in spring water flow and quality can degrade the recreational experiences of springs users and diminish other environmental services (Figure 2). To effectively manage water resources in Florida and to protect spring systems, it is important to document the services they provide and to measure the economic value of these services to local communities that depend on these resources.



Figure 2. Algae at a spring site  
*Source: Florida Water Coalition website*

Toward this goal, the University of Florida, Food and Resource Economics Department (UF/FRE), in partnership with The Alachua County Environmental Protection Department (ACEPD) and the local non-profit organization Save Our Suwannee (SOS), conducted a study of the economic contributions generated by recreation and tourism activities at these springs. ACEPD managed the project and assisted with the coordination of data collection and distribution.

The objectives of this study were to (1) measure the economic contribution of springs-based tourism on the local economy and (2) catalogue the ecosystem services provided by the springs to society. This study focused on fifteen recreational spring sites located in the lower Suwannee and Santa Fe River Basins of north-central Florida. The map in Figure 3 shows the nine counties in the study area (Alachua, Bradford, Columbia, Dixie, Gilchrist, Lafayette, Levy, Suwannee, and Union), along with the 15 spring sites considered. Note that the study area has several smaller springs that were not included in the analysis due to the lack of available data.

The ten spring sites on public lands that are included in this analysis are Fanning Springs State Park, Hart Springs County Park, Ichetucknee Springs State Park, Lafayette Blue Springs State Park, Little River Springs County Park, Manatee Springs State Park, Poe Springs County Park, Rum Island Springs County Park, Troy Springs State Park, and Wes Skiles Peacock Springs State Park (Figures 4 and 5). The five privately owned springs included in this study are Blue Grotto, Blue Springs, Devil's Den, Ginnie Springs, and Hornsby Springs (Figure 6).

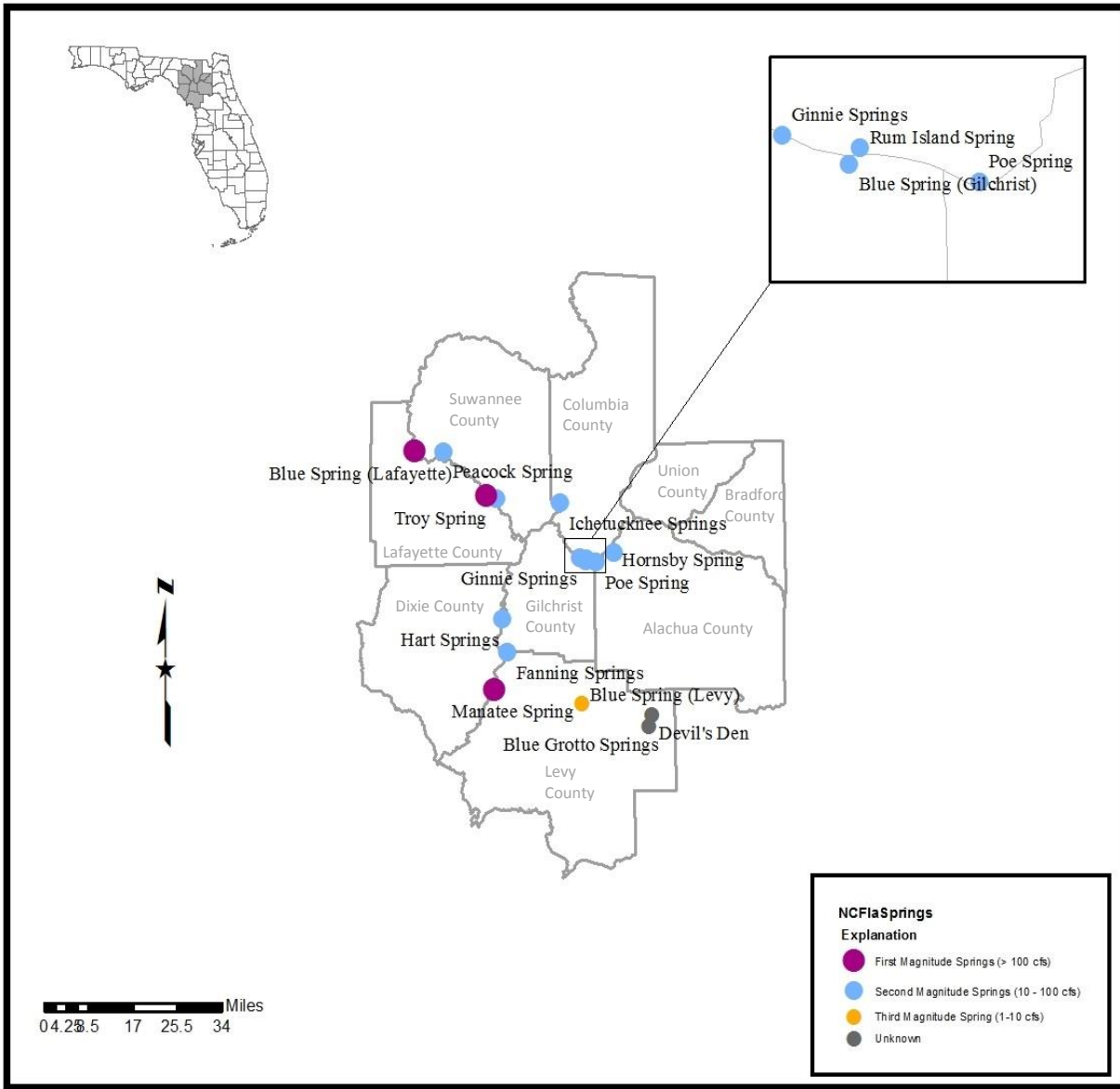


Figure 3. Nine-county study area and locations of major springs studied in north-central Florida  
*Credit: Alachua County Environmental Protection Department*



Figure 4. Blue Hole Spring in Ichetucknee Springs State Park  
*Credit: Mark Long*

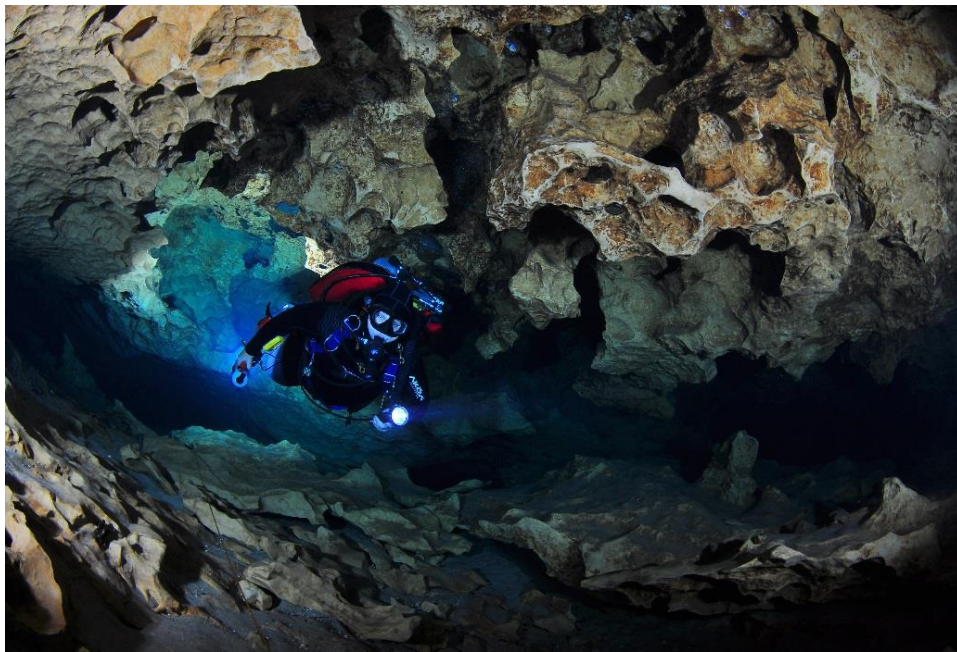


Figure 5. Cave diver in Peacock Springs  
*Credit: Mark Long*

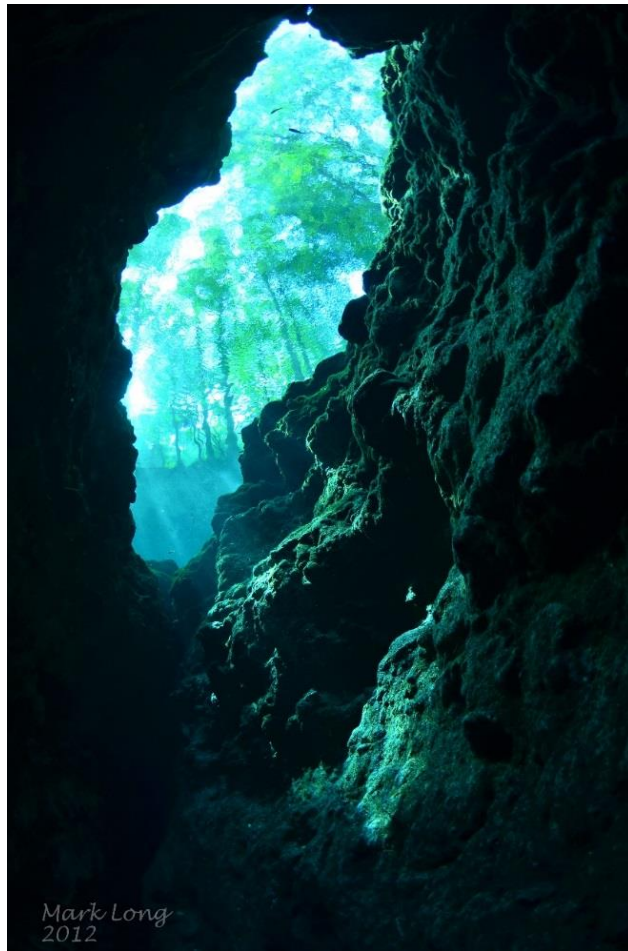


Figure 6. Ginnie Springs  
*Credit: Mark Long*

Most of the springs evaluated in this study are first or second magnitude springs (springs are classified by the volume of the water they discharge). First magnitude springs discharge, on average, 100 cubic feet per second (cfs) or more, which can be converted to approximately 748 gallons per second, or 65 million gallons per day. Second magnitude springs discharge between 10 and 100 cubic feet per second, on average, equivalent to more than 75–748 gallons per second, or 6–65 million gallons per day (Florida Geological Survey 2003). All of the springs in the study are used for recreational activities, including swimming, snorkeling, canoeing, kayaking, hiking, and wildlife viewing. Table 1 (public springs) and Table 2 (private springs) shows additional recreational activities and amenities available at each spring site. Many sites have facilities for picnicking and overnight stay at camp sites and/or cabins, and some offer opportunities for cave or cavern diving.

Brief descriptions of the selected springs covered in this study are provided below. The descriptions are based primarily on information provided on websites, along with reports developed by Florida agencies and tourism and marketing organizations. In addition, user fees for the springs are summarized in Table 3 (publically managed springs) and Table 4 (privately managed springs).

Table 1. Main recreational activities and amenities available at public spring sites studied

Activities Available	Publicly-managed spring sites									
	Fanning	Hart	Ichetucknee	Lafayette Blue	Little River	Manatee	Poe	Rum Island	Troy	Wes Skiles Peacock
Magnitude*	2	2	1	1	2	1	2	2	1	2
Boat Ramp	X	X	X	X			X	X		
Cabins	X	X		X						
Camping (full/primitive)	X	X		X		X				
Concession/ Restaurant	X	X	X			X	X			
Dive shop										
Picnic Pavilion	X	X	X	X		X	X		X	X
Scuba diving	X	X	X	X	X	X		X	X	X
Tubing			X				X			
Visitor Center			X						X	

\* First magnitude springs (1) are springs with discharge exceeding 100 cubic feet per second.

Second magnitude springs (2) discharge between 10 and 100 cubic feet per second.

Some of the parks and recreational areas considered in this study have more than one spring on the property, and the magnitude is reported for the spring that gave the name to the park or property.

\*\* Spring discharge is highly variable.

Table 2. Main recreational activities and amenities available at private spring sites studied

Activities Available	Spring sites on private lands				
	Blue Grotto	Blue	Devil's Den	Ginnie	Hornsby
Magnitude*	NA	2	NA	2	2**
Boat Ramp				X	
Cabins	X		X	X	
Camping (full/primitive)		X	X	X	X
Concession/ Restaurant		X		X	X
Dive shop	X		X	X	
Picnic Pavilion	X	X	X	X	X
Scuba diving	X		X	X	
Tubing		X		X	
Visitor Center				X	

\* First magnitude springs (1) are springs with discharge exceeding 100 cubic feet per second.

Second magnitude springs (2) discharge between 10 and 100 cubic feet per second.

Some of the parks and recreational areas considered in this study have more than one spring on the property, and magnitude is reported for the spring that gave the name to the park or property.

\*\* Spring discharge is highly variable.

Table 3. User fees for public spring recreational areas examined

Fee types	Publicly-managed spring sites								
	Fanning	Hart	Ichetucknee	Lafayette Blue	Manatee	Poe	Rum Island	Troy	Wes Skiles Peacock
Admission: Group*	\$6	\$5-\$12	\$6	\$5**	\$6	Free	Free	\$5**	\$4**
Admission: Individual	\$2-\$4**	\$2-\$4	\$2-\$4	\$2-\$4	\$2-\$4	Free	Free	\$2-\$4**	\$2
Canoe/Kayak rental			\$5/person						
Tubing			\$5-\$6						
Lodging (per night)	\$100	\$125		\$100					
Camping (per night)	\$5/person	\$20/site		\$10/site	\$20/site				
RV (per night)		\$24							
Pavilion rentals (per day)	\$15-\$25	\$25			\$35				
Diver entrance		\$18							
Full diving gear package (per day)									
Source	FPS, undated (a)	Hart Springs.com	FPS, undated (b)	FPS, undated (c)	FPS, undated (d)	Authors	Authors	FPS, undated (e)	FPS, undated (e)

Information as of September 2014. Admission fees do not reflect discounts for seniors, youth, annual passes, packages, or extended stays. Some reported prices exclude taxes. Fee information not available for Little River Springs Park.

\* Group admission fee per vehicle or boat; limit is 6 to 8 people per vehicle/boat for most sites.

\*\* All or some of the fees are collected through honor box.

\*\*\* Fees for Hornsby Springs vary for some groups; swimming in the spring is not included in the admission fee.

Table 4. User fees for private spring recreational areas examined

Fee Types	Spring sites on private lands				
	Blue Grotto	Blue	Devil's Den	Ginnie	Hornsby**
Admission: Group*					
Admission: Individual (adult)	\$3-\$5	\$10	\$5-15	\$12	\$5-\$17
Canoe/Kayak rental		\$10-\$15/2 hours		\$10/2 hours; \$25/day	\$15.75-\$23.75/day
Tubing		\$5		\$6-\$12	
Lodging (per night)	\$65-\$95		\$75-\$170	\$175	\$68.50-\$240
Camping (per night)	\$5-\$10/person	\$15/person	\$10/person	\$20.40/person	\$5.25/person; \$11.50/family
RV (per night)	\$5-\$10/person (plus power fee)	\$15/person (plus power fee)	\$24		\$25
Pavilion rentals (per day)		\$75		\$25-\$75	\$83-\$141
Diver entrance	\$40		\$10-\$38	\$22-\$30	
Full diving gear package (per day)	\$40		\$40	\$59.95	
Source	The Blue Grotto Dive Resort	Blue Springs Park.com	Devils Den.com	Ginnie Springs Outdoors	Camp Kulaqua.com

Information as of September 2014. Admission fees do not reflect discounts for seniors, youth, annual passes, packages, or extended stays. Some reported prices exclude taxes.

\* Group admission fee per vehicle or boat; limit is 6 to 8 people per vehicle/boat for most sites.

\*\* Fees for Hornsby Springs vary by group; swimming in spring is not included in admission fee.



Fanning Springs State Park. This park provides ample hiking, and bird and wildlife watching opportunities, with the trails in the park being part of the Florida birding trails and Suwannee River Wilderness Trails. The park has lodging facilities that are designated as part of the Florida Green Lodging Program. There are five full-service cabins, and multiple camping opportunities in the park. The park was developed around Fanning Springs, which was a first magnitude spring up to the 1990s, but then due to a reduction in water flow, it was reclassified as second magnitude. Current flow level is on average 94 cubic feet per second (cfs) (Burkett 2010). The main recreational activities at the spring are swimming, snorkeling, picnicking, and wildlife viewing.

Hart Springs County Park. This county-owned park is located in proximity to the Gilchrist Blueway Trail and the Suwannee River Wilderness Trail and it is connected to the Florida Greenway trail and other routes. Hart Springs, located inside the park in Gilchrist County, is a second magnitude spring with the 1932–1997 average discharge rate of 71.7 cfs (Scott et al. 2004). The average discharge rate for 2008–2013 was 49.7 cfs (based on 20 flow measurements, SRWMD undated). Popular activities in the park include hiking, biking, camping, picnicking, and swimming.

Ichetucknee Springs State Park. This state park consists of 2,600 acres and a shoreline of 37,400 feet (6 miles) along the Ichetucknee River. The Ichetucknee River is formed by seven springs, and on average supplies about 25 percent of the base flow in the Santa Fe River and 4 percent of the average base flow in the Suwannee River (Bonn and Bell 2003). The trails in the state park have special designation as Florida birding trails. Ichetucknee Springs is designated a National Natural Landmark and a site for Learning in Florida's Environment. Popular recreational activities include tubing, scuba diving (Blue Hole), picnicking, snorkeling, canoeing, swimming, hiking, and wildlife viewing.

Lafayette Blue Springs State Park. This park is developed around Lafayette Blue Springs, which is a second magnitude spring. The average water discharge rate in this spring for 1973–2004 was approximately 81.8 cfs (FDEP 2005). The discharge rate for 2008–2013 was 75.0 cfs (based on 36 flow measurements, SRWMD undated). In this park, primary recreational activities include swimming, picnicking, fishing, canoeing, kayaking, bicycling, hiking, and wildlife viewing. Trails are designated as Suwannee River Wilderness Trails and the site participates in Florida Green Lodging Program.

Little River Springs County Park. This Suwannee County park has a spring run of approximately 150 feet, and a cave system over 1,200 feet long. Little River Springs is a second magnitude spring with a discharge rate of approximately 84.6 cfs (Scott et al. 2004). The average discharge rate for 2008–2013 was 51.3 cfs (based on 25 flow measurements, SRWMD undated). This park is 125 acres with trails that allow for nature walks and a wide variety of wildlife viewing. The spring is utilized for swimming and cave diving, and park visitors also enjoy hiking, picnicking, and nature watching (Florida Communities Trust Parks Website).

Manatee Springs State Park. This park's main attraction is the first magnitude Manatee Springs, designated as a National Natural Landmark. Before 2008, the spring's average discharge rate was 180 cfs (Florida Department of Environmental Protection 2004). The average discharge rate for 2008–2013 was 128.5 cfs (based on 1880 USGS approved flow measurements, SRWMD undated). This park's main recreational activities are snorkeling, scuba diving, canoeing, kayaking, fishing, and wildlife watching, especially of the West Indian Manatee during the winter months. Playground and picnic areas are available, along with hiking and biking trails and a campground. Trails within this park are designated as Florida Birding and Wildlife Trails, and Suwannee River Wilderness Trails.

Poe Springs County Park. This park is managed by Alachua County, and it consists of 202 acres located along the banks of the Santa Fe River. Average flow for Poe Springs located inside the park was 63.3 cfs in 1917–2002 (Scott et al. 2004). The average discharge rate for 2008–2013 was 35.3 cfs (based on 62 approved, provisional, manually read flow measurements, SRWMD undated). Park visitors can enjoy

swimming, snorkeling, canoeing, kayaking, wildlife viewing, picnic areas, playground, volleyball, softball, soccer, hiking, and nature trails (FloridasSprings.org).

*Rum Island Springs Park.* This park is managed by Columbia County. The Rum Island Springs is located inside the park, and park visitors can enjoy canoeing, boating, swimming, snorkeling, and fishing. Before 2007, Rum Island Springs discharged approximately 60.8 cfs on average (Scott et al. 2004). The average discharge rate for 2008–2013 was 15.8 cfs (based on 13 good manually read flow measurements, SRWMD undated).

*Troy Spring State Park.* The measured discharge rate for Troy Springs averaged 153.8 cfs in 1942–2001 (Scott et al, 2004) and 112.7 cfs in 2008–2013 (based on 23 flow measurements, SRWMD undated). Troy Springs State Park includes a variety of recreational activities such as hiking along nature trails; picnicking; wildlife viewing for whitetail deer, turkey, gopher tortoise, and a variety of birds; and fishing for mullet, brim, and largemouth bass. Swimming, snorkeling, and scuba diving are also available. Visitors can explore the wreck of a nineteenth century steamship at the end of the spring run.

*Wes Skiles Peacock Springs State Park.* This park includes two springs, six sinkholes, and a spring run. Springs form 33,000 feet of underground passages, one of the longest underwater cave systems in the continental United States. The primary recreational activity at the springs is cave diving, but park visitors also enjoy picnicking and nature trails, including a trail that leads visitors on a path tracing the twisting tunnels of the caves located far below their feet. Swimming in Peacock Springs and Orange Grove Sink are popular activities during the summer. Discharge from the group of springs contained in Wes Skiles Peacock Springs State Park is intermittent and highly variable.

*Blue Grotto (Levy County).* Blue Grotto is technically a karst window in which water levels vary with changes in the Floridan aquifer. Blue Grotto is a privately owned site with a large cavern (100 feet or 30 meters) that is popular for divers (The Blue Grotto Dive Resort).

*Blue Springs.* Blue Spring is a second magnitude spring. The average discharge rate for 2011–2013 was 27.1 cfs (based on 14 good manually read flow measurements, SRWMD undated). This privately-owned site offers a playground, picnic area, camping/RV sites, bathhouse, and concession store. A 1,500-foot boardwalk follows the spring run to the Santa Fe River. Scuba diving is not allowed at the spring, but there are plentiful opportunities for swimming and snorkeling, as well as underwater photography (VisitNatureCoast.com, BlueSpringsPark.com).

*Devil's Den (Levy County).* This site is a very large dry cavern with a spring inside it, and is a popular site for diving. The remains of extinct animals from the Pleistocene Age (2 million–10,000 years ago) were discovered at the spring (VisitNatureCoast.com, DevilsDen.com).

*Ginnie Springs Recreation Area.* Ginnie Springs Recreation Area is a privately owned facility consisting of a group of eleven springs with a combined total discharge of 260 million gallons per day, which contributes approximately 10 percent of the base flow of the Santa Fe River (Florida Springs Task Force 2000). Ginnie Springs attracts cave divers from around the world. In addition to cave diving, visitors also enjoy snorkeling; swimming; and watching fish, turtles, and wading birds. The recreation area offers camping sites, picnic areas, a volleyball court, and a playground. The area includes a dive shop that offers training and Professional Association of Diving Instructors (PADI) certification, and a campground store selling recreational gear (FloridasSprings.org). There is a spring water bottling plant located on property.

*Hornsby Springs.* Hornsby Spring was formerly classified as a first magnitude spring, but its flow is highly variable. The spring stopped flowing in 2001/02 (Scott et al, 2004; Pittman, 2012; SRWMD undated). The average discharge rate for 2008–2013 was 21.3 cfs (based on 24 good manually read flow measurements, SRWMD undated); in 2013, one of the measurements showed a flow of 145 cfs (SRWMD undated). The spring is located within privately owned property (Camp Kulaqua), and primarily is used for group camping. The facility offers a wide range of recreational activities, including swimming,

canoeing, hiking, basketball, volleyball, softball, soccer, shuffleboard, horseback riding, skate park, mini-golf, rodeo go-cart driving, hayrides, bonfires, zip line, rock climbing, an inflatable water slide, and a low-elements challenge course. The facility also has a zoo, nature center, free WiFi, and a private air strip (CampKulaqua.com). When the spring ceased flowing in 2001/02, the owners spent over \$1 million on the construction of a waterpark to replace it (Pittman 2012).

### Methods

Information about the number of visitors at each site and the primary activities and expenditures of these visitors was collected from a variety of sources. To estimate the average annual number of visitors for the publicly owned springs, published reports by the Florida Park Service were obtained for the period 2000–2012. This information was verified through phone conversations with park managers. The 2011 *Annual Visitor Study* report by *Visit Florida* was used to estimate typical visitor spending for transportation, food and lodging associated with springs recreational use. The Visit Florida report is based on personal interview surveys with domestic and international visitors to the state conducted by the travel research firm D.K. Shifflet & Associates.

Interviews with owners and managers of local businesses serving springs visitors, as well as state park managers, local government representatives, and researchers were conducted by the project investigators September 2013–March 2014. The list of local businesses was developed in collaboration with Save Our Suwannee and Alachua County Environmental Protection Department. The stakeholders were initially contacted by mail to introduce the study and then interviewed by telephone. Over 20 interviews were conducted. The interviews followed a standard set of questions about the importance of the springs for the region, demographic profile of visitors, origin of visitors, typical spending amounts, trends in springs-related activity, etc. (Appendix D and Appendix E).

In addition, published academic studies and other economic reports that focused on springs were reviewed for pertinent information, including the following:

- Bonn, M.A. and F.W. Bell. 2003. *Economic Impact of Selected Florida Springs on Surrounding Local Areas*. Florida Department of Environmental Protection, Tallahassee, FL (Springs: Ichetucknee, Wakulla, Homosassa, and Blue).
- Bonn, M.A. 2004. *Visitor Profiles, Economic Impacts, and Recreational Aesthetic Values Associated with Eight Priority Florida Springs Located in the St. Johns River Water Management District*. St. Johns River Water Management District, Palatka, FL (Springs: Silver Glen, Silver, Alexander, Apopka, Bugg, Ponce de Leon, Gemini, and Green).
- Foster, C. 2008. Valuing preferences for water quality improvement in the Ichetucknee Springs system: a case study from Columbia County, FL. Master Thesis, University of Florida.
- Huth, W.L. and O.A. Morgan. 2011/ Measuring the willingness to pay for cave diving. *Marine Resource Economics* 26:151–166 (Wakulla Springs).
- Morgan, O.A. and W.L. Huth. 2011. Using revealed and stated preference data to estimate the scope and access benefits associated with cave diving. *Resource and Energy Economics* 33:107–118 (Blue Springs, Jackson County, Florida).
- Knight, R. 2012. *Ichetucknee Springs & River: A Restoration Action Plan*. Howard T. Odum Florida Springs Institute, Gainesville, FL.
- Shrestha R.L., J.R.R. Alavalapati, T.V. Stein, D.R. Carter, and C.B. Denny. 2002. Visitor preferences and values for water-based recreation: A case study of the Ocala National Forest. *Journal of Agricultural and Applied Economics* 34(3):547–559 (Springs: Sweetwater, Silver Glen, Juniper, and Salt).

The following information was collected for this study:

- Annual site attendance: Number of visitors (Florida Park Service reports and informal interviews with the park officers, county staff, and springs owners)
- Proportion of visitors from outside local area (park managers, springs owners)
- Proportion of visitors as divers (park managers, springs owners)
- Spending by general visitors for food, transportation, accommodations (assumed to be the same for all springs; \$67.70 per person per day, based on Visit Florida 2011)
- Entry fees (\$4 to \$40 per day; springs websites and interviews)
- Spending by divers for gear rentals, breathing gases, and training: up to \$320 per day; 50 percent rent gear, 25 percent receive training (W. Huth, interviews with dive shops owners/managers)
- Number of users and spending at Santa Fe River outfitters (\$15–\$23) and Ichetucknee tube rentals (\$3.5–\$5).

### **Economic Contribution Analysis**

An analysis of the economic contributions of springs-based recreational spending was carried out using a regional economic model of the nine-county study area constructed with the IMPLAN software and associated database for Florida counties (IMPLAN Group, LLC). IMPLAN is widely used for estimating regional economic impacts of various economic events, activities, policies, and programs. The terminology of regional economic analysis is defined in the glossary (Appendix A) for the following underlined terms. IMPLAN models rely on input-output analysis and Social Accounting Matrices that describe the flow of goods and services for a local economy (Miller and Blair 2007; Mulkey and Hodges 2012). New economic activity associated with the expansion of the local and regional economies is referred to as new final demand, and it leads to three types of effects:

- Direct effects: change in economic activity of businesses directly associated with spring-based recreation
- Indirect effects: change in activity of businesses supplying inputs to the springs-related businesses
- Induced effects: change in activity of businesses selling goods and services to households and governments as a result of increased income in the sectors directly and indirectly affected by spring-related spending.

Economic contributions are evaluated in terms of several different measures:

- Industry output: sale revenues, the dollar value of goods and services produced
- Value added: the increase in value of goods and services produced by a business or industry, calculated as the value of output less the cost of inputs purchased from other businesses; value added for all industries is equivalent to the Gross Domestic Product (GDP)
- Employment: the number of full-time and part-time jobs
- Labor income: employee compensation and benefits, and business owner (proprietor) income
- Other property income: rents, royalties, interest, dividends, and other earnings on investments
- Taxes: revenues to local, state and federal governments from taxes on sales, production, and imports

Economic contributions associated with spring-based recreation are estimated using regional multipliers calculated by the regional input-output model for each industry sector. Multipliers represent the number of times that the initial change in direct spending is re-spent in the local economy due to economic linkages. The size of the multiplier depends on the overall size and degree of economic integration in the region, which affects the proportion of goods and services that are sourced from local businesses. For example, businesses that source inputs from other local firms rather than national suppliers tend to have higher multipliers (Mulkey and Hodges 2012).

Multipliers used in this analysis are summarized in Table 5. These multipliers represent the total effects, that is, the sum of direct, indirect, and induced multiplier effects noted above. For example, the industry output multiplier for hotels and motels (sector 411) has a value of 2.11, meaning that for each dollar of new spending by springs visitors, a total of \$2.11 in industry sales is generated in the region by hotel suppliers and spending by industry employees. Employment multipliers are denominated in jobs per million dollars of output (spending). For hotels and motels, the employment multiplier of 21.5 implies that 21.5 jobs are created for every one million dollars spent by visitors in hotels or motels.

Table 5. Regional economic multipliers for selected industry sectors in north-central Florida study area

Expenditure Item(s)	<i>IMPLAN</i> Industry Sector	Output (Revenue)	Employment (jobs/M\$)	Labor Income	Value Added	Indirect Business Taxes
Food & beverages	324. Retail stores–food and beverage	2.17	31.4	0.93	1.42	0.22
	413. Food services and drinking places	1.98	28.6	0.68	1.13	0.13
Transportation (gasoline)	326. Retail stores–gasoline stations	2.15	21.8	0.85	1.48	0.20
Diving training	393. Other private educational services	2.06	30.9	0.76	1.27	0.07
Private springs entry fees, diving gear rentals	410. Other amusement and recreation industries	2.08	32.0	0.73	1.31	0.18
Lodging	411. Hotels and motels, including casino hotels	2.11	21.5	0.66	1.20	0.16
	412. Other accommodations	2.12	25.3	0.68	1.14	0.11
Public springs entry fees	432. Other state and local government enterprises	2.03	15.1	0.63	1.07	0.05

Total effects multipliers include direct, indirect and induced effects.

Source: *IMPLAN* software and data for Florida counties.

Estimated expenditures by springs visitors were used as inputs to the *IMPLAN* model to estimate economic contributions of spring-based recreation. Expenditures by local residents and nonlocal visitors were analyzed separately. Spending by nonlocal visitors represents "new" final demand to the area, and is therefore subject to the total multiplier effects. On the other hand, spending by local residents typically represents a substitution or transfer of money from one sector to another, so only the direct effects multipliers were applied to this spending (Watson, Thilmany, and Winter 2007).

### Consumer Surplus Estimates for Springs Visitors

As discussed above, contributions of springs to the local economy are evaluated based on the spending of springs visitors. However, the total value of visitors' experiences at the springs can exceed their total spending. The difference between the total values assigned by the visitors to their experiences at the springs and their total spending is referred to as consumer surplus. Consumer surplus is often measured by surveying the visitors, which includes asking them about their willingness to pay for recreational experiences above the actual expenditures incurred. However, conducting a survey of springs visitors was beyond the scope of work for this project, so we opted to use consumer surplus estimates reported in other Florida-based studies. It is important to emphasize that these estimates should be verified in the future by conducting visitor surveys.

Shrestha et al. (2002) examined consumer surplus for visitors to four springs located in the Ocala National Forest (Sweetwater Springs, Silver Glen Springs, Juniper Springs, and Salt Springs). The primary recreational experiences examined were snorkeling, swimming, and canoeing. The researchers

divided visitors into two groups: day visitors and extended visitors staying longer than a day. During May–August 2000, the researchers collected responses to a mail survey from 445 visitors to the springs sites. The survey focused on visitors' willingness to pay in excess of their expenses for recreation at the springs. Three sets of springs site amenities were described in the survey:

1. Unimproved facilities (i.e., minimally developed sites)
2. Moderately developed facilities, including showers at campground; boating; parking; groceries; camping equipment rentals; weekday interpretive tours; and tent and RV camping areas.
3. More developed facilities, including play area and game room; restaurants; paddle boats; tubes; weekend interpretive tours; hiking; boardwalk trails; cabin rentals; and overnight boat parking.

The willingness to pay for springs recreation differed in relation to demographic characteristics. Willingness to pay was higher for visitors in organized groups; females; people with high incomes; visitors travelling longer distances; visitors spending more time onsite; and, those with higher preferences for natural scenes or interested in learning more about natural phenomena. On average, the willingness to pay by day-visitors for the amenity sets described above as A, B, and C were \$4.88, \$8.75, and \$11.72 per trip, respectively. For extended-visitors, the mean willingness to pay was \$9.33, \$12.95, and \$17.45 per trip, respectively. Shrestha et al. (2002) stated that because of the way respondents were asked about their willingness to pay, these values likely present lower bound estimates of consumer surplus.

The characteristics of the springs and their visitors may differ between the Ocala National Forest and the Suwannee River Basin regions. Because Shrestha et al. (2002) was the only Florida-based study of recreational visitors' consumer surplus, these estimates were applied to the spring sites in the study area. Most of the springs in the study area have moderately developed facilities, and hence we used consumer surplus for amenity set B (\$8.75 and \$12.95 per trip). Using the Implicit Price Deflator for Gross Domestic Product (US DOC 2014), the estimates were indexed to November 2013, resulting in a value \$11.42 per trip for day-visitors and \$16.90 per trip for extended-visitors.

Previously, we presented the number of visitor days and the proportion of the visitors from outside the local area for the springs studied. In this section, to examine consumer surplus, it is important to estimate the number of day-visitors versus extended-visitors. To do that, owners and managers of private springs sites were contacted via email and phone. While most of them did not provide specific estimates about the numbers of day-visitors and extended-visitors, one of the managers estimated that approximately half of the springs visitors stay overnight. Another informant stated that most of the springs site visitors stay for 1–2 nights. Based on this information, we assumed that for the private springs, approximately 50 percent of visitors stay for 2 nights and the other 50 percent are day-visitors. For the publicly managed springs sites, it was assumed that local visitors come to the springs sites for day-trips only, and hence, the number of *day-visitors from the local area* was estimated as the total number of visitor days multiplied by the proportion of visitors from the local area. For visitors from outside the local area, we used information from Bonn and Bell (2003), who estimated that for Ichetucknee Springs, Homosassa Springs, and Blue Springs, on average, *day-visitors* comprised 52.4 percent of all the visitors originating from outside the local area, and that extended-visitors stayed at the springs sites an average of 5.2 days. These relationships were used to estimate the number of day-visitors and extended-visitors for all publicly owned springs sites in this study. Note that divers were not considered in these calculations.

Divers are a special category of visitors who likely have higher consumer surplus than those who come to the springs for other activities. Morgan and Huth (2011) reported consumer surplus values for cave diving in Jackson Blue Spring (Jackson County) from a mail survey of 186 domestic divers who used this site over a four-year period. Consumer surplus was estimated to range from \$146 to \$167 per person per trip based on different estimation methods. A mid-range value of \$155 was adjusted for inflation to express in 2013 dollars as \$166 per person per trip using the GDP Implicit Price deflator (US DOC 2014). Assuming the, average length of stay at the springs site for divers is 5.2 days, the total number of divers visiting each site is estimated as the number of diver visitor-days divided by 5.2.

## Ecosystem Services provided by Spring Sites

Springs provide a myriad of other ecosystem services in addition to public recreational opportunities. Estimating the value of these other ecosystem services was outside the scope of this project; however, a generalized catalogue of various ecosystem services provided by the springs was developed based on a review of the literature.

## Results

### Springs Visitation Trends

Total recreational use at all springs sites, and related springs activities was estimated to average slightly over one million visitor-days annually over the 2008–2013 period. Attendance averaged over 100,000 visitor-days annually at several individual springs, including Manatee Springs State Park (142,641), Fanning Springs State Park (293,303), Ichetucknee Springs State Park (177,543), and Ginnie Springs (190,000). The total number of diving visitor-days was estimated at around 57,000, with over 10,000 at Peacock Springs (11,804), Ginnie Springs (15,000) and Blue Grotto (13,000), as shown in Table 6.

Table 6. Annual average attendance and visitor spending at springs in the Lower Suwannee and Santa Fe River basins in north-central Florida, FY 2012/13\*

Site / Activity	Average number visitor-days annually	Average number <u>diving</u> visitor-days annually	Share of customers from outside local area	Total Spending	Total Spending by Nonlocal Visitors
Manatee Springs State Park	142,641	2,573	70%	\$10,626,084	\$7,438,259
Fanning Springs State Park	293,303		10%	\$21,029,839	\$2,102,984
Ichetucknee Springs State Park	177,543	108	70%	\$13,096,587	\$9,167,611
Lafayette Blue Springs State Park	33,684	6	70%	\$2,416,044	\$1,691,231
Peacock Springs State Park	13,887	11,804	70%	\$2,825,392	\$1,977,774
Troy Spring State Park	11,293	8,470	70%	\$2,122,519	\$1,485,764
Little River Spring County Park	11,025	4,380	70%	\$1,469,393	\$1,028,575
Hart Springs	35,000	200	40%	\$2,540,500	\$1,016,200
Poe Spring	5,730		40%	\$387,921	\$155,168
Rum Island Spring	9,800		5%	\$663,460	\$33,173
Ginnie Springs	190,000	15,000	70%	\$17,313,000	\$12,119,100
Blue Springs (Gilchrist County)	41,000		70%	\$3,185,700	\$2,229,990
Hornsby Springs	20,000		50%	\$1,554,000	\$777,000
Blue Grotto	13,000	13,000	90%	\$3,415,100	\$3,073,590
Devil's Den	5,000	1,665	75%	\$739,955	\$554,966
Santa Fe River Canoeing (outfitters)	9,160		60%	\$806,732	\$484,039
<b>Total All Springs</b>	<b><u>1,012,066</u></b>	<b><u>57,206</u></b>	<b>-</b>	<b><u>\$84,192,226</u></b>	<b><u>\$45,335,424</u></b>

\*State fiscal year is July–June.

Source: Published reports and interviews with local business owners and managers.

The number of visitor-days varies significantly from year to year, based on weather and economic conditions. For illustration, the annual number of visitor-days at selected state parks between 2000 and 2012 is presented in Figure 7 (for 2000–2012) and Figure 8 (for 2005–2012). Visitation at these selected sites peaked in 2007/08 at around 700,000 visitor-days, then continued at a high level through 2010/11, before declining to around 550,000 in FY 2011/12. Variations in springs visitation were largely attributed

by interviewed stakeholders to weather and economic conditions. For example, during periods of high water levels, some springs may become inundated with tannic (colored) water that reduces visibility and desirability for in-water activities such as swimming and diving.

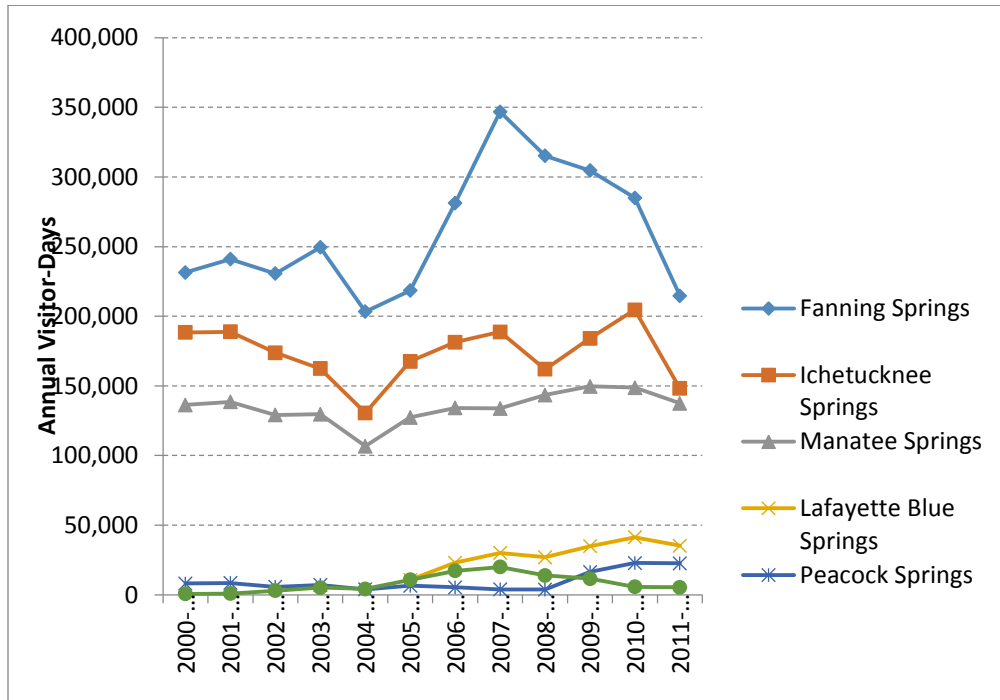


Figure 7. Annual visitation to selected springs at state and county parks in north-central Florida, FY 2000/01–2011/12

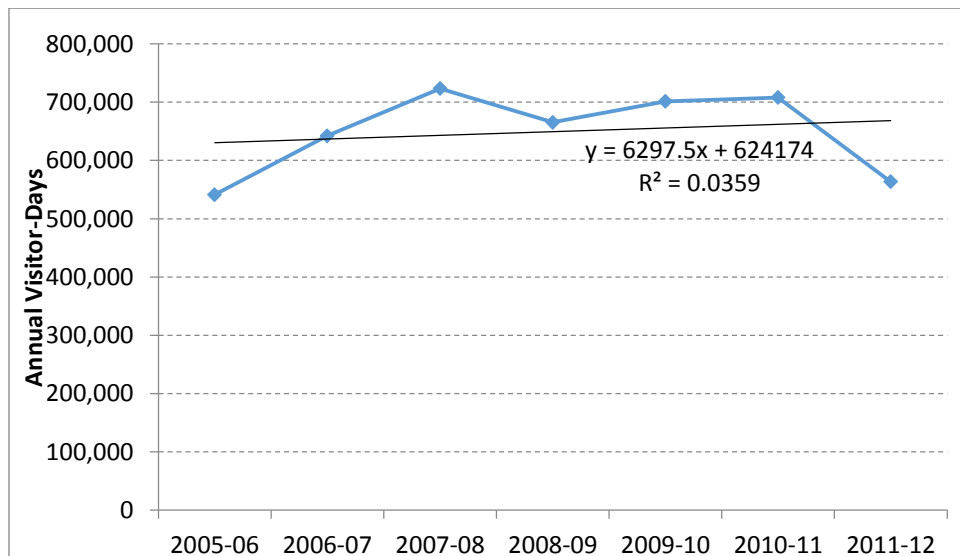


Figure 8. Annual visitation to springs at state/county parks in north-central Florida, FY 2005/06–2011/12: combined attendance at six sites (Fanning, Ichetucknee, Manatee, Lafayette Blue, Peacock, and Troy) and average trend line. Note: Data unavailable for Lafayette Blue Springs prior to 2005/06

Source: Florida Park Service annual reports



## Monetary Economic Contributions of Springs-Based Recreation

The estimated share of nonlocal visitors to the springs from outside the nine-county study area ranged from a low of 5 percent for Rum Island Spring, to a high of 90 percent for Blue Grotto, with a mid-range value of 70 percent for most of the other springs. Total annual visitor spending attributed to springs recreation was estimated at \$84.2 million, including \$45.3 million by nonlocal visitors (Table 6).

Visitor spending is summarized by category in Table 7. The largest spending amounts were for transportation-gasoline (\$23.68 million), followed by hotels/motels and other accommodations (\$11.44 million each), and restaurants and food and beverage stores (\$10.98 million each).

Table 7. Summary of visitor spending, by expense category and local vs. nonlocal visitors, at springs in the Lower Suwannee and Santa Fe River basins in north-central Florida, FY 2012/13

Expense Item	Nonlocal Visitors	Local Visitors	Total
Private spring entry fees	\$2,450,035	\$948,345	\$3,398,380
Public park entry fees	\$1,265,525	\$1,607,979	\$2,873,504
Transportation	\$11,976,337	\$11,706,007	\$23,682,344
Hotels / motels	\$5,783,445	\$5,652,901	\$11,436,346
Other accommodations	\$5,783,445	\$5,652,901	\$11,436,346
Restaurants	\$5,553,131	\$5,427,785	\$10,980,916
Food & beverage stores	\$5,553,131	\$5,427,785	\$10,980,916
Gear rental and diving gasses	\$5,690,360	\$1,996,945	\$7,687,305
Diver training	\$1,280,016	\$436,153	\$1,716,169
<b>Total</b>	<b>\$45,335,424</b>	<b>\$38,856,802</b>	<b>\$84,192,226</b>

Source: Visit Florida, and information from interviewed stakeholders.

The total economic contributions of recreational spending within the local economy due to direct spending, supply chain activity (indirect effects), and income re-spending by households and governments (induced effects) estimated using the IMPLAN software (see methods section) are summarized in Table 8. The total employment impact was estimated at 1,160 full-time and part-time jobs. Labor income impacts of \$30.42 million represent employee earnings and business owner income. Industry output impacts of \$94 million represent the change in total industry revenues attributable to springs recreation. Value added impacts of \$52.58 million represent the increase in regional Gross Domestic Product (GDP). For the nine-county study area in 2012, GDP was \$14.65 billion, so the estimated value added contribution of springs-related recreational spending represented 0.36 percent of the region's overall GDP. The workforce employment in the region was 235,194 jobs, so the employment impact of springs represented 0.49 percent of all jobs. Approximately 71 percent of the total employment impact was attributable to direct effects (i.e., jobs within businesses directly catering to springs visitors).

Table 8. Summary of regional economic contributions of springs-related recreational spending in the Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012/13

Impact Type	Employment (full-time and part-time jobs)	Labor Income (M\$)	Value Added (M\$)	Industry Output (M\$)
Direct Effect	827	\$17.56	\$31.01	\$58.96
Indirect Effect	80	\$2.58	\$4.69	\$8.77
Induced Effect	254	\$10.28	\$16.88	\$26.27
<b>Total Effect</b>	<b>1,160</b>	<b>\$30.42</b>	<b>\$52.58</b>	<b>\$94.00</b>

Values in millions 2014 dollars. Results reflect direct effects for all visitor spending, plus indirect and induced effects for nonlocal visitor spending.

The economic contributions of springs recreation are summarized by major industry group in Table 9. The largest industry groups in terms of employment impacts were Accommodation and Food Services (493 jobs); Arts, Entertainment, and Recreation (230 jobs); and Retail Trade (132 jobs). These same industry groups also had the largest impacts in terms of value added contribution to GDP: Accommodation and Food Services (\$17.83 million); Arts, Entertainment, and Recreation (\$7.17 million); and Retail Trade (\$6.59 million).

Table 9. Regional economic contributions by industry group for springs-related recreational spending in the Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012/13

Industry Group (NAICS)	Employment	Labor Income (\$1,000)	Value Added (\$1,000)	Industry Output (\$1,000)
11. Agriculture, Forestry, Fishing, Hunting	1	\$28	\$53	\$126
21. Mining	1	\$5	\$15	\$182
22. Utilities	1	\$110	\$501	\$1,084
23. Construction	13	\$425	\$518	\$1,146
31-33. Manufacturing	2	\$113	\$165	\$830
42. Wholesale Trade	6	\$313	\$649	\$919
44-45. Retail trade	132	\$4,036	\$6,589	\$9,257
48-49. Transportation & Warehousing	8	\$273	\$351	\$814
51. Information	5	\$277	\$509	\$1,203
52. Finance & insurance	10	\$500	\$1,321	\$2,352
53. Real estate & rentals	16	\$241	\$3,901	\$5,782
54. Professional, scientific & tech. services	30	\$1,039	\$1,638	\$2,869
55. Management of companies	3	\$135	\$176	\$410
56. Administrative & waste services	25	\$588	\$779	\$1,506
61. Educational services	41	\$789	\$1,234	\$2,088
62. Health & social services	38	\$1,890	\$2,123	\$3,702
71. Arts, entertainment & recreation	230	\$3,690	\$7,168	\$12,099
72. Accommodation & food services	493	\$10,187	\$17,829	\$37,608
81. Other services	23	\$622	\$713	\$1,318
92. Government & non NAICS	85	\$5,227	\$6,465	\$8,908
<b>Total</b>	<b>1,160</b>	<b>\$30,423</b>	<b>\$52,582</b>	<b>\$94,001</b>

Values in 2014 dollars. Employment represents fulltime and part-time jobs. Industry groups are classified according to the North American Industry Classification System (NAICS).

The contributions of springs recreational spending to local/state and federal government tax revenues are summarized in Table 10. Tax contributions to local and state governments totaled \$6.56 million, while contributions to the federal government were \$6.57 million. The largest tax impact items for local/state governments were property taxes (\$4.13 million) and sales taxes (\$1.58 million).

Economic contributions of recreational spending for individual springs in the study area are summarized in Table 11. The springs with the largest total employment and value added contributions (including direct, indirect, and induced effects) were Ginnie Springs (285 jobs, \$12.73 million), Fanning Springs (180 jobs, \$7.70 million), Ichetucknee Springs (169 jobs, \$8.29 million), and Manatee Springs (139 jobs, \$6.78 million). The other springs each had employment contributions of 4 to 88 jobs, and value added of \$0.19 million to \$3.80 million.

Table 10. Tax revenue impacts to local/state and federal governments from recreational spending for springs in the Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012/13

Description	Amount (\$1,000)
<b>State and Local Government Taxes</b>	
Dividends	\$4
Social Ins Tax- Employee Contribution	\$21
Social Ins Tax- Employer Contribution	\$38
Tax on Production and Imports: Sales Tax	\$1,581
Tax on Production and Imports: Property Tax	\$4,132
Tax on Production and Imports: Motor Vehicle Licenses	\$19
Tax on Production and Imports: Severance Tax	\$0
Tax on Production and Imports: Other Taxes	\$249
Tax on Production and Imports: Stat/Local Non Taxes	\$369
Corporate Profits Tax	\$51
Personal Income Tax	\$0
Personal Non Taxes (Fines- Fees)	\$64
Personal Tax: Motor Vehicle License	\$7
Personal Tax: Property Taxes	\$17
Personal Tax: Other Tax (Fishing/Hunting)	\$3
<b>Total State and Local Tax</b>	<b><u>\$6,557</u></b>
<b>Federal Government Taxes</b>	
Social Ins Tax-Employee Contribution	\$1,387
Social Ins Tax-Employer Contribution	\$1,665
Tax on Production and Imports: Excise Taxes	\$473
Tax on Production and Imports: Customs Duties	\$200
Tax on Production and Imports: Federal Non Taxes	\$0
Corporate Profits Tax	\$972
Personal Income Tax	\$1,872
<b>Total Federal Tax</b>	<b><u>\$6,568</u></b>

Values in 2014 dollars.

Table 11. Economic contributions of individual springs in the Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012/13

Activity / Business	Employment (full-time and part-time jobs)	Labor Income (M\$)	Value Added (M\$)	Industry Output (M\$)
<u>State or County Owned Springs</u>				
Manatee Springs State Park	139	\$3.97	\$6.78	\$12.26
Fanning Springs State Park	180	\$4.49	\$7.70	\$14.95
Ichetucknee Springs State Park	169	\$4.86	\$8.29	\$15.02
Lafayette Blue Springs State Park	30	\$0.88	\$1.50	\$2.72
Peacock Springs State Park	63	\$1.51	\$2.66	\$4.49
Troy Spring State Park	46	\$1.11	\$1.97	\$3.33
Little River Spring County Park	29	\$0.71	\$1.25	\$2.14
Hart Springs	27	\$0.74	\$1.26	\$2.35
Poe Spring	4	\$0.11	\$0.19	\$0.34
Rum Island Spring	6	\$0.13	\$0.22	\$0.43
<u>Privately owned springs</u>				
Ginnie Springs	285	\$7.31	\$12.73	\$22.17
Blue Springs (Gilchrist County)	46	\$1.24	\$2.13	\$3.77
Hornsby Springs	20	\$0.52	\$0.90	\$1.61
Blue Grotto	88	\$2.15	\$3.79	\$6.31
Devil's Den	16	\$0.38	\$0.67	\$1.14
Santa Fe River Canoeing	12	\$0.31	\$0.54	\$0.95
<b>Total All Springs</b>	<b><u>1,160</u></b>	<b><u>\$30.42</u></b>	<b><u>\$52.58</u></b>	<b><u>\$94.00</u></b>

Values in millions 2014 dollars.

### Consumer Surplus from Springs Recreation

Consumer surplus is usually estimated by surveying site visitors and asking them about their willingness to pay for their recreational experiences, in excess of actual visitor spending. In this study, we relied on consumer surplus estimates reported in two previous Florida-based studies (see methods). Shrestha et al. (2002) estimated consumer surplus for water-based recreation at springs in Ocala National Forest, including boating, canoeing, swimming, fishing, and wildlife viewing. Consumer surplus for cave diving was estimated by Morgan and Huth (2011). The consumer surplus estimates from both studies were indexed to 2013 dollars. In this study, consumer surplus for day-visitors, extended-visitors, and divers was assumed to be \$11.4, \$16.9, and \$166.3 per person per trip, respectively. These consumer surplus estimates were combined with the estimated number of visitors for the springs in the study area. Results for consumer surplus are presented in Table 12. Total consumer surplus for the springs in the study area is estimated at \$9.44 million per year.

To estimate the total economic value of the recreational activities, the consumer surplus estimates were combined with the industry output impact estimates described above, to give a total economic value of springs-based recreation estimated at \$103 million dollars annually (Table 13).

Table 12. Estimated numbers of day visitors and extended visitors, and consumer surplus for springs-related recreation in the Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012/13

Spring Site / Activity	Number of Day Visitors			Number of extended (over-night) visitors	Number of diving visitors	Consumer Surplus (\$)			
	From local area	From outside local area	Total			Day visitors	Extended visitors	Divers	Total
Public Parks									
Manatee	42,020	28,238	70,258	13,433	495	\$802,348	\$227,010	\$82,287	\$1,111,644
Fanning	263,973	8,447	272,420	4,018	0	\$3,111,034	\$67,908	\$0	\$3,178,943
Ichetucknee	53,231	35,771	89,001	17,016	21	\$1,016,396	\$287,571	\$3,454	\$1,307,421
Lafayette	10,103	6,789	16,893	3,230	1	\$192,917	\$54,582	\$192	\$247,691
Blue Peacock	625	420	1,045	200	2,270	\$11,932	\$3,376	\$377,501	\$392,809
Troy	847	569	1,416	271	1,629	\$16,171	\$4,575	\$270,877	\$291,623
Little River	1,994	1,340	3,333	637	842	\$38,064	\$10,770	\$140,076	\$188,910
Hart	20,880	4,009	24,889	1,907	38	\$284,232	\$32,229	\$6,396	\$322,857
Poe	3,438	660	4,098	314	0	\$46,800	\$5,307	\$0	\$52,107
Rum Island	9,310	141	9,451	67	0	\$107,932	\$1,135	\$0	\$109,066
Privately-Owned Springs									
Ginnie			58,333	16,783	2,885	\$666,167	\$283,624	\$479,712	\$1,429,503
Blue			13,667	3,932	0	\$156,073	\$66,449	\$0	\$222,522
Hornsby			6,667	1,370	0	\$76,133	\$23,153	\$0	\$99,286
Blue Grotto			0	0	2,500	\$0	\$0	\$415,750	\$415,750
Devil's Den			1,112	343	320	\$12,695	\$5,791	\$53,248	\$71,734
<u>Total All Springs</u>			<u>572,583</u>	<u>63,520</u>	<u>11,001</u>	<u>\$6,798,143</u>	<u>\$1,073,480</u>	<u>\$1,829,492</u>	<u>\$9,441,866</u>

Table 13. Total economic value of springs-related recreation in the Lower Suwannee and Santa Fe Rivers of north-central Florida, FY 2012/13

Site / Activity	Industry Output Contribution (million \$)	Consumer Surplus (million \$)	Total Economic Value (million \$)
Manatee Springs State Park	\$12.26	\$1.11	\$13.37
Fanning Springs State Park	\$14.95	\$3.18	\$18.13
Ichetucknee Springs State Park	\$15.02	\$1.31	\$16.33
Lafayette Blue Springs State Park	\$2.72	\$0.25	\$2.97
Peacock Springs State Park	\$4.49	\$0.39	\$4.88
Troy Spring State Park	\$3.33	\$0.29	\$3.62
Little River Spring County Park	\$2.14	\$0.19	\$2.33
Hart Springs	\$2.35	\$0.32	\$2.67
Poe Spring	\$0.34	\$0.05	\$0.39
Rum Island Spring	\$0.43	\$0.11	\$0.54
Ginnie Springs	\$22.17	\$1.43	\$23.60
Blue Springs	\$3.77	\$0.22	\$3.99
Hornsby Springs	\$1.61	\$0.10	\$1.71
Blue Grotto	\$6.31	\$0.42	\$6.73
Devil's Den	\$1.14	\$0.07	\$1.21
Santa Fe River Canoeing (outfitters)	\$0.95		\$0.95
<u>Total of All Studied Springs/Activities</u>	<u>\$94.00</u>	<u>\$9.44</u>	<u>\$103.42</u>

## Ecosystem Services Provided by Springs

Economic contribution analysis discussed above focuses on the income and employment associated with recreation and tourism. However, springs provide a variety of other services that are not traded in the market. Ecosystem services are all the benefits that humans derive from ecosystems, their structure, and processes (MEA 2005). As illustrated in **Figure 9**, all ecosystem services can be classified into

1. Provisioning services (e.g., water, timber, and other raw materials)
2. Regulating services (e.g., flood regulation or carbon sequestration / climate regulation)
3. Cultural services (e.g., recreational and spiritual uses)
4. Supporting services (e.g., nutrient cycling, biodiversity, net primary productivity)

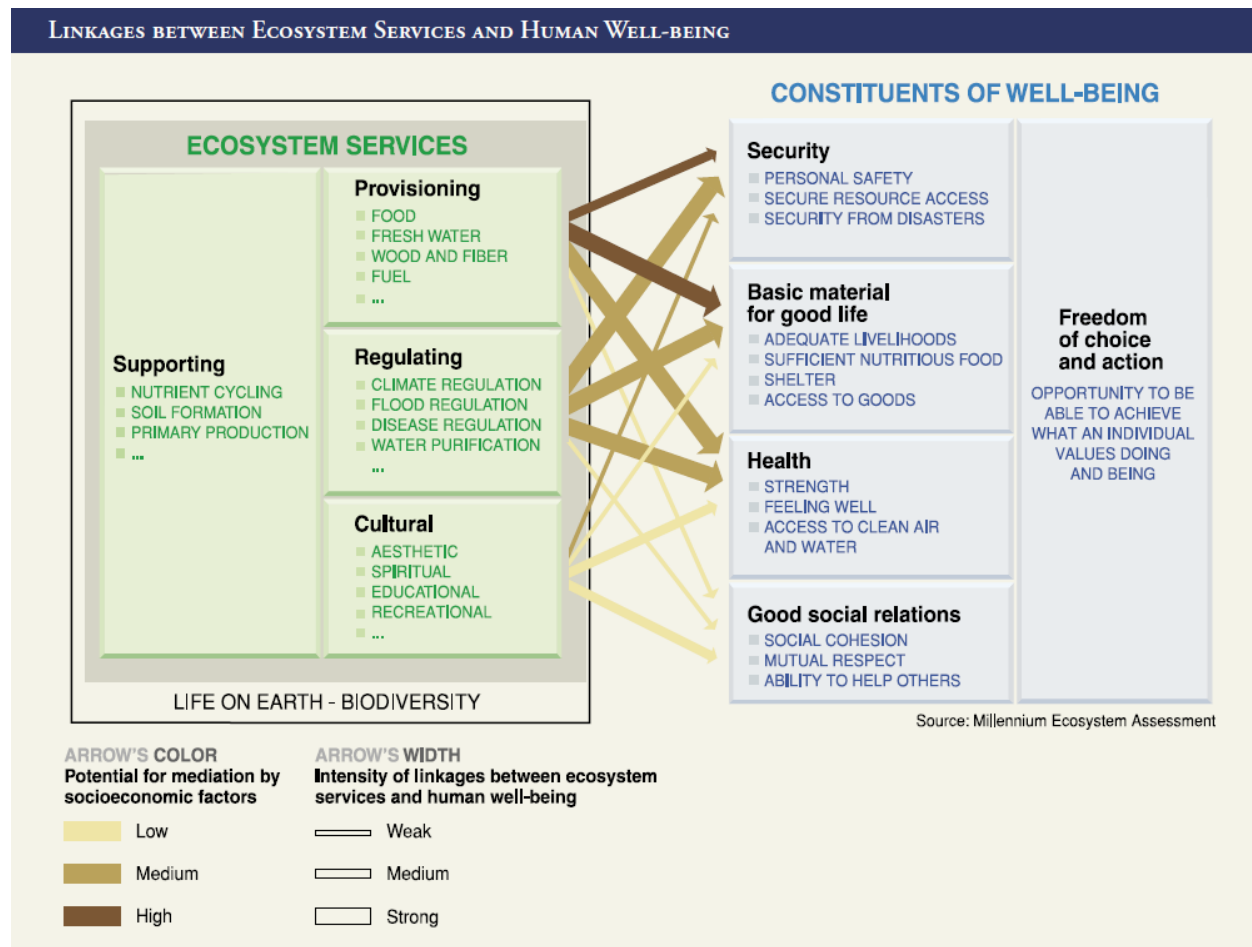


Figure 9. Typology of ecosystem services and linkages to human well-being  
Source: Millennium Ecosystem Assessment (2005)

For the springs sites in the study area specifically, the following ecosystem services are applicable.

Supporting services consist of sustaining habitats for aquatic and riparian plant, fish, insects, and animal communities. This ecosystem service category also includes providing biological/population control through trophic relationships in the ecosystems (Table 14). Springs are also an important part of the hydrologic and nutrient cycles.

Table 14. Catalog of ecosystem services provided by freshwater springs and associated riparian areas

Categories	Ecosystem Services
<b>In-Stream Services Provided by the Spring Vents and Spring Runs</b>	
Supporting	Nitrogen cycle, water cycling, carbon cycling
Provisioning	Groundwater for drinking; bottling company
Regulating	In-stream vegetation: air purification, erosion control, soil fertility regulation, carbon sequestration / climate regulation
	Water regulation / flood control
	In-stream flows / habitat for fish, aquatic microinvertebrates, animals, plants (including rare, threatened, and endangered species)
Cultural	Scientific knowledge
	Environmental education
	Traditional ecological knowledge (practices and customs transmitted through generations)
	Recreational activities – in-stream (eco-tourism, wilderness, cave diving, canoeing, kayaking, swimming, snorkeling, tubing, etc.)
	Spiritual values
	Inspiration, art, cultural heritage, identity values
<b>Services Provided by Riparian Areas Along the Spring Runs</b>	
Regulating	Biodiversity - habitat for birds; wildlife; plants; insects; etc.
	Carbon sequestration and storage / climate regulation by riparian communities
	Air purification, erosion control, soil fertility regulation by riparian / in-stream vegetation
Supporting	Nitrogen cycle, water cycling, carbon cycling
Cultural	Recreational activities (eco-tourism, hiking, birdwatching, hunting, bicycling)

Provisioning services are primarily linked to water extraction by a water bottling plant located near Ginnie Springs. The water is labeled as spring water, and according to the definition at BottledWater.org, this label is only possible when the water is "derived from an underground formation from which water flows naturally to the surface of the earth. Spring water must be collected only at the spring head or through a borehole tapping the underground formation near the spring. Spring water collected with the use of an external force must be from the same underground stratum as the spring and must have the same physical properties before treatment, and be of the same composition and quality as the water that flows naturally to the surface of the earth" (BottledWater.org). In other words, only the existence of the springs makes the spring water label possible. For the spring water bottling plant near Ginnie Springs, the number of people employed by the plant fluctuates over time, with the maximum number of employees being 185–200. The company holds a Consumptive Water Use permit issued by Suwannee River Water Management District (permit expires in 2019) for an average withdrawal of 1.15 million gallons per day, and a maximum daily withdrawal of 1.73 million gallons, although historically the actual withdrawals were less than one-third this amount (Clark 2011; Curry 2012). The beneficiaries of this provisioning service include the bottling company and its employees and business suppliers, as well as the consumers of the bottled water. The condition of the springs can affect the level of provision of this service. The depth to groundwater and head pressure, and concentrations of recognized pollutants that affect taste and odor or present potential health risks may increase the treatment costs of the bottling company.

Regulating services are related to the regulation of water flow and water quality. For example, the springs likely contribute to flood mitigation, by allowing water to backflow into the springs during times of high

water levels. Springs also support riparian and in-stream ecosystems, and aquatic and riparian plant communities that provide regulating services related to carbon sequestration and storage.

Cultural services are defined as "non-material benefits people obtain through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (MEA 2005). By supporting biodiversity and native ecosystems, springs provide support for key recreational activities such as bird watching, wildlife viewing, and hunting, as well as traditional water-based recreation, such as canoeing, kayaking, tubing, swimming, and snorkeling. Cave diving is a unique recreational activity associated with Florida springs, which depends on the quality of the spring water (transparency/turbidity), as well as support for native aquatic ecosystems. Springs also serve as inspiration to artists (springs photographs and paintings are enjoyed nationwide and internationally). Springs serve as sites for scientific studies, and they provide spiritual values. Support for unique or rare, endangered, and threatened species also provides service to society in terms of existence or nonuse values. Nonuse value may be important, given springs' national and international significance as an iconic feature of Florida.

In conclusion, the ecosystem services provided by the springs include in-stream flow services, and riparian and wetland services. Moreover, water from springs supports the stream flow of both the Santa Fe River and the Suwannee River, and hence, contributes to the ecosystem service provision associated with these rivers, including nutrient regulation, hydrologic regulation, water purification, flood control, dilution of runoff discharges, cultural services, etc. Finally, as springs are the outlets of the vast Floridan aquifer, they can be linked to the services provided by it.

### **Conclusions**

This study examines the monetary economic contributions and consumer surplus of recreational use, and ecosystem services provided by fifteen key springs sites to the local economy of a nine county area in north-central Florida.

Total recreational use at all springs sites (and related Santa Fe River activities) was estimated to average slightly over one million visitor-days annually during the 2008–2013 period. Attendance averaged over 100,000 visitor-days annually at several of these springs. In addition, the total number of diving visitor-days was estimated at around 57,000 annually. The estimated share of nonlocal visitors to the springs from outside the nine-county study area was typically about 70 percent for most of the sites studied. Total annual visitor spending attributed to springs recreation was estimated at \$83.8 million, including \$45.2 million by nonlocal visitors.

The estimated total economic contributions of recreational spending (due to direct spending, supply chain activity and income re-spending) included employment of 1,160 full-time and part-time jobs, labor income of \$30.42 million annually, value added of \$52.58 million annually, and industry output (revenue) of \$94 million annually. The value added contribution is comparable to Gross Domestic Product (GDP). Tax revenue impacts to local/state governments totaled \$6.56 million, and impacts to the federal government were \$6.57 million. The largest tax impact items for local/state governments were property taxes (\$4.13 million) and sales taxes (\$1.58 million). In addition, the total consumer surplus for the fifteen spring sites in the study area was estimated at \$9.44 million annually.

The estimates of the direct economic contribution and consumer surplus focus on the value of recreational activities only. In addition to recreation, springs sites and related hydrologic systems provide a variety of ecosystem services, including provisioning (spring water bottling plant), supporting (e.g., hydrologic and nutrient cycling), regulating (e.g., flood control), and cultural (inspiration, art, cultural heritage, scientific knowledge, environmental education, existence value for endangered species, etc.).

It is important to recognize the limitations of this study, including limited visitation data for private springs, the reliance on spending data from secondary sources, the use of consumer surplus estimates



derived from studies developed for other Florida regions, and the focus on recreation activities only. For future research, we suggest conducting a larger, more comprehensive study that would involve primary data collection through visitor surveys and advanced econometric methods for the survey response analysis and the assessment of ecosystem service values provided by springs.

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## Appendix A

### Springs Water Quality and Flow Trends

For a subset of the springs in the study area, water quality data were obtained from the Suwannee River Water Management District (SRWMD undated). The trend in total nitrogen concentrations (Figure A1), total phosphorous concentrations (Figure A2), and water clarity (Secchi disk visibility, in meters) (Figure A3) are plotted. For some springs, particularly Fanning Springs, nitrogen concentrations have increased steadily since the mid-1990s. Existing studies and reports attribute this increase in nitrogen concentration to agricultural and urban land uses, as well as discharges from septic tanks in residential areas in the springshed (Hallas and Magley 2008; Howard T. Odum Florida Springs Institute 2012). Phosphorous concentrations are highly variable, and no trend over time was discernable. Data for average annual discharge for several springs in the study area during the 1998–2013 period is presented in Figure A4. For most springs, the average annual discharge shows significant variation from year to year. However, for all springs, the average annual discharge declined during the 1998–2013 period, with the reduction being especially noticeable for Manatee Springs, Fanning Springs, and Hornsby Springs.

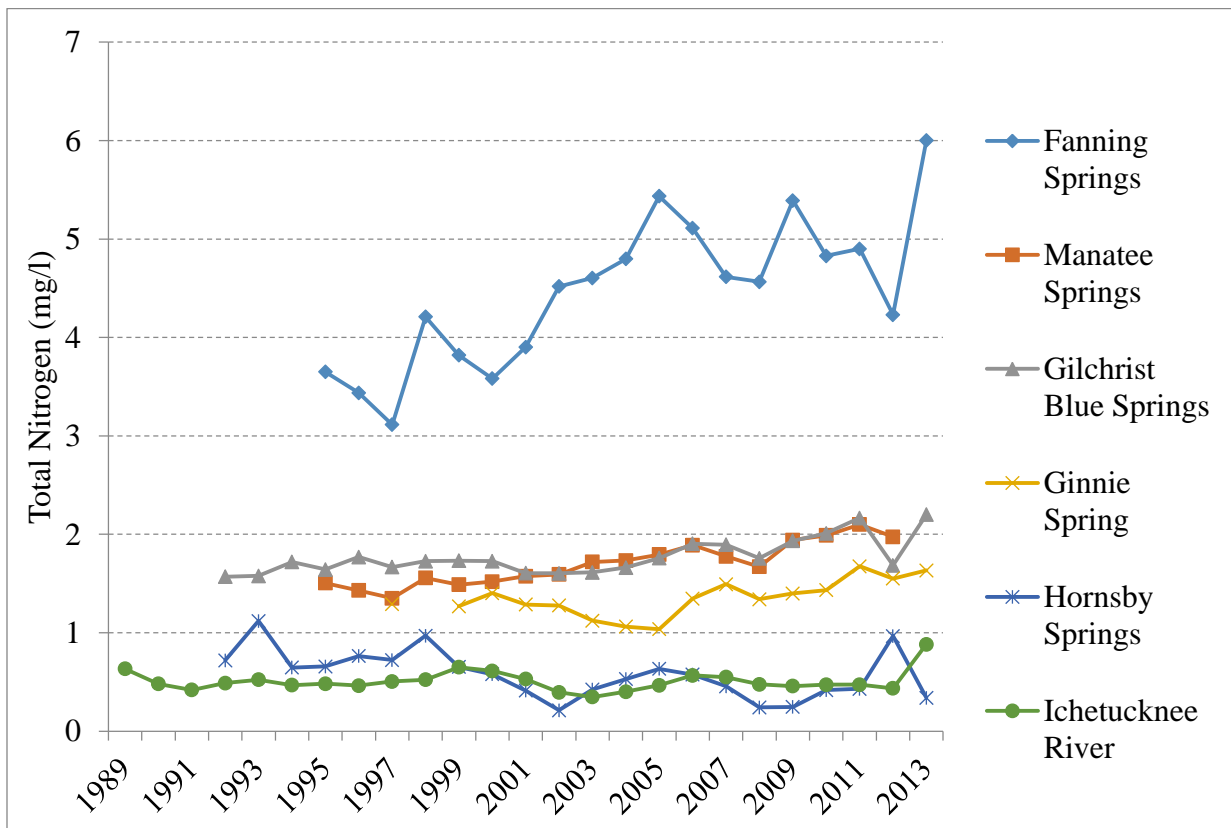


Figure A1. Trend in total nitrogen concentrations in selected springs in the Lower Suwannee and Santa Fe River basins, 1989–2013

Source: SRWMD. Data are provisional and subject to revision.

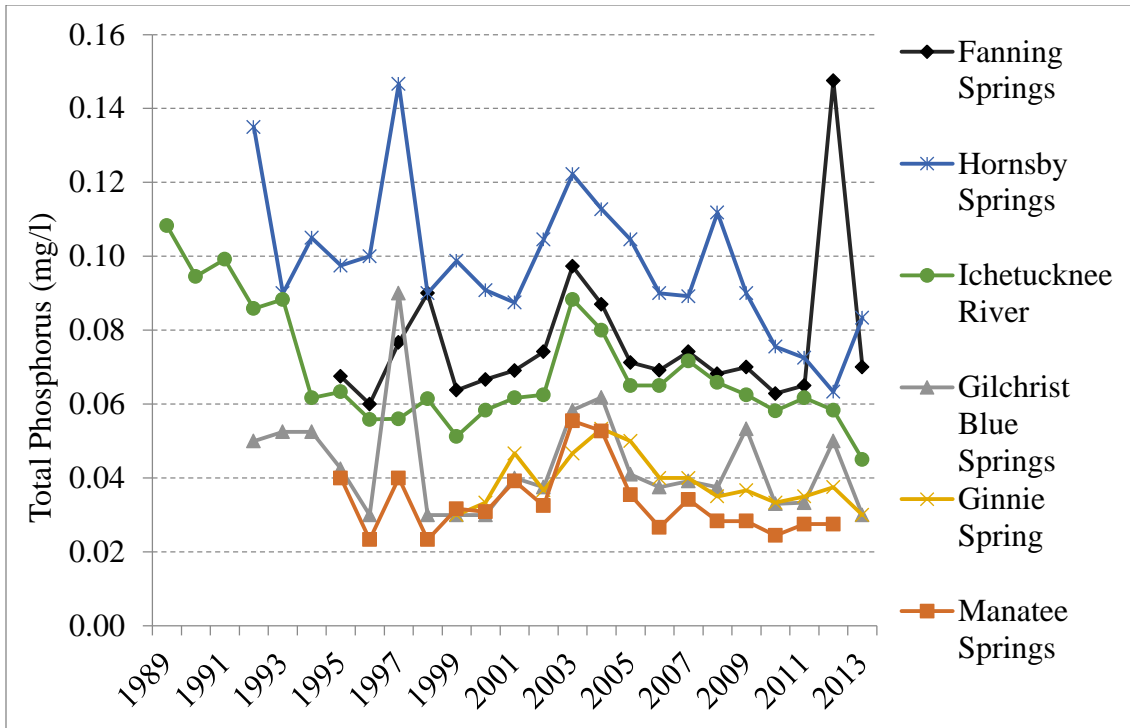


Figure A2. Trend in total phosphorus concentrations in selected springs in the Lower Suwannee and Santa Fe River basins, 1989–2013

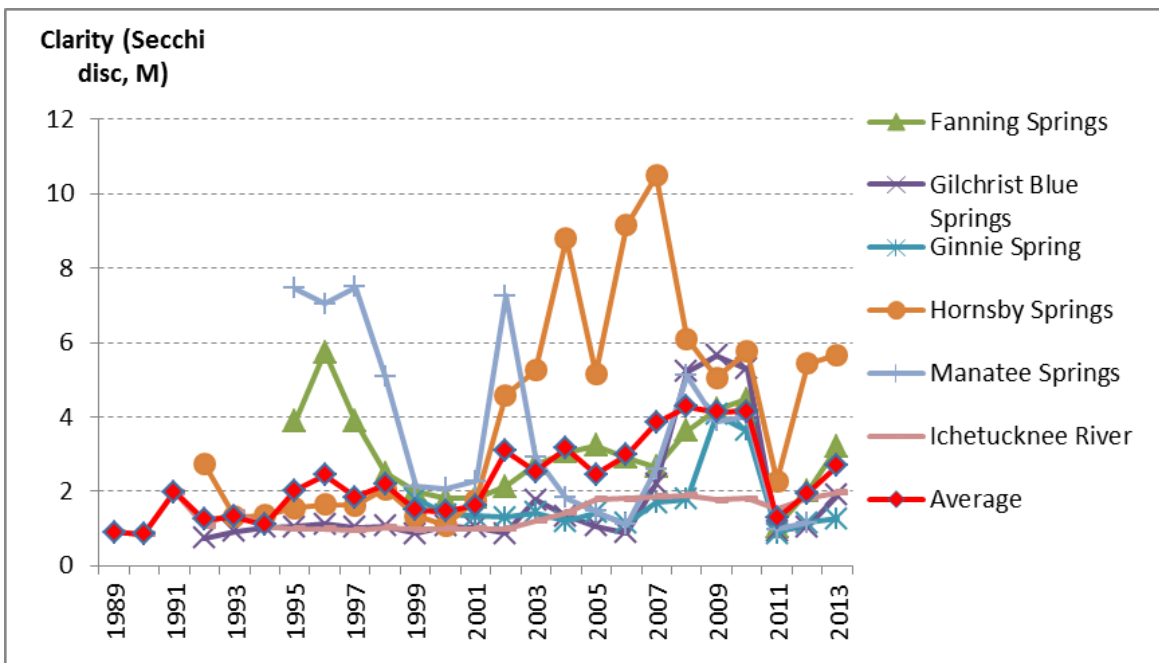
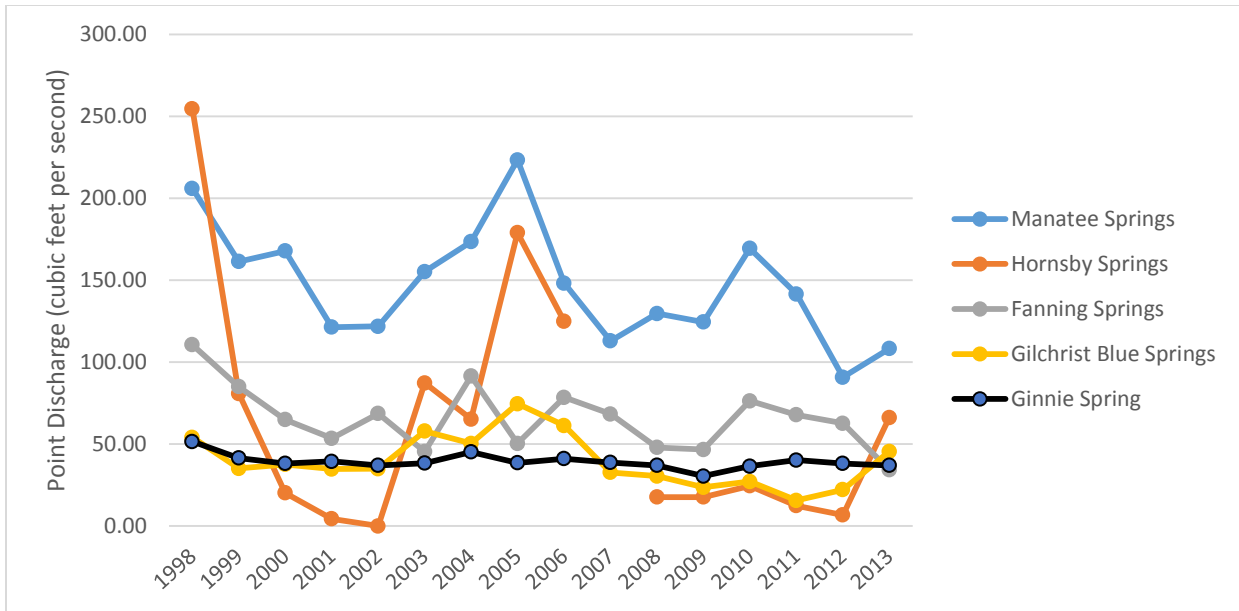


Figure A3. Trend in water clarity in selected springs in the Lower Suwannee and Santa Fe River basins, 1989-2013

Source: SRWMD



**Figure A4.** Average annual water discharge volume for selected springs in the study area  
*Source: SRWMD*



## Appendix B

### Endemic Species Found in Springs in the North-Central Florida Area

The following rare, endangered, and threatened species have been found in the Suwannee River Basin, which covers a large part of the study area (IUCN 2013; Lopez 2013):

- Suwannee Moccasinshell (*Medionidus walkeri*)—Critically Endangered (i.e., facing an extremely high risk of extinction)
- Oval Pigtoe (*Pleurobema pyriforme*)—Endangered (i.e., facing a very high risk of extinction)
- Santa Fe Cave Crayfish (*Procambarus erythrops*)—Endangered (i.e., facing a very high risk of extinction)
- Pallid Cavecrayfish (*Procambarus pallidus*)—Near Threatened (i.e., likely to become endangered in the near future)

Since the springs contribute a significant proportion of the flow of both the Santa Fe River and Suwannee River, the springs also contribute to habitat support for these species. These species are described in more details below.

*Suwannee Moccasinshell* (*Medionidus walkeri*) is a localized endemic; that is, its extent of occurrence is small; less than 250 km<sup>2</sup> (97 square miles) in the Florida portion of Suwannee River Basin, including New River, Withlacoochee, Suwannee, and Santa Fe drainages (Figure B1). Furthermore, the Suwannee Moccasinshell's population has experienced significant decline. According to IUCN (2013), "only one individual from a single site has been collected in the last decade... Previously, it was also collected from a second site, but again in very low numbers. Whether it still exists at that site is questionable... Further research is required regarding this species' habitat and population trends, and the threats to this species."



Figure B1. Suwannee Moccasinshell  
Source: *The MUSSEL Project* (2013)

Reduction in Suwannee Moccasinshell's population has been linked to deteriorating habitat, water quality problems, and overharvesting (IUCN 2013). Specifically, habitat deterioration can be linked to habitat modifications and sedimentation (related to agricultural and silvicultural activities, and residential development in the basin). Disappearance of a host fish is also a possibility. Water quality problems are related to eutrophication (due to phosphate mining, industrial and municipal pollution, and water runoff from residential areas).

*Oval Pigtoe* (*Pleurobema pyriforme*) has lost 73 percent of its historic extent of occurrence (which likely corresponds to more than 50% reduction in population), and it is still declining in abundance (Figure B2). Note that the population of Oval Pigtoe in the Suwannee River is disjoint from the rest of the population, and may be genetically different, which makes protection of this population even more important (Figure B3) (IUCN 2013).



*Pleurobema pyriforme*  
Oval pigtoe

Figure B2. Oval Pigtoe  
Source: US FWS (2012)

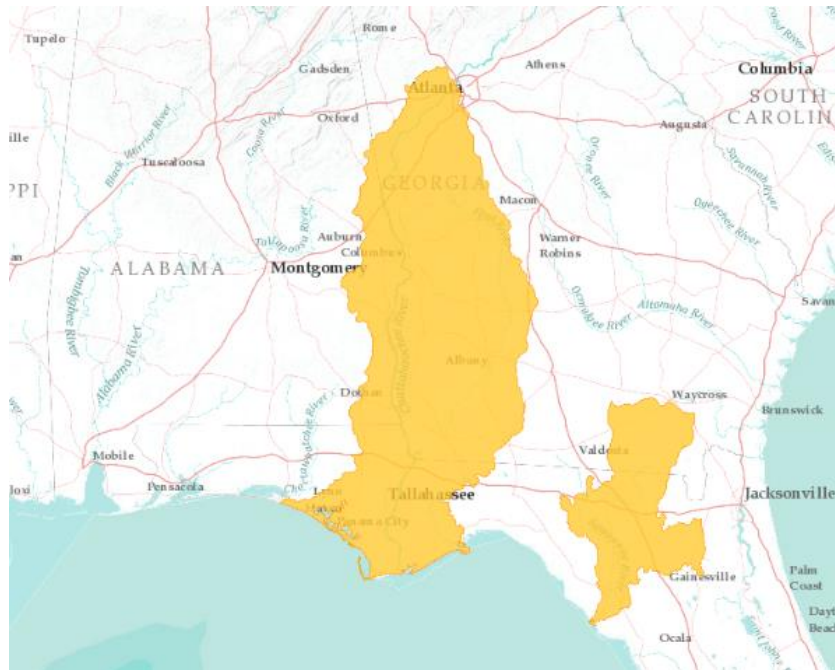


Figure B3. Range of occurrence of Oval Pigtoe  
Source: IUCN, 2013)

The species generally occur in medium-size creeks or small rivers with slow to moderate currents that offer silty sand, sand, or gravel substrates (IUCN 2013). The species' habitat has been affected by physical modifications (such as impoundments and/or channelization), sedimentation/siltation, changes in

turbidity, and pollution (including pesticides). These changes in habitat can be associated with poorly conducted agricultural and silvicultural activities, as well as industrial, municipal, and residential pollution and watershed development. Other possible localized factors affecting the habitat of the species include water withdrawals, invasive species, and toxic spills.

This species shows little ability to recover from habitat loss without human intervention, and a recovery plan for the species was created by the US Fish and Wildlife Service. Both the Santa Fe River and New River are included in the critical habitat designation for this species.

*Santa Fe Cave Crayfish* (*Procambarus erythropus*) is listed as Endangered due to its restricted range of occurrence (approximately 227 km<sup>2</sup> (87 square miles) that cover five caves located north of the Santa Fe River, east of the Suwannee River, and west of Ichetucknee Springs), as well as the on-going habitat degradation (Figure B4).



Figure B4. Santa Fe Cave Crayfish  
Source: Arkive (2013)

IUCN (2013) gives the following description of the habitat of this species, "This species inhabits subterranean waters. It is inferred that the five caves in which this species is found, are linked by passages which allow some genetic flow to occur (Streever 1996). The type of locality is a fully flooded cave with a water temperature of 21°C and has a maximum depth of 12.5 m (Streever 1996)" (Figure B5).

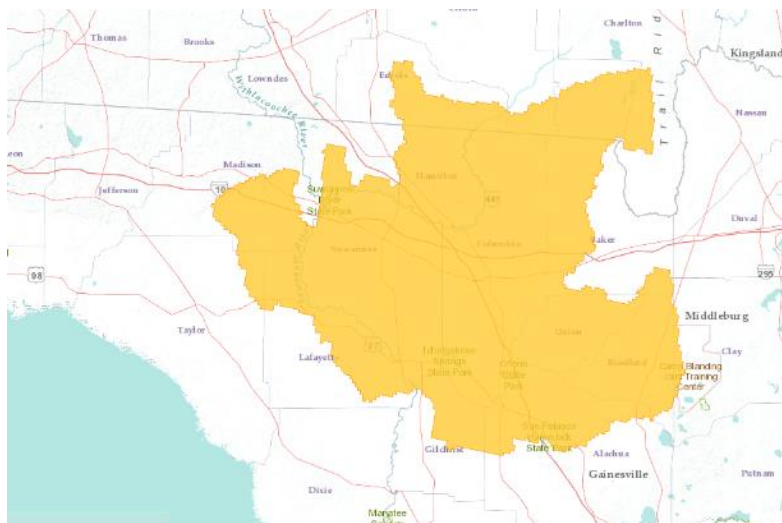


Figure B5. Range of occurrence of Santa Fe Cave Crayfish  
Source: IUCN (2013)

The species' habitat is affected by pesticide and herbicide use in the surrounding area, groundwater withdrawals, as well as destruction of the cavern systems supporting the species by mining activities (IUCN 2013). One of the sites at which this species is found is currently protected by The Nature Conservancy, but further site protection is required to prevent further declines of this species). Further research is also needed to determine the current population status of this species.

Pallid Cave crayfish (*Procambarus pallidus*) is classified as Near Threatened, and it was assigned an American Fisheries Society Status of 'vulnerable' due to the relatively small area of occurrence (82 caves across approximately 3,000 km<sup>2</sup>) and continuous habitat decline (Figure B6). The population of Pallid Cavecrayfish is assessed as low (Figure B7) (IUCN 2013).



Figure B6. Pallid Cavecrayfish  
Source: IUCN (2013)



Figure B7. Range of occurrence of Pallid Cavecrayfish  
Source: IUCN (2013)

The factors that affect the habitat and the population of Pallid Cavecrayfish include urban development in the region, groundwater pollution, and human disturbance (such as recreational diving in the caves that provide habitat for the species) (IUCN 2013). In addition, the population was affected by a flood from unconfined aquifer (IUCN 2013).

In addition to these four species that have an official status of critically endangered, endangered, or near threatened, the Florida Spring Task Force Report (2000) states that "Many of Florida's spring and cave creatures are extremely rare. In fact, twenty-two Florida cave-dependent species are found nowhere else in the world. The Florida Committee on Rare and Endangered Plants and Animals has recognized that most Florida spring- and cave-dependent species merit state or federal protection." Protecting and improving aquatic habitats in the Suwannee and Santa Fe River Basins would help prevent reduction in the number of springs and cave species, and contribute to the protection and population increase for the four species identified above.

## Appendix C

### Glossary of Economic Impact Terms

(Based on Rahmani, Hodges, and Clouser 2010)

**Employment** (or **jobs**) is a measure of the number of jobs required to produce a given volume of sales/production, usually expressed as full-time equivalents, or as the total number including full-time, part-time and seasonal positions.

**Final Demand** is sales to final consumers, including households, governments, and exports.

**Impact analysis** estimates the impact of a change in output or employment resulting from a change in final demand to households, governments, or exports.

**IMPLAN** is a computer-based input-output (I-O) modeling system and Social Accounting Matrix (SAM). With IMPLAN, one can estimate I-O models of up to 440 sectors for any region consisting of one or more counties. IMPLAN includes procedures for generating multipliers and estimating impacts by applying final demand changes to the model.

**Income** is the money earned within the region from production and sales.

**Input-output (I-O) analysis** is a representation of the flows of economic activity between industry sectors within a region. I-O models capture what each business or sector must purchase from every other sector in order to produce its output of goods or services.

**Intermediate sales** are sales to other industrial sectors.

**Margins** (retail, wholesale, transportation, production) are the portions of the purchaser price accruing to the retailer, wholesaler, transporter, and producer, respectively. Only the retail margins of many goods purchased by consumers accrue to the local region, as the wholesaler, shipper, and manufacturer often lie outside the local area.

**Multipliers** for a region may be derived from an Input-output (I-O) model of the region's economy. Multipliers capture the total effects, both direct and secondary, in a given region. The total effect is captured as a ratio of the total change in economic activity in the region relative to the direct change. Multipliers may be expressed as ratios of sales, income, or employment, or as ratios of total income or employment changes relative to direct sales. Multipliers express the degree of interdependency between sectors in a region's economy and therefore vary considerably across regions and sectors. A sector-specific multiplier gives the total changes to the economy associated with a unit change in output or employment in a given sector.

- **Direct effects multipliers** are the changes in economic activity directly related to the changes in an economic sector due to a project or policy (referred to as “the first round of spending”).
- **Indirect effects multipliers** are the changes in economic activity within the region in industries supplying goods and services to businesses (e.g., increased sales in input-supply firms that is attributed to more recreational industry sales).
- **Induced effects multipliers** are the changes in economic activity within the region from household spending of the income earned in the direct and supporting industries (i.e., employees in the direct and supporting industries spend the income they earn on housing, utilities, groceries, and other consumer goods and services, which generates sales, income, and employment throughout the region's economy).

**Output** (or **sales**) is the dollar volume of a good or service produced or sold.

**Purchaser prices** are the prices paid by the final consumer of a good or service.

**Producer prices** are the prices of goods at the factory or production point. For manufactured goods, the purchaser price equals the producer price plus a retail margin, a wholesale margin, and a transportation margin. For services, the producer and purchaser prices are equivalent.

**Region** defines the geographic area for which impacts are estimated. Regions are generally an aggregation of one or more counties.

**Sales or output** is the dollar volume of a good or service produced or sold.

**Sector** is a grouping of industries that produce similar products or services, or production processes. Most economic reporting and models in the United States are based on the Standard Industrial Classification system (SIC code) or the North American Industrial Classification System (NAICS).

**Total income** includes personal income (wage and salary income, including sole proprietor profits and rents).

**Value Added** is the sum of total income and indirect business taxes. Value added is the most commonly used measure of the contribution of a region to the national economy, as it avoids double counting of intermediate sales and captures only the "value added" by the region to final products.

## Appendix D

### Introductory Letter and Questions Used for Local Stakeholder Interviews

[Date]

Dear [Name],

We are contacting you about a new research project titled "**Economic Impact of Springs in the Santa Fe River Basin**". This project seeks to document the level of recreational usage of public and private springs in the north-central Florida region, to measure the economic impacts of springs-related tourism on the local economy, and to explore the value of non-market ecosystem services provided by springs. The project is funded by the *Wildlife Foundation of Florida* (through the Protect Florida Springs Tag Grant Program) and by *Save Our Suwannee*. The project will be implemented by researchers at the University of Florida, Food and Resource Economics Department, and coordinated by the Alachua County Environmental Protection Department.

We are asking for your cooperation with this project. Specifically, during the next three months you will be contacted by the researchers about recreational activities at your spring site or related business. We are seeking information about the number of people visiting your site in recent years, and visitors' expenditures at the springs sites and other local businesses. Your answers will be kept confidential, and the information collected will only be used to estimate the overall economic impacts of spring-based recreation to the region. Your participation is voluntary, and you do not have to answer any question that you do not wish to answer.

The project will be completed in June 2014, and we will be happy to share with you the results of the analysis. If you have any questions about this project, please, feel free to contact us.

Alan Hodges, PhD, and Tatiana Borisova, PhD  
Food and Resource Economics Department, University of Florida, Gainesville, FL  
352-294-7674, or 352-294-7666  
[awhodes@ufl.edu](mailto:awhodes@ufl.edu) or [tborisova@ufl.edu](mailto:tborisova@ufl.edu)

Annette Long, President, Save Our Suwannee  
352-490-8930, [long5892@bellsouth.net](mailto:long5892@bellsouth.net)

Stacie Greco, Alachua County Environmental Protection Department  
352-264-6829, [sgreco@alachuacounty.us](mailto:sgreco@alachuacounty.us)



## Appendix E

### Questions for Interviews with Springs Stakeholders

What types of recreational activities do people participate in at the springs at your location? For example, swimming, diving, canoeing, kayaking, tubing, wildlife watching, photography, fishing, picnicking, camping, and special events (concerts, nature programs).

What is the demographic profile of people who visit the springs at your location?

- age
- race/ethnicity
- income
- other characteristics

Approximately how many springs visitors patronized your business or location last year? Was this a typical year? How does this number fluctuate from year to year?

What factors tend to affect the levels of visitation? (weather, flooding, etc.)

What share of springs visitors at your location come from outside the local area of north-central Florida? What are some common places that people come from? What is the farthest that somebody has travelled?

What share of springs visitors at your location come on day trips vs. overnight stays? For those staying overnight, what is the average length of stay?

For springs visitors from outside the local area, is visiting the springs typically the primary purpose of their trip? What other activities do springs visitors engage in during their trips to this area?

What share of visitors are individuals, couples, families, or large organized groups? What is the average group size for parties that visit the springs?

How much do springs visitor parties typically spend in the local area for the following expenditure categories (note that some expense items apply only to certain kinds of businesses):

- site admission
- retail food & beverages
- ice
- restaurants
- lodging (hotel, bed & breakfast, camping, stay with friends/relatives)
- equipment purchases/rentals (boats, swim gear, dive gear)
- guide/instruction services
- clothing
- gas
- vehicle rental
- entertainment
- gifts
- miscellaneous other goods

How has the number of springs visitors and their spending at your business/location changed over the past 10 years?

Has the water quality or flow changed at the springs in your area in recent years? What changes have you noticed? How have these changes affected visitor attendance and spending?

What do you believe are the factors affecting changes in the springs? What actions are needed to restore the environmental quality of springs and maintain visitation?