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

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Manatees in Manatee Springs (Credit: Mark Long)

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Executive summary

This study examines the economic contributions provided by fifteen key spring sites to the local economy of North-Central Florida. The objectives of this study are:

- 1. To measure the economic contributions of springs-based recreation and tourism on the local economy;
- 2. To catalogue the ecosystem services provided by the springs to society.

Specifically, we focus on ten spring sites on public lands, including six State Parks (Fanning, Ichetucknee, Lafayette Blue, Manatee, Troy, Wes Skiles Peacock) and four County Parks (Hart, Little River, Poe, Rum Island). We also examine five privately owned spring sites: Blue Grotto, Blue Springs, Devil's Den, Ginnie Springs, and Hornsby Springs. All the springs are located in a nine-county study area that includes Alachua, Bradford, Columbia, Dixie, Gilchrist, Lafayette, Levy, Suwannee, and Union counties in Florida.

To estimate the total annual number of visitor-days for the publicly owned springs, published reports by the Florida Park Service were obtained for the period 2000-12. 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. In addition, informal interviews were conducted with owners and managers of local businesses serving springs visitors, as well as local government representatives and researchers to estimate and/or verify the annual visitation and spending for public and private sites. Published academic studies and other economic reports focused on springs were also reviewed.

Analysis of the economic contributions of springs recreational spending was carried out using a regional economic model constructed with the IMPLAN software and associated database for Florida counties (IMPLAN Group, LLC). IMPLAN models rely on input-output analysis and Social Accounting Matrices that describe the flow of goods and services in a local economy, from producers, through intermediaries, to final consumers (Miller and Blair, 2007; Mulkey and Hodges, 2012). The economic model of the nine-county study area enabled analysis of the economic contributions of springs-based recreational spending in terms of contribution to Gross Regional Product, employment, labor income, other property income, industry output, and local/state and federal government tax revenues.

Total recreational use at all springs sites (and related Santa Fe river activities) was estimated to average slightly over one million visitor-days annually over the past five years. Average annual attendance exceeded 100,000 visitor days at several springs, including Manatee Springs State Park, Fanning Springs State Park, Ichetucknee Springs State Park, and Ginnie Springs. The total number of diving visitor-days was estimated at around 57,000 annually, with over 10,000 visitor-days at each of the following sites: Peacock Springs, Ginnie Springs, and Blue Grotto. 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 70 percent for most of the other springs, to a high of 90 percent for Blue Grotto. Average annual visitor spending attributed to springs recreation was estimated at \$83.8 million, including \$45.2 million by non-local visitors.

The estimated total annual economic contributions of recreational spending (due to direct spending, supply chain activity and income re-spending) included employment of 1,160 fulltime and part-time jobs, labor income of \$30.42 million, industry output (revenue) of \$94.00 million, and value added contribution to Gross Domestic Product of \$52.58 million annually. Impacts to local/state government revenues totaled \$6.56 million, and impacts to the federal revenues 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, for springs visitors, the total value of their experiences at the springs can exceed their total spending. The difference between the total visitors' values and their total spending is referred to as consumer surplus. Shrestha *et al.* (2002) examined consumer surplus for visitors to four springs located in the Ocala National Forest: Sweetwater Spring, Silver Glen Spring, Juniper Spring, and Salt Springs. The researchers surveyed a sample of the visitors, and asked them about the willingness to pay for recreation at the springs (in

excess of their expenses). For the springs with "moderately improved" facilities, the willingness to pay was \$11.42 per trip for day visitors, and \$16.90 per trip for extended visitors (stated in 2013 dollars using the GDP Implicit Price Deflator). Similarly, Morgan and Huth (2011) examined consumer surplus for cave diving in Jackson Blue spring (Jackson County FL), and found an average value of \$166 (2013 dollars). Applying these consumer surplus estimates to the study area, and using the estimates of the average length of stay at the spring sites from previous studies and responses from spring site owners and managers, we assessed that the total consumer surplus for the fifteen spring sites in the study area is \$9.44 million annually.

These estimates of the economic contributions and consumer surplus focus on the value of recreational activities only. In addition to the recreational activities, spring 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 limitations of this study, including: (a) limited visitation data for private springs sites; (b) spending data were taken from secondary sources; (c) consumer surplus estimates were derived from studies for other Florida regions; (d) the study focuses on recreation activities only, that are just one type of services provided by springs. We suggest conducting a larger, more comprehensive study that would involve primary data collection through visitor surveys, the use of more advanced econometric methods for the survey response analysis, and the assessment of ecosystem service values provided by springs.

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

Figure 1. Ichetucknee Spring (Source: Ichetucknee Springs State Park Website).



human society are 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.

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 in turn degrade the recreational experiences of springs users and diminish other environmental services. 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.

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:

- 1. To measure the economic contribution of springs-based tourism on the local economy; and
- 2. To catalogue the ecosystem services provided by the springs to society.

This study focuses on fifteen recreational spring sites located in the lower Suwannee and Santa Fe River Basins of North-central Florida (North-central Florida). The maps in Figure 3 and 4 show the nine counties in the study area (Alachua, Bradford, Columbia, Dixie, Gilchrist, Lafayette, Levy, Suwannee, and Union), along with the spring sites considered. Note that the study area has several smaller springs that were not included in the analysis due to the lack of data available for these spring sites.

Figure 2. Algae at a Spring Site (Source: Florida Water Coalition website)





Figure 3. Nine-county springs study area in North-Central Florida (Credit: Alachua County Environmental Protection Department)

The study examined ten springs located on public lands, and five springs located on private lands. A map of the locations of the springs is shown in Figure 4.

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 Spring County Park
- Manatee Springs State Park
- Poe Springs County Park
- Rum Island Spring County Park
- Troy Spring State Park
- Wes Skiles Peacock Springs State Park

The five privately owned springs included in the study are:

- Blue Grotto
- Blue Springs
- Devil's Den
- Ginnie Springs
- Hornsby Springs



Figure 4. Map of locations of major springs studied in North-Central Florida (Credit: Alachua County Environmental Protection Department)

Most of the springs evaluated in this study are first or second magnitude springs¹. All of the springs are used for recreational activities, including swimming, snorkeling, canoeing, kayaking, hiking, and wildlife viewing. Table 1 shows additional recreational activities and amenities available at each spring site. Many sites also 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 the springs websites, along with the reports developed by Florida agencies and tourism and marketing organizations. In addition, general park fees are summarized in Table 2.

¹ 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 64.6 million gallons per day. Second magnitude springs discharge between 10 and 100 cubic feet per second, on average, equivalent to 6.46 – 64.6 million gallons per day (Florida Geological Survey, 2003).

				Publicly-	manage	d spring	sites				Spring sites on private lands				nds
Activities Available	Fanning	Hart	Ichetucknee	Lafayette Blue	Little River	Manatee	Poe	Rum Island	Troy	Wes Skiles Peacock	Blue Grotto	Blue	Devil's Den	Ginnie	Hornsby
Magnitude of the spring*	2	2	1	1	2	1	2	2	1	2	NA	2	NA	2	2**
Boat Ramp	Х	Х	Х	Х			Х	Х						Х	
Cabins	Х	Х		Х							Х		Х	Х	
Camping (full/primitive)	х	х		х		х						х	х	х	х
Concession/ Restaurant	х	х	х			х	х					х		х	х
Dive shop											Х		Х	Х	
Picnic Pavilion	Х	Х	Х	Х		Х	Х		Х	Х	Х	Х	Х	Х	Х
Scuba diving	Х	Х	Х	Х	Х	Х		Х	Х	Х	Х		Х	Х	
Tubing			Х				Х					Х		Х	
Visitor Center			Х						Х					Х	

Table 1. Key amenities available at each spring recreational area examined in the study

First Magnitude springs are springs with discharge exceeding 100 cubic feet per second. Second Magnitude springs 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

	Publicly-managed spring sites							Spring	sites on p	orivate lands				
Fee types	Fanning	Hart	Ichetucknee	Lafayette Blue	Manatee	Рое	Rum Island	Troy	Wes Skiles Peacock	Blue Grotto	Blue	Devil's Den	Ginnie	Hornsby***
Admission: Group	\$6	\$5 to \$12	\$6	\$5**	\$6	Free	Free	\$5**	\$4**			\$10		
Admission: Individual (adult)	\$2 - \$4	\$1-\$2	\$2 - \$4	\$2 - \$4	\$2 - \$4	Free	Free	\$2 - \$4**		\$3 - \$5	\$10	\$5	\$12	\$5 - \$17
Canoe/ Kayak rental			\$5 / person								\$10-\$15 / 2 hours		\$10 / 2 hours; \$25 / day	\$12.50 - \$15.75 / day
Tubing (per day)			\$5-\$6								\$5		\$6 - \$12	
Lodging (per night)	\$100	\$125		\$100						\$60- \$105		\$75 - \$150	\$175	Vary
Camping (per night)	\$5 / person	\$20 / site		\$10 /site	\$20/site					\$5-\$10 / person	\$15 / person		\$20.40 / person	\$5-\$5.25 / person; \$10.75 - \$11.50 / family
RV (per night)		\$24								\$5-\$10 / person	\$15 / person	\$24		\$22.25 - \$25
Pavilion Rentals (per day)	\$15 - \$25	\$25			\$35						\$75		\$25 - \$75	
Diver entrance		\$18								\$40		\$10 - \$15	\$22 - \$30	
Full diving gear package (per day)										\$40		\$40	\$59.95	
Source:	FPS, undated (a)	Hart Springs. com	FPS, undated (b)	FPS, undated (c)	FPS, undated (d)	Personal experience	Personal experience	FPS, undated (e)	FPS, undated (e)	The Blue Grotto Dive Resort	Blue Springs Park. com		Ginnie Springs Outdoors	Camp Kulaqua. com

Table 2. Selected park fees at each spring recreational area examined in the study

^{*}Fee information for Little River Springs Park was not found ^{**}Honor box. ^{***} Prices vary for members of the Seventh Day Adventists Church, Florida Conference Group, and general visitors.

Fanning Springs State Park. The 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 5 full-service cabins, and camping opportunities in the park. The park was developed around Fanning Spring, which was a first magnitude spring up to the 1990s, but then due to a reduction in water flow, it was re-classified 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.

<u>Hart Springs County Park</u>. This Gilchrist 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 Spring located inside the park is a second magnitude spring with the 1932 - 1997 average discharge rate of 71.7

Figure 3. Blue Hole Spring Inside Looking Out, Ichetucknee Springs State Park. (Credit: Mark Long)



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.

<u>Ichetucknee Springs State Park</u>. 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 parks 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. The park is developed around Lafayette Blue spring, which is a second magnitude spring. The spring's average discharge rate, from 1973 to 2004, was approximately 81.8 cfs (Florida Department of Environmental Protection, 2005). The 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 in the park are designated as Suwannee River Wilderness Trails and the site participates in the Florida Green Lodging Program.

<u>Little River Springs County Park</u>. 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). The 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).

<u>Manatee Springs State Park</u>. The park's main attraction is the first magnitude Manatee Springs, designated as a National Natural Landmark. The spring was discharging on average 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). The main recreational activities in the park 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 the park are designated as Florida Birding and Wildlife Trails, and Suwannee River Wilderness Trails.

<u>Poe Springs County Park.</u> The 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 spring located in 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, kayaking/canoeing, wildlife viewing, picnic areas, playground, volleyball, softball, soccer, hiking, and nature trails (FloridasSprings.org).

<u>Rum Island Spring Park</u>. The park is managed by Columbia County. The Rum Island spring is located inside the park, and park visitors can enjoy canoeing, boating, swimming, snorkeling, and fishing. Rum Island Spring discharged approximately 60.8 cfs when measured in 1997 (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).

<u>Troy Spring State Park</u>. Average measured discharge for Troy Spring, the key park's attraction, was 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, a variety of birds, and fishing for mullet, brim or largemouth bass. Swimming, snorkeling and scuba diving are also possible. Visitors can explore the wreckage of a 19th century steamship at the end of the spring run.

<u>Wes Skiles Peacock Springs State</u> <u>Park</u>. The park includes two springs, six sinkholes, and a spring

Figure 4. Cave Diver in Peacock Spring (Credit: Mark Long)



run. Springs form 33,000 feet of underground passages, one of the longest underwater cave systems in the continental U.S. The primary recreational activity at the spring 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 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.

<u>Blue Grotto</u> (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).

<u>Blue Springs</u>. 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). The privately-owned site offers a playground, picnic area, camping/RV site, 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).

<u>Devil's Den</u> (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).

Figure 5. Ginnie Spring (Credit: Mark Long)



<u>Ginnie Springs Recreation Area</u>. Ginnie Springs Recreation Area is a privately owned facility consisting of a group of eleven springs with 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, 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 (FloridaSprings.org). There is a water bottling plant located on the property.

<u>Hornsby Springs</u>. Hornsby Spring was formerly classified as a first magnitude spring, but its flow is highly variable. The spring stopped flowing in 2001 - 2002 (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); while a measurement done in August 2013 showed the flow of 145 cfs (SRWMD undated). The spring is located within privately-owned Camp Kulaqua, primarily 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, 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 2001-2002, 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 2000-12. 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 during September, 2013 - March, 2014. The list of local businesses was developed in collaboration with Save Our Suwannee (Annette Long) and Alachua County Environmental Protection Department (Stacie Greco). These stakeholders were initially contacted by mail to introduce the study and then interviewed by telephone. Over 20 interviews were conducted. Although the interviews were informal, each included a similar set of questions (see Appendix A) 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.

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

- <u>Bonn, M. A. and F. W. Bell.</u> Economic impact of selected Florida springs on surrounding local areas. Florida Department of Environmental Protection, 2003 (Ichetucknee, Wakulla, Homosassa, Blue springs).
- <u>Bonn, M.A.</u> 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, 2004 (Silver Glen, Silver, Alexander, Apopka, Bugg, Ponce de Leon, Gemini, Green springs).
- <u>Foster, C</u>. Valuing preferences for water quality improvement in the Ichetucknee Springs system: a case study from Columbia County, FL. Master Thesis, University of Florida, 2008.
- <u>Huth, W.L. and O.A. Morgan</u>. Measuring the willingness to pay for cave diving. *Marine Resource Economics* vol. 26, pp 151-166, 2011 (Wakulla Springs).
- <u>Morgan, O.A. and W.L. Huth</u>. Using revealed and stated preference data to estimate the scope and access benefits associated with cave diving. *Resource and Energy Economics* vol. 33, pp. 107-118, 2011 (Blue Spring, Jackson County, Florida).
- <u>Knight, R</u>. *Ichetucknee Springs & River: A Restoration Action Plan*. Howard T. Odum Florida Springs Institute, 2012.
- <u>Shrestha R.L., Alavalapati, J.R.R., Stein T.V., Carter, D.R., and C.B. Denny</u>. 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, 2002 (Sweetwater, Silver Glen, Juniper, Salt Springs).

Overall, the following information was collected:

- 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 (\$67.70 per person-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% rent gear, 25% 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 to \$5).

Economic Contribution Analysis

Analysis of the economic contributions of spring-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 is a software package and database widely used for estimating regional economic <u>impacts</u> for a wide range of economic events, activities, and programs (IMPLAN Group, 2011; underlined terms are described in glossary, Appendix B). The IMPLAN model can be used to estimate economic contributions in terms of industry <u>output</u> (revenues), <u>value added</u> (comparable to Gross Regional Product), <u>employment</u>, labor income, other property income, and local/state and federal government tax revenues. IMPLAN models rely on <u>input-output</u> 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). It also estimates the regional <u>multiplier</u> effects arising from new <u>final demand</u> on industry supply chain activity (<u>indirect effects</u>) and income re-spending by households and governments (<u>induced effects</u>). Multipliers used in this analysis are shown in Table 1. For example, the output (revenue) multiplier for commercial lodging at hotels and motels (<u>sector</u> 411) has a value of 2.11, meaning that for each dollar of new spending by springs visitors a total of \$2.11 in total economic activity is generated in the region. The employment multipliers are denominated in jobs (fulltime and part-time) per million dollars of spending. The size of the multiplier depends on the proportion of local spending and the size

and composition of the local economy; industries that purchase a greater share of their inputs from within the local economy will tend to have higher multipliers. For example, retail stores that source goods from local producers and processors rather than national suppliers have higher multipliers. The total impact for an industry also depends on the level of sales outside the local region; firms with greater external sales have greater impacts by generating new final demand in the region (Mulkey and Hodges 2012<u>http://edis.ifas.ufl.edu/fe168</u>).

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 non-local visitors were analyzed separately. Spending by non-local visitors represents new final demand to the area, while spending by local residents was not treated as new final demand to the region, and therefore was applied only to <u>direct effects</u> multipliers (Watson, Thilmany and Winter, 2007).

Expenditure Item(s)	IMPLAN 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	.007
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

Table 3. Regional economic multipliers for the north-central Florida study area.

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

Consumer Surplus Estimates for Springs Visitors

As discussed above, the estimates of the springs' contributions to the local economy are 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 visitors and 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 Spring, Silver Glen Spring, Juniper Spring, 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 spring sites. The survey focused on visitors' willingness to pay in excess of their expenses for recreation at the springs. Three sets of spring site amenities were described in the survey:

- A. Unimproved facilities (i.e., minimally developed sites).
- B. Moderately improved facilities, including showers at campground, boating, parking, groceries, camping equipment rentals, weekday interpretive tours, tent and RV camping areas.
- C. More improved facilities, including children's play area and game room, restaurant, paddle boats, tubes, weekend interpretive tours, hiking, boardwalk trails, cabin rentals, and overnight boat parking.

The respondents' willingness to pay differed with their 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 on site; and, those with higher preference 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.* stated that because of the way that 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, however, since 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 (U.S. Department of Commerce, 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 the consumer surplus, it is important to estimate the number of day- and extended-visitors. To do that, the owners and managers of the private springs sites were contacted via e-mail and phone. While most of them did not provide specific estimates about the numbers of day- and extended-visitors, one of the managers estimated that approximately half of the spring site visitors stay overnight. Another informant stated that most of the spring site visitors stay for 1-2 nights. Based on these responses, we assumed that for the private spring sites approximately 50 percent of visitors stay for 2 nights and the other 50 percent are day visitors. Thus, the number of day visitors and extended visitors can then be found from the following relationships:

number of day visitors = number of extended visitors =
$$\frac{1}{3} \times$$
 number of visitor days

For the publicly-managed spring sites, it was assumed that local visitors come to the spring sites for day-trip only, and hence, the number of *day visitors from the local area* was estimated as:

For the visitors outside the local area, we used information from Bonn and Bell (2003), who estimated that for Ichetucknee, Homosassa, and Blue springs, on average, *day* visitors comprised 52.4 percent of all the visitors originating from outside the local area.

Number of day visitors from outside local area = 0.524 x total number of visitors from outside local area Bonn and Bell (2003) also estimated that extended visitors stayed at the spring sites an average of 5.2 days: Number of day visitors from outside local area + $5.2 \times$ (number of extended visitors) = Total number of visitor days for those from outside the local area

These formulas were used to estimate the number of day and extended visitors for all publicly owned spring sites examined in this study. Note that in these relationships, we focus on non-divers only.

Divers are a special category of visitors that likely have a higher consumer surplus than those who come to the springs to enjoy snorkeling, swimming, and canoeing. Morgan and Huth (2011) examined consumer surplus for cave diving in Jackson Blue spring (Jackson County FL). In April 2009, responses to a mail survey were collected from 186 domestic divers who registered to dive at Jackson Blue over the last 4 years. The per person per trip consumer surplus was estimated to range from \$145.96 to \$166.99, based on different estimation methods. An average value of \$155 is used in this study. We indexed this number to Oct. 2013 (U.S. Department of Commerce, 2014), and estimated the consumer surplus to be \$166.3 per visit/trip. Assuming that for divers the average length of stay at the spring site 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

Note that the analysis described above focuses on the value of recreational experiences for spring-site visitors. This does not account for the value of springs ecosystem services - other than recreational experiences. A generalized catalogue of various ecosystem services provided by the springs was developed based on a literature review. While estimating the total value of all ecosystem services provided by springs was not a part of this project, we present a summary of two studies focused on the valuation of water-based ecosystem services in North Florida in Appendix C.

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 past five years. 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 3.

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 three State parks is presented in Figures 7 and 8. Visitation at these three 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 2012-13. 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 to 2011-12





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 70 percent for most of the other springs, to a high of 90 percent for Blue Grotto. Total annual visitor spending attributed to springs recreation was estimated at \$83.8 million, including \$45.2 million by non-local visitors (Table 4).

Visitor spending is summarized by category in Table 5. The largest spending amounts were for transportationgasoline (\$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).

Site / Activity	Average number visitor-days annually	Average number diving visitor- days annually	Share of customers from outside local area	Total Spending	Total Spending by Non-Local 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
Total All Springs	<u>1,012,066</u>	<u>57,206</u>	<u>-</u>	<u>\$84,192,226</u>	<u>\$45,335,424</u>

Table 4. Annual average attendance and visitor spending at springs in the Lower Suwannee and Santa Fe Riverbasins in north-central Florida, FY 2012-13*

*State fiscal year is July-June.

Table 5. Summary of visitor spending, by category,	at springs in the Lower Suwannee and Santa Fe River basins
in north-central Florida. FY 2012-13*	

Expense Item	Non-Local 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	
Diving Training	\$1,280,016	\$436,153	\$1,716,169	
Total	<u>45,335,424</u>	<u>38,856,802</u>	<u>\$84,192,226</u>	

The total economic contributions of recreational spending within the local economy due to direct spending, supply chain activity and income re-spending were estimated using the IMPLAN software and county datasets, as described in the methods section of the report. See Appendix B for a glossary of key terms. Note that for each particular industry/spending-category, IMPLAN uses multipliers to estimate three components of the total economic changes within the local area (Mulkey and Hodges, 2012):

- *Direct effects* represent the initial change in the industry in question.
- *Indirect effects* are changes in inter-industry transactions as supplying industries respond to increased demands from the directly affected industries.
- *Induced effects* reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors.

Estimated economic contributions of springs recreation are summarized in Table 6, including employment of 1,160 fulltime and part-time jobs, labor income of \$30.42 million, value added of \$52.58 million, and industry output (revenue) of \$94.00 million. Labor income represents employee wages, salaries, and benefits, plus proprietor (business owner) income. The value added contribution is comparable to Gross Domestic Product (GDP). For the nine county study area, GDP in 2012 was \$14.65 billion, so the estimated value added and employment contributions of springs related recreational spending represented 0.36 percent and 0.49 percent of the region's overall GDP and employment, respectively.

Table 6. Summary of regional economic contributions of springs-related recreational spending in the Lowe
Suwannee and Santa Fe River basins of north-central Florida, FY 2012-13

Impact Type	Employment	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
Total Effect	<u>1,160</u>	<u>\$30.42</u>	<u>\$52.58</u>	<u>\$94.00</u>

Values in 2014 dollars. Employment represents fulltime and part-time jobs. Results reflect direct effects for local and nonlocal visitor spending, plus indirect and induced effects for nonlocal visitor spending.

The economic contributions of springs recreation is summarized by major industry group in Table 7. 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).

The contributions of springs recreational spending to local/state and federal government tax revenues are summarized in Table 8. 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 spending associated with individual springs in the study area are summarized in Table 9. 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.

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
Total	<u>1,160</u>	<u>\$30,423</u>	<u>\$52,582</u>	<u>\$94,001</u>

Table 7. Regional economic contributions by industry group for springs-related recreational spending in theLower Suwannee and Santa Fe River basins of north-central Florida, FY 2012-13

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

Description	Amount (\$1,000)
State and Local Government Taxes	
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
Total State and Local Tax	<u>\$6,557</u>
Federal Government Taxes	
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
Total Federal Tax	<u>\$6,568</u>

Table 8. Tax revenues impacts to local/state and federal governments from recreational spending for springs inthe Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012-13

Values in 2014 dollars.

Activity / Business	Employment	Labor Income (M\$)	Value Added (M\$)	Industry Output (M\$)
State or County owned Springs				
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
Privately owned springs				
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
Total All Springs	<u>1,160</u>	<u>\$30.42</u>	<u>\$52.58</u>	<u>\$94.00</u>

Table 9. Economic contributions of individual springs in the Lower Suwannee and Santa Fe River basins of north-
central Florida, FY 2012-13

Values in millions 2014 dollars. Employment represents full time and part time jobs.

Consumer Surplus from Recreational Activities

Consumer surplus is usually estimated by surveying site visitors and asking them about their willingness to pay for their recreational experiences, in excess of the actual visitors' spending. In this study, we relied on consumer surplus estimates reported in two previous Florida-based studies. In the future, it is recommended to verify these estimates by conducting a survey of spring site visitors in North-Central Florida.

Two previous studies were used to assess consumer surplus associated with springs recreation. First, Shrestha *et al.* 2002 estimated consumer surplus for water-based recreation at springs in Ocala National Forest. The study focused on boating, canoeing, swimming, fishing, and wildlife viewing. Second, consumer surplus was estimated by Morgan and Huth (2011) for cave diving at Blue Spring in Jackson County FL. Note that consumer surplus estimates from both studies were indexed to 2013 dollars using Implicit Price Deflator for Gross Domestic Product (U.S. Department of Commerce, 2014).

These consumer surplus estimates per visitor per trip were combined with the estimated number of visitors for the spring sites in the study area. Results for the estimated consumer surplus are presented in Table 10. Based on the assumptions made in the study, total consumer surplus for the spring sites in the study area is estimated at \$9.44 million per year.

To estimate the total economic value of the recreational activities, we combined the consumer surplus estimates with the economic output estimates described above. As presented in Table 11, the estimated total economic value of recreation the springs studies in the Lower Suwannee and Santa Fe River basins is \$103 million dollars annually.

Table 10. Estimated numbers of day visitors and extended visitors, and consumer surplus for springs-relatedrecreation in the Lower Suwannee and Santa Fe River basins of north-central Florida, FY 2012-13

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

*Consumer surplus for day visitors, extended visitors and divers is assumed to be \$11.4, \$16.9, and \$166.3 per person-trip, respectively.

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
Total of All Studied Springs/Activities	<u>\$94.00.</u>	<u>\$9.44</u>	<u>\$103.42</u>

 Table 11. Total economic value of springs-related recreation in the Lower Suwannee and Santa Fe Rivers of north-central Florida, FY 2012-13

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, which support climate regulation)
- 3. Cultural services (e.g., recreational and spiritual uses)
- 4. Supporting services (e.g., nutrient cycling, biodiversity, net primary productivity).





Source: MEA, 2005

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

<u>Supporting services</u> 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 12). Springs are also an important part of the hydrologic and nutrient cycles.

<u>Provisioning services</u> are primarily linked to water extraction by a water bottling plants 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 spring 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 (to be expired 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 of 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 spring 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 risks may increase the treatment costs of the bottling company.

<u>Regulating services</u> are related to the regulation of water flow and water quality. For example, the springs likely contribute to flood mitigation, by allowing water to back-flow into the springs during the 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.

<u>Cultural services</u> 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 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 (see Appendix D), also provides service to society in terms of existence or non-use values. Non-use value may be important, given springs' national and international significance as an iconic feature of Florida.

Categories	Ecosystem Services				
In-Stream Services Provided by the Spring Vents and Spring Runs					
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				
	Aesthetic values				
Services Provid	ed by Riparian Areas Along the Spring Runs				
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)				

Table 12. Catalog of ecosystem services provided by freshwater springs and associated riparian areas

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 the Santa Fe and Suwannee rivers, 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 spring 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 over the past five years. 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 ranged from a low of 5 percent for Rum Island Spring, to 70 percent for most of the other springs, to a high of 90 percent for Blue Grotto. Total annual visitor spending attributed to springs recreation was estimated at \$83.8 million, including \$45.2 million by non-local 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 fulltime and part-time jobs, labor income of \$30.42 million annually, value added of \$52.58 million annually, and industry output (revenue) of \$94.00 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, spring 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: (a) limited visitation data for private springs; (b) the reliance on spending data from secondary sources; (c) the use of consumer surplus estimates derived from studies developed for other Florida regions; and, (d) the focus on recreation activities only, that are just one type of services provided by springs. 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 sub-set 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, total phosphorous concentrations, water clarity (Secchi disk visibility, in meters), and flow are plotted in Figures A1, A2, A3 and A4, respectively. 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 in 1998 - 2013 is presented on Figure A4. For most springs, the average annual discharge has been declining over the period of 1998-2013, and the reduction is especially noticeable for Manatee, Fanning, 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 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 discharge volume for selected springs in the study area

Appendix B. 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 (see a definition below) 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) model 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.

Jobs or employment 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.

Margins (retail, wholesale, and transportation) are the portions of the purchaser price accruing to the retailer, wholesaler, and grower, 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. Type I multipliers include only direct and indirect effects. Type II multipliers also include induced effects. Type SAM (for Social Accounting Matrix) multipliers used by IMPLAN additionally account for capital investments and transfer payments such as welfare and retirement income. 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 are the changes in economic activity during the first round of spending.

Secondary effects are the changes in economic activity from subsequent rounds of re-spending (there are two types of secondary effects: indirect and induced).

Indirect effects are the changes in sales, income, or employment within the region in backward-linked 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 are the increased sales 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 C. Ecosystem Service Valuation Studies Focused on North Florida

Two non-peer reviewed studies were found that estimated the willingness to pay for water quality improvements in North Florida water bodies:

- Kreye M., Escobedo F.J., Adams D.C., Stein T., and T. Borisova. Valuing the Ecosystem Services of Florida's Forest Conservation Programs: The Economic Benefits of Protecting Water Quality. UF/EDIS publication, FR37700 (extended version of the publication can be found in Escobedo and Timilsina 2012).
- <u>Foster, C</u>. Valuing preferences for water quality improvement in the Ichetucknee Springs System: A Case Study from Columbia County, FL. Master Thesis, University of Florida, 2008.

Kreye et al. (2013) reviews past studies that assessed household willingness to pay (WTP) for maintenance and protection of relatively unpolluted aquatic resources. The relatively unpolluted aquatic resources are selected to examine water purification ecosystem service provided by forested lands, such as the lands in the Suwannee River Basin. Seventeen studies completed in different US states were found; and these studies provided 43 WTP observations. The researchers examined the relationship among WTP estimates and the study site attributes, as well as other study characteristics (such as survey method and the socio-demographic characteristics of the population in the study area). Based on these relationships, the researchers estimated potential willingness to pay for protection of the relatively unpolluted aquatic resources for four aggregate Florida regions: Panhandle, North, Central, and South Florida. For programs that protect all surface water resources within a drainage basin, the annual household WTP is estimated to be \$87.96 for North Florida (2010 US\$). Total annual WTP for all residents of North Florida is then \$81.6 million in 2010 US\$ (or \$86.2 million if one use Implicit Price Deflator for Gross Domestic Product to convert this to 2013 USD). Note that this value averages out willingness to pay among households, and among all surface water resources in the North Florida. This study is a part of larger analysis of ecosystem services provided by Florida Forest Stewardship Program (see Escobedo and Timilsina).

Foster (2008) examined WTP of Columbia county residents for water quality improvements (specifically, nitrate-N reduction) in the Ichetucknee Springs and River. Using mail survey, the respondents were asked about their WTP for a program that would update, modify, and maintain septic tanks in the county in order to improve water quality in the Ichetucknee River, given that such program will result in increase in monthly utility bills. The program would use tax dollars to create incentives and/or to compensate homeowners who currently have septic tanks to up-date to new treatment technologies. The program was described as expecting to reduce nitrate loading to the Ichetucknee River by approximately 20% over the next 10 years. The ecological benefits in the Ichetucknee were described as improved water clarity, reduction of excessive algae growth, and protection of natural wildlife habitat. The responses to the survey revealed that most of the respondents have visited the Ichetucknee and believe that protecting water quality in the River is important. The WTP depended on respondents' political affiliation, the frequency of visits to the Ichetucknee, and the ranking of relative importance of water quality in the river. The mean willingness to pay was estimated to be \$202 per household per year in 2007 dollars (or \$222.03 in 2013 dollars using Implicit Price Deflator for Gross Domestic Product) over the course of 10 years. This amounts to \$42.4 million for all Columbia County households, which exceeds the costs of implementing the program (\$25 million). Note that this WTP is based on the low number of responses (n=132), and the respondents may not represent the "typical" household in the county (the respondents are reported to have higher income and better education than the average for Columbia county). In addition, the survey only considered Columbian county residents, and did not incorporate the WTP for the spring protection of the residents of other counties and states.

Both studies focused on water quality improvements only, and did not consider the value assigned to the spring water flow.

Appendix D. Introductory Letter and Questions Used For Interviews with Local Stakeholders

[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 northcentral 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 spring 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.

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Stacie Greco, Alachua County Environmental Protection Department 352-264-6829, sgreco@alachuacounty.us

Questions for Interviews with Springs Stakeholders

What types of recreational activities do people participate in at the springs at your location? (e.g. swimming, diving, canoeing/kayaking, tubing, wildlife watching, photography, fishing, picnicking, camping, special events (e.g. 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?

Appendix E. Endemic Species Found in Springs in the North-Central Florida Area

According to the Florida Spring Task Force Report (2000): "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." The following rare, endangered, and threatened species have been found in the Suwannee River Basin that covers large part of the study area (Lopez 2013, IUCN 2013):

- Suwannee Moccasinshell (Medionidus walkeri) Critically Endangered
- Oval Pigtoe (Pleurobema pyriforme) Endangered
- Santa Fe Cave Crayfish (Procambarus erythrops) Endangered
- Pallid Cavecrayfish (Procambarus pallidus) Near Threatened

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

<u>Suwannee Moccasinshell</u> (Medionidus walkeri) is classified as a Critically Endangered species, as well as NatureServe Global Heritage Status Rank G1 - Critically Imperiled, and a State/Province Status Rank S1 - Critically

Imperiled for Florida (IUCN, 2013). This species is a localized endemic, Figure B1. Suwannee Moccasinshell (Source: i.e., its extent of occurrence is small – less than 100 km² to 250 km² in The MUSSEL Project, 2013).

the Florida portion of Suwannee River Basin (including New River, Withlacoochee, Suwannee, and Santa Fe drainages). Furthermore, 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."

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, as well as runoff form residential areas).
Figure B2. Oval Pigtoe

<u>Oval Piqtoe</u> (Pleurobema pyriforme) has been listed as Endangered, as well as NatureServe Global Heritage Status Rank G2 - Imperiled, and a State/Province Status Rank S1S2 - Critically Imperiled to Imperiled for Florida. The species lost 73% of its historic extent of occurrence (which likely corresponds to more than 50% reduction in population), and it is still declining in abundance. Note that the population of Oval Pigtoe in Suwannee River is disjoint from the rest of the population, and may be genetically different, which makes protection of this population even more important (Fig. 3) (IUCN, 2013).



(Source: US FWS, 2012)

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, as well as 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 is shows little ability to recover from habitat loss without human intervention, and a recovery plan for the species was created by US Figure B3. Range of occurrence of Oval Pigtoe (Source: IUCN, 2013)



Fish and Wildlife Service. Santa Fe and New Rivers are included into critical habitat designation for this species.

Santa Fe Cave Crayfish (Procambarus erythrops) is listed as Endangered due Figure B4. Santa Fe Cave Crayfish to its restricted range of occurrence (approximately 227 km² 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.

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 locality is a fully flooded cave with a water temperature of 21°C and has a maximum depth of 12.5 m (Streever 1996)."

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.



(Source: Arkive, 2013)



<u>Pallid Cavecrayfish</u> (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 km²) and

continuous habitat decline. The population of Pallid Cavecrayfish is assessed as low (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).

Figure B6. Pallid Cavecrayfish (Source: IUCN, 2013).



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

