Summary of Existing Data - Rainbow Springs (Marion Co.)

Prepared by

Wetland Solutions, Inc.

Contents

Cover photo: Underwater view of Rainbow Springs run with largemouth bass (*Micropterus salmoides*) and spotted sunfish (*Lepomis punctatus*) swimming above beds of strap-leaf sagittaria (*Sagittaria kurziana*) (S.K. Notestein, 06/09/09).

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Summary of Existing Springs Data

This report summarizes known existing physical, chemical, and biological data for Rainbow Springs (Marion County). These data were collected from sources such as the Southwest Florida Water Management District (SWFWMD), the U.S. Geological Survey (USGS), and the Florida Department of Environmental Protection (FDEP); as well as through literature searches of journal publications, technical reports, and student dissertations.

Rainbow Springs State Park

Physical Address

Rainbow Springs State Park; 19158 S.W. 81st Pl. Rd.; Dunnellon, Florida 34432; Phone: 352-465-8555; latitude/longitude: 29.102500°, -82.437500°; park website: http://www.floridastateparks.org/rainbowsprings/ .

Driving Directions

From I-75, exit onto State Road 40 and drive west until it dead ends at U.S. 41. Turn left, the park entrance is on the left-hand side of the road. From Tampa, take U.S. 41, north and drive through the town of Dunnellon. The park is located on the right-hand side of the road, approximately 4 km (2.5 mi) north of Dunnellon (**Figure 1**).

The campground (18185 S.W. 94th Street - Dunnellon, FL 34432; 352-465-8550) is separate from the headsprings day use area and is located 4 km (2.5 mi) north of C.R. 484 off of S.W. 180th Avenue or 4 km (2.5 mi) south of Highway 40 off of S.W. 180th Avenue. The park campground has recently been extensively renovated.

General

This first magnitude spring complex has a long history of human usage (from the 1930s through the 1970s, it was a privately-owned attraction) and is presently administered by the FDEP/FPS. The entire Rainbow River was designated as a Registered Natural Landmark in 1972, an Aquatic Preserve in 1986, and an Outstanding Florida Waterway in 1987. In 1989 the Southwest Florida Water Management District (SWFWMD) adopted the Rainbow River as a surface water improvement and management (SWIM) water body. The state purchased the original area that was the Rainbow Springs Attraction in 1990. Volunteers cleared the overgrown park and opened the park on weekends to the public and the Florida Park Service officially opened Rainbow Springs State Park on a full time basis on March 9, 1995. The park facilities are well developed and include gardens, camping, pavilions, tubing and canoe rentals; the overnight camping area is currently undergoing restoration (**Figure 2**). This site is a regionally popular swimming, SCUBA, and tubing destination. Rainbow River is also utilized by the Marion County Parks and Recreation Department, at the K.P. Hole county park, where floats, canoes, kayaks, and boat launching are available.

Rainbow Springs forms the headwaters of the Rainbow River which is nearly 10 km (6 mi) long and merges with the Withlacoochee River (south) at Dunnellon. From there, the Withlacoochee River travels west and ultimately discharges into the Gulf of Mexico at Yankeetown, Florida.

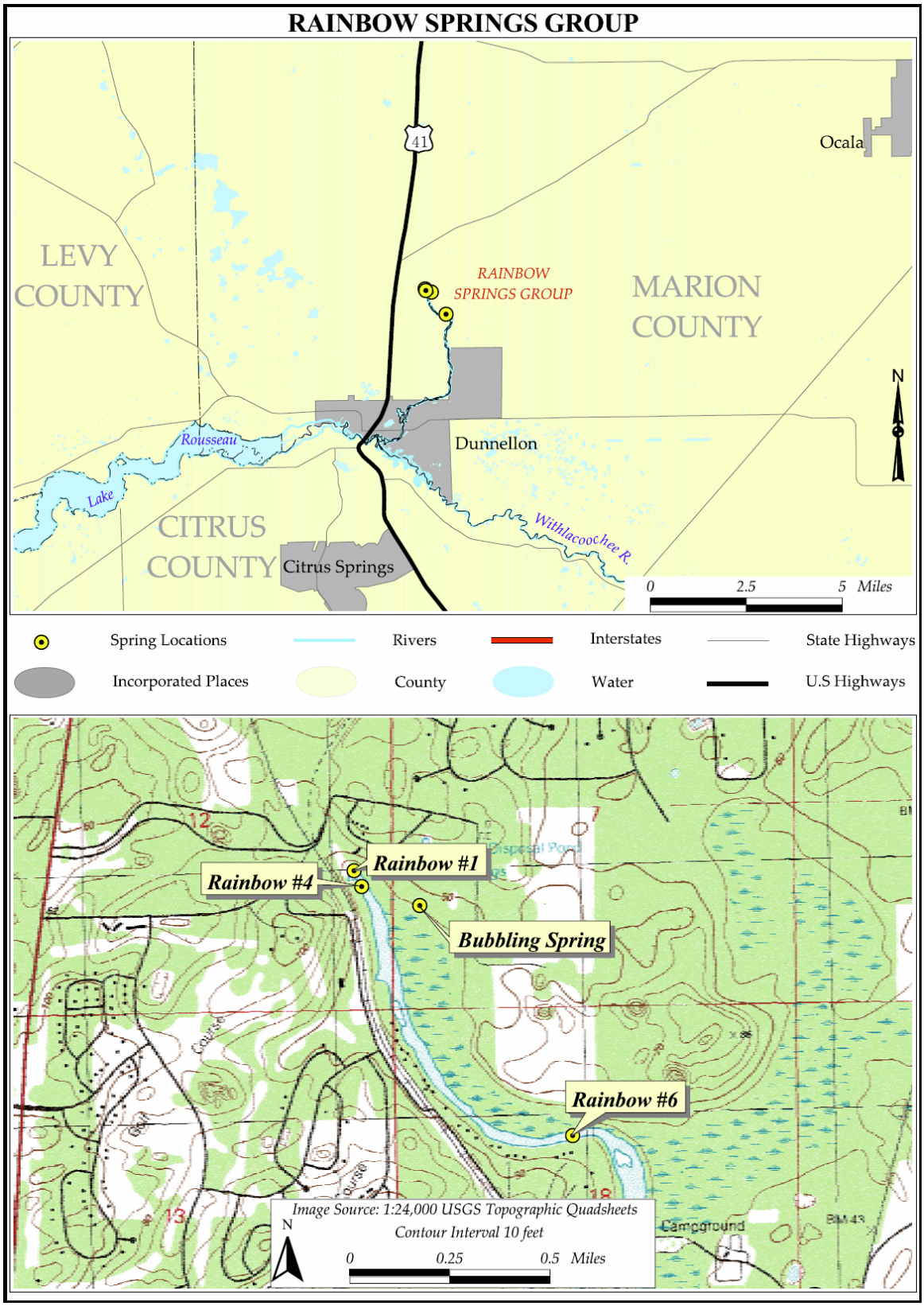


FIGURE 1
Rainbow Springs geographic location (from Scott *et al.* 2002).

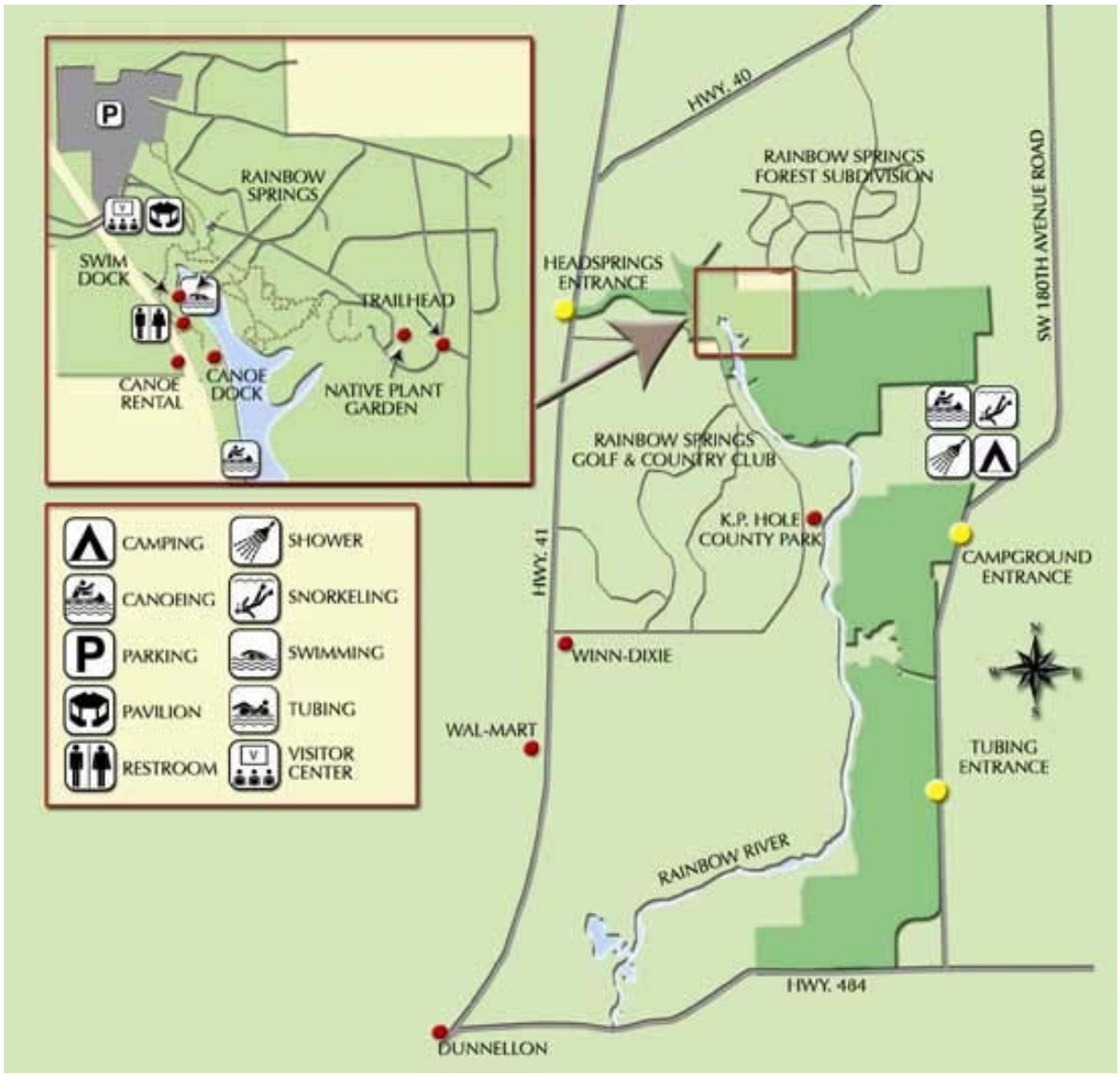


FIGURE 2
Map of Rainbow Springs State Park (from FDEP).

Physical

Rainbow Springs begins as a collection of vents distributed around the spring pool, *e.g.*, Bridge Seep North, Rainbow Springs #1, Rainbow Springs #4, Bubbling Spring, Rainbow Springs #6 (**Figure 3**). These multiple springs create the main spring pool area which is semicircular and approximately 107 m (350 ft) in diameter and approaching 3 m (10 ft) in depth. Spring vents are generally surrounded by karst geology and lack navigable caverns; there are numerous smaller sand boils around the pool as well. The pool is partially enclosed by a concrete wall and swim entry dock. A central component of the spring pool is the defined swim area overlying bare quartz sand (**Figure 4**). The lands immediately surrounding the pool are hilly and maintained as open grass, scattered trees, and park buildings.

The spring run is approximately 46 m (150 ft) wide and travels for roughly 9.2 km (5.7 mi) before joining the Withlacoochee River (south) near the town of Dunnellon. Along the spring run, which is also known as Blue Run or Rainbow River, there are numerous springs which discharge into the river bed through conduits in the underlying karst. During mapping of the aquatic vegetation in Rainbow River, 87 unique spring vents were identified (SWFWMD 2007). About 1.6 km (1 mi) south of the head spring area, a spring-fed tributary (Indian Creek) joins the Rainbow River. The lands along the eastern banks of the spring run are primarily undeveloped, in contrast to the western banks which are largely developed as residential properties. Quartz sand derived from Miocene and Pliocene marine deposits makes up the majority of sediments in the spring and run (GARI 2007). In portions of the spring run the underlying karst geology is visible, particularly around the spring vents.

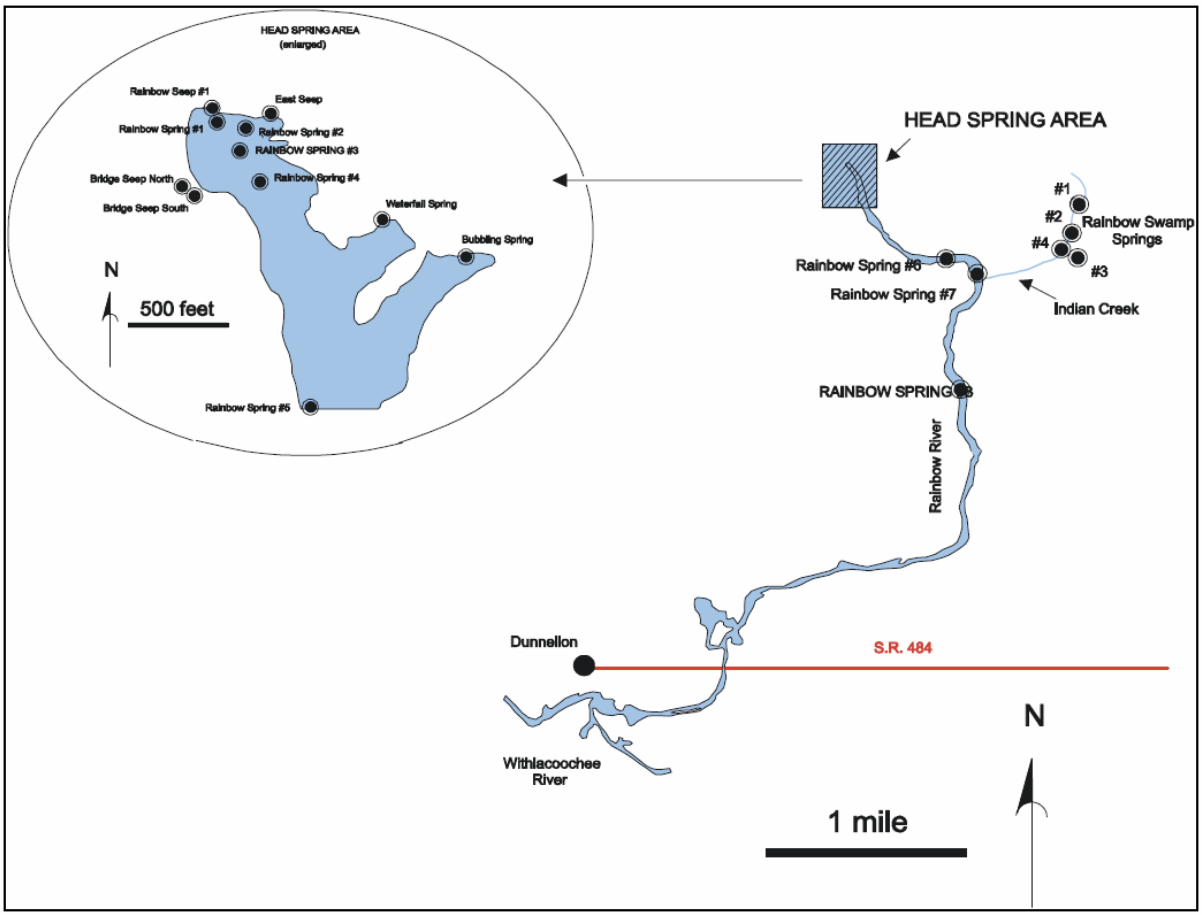


FIGURE 3
Graphic of the Rainbow Springs Group showing the locations of major springs (from Jones *et al.*1996).

FIGURE 4
South facing photograph of Rainbow Springs pool (swim area on right) continuing on to the spring run (from SWFWMD 2008).

Physiography

Based on the underlying sediments and topographic relief Marion County has been divided into eleven physiographic provinces: Central Valley, Marion Upland, Mount Dora Ridge, the Fairfield, Ocala, Martel, and Belleview Hills, Brooksville Ridge, Cotton Plant Ridge, Western Valley, and Sumter Upland (White 1970). Rainbow Springs overlies karst terrain that is generally rolling and spotted with lakes. The elevation ranges from 15 to 30.5 m (50 to 100 ft) above mean sea level. The Brooksville Ridge is underlain by a thin veneer of unconsolidated quartz sand that becomes increasingly clayey with depth. Soils in upland and flat settings range from moderately well drained to very poorly drained. These soils support mostly pine flatwoods, mixed hardwood forests, and riverine swamps. Geologic incision and drainage is carried out by the Withlacoochee River and its tributary the Rainbow River.

Geology

The geology of Marion County consists of Pliocene to Recent age sands overlying Cretaceous and Tertiary clays and carbonates which were sequentially deposited in shallow seas during interglacial periods (SWFWMD 1987, **Figure 5**). Clastic rocks and sediments which overlie limestone units are Miocene age and younger. The unconsolidated Holocene and Pleistocene age sediments consist of sand, clay, peat and marl. The Holocene sediments are mostly alluvial lake and windblown deposits, while the Pleistocene units are marine sediments from former shoreline terraces (MacNeil 1950).

Rainbow River overlies an area where the Ocala Limestones are relatively close to the surface and contains deposits of limestone and dolostones with shell fragments of marine origin. Avon Park limestone underlies the Ocala Limestone formation with the two units

together comprising the Floridan Aquifer. Historical phosphate mining operations can be found on both sides of the Rainbow River

The Hawthorn Formation, which outcrops near Rainbow Springs and ranges from a meter to over 76 m (250 ft) thick, consists of an upper part made up of shallow marine sand mixed with layers of clay and clayey sand and a lower unit comprised of permeable limestone and dolostones (SWFWMD 1987). The upper portion acts as a confining unit to the Floridan Aquifer, although where the Rainbow River crosses the exposed Hawthorn formation limestone numerous spring vents can be found.

Hydrogeology

Rainfall within Marion County not lost to surface drainage and evapotranspiration, percolates through the surficial unconsolidated material or enters into sinkholes to recharge the Floridan Aquifer. The internal drainage route generally follows the potentiometric surface of the pressurized limestone units making up the Aquifer and eventually, the water reappears at points of major discharge, such a Marion County's three first order springs - Rainbow, Silver, and Silver Glen Springs. Faulkner (1973) reported that most of the groundwater to Rainbow Springs is derived from the Ocala Limestone in the upper 30.5 m (100 ft) of the Floridan Aquifer, a water zone with rapid flow rates and relatively short residence times.

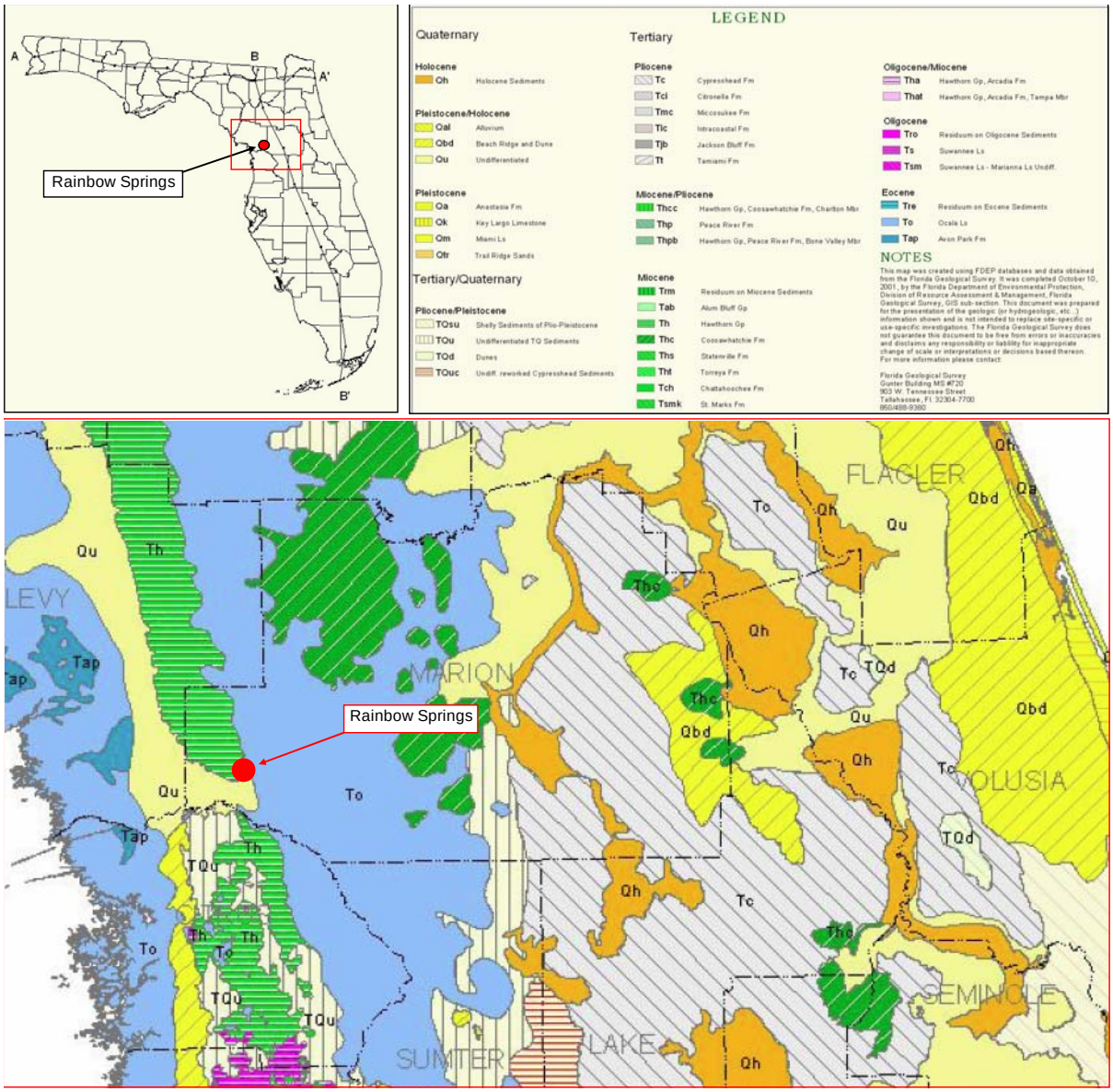


FIGURE 5
Geologic map of Rainbow Springs (adapted from Scott *et al*. 2001).

Springshed

The springshed for Rainbow Springs includes portions of Alachua, Levy, and Marion Counties. The Rainbow River watershed boundary lies within the USGS defined Withlacoochee Hydrologic Unit (Seaber et al. 1987, Foose 2000) and is approximately 189 km^2 (73 mi^2 or 46,700 ac, FGS 2007). However the vast majority of water discharged from the Rainbow River (97 to 99%) results from groundwater rather than surficial inputs (WAR 1991). Several estimates of the groundwater recharge area have been made; Faulkner (1973) reported the total Rainbow Springs groundwater basin having an area of approximately 1,671 km^2 (645 mi^2 or 412,798 ac), while Jones *et al*. (1996) reported the immediate recharge area was approximately 906 km^2 (350 mi^2 or 224,000 ac). Based on Florida Geological Survey delineations (FGS 2007), the Rainbow Springs springshed is estimated to be 1,909 km^2 (737 mi^2 or 471,700 ac, **Figure 6**). These areas are larger than previous estimates made by Faulkner (1973) and Jones *et al.* (1996).

Springshed Land Use

Utilizing USGS photography and SWFWMD GIS data, the land uses within the Rainbow River watershed have changed significantly between 1944 and 1999 (**Figures 7** and **8**, respectively). Land uses and cover types have transitioned from a dominance of forested uplands to those of agriculture to urban uses (Jones *et al.* 1996, SWFWMD 2004). Residential and commercial land uses have increased from 26 ha (64 ac) in 1944 to 2,894 ha (7,151 ac) in 1999, with an additional 4,188 ha (10,349 ac) platted for development (SWFWMD 2004). Agricultural lands increased from 3,017 ha (7,454 ac) in 1944 to 7,454 ha (18,418 ac) in 1999, while forested lands decreased from 14,961 to 3,893 ha (36,969 to 9,620 ac) during the same time period (SWFWMD 2004). Land uses within the springshed are expected to have followed the same trends observed in the river watershed.

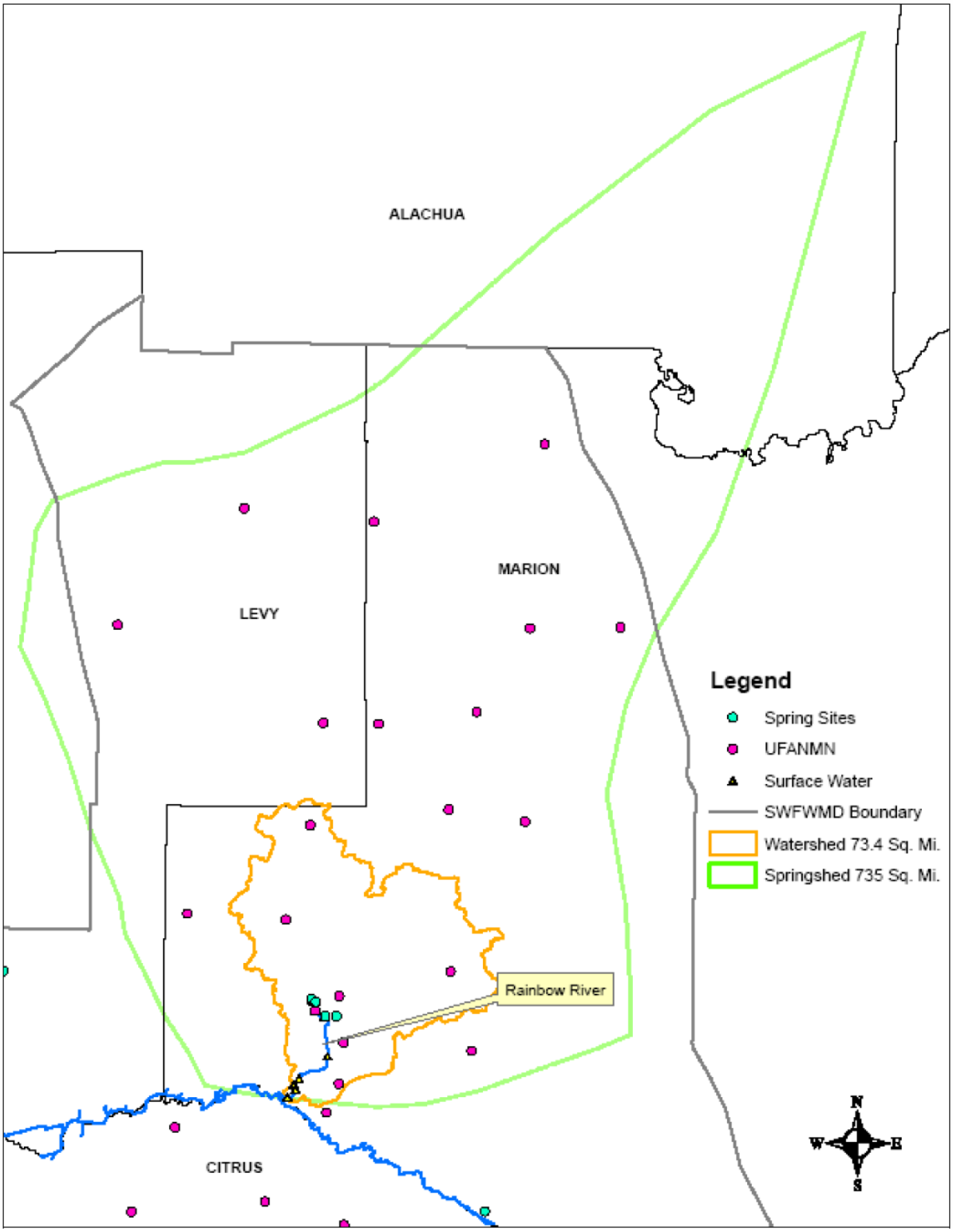


FIGURE 6
The watershed and springshed delineation of Rainbow Springs (from SWFWMD 2008).

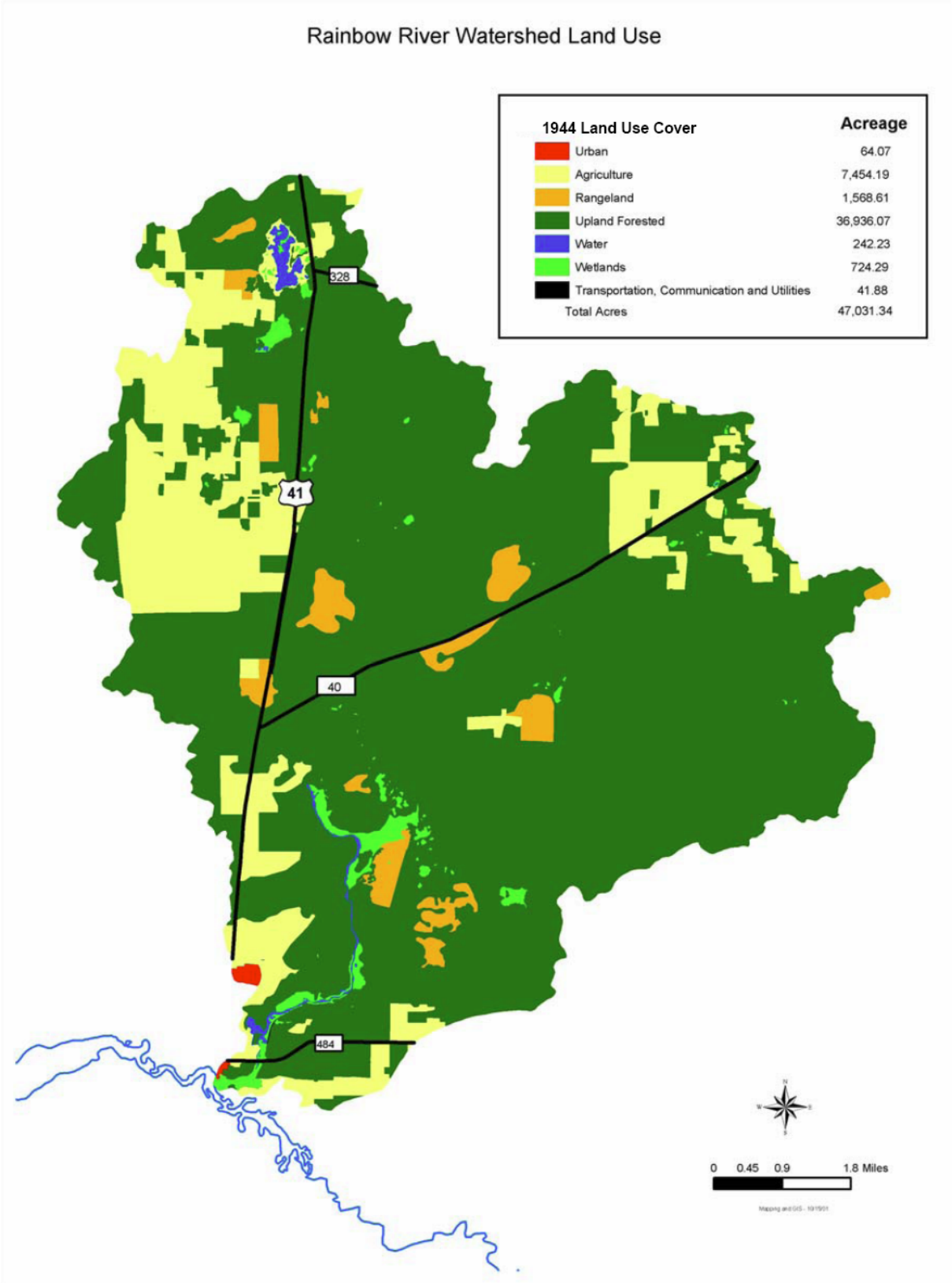


FIGURE 7
Land use in the Rainbow River watershed in 1944 (from SWFWMD 2004).

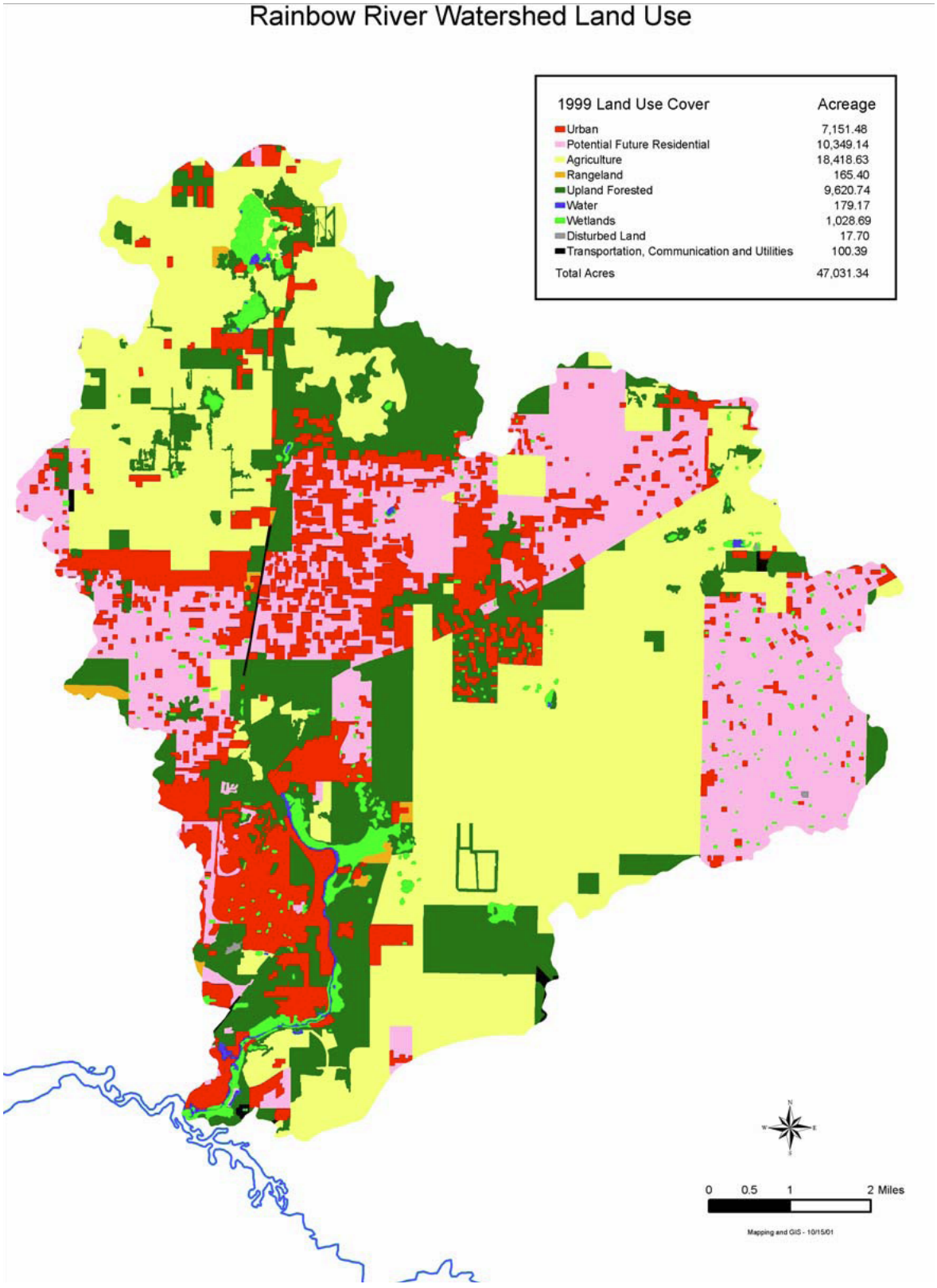


FIGURE 8
Land use in the Rainbow River watershed in 1999 (from SWFWMD 2004).

Study Area

The project study area for Rainbow Springs is defined as the spring pool and the upper 1.1 km (0.7 mi) of the spring run. **Figure 9** shows an approximation of the study area and data sonde locations are indicated by red icons.

FIGURE 9
The study area for Rainbow Springs (with data sonde locations as red icons).

Meta data (source, station, location, and STORET Origin ID) for the water quality data presented in the historical description of Rainbow Springs are given in **Table 1** below.

TABLE 1
Source information for the Rainbow Springs historical water quality data described in this report.

Org ID	Org Name	Station ID	Station Name	Latitude	Longitude
21FLA	Florida Department of Environmental Protection	23010404	WITHLACOOCHEE R. BASIN/DUNNELLON/FRESHWATER	29.049639	-82.448195
21FLA	FDEP	23010409	RAINBOW RIVER/DUNNELLON/FRESHWATER REF SITE	29.092806	-82.426195
21FLA	FDEP	23010441	WITHLACOOCHEE R. BASIN/DUNNELLON/FRESHWATER	29.101944	-82.437778
21FLA	Florida Department of Environmental Protection	BUBBLING SPRING	FL Springs Initiative	29.101238	-82.434848
21FLA	Florida Department of Environmental Protection	RAINBOW SPRING #1	FL Springs Initiative	29.102476	-82.437466
21FLA	Florida Department of Environmental Protection	RAINBOW SPRING #4	FL Springs Initiative	29.101908	-82.437159
21FLA	Florida Department of Environmental Protection	RAINBOW SPRING #6	FL Springs Initiative	29.092808	-82.428565
21FLBRA	Florida Department of Environmental Protection	1320A-A	1320A - Rainbow Springs #1 - inside Rainbow Springs	29.102231	-82.437886
21FLGW	Florida Department of Environmental Protection	9699	BUBBLING SPRING	29.101238	-82.434848
21FLGW	Florida Department of Environmental Protection	9700	RAINBOW #1	29.102476	-82.437466
21FLGW	Florida Department of Environmental Protection	9701	RAINBOW #4	29.101908	-82.437159
21FLGW	Florida Department of Environmental Protection	9702	RAINBOW #6	29.092808	-82.428565
21FLGW	Florida Department of Environmental Protection	17967	SWA-LR-1031 RAINBOW RIVER	29.081018	-82.428821
21FLKWAT	Florida Lake Watch	MAR-RA-RIVER-1	Marion-Rainbow River-1-1	29.103000	-82.437000
21FLKWAT	Florida Lake Watch	MAR-RA-RIVER-2	Marion-Rainbow River-2-2	29.087333	-82.428833
21FLKWAT	Florida Lake Watch	MAR-RA-RIVER-3	Marion-Rainbow River-3-3	29.050000	-82.447833
21FLTPA	Florida Department of Environmental Protection	23010404	TP23 - BLUE RUN/RAINBOW RIVER	29.049639	-82.448195
21FLTPA	Florida Department of Environmental Protection	23010409	TP33 - RAINBOW RIVER	29.092806	-82.426195
21FLTPA	Florida Department of Environmental Protection	23010441	TP129 - RAINBOW SPRING	29.101944	-82.437778
21FLTPA	Florida Department of Environmental Protection	29051718225386	TP249-Blue Run	29.088083	-82.427389
21FLTPA	Florida Department of Environmental Protection	29052808225344	TP247-Blue Run	29.091111	-82.426222
21FLTPA	Florida Department of Environmental Protection	29053408225445	TP248-Blue Run	29.092778	-82.429028
21FLWQSP	FDEP	MRN504LR	Rainbow River at state park campground (WBID 1320)	29.089038	-82.426285
USGS	USGS	2313092	USGS 02313092 RAINBOW NUMBER 1 SPRING NEAR DUNNELLON, FL.	29.102500	-82.437500
USGS	USGS	2313093	USGS 02313093 RAINBOW NUMBER 4 SPRING NEAR DUNNELLON, FL.	29.101944	-82.437222
USGS	USGS	2313094	USGS 02313094 RAINBOW BUBBLING SPRING NEAR DUNNELLON, FL.	29.101111	-82.434736
USGS	USGS	2313096	USGS 02313096 RAINBOW NUMBER 6 SPRING NEAR DUNNELLON, FL	29.092778	-82.428611
USGS	USGS	2313100	USGS 02313100 RAINBOW SPRINGS NEAR DUNNELLON, FL	29.102222	-82.437778

Discharge and Stage

Rainbow Springs has a wide range in discharge values (which are typically measured approximately five miles downstream, at SR 484 near Dunnellon). Historical instantaneous discharges reported by Rosenau *et al.* (1977) ranged from a minimum of 487 cfs (October 3, 1932) to a maximum of 1,230 cfs (October 12, 1964); with an average discharge of 763 cfs (1965-1974). Other measures of discharge include a value of 634 cfs (October 23, 2001) by Scott *et al.* 2002.

The US Geological Survey computes discharge of the Rainbow River (station # 02313100) based on the relation between discharge measurements (made 0.25 mi upstream of SR 484) and artesian pressure at a well near the head springs (well # 290514082270701, USGS 2008). The resulting USGS discharge measurements include an annual mean value of 688 cfs (1965 to 2008), a minimum annual mean of 521 cfs from 2001, and a maximum annual mean of 897 cfs from 1970 (USGS 2008). **Table 2** and **Figure 10** illustrates the variability of discharge at this spring system (USGS 2008).

Stage values for Rainbow Springs have been collected by USGS from a location near the head springs. Water-stage was instrument recorded between 1933 and 1969, since April 1971 the non-recording gage has only been read during discharge measurements. A maximum observed stage of 5.90 ft (NGVD 1929) was observed on April 6, 1960 (USGS 2008).

TABLE 2
Summary statistics for the discharge (cfs) and stage (ft) of Rainbow River (near Dunnellon, from USGS 2008).

SUMMARY STATISTICS

	Calendar Year 2007		Water Year 2008		Water Years 1965 - 2008	
Annual total	209,814		220,035			
Annual mean	575		601		688	
Highest annual mean					897	1970
Lowest annual mean					521	2001
Highest daily mean	611	Mar 4	758	Sep 9	1,060	Sep 19, 1988
Lowest daily mean	545	Jul 9,13	554	Jun 7,8	[a]470	Jun 18, 2001
Annual seven-day minimum	546	Jul 8	556	Jun 4	473	Jun 15, 2001
Maximum peak flow					[d]1,230	Oct 12, 1964
Maximum peak stage			[c]3.13	Aug 29	[b]5.90	Apr 6, 1960
Instantaneous low flow			548	Jun 7	460	Jun 7, 2000
10 percent exceeds	597		660		845	
50 percent exceeds	574		584		672	
90 percent exceeds	554		564		564	

[a] Jun 18, 19, Jul 9, 2001
[b] Observed
[c] Observed at spring pool
[d] Measured

The variation in discharge among the Rainbow Springs group (and other springs) appears to be climatologically influenced. Evidence for this is shown in **Figure 11** which illustrates discharge for both Rainbow and Weeki Wachee Springs by monthly average and by annual average (Champion and Starks 2001). Lowest discharge values for both spring systems are observed in June and highest discharge values are observed in October, a response which likely corresponds to typical rainfall patterns in central Florida. In turn, annual average discharge data between these two spring systems are similar and suggests that rainfall inputs broadly control spring discharge rates (**Figure 11**).

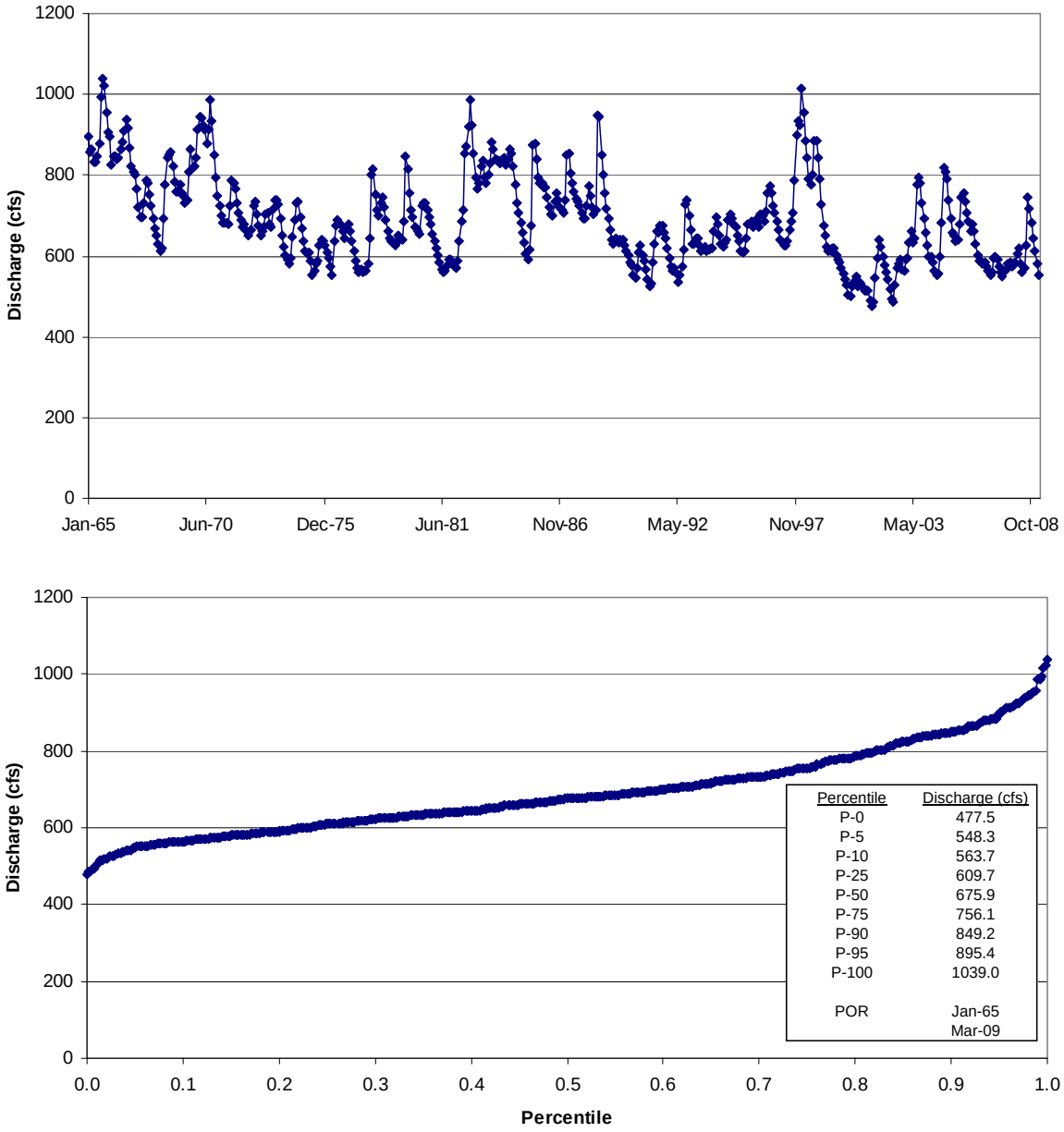
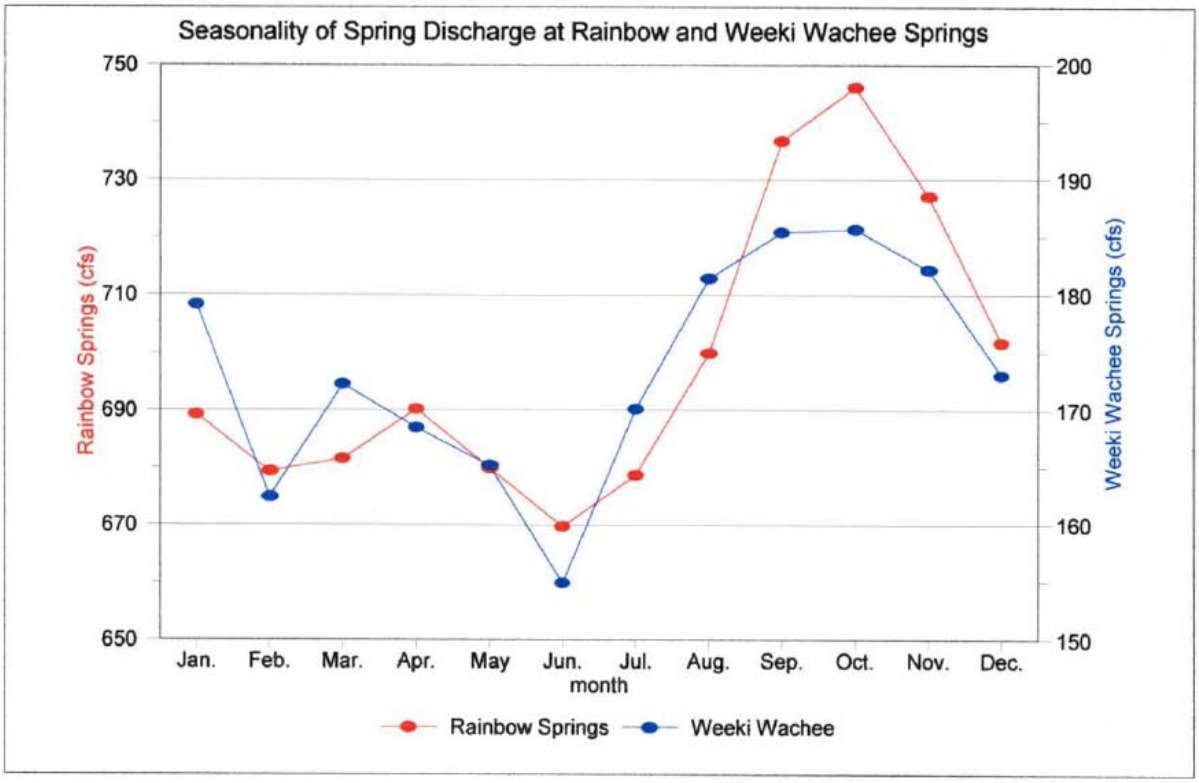


FIGURE 10
Monthly average discharge time series and frequency curve for Rainbow River.



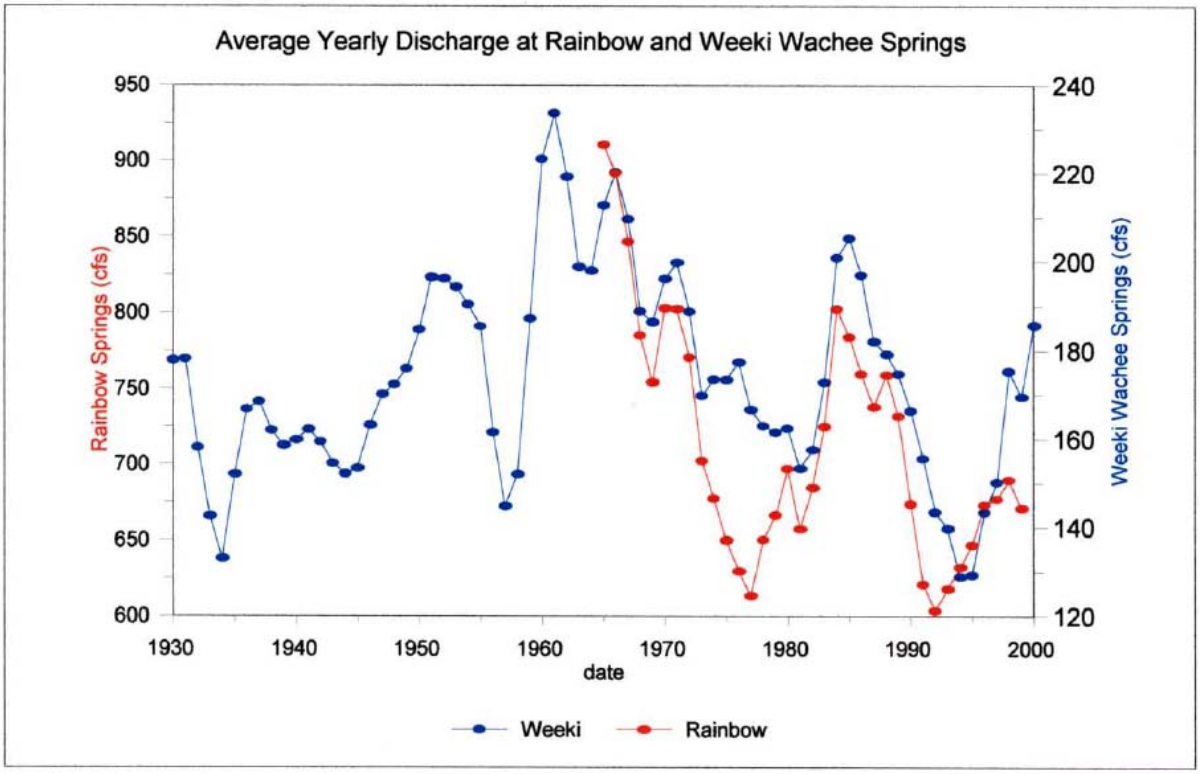


FIGURE 11
Monthly and annual fluctuations in Rainbow and Weeki Wachee Springs discharge from1930 to1997 (from Champion and Starks 2001).

Water Quality

Water quality data for Rainbow Springs are available from as early as 1927 by Rosenau *et al.* (1977); however STORET data (USGS and FDEP data) primarily spans from the 1950s to as recent as March 2009. Among water chemistry parameters, the numbers of samples collected ranges from 1 to 202 records, with most samples collected from the main pool. These data are summarized in **Table 3** which provides statistics for the available water quality parameters, as well as decadal averages (if available), and the period-of-record (POR) dates. Rainbow Springs (main boil) POR averages for several key parameters (with the number of samples) are:

- Water temperature – 23.3 °C (n = 178)
- Dissolved oxygen – 6.87 mg/L (n = 89)
- pH – 7.84 SU (n = 138)
- Specific conductance – 144 umhos/cm (n = 202)
- Turbidity – 0.617 NTU (n = 60)
- Color – 3.54 CPU (n= 128)
- Total chloride – 3.51 mg/L (n = 128)
- Sulfate – 5.24 mg/L (n = 64)
- Nitrate+nitrite nitrogen – 0.482 mg/L (n = 53 only through 1999)
- Total phosphorus – 0.036 mg/L (n = 70)

TABLE 3
Rainbow Springs water quality table for the period-of-record.

PARAMETER GROUP	PARAMETER	UNITS	STATION	Decade										POR Statistics					Period of Record	
				1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Average	Min	Max	StDev	N		
BACTERIOLOGICAL	EColi	#/100ml	Spring 1											1.51	1.51	0.500	4.10	1.08	10	10/23/2001	10/17/2006
			Spring 4											1.00	1.00	1.00	1.00	0.00	4	10/23/2001	1/23/2002
			Bubbling Spring											1.00	1.00	1.00	1.00	0.00	2	10/23/2001	10/23/2001
			Spring 6											1.00	1.00	1.00	1.00	0.00	2	10/23/2001	10/23/2001
	Enterococci	#/100ml	Spring 1											1.48	1.48	1.00	2.00	0.512	21	10/23/2001	10/24/2006
			Spring 4											1.57	1.57	1.00	4.00	0.746	21	10/23/2001	10/24/2006
			Bubbling Spring											1.65	1.65	1.00	4.00	0.745	20	10/23/2001	10/24/2006
			Spring 6											6.55	6.55	1.00	70.0	15.8	20	10/23/2001	10/24/2006
			Spring Run (mid)											22.0	22.0	22.0	22.0		1	5/28/2003	5/28/2003
	FC	#/100ml	Main Boil								0.00				0.00	0.00	0.00	0.00	6	1/17/1975	11/18/1975
			Spring 1											1.49	1.49	1.00	2.00	0.505	55	10/23/2001	4/30/2008
			Spring 4											1.49	1.49	1.00	2.00	0.505	55	10/23/2001	4/30/2008
			Bridge Seep											5.10	5.10	1.00	30.0	8.71	20	3/1/2004	12/6/2004
			Bubbling Spring											1.62	1.62	1.00	4.00	0.686	53	10/23/2001	4/30/2008
			Spring 6											1.94	1.94	1.00	6.00	1.35	53	10/23/2001	4/30/2008
			Spring Run (mid)											34.4	34.4	1.00	160	50.3	16	11/27/2000	12/13/2006
			Spring Run (SR 484)											106	106	1.00	450	182	10	3/1/2004	12/15/2004
	TC	#/100ml	Main Boil							420	110				140	0.00	640	155	21	5/16/1969	5/20/1977
			Spring 1											124	124	0.500	2,400	440	59	10/23/2001	4/30/2008
			Spring 4											4.75	4.75	1.00	18.0	6.07	53	10/23/2001	4/30/2008
			Bridge Seep											60.6	60.6	1.00	230	67.8	20	3/1/2004	12/6/2004
			Bubbling Spring											5.10	5.10	1.00	70.0	13.4	51	10/23/2001	4/30/2008
			Spring 6											7.98	7.98	1.00	48.0	13.3	51	10/23/2001	4/30/2008
			Spring Run (mid)											67.3	67.3	1.00	280	93.0	15	11/27/2000	12/13/2006
			Spring Run (SR 484)											103	103	1.00	220	91.0	10	3/1/2004	12/15/2004
BIOLOGICAL	Chl-a corr	µg/L	Spring 1											1.70	1.70	0.500	7.10	2.66	6	5/3/2006	10/17/2006
			Bridge Seep											0.491	0.491	0.425	1.10	0.198	22	3/1/2004	12/6/2004
			Spring Run (mid)											0.511	0.511	0.425	1.60	0.282	17	5/28/2003	1/9/2006
			Spring Run (SR 484)											3.08	3.08	0.850	12.0	4.70	10	3/1/2004	12/6/2004
	Pheo-a	µg/L	Spring 1											19.6	19.6	0.500	100	39.5	6	5/3/2006	10/17/2006
			Bridge Seep											0.391	0.391	0.00	0.480	0.128	22	3/1/2004	12/6/2004
			Spring Run (mid)											0.429	0.429	0.425	0.480	0.015	13	5/28/2003	11/1/2004
			Spring Run (SR 484)											0.770	0.770	0.450	0.850	0.169	10	3/1/2004	12/6/2004
DISSOLVED OXYGEN	DO	%	Main Boil							82.8	75.5	67.0			75.3	49.0	91.0	9.40	35	5/17/1967	6/29/1982
			Bridge Seep											88.0	88.0	5.40	125	26.9	26	3/1/2004	12/6/2004
			Spring Run (mid)											97.3	97.3	84.2	120	12.9	16	3/1/2004	12/12/2006
			Spring Run (SR 484)											93.1	93.1	66.3	131	21.9	12	3/1/2004	12/15/2004
	DO	mg/L	Main Boil							7.10	6.33	7.16	7.18		6.87	4.20	12.3	1.01	89	5/17/1967	9/2/1999
			Spring 1											6.60	6.60	5.68	7.75	0.344	59	10/23/2001	4/30/2008
			Spring 4											5.11	5.11	4.00	6.01	0.318	55	10/23/2001	4/30/2008
			Bridge Seep											7.52	7.52	0.440	10.6	2.31	26	3/1/2004	12/6/2004
			Bubbling Spring											4.60	4.60	3.94	7.38	0.712	55	10/23/2001	4/30/2008
			Spring 6											5.89	5.89	4.75	7.19	0.553	55	10/23/2001	4/30/2008
			Spring Run (mid)										6.73	7.89	7.75	6.45	10.2	1.11	33	3/16/1998	12/12/2006
			Spring Run (SR 484)											8.17	8.17	5.64	11.4	1.93	12	3/1/2004	12/15/2004
FLOW	Flow	cfs	Main Boil							809	690	735	667	606	691	470	1,060	110	16181	1/1/1965	3/25/2009
			Bubbling Spring											26.3	26.3	26.3	26.3		1	7/29/2004	7/29/2004
	Flow-Inst	cfs	Main Boil	782	738	838	692	720	717	784	675	734	708		714	487	1,230	107	531	12/24/1904	9/2/1999
			Spring 1											163	163	22.0	254	114	5	8/8/2006	8/22/2007
			Spring 4											169	169	105	261	70.5	5	8/8/2006	8/22/2007
			Bubbling Spring											17.1	17.1	11.0	26.3	5.51	6	7/29/2004	8/22/2007
			Spring 6											317	317	307	326	7.23	5	8/8/2006	8/22/2007

TABLE 3 (CONTINUED)
Rainbow Springs water quality table for the period-of-record continued.

PARAMETER GROUP	PARAMETER	UNITS	STATION	Decade										POR Statistics					Period of Record	
				1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Average	Min	Max	StDev	N		
GENERAL INORGANIC	Alk	mg/L as Ca	Main Boil						114	70.1	56.2	70.0			62.8	47.0	114	20.0	34	5/2/1956	5/29/1981
			Spring 1											57.4	57.4	0.500	67.0	10.3	39	10/23/2001	4/30/2008
			Spring 4											115	115	107	125	4.62	33	10/23/2001	4/30/2008
			Bubbling Spring											155	155	147	166	5.57	32	10/23/2001	4/30/2008
			Spring 6											118	118	104	134	6.84	32	10/23/2001	4/30/2008
	Cl-T	mg/L	Main Boil						5.50	3.58	3.27	3.45	3.87		3.51	1.60	8.00	0.874	128	5/2/1956	9/2/1999
			Spring 1											4.28	4.28	0.036	5.20	0.595	79	10/23/2001	4/30/2008
			Spring 4											5.04	5.04	4.20	5.90	0.340	73	10/23/2001	4/30/2008
			Bridge Seep											3.85	3.85	3.50	4.10	0.187	22	3/1/2004	12/6/2004
			Bubbling Spring											5.92	5.92	5.20	6.60	0.312	70	10/23/2001	4/30/2008
			Spring 6											6.83	6.83	4.80	8.00	0.658	70	10/23/2001	4/30/2008
			Spring Run (mid)											5.35	5.35	4.90	5.80	0.276	13	5/28/2003	11/1/2004
			Spring Run (SR 484)											5.56	5.56	5.20	5.90	0.255	10	3/1/2004	12/6/2004
	CO2	mg/L	Main Boil						8.90	5.31	1.80	2.81	16.9		6.50	0.100	151	20.6	63	5/2/1956	9/2/1999
	F-D	mg/L	Main Boil							0.144	0.157	0.126	0.100		0.127	0.00	0.300	0.061	62	11/9/1960	9/2/1999
			Spring 1											0.088	0.088	0.072	0.120	0.009	33	10/23/2001	4/30/2008
			Spring 4											0.117	0.117	0.094	0.150	0.010	33	10/23/2001	4/30/2008
			Bubbling Spring											0.131	0.131	0.050	0.150	0.018	32	10/23/2001	4/30/2008
			Spring 6											0.129	0.129	0.110	0.150	0.010	32	10/23/2001	4/30/2008
	F-T	mg/L	Spring 1											0.087	0.087	0.050	0.110	0.011	33	10/23/2001	4/30/2008
			Spring 4											0.116	0.116	0.097	0.140	0.009	33	10/23/2001	4/30/2008
			Bubbling Spring											0.133	0.133	0.110	0.160	0.011	32	10/23/2001	4/30/2008
			Spring 6											0.129	0.129	0.110	0.150	0.011	32	10/23/2001	4/30/2008
	Hardness	mg/L as Ca	Main Boil						130	74.7	65.8	69.5	72.3		70.5	44.0	170	20.0	128	5/2/1956	9/2/1999
	Si-D	mg/L	Main Boil						6.20	13.6	6.80	6.66	6.70		7.65	5.50	66.0	7.31	66	5/2/1956	9/2/1999
	SO4	mg/L	Main Boil						18.0	6.13	5.00	5.01	4.61		5.24	2.40	18.0	3.16	64	5/2/1956	9/2/1999
			Spring 1											4.72	4.72	0.030	5.20	0.590	79	10/23/2001	4/30/2008
			Spring 4											5.05	5.05	4.50	6.00	0.246	73	10/23/2001	4/30/2008
			Bridge Seep											4.39	4.39	4.10	4.60	0.179	24	3/1/2004	12/6/2004
			Bubbling Spring											8.59	8.59	7.60	10.0	0.604	70	10/23/2001	4/30/2008
			Spring 6											35.5	35.5	8.30	46.0	8.89	70	10/23/2001	4/30/2008
			Spring Run (mid)											12.0	12.0	7.40	16.0	3.11	16	5/28/2003	11/1/2004
			Spring Run (SR 484)											14.4	14.4	14.0	15.0	0.516	10	3/1/2004	12/6/2004
GENERAL ORGANIC	TOC	mg/L	Main Boil							3.00	3.88	0.763	1.85		2.42	0.00	33.0	6.09	61	9/19/1968	9/2/1999
			Spring 1											0.543	0.543	0.150	3.30	0.375	61	10/23/2001	4/30/2008
			Spring 4											0.625	0.625	0.500	6.00	0.762	55	10/23/2001	4/30/2008
			Bridge Seep											0.600	0.600	0.500	1.10	0.218	22	3/1/2004	12/6/2004
			Bubbling Spring											0.700	0.700	0.500	7.90	1.05	53	10/23/2001	4/30/2008
			Spring 6											0.632	0.632	0.500	4.70	0.620	53	10/23/2001	4/30/2008
			Spring Run (mid)											0.542	0.542	0.500	1.21	0.172	17	5/28/2003	1/9/2006
			Spring Run (SR 484)											6.30	6.30	1.00	26.0	10.4	10	3/1/2004	12/6/2004
METAL	Ag-T	µg/L	Main Boil									1.00			1.00	1.00	1.00		1	1/17/1985	1/17/1985
	Al-T	µg/L	Main Boil								75.0	8.33	23.1		27.5	0.00	100	31.6	27	5/2/1970	9/2/1999
			Spring 1											6.37	6.37	1.50	37.5	9.96	23	10/23/2001	4/21/2005
			Spring 4											6.07	6.07	1.50	37.5	9.97	23	10/23/2001	4/21/2005
			Bubbling Spring											6.07	6.07	1.50	37.5	9.97	23	10/23/2001	4/21/2005
			Spring 6											6.07	6.07	1.50	37.5	9.97	23	10/23/2001	4/21/2005
	As-T	µg/L	Main Boil								1.33	0.938	1.00		1.05	0.00	4.00	0.532	43	8/29/1972	9/2/1999
			Spring 1											2.40	2.40	1.50	3.00	0.608	24	10/23/2001	4/21/2005
			Spring 4											2.40	2.40	1.50	3.00	0.608	24	10/23/2001	4/21/2005
			Bubbling Spring											2.69	2.69	1.50	6.00	1.19	24	10/23/2001	4/21/2005
			Spring 6											2.40	2.40	1.50	3.00	0.608	24	10/23/2001	4/21/2005

TABLE 3 (CONTINUED)
Rainbow Springs water quality table for the period-of-record continued.

				Decade											POR Statistics						
PARAMETER GROUP	PARAMETER	UNITS	STATION	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Average	Min	Max	StDev	N	Period of Record	
METAL	Ba-T	µg/L	Main Boil									100			100	100	100		1	1/17/1985	1/17/1985
			Spring 1											0.948	0.948	0.250	1.50	0.308	21	10/9/2002	4/21/2005
			Spring 4											1.27	1.27	0.250	2.10	0.506	21	10/9/2002	4/21/2005
			Bubbling Spring											1.75	1.75	0.560	2.50	0.623	21	10/9/2002	4/21/2005
			Spring 6											1.89	1.89	0.870	2.90	0.765	21	10/9/2002	4/21/2005
	Ca-D	mg/L	Main Boil						43.0	25.7	20.0	22.3	23.1		22.5	14.0	43.0	7.88	72	5/2/1956	9/2/1999
			Spring 1											22.6	22.6	17.7	25.9	1.66	34	10/23/2001	4/30/2008
			Spring 4											42.8	42.8	38.4	45.5	1.95	34	10/23/2001	4/30/2008
			Bubbling Spring											58.5	58.5	54.1	66.2	2.29	33	10/23/2001	4/30/2008
			Spring 6											53.4	53.4	39.5	61.4	5.52	33	10/23/2001	4/30/2008
	Ca-T	mg/L	Spring 1											21.9	21.9	0.080	25.0	2.90	80	10/23/2001	4/30/2008
			Spring 4											42.7	42.7	38.1	67.4	3.69	74	10/23/2001	4/30/2008
			Bridge Seep											19.4	19.4	18.4	24.2	1.60	22	3/1/2004	12/6/2004
			Bubbling Spring											58.4	58.4	49.6	66.5	2.68	71	10/23/2001	4/30/2008
			Spring 6											53.3	53.3	38.1	61.5	5.24	71	10/23/2001	4/30/2008
			Spring Run (mid)											42.8	42.8	41.4	44.1	0.826	13	5/28/2003	11/1/2004
			Spring Run (SR 484)											43.1	43.1	42.3	44.9	0.987	10	3/1/2004	12/6/2004
	Cd-T	µg/L	Main Boil								1.33	0.889	1.06		1.03	0.00	2.00	0.490	30	5/16/1972	9/2/1999
			Spring 1											0.276	0.276	0.250	0.375	0.052	24	10/23/2001	4/21/2005
			Spring 4											0.276	0.276	0.250	0.375	0.052	24	10/23/2001	4/21/2005
			Bubbling Spring											0.276	0.276	0.250	0.375	0.052	24	10/23/2001	4/21/2005
			Spring 6											0.276	0.276	0.250	0.375	0.052	24	10/23/2001	4/21/2005
	Co-T	µg/L	Main Boil								0.00				0.00	0.00	0.00	0.00	2	5/16/1972	8/29/1972
			Spring 1											0.717	0.717	0.250	1.00	0.311	23	10/23/2001	4/21/2005
			Spring 4											0.717	0.717	0.250	1.00	0.311	23	10/23/2001	4/21/2005
			Bubbling Spring											0.861	0.861	0.250	4.30	0.809	23	10/23/2001	4/21/2005
			Spring 6											0.717	0.717	0.250	1.00	0.311	23	10/23/2001	4/21/2005
	Cr-T	µg/L	Main Boil								6.67	2.00			5.50	0.00	20.0	9.71	4	5/2/1970	1/17/1985
			Spring 1											0.983	0.983	0.250	1.50	0.254	24	10/23/2001	4/21/2005
			Spring 4											1.18	1.18	0.250	2.20	0.529	24	10/23/2001	4/21/2005
			Bubbling Spring											1.35	1.35	0.250	2.60	0.715	24	10/23/2001	4/21/2005
			Spring 6											0.983	0.983	0.250	1.50	0.254	24	10/23/2001	4/21/2005
	Cu-T	µg/L	Main Boil								20.0				20.0	0.00	40.0	28.3	2	5/16/1972	1/17/1985
			Spring 1											2.01	2.01	1.00	3.00	0.690	24	10/23/2001	4/21/2005
			Spring 4											2.01	2.01	1.00	3.00	0.690	24	10/23/2001	4/21/2005
			Bubbling Spring											2.18	2.18	1.00	5.20	0.930	24	10/23/2001	4/21/2005
			Spring 6											2.01	2.01	1.00	3.00	0.690	24	10/23/2001	4/21/2005
	Fe-T	µg/L	Main Boil								35.5	50.0	13.9		33.3	3.00	190	37.8	42	5/16/1972	9/2/1999
			Spring 1											7.74	7.74	2.50	34.0	7.23	24	10/23/2001	4/21/2005
			Spring 4											6.44	6.44	2.50	17.5	4.66	24	10/23/2001	4/21/2005
			Bubbling Spring											6.44	6.44	2.50	17.5	4.66	24	10/23/2001	4/21/2005
			Spring 6											6.44	6.44	2.50	17.5	4.66	24	10/23/2001	4/21/2005
	Hg-T	µg/L	Main Boil								0.375	0.129	0.144		0.211	0.00	0.500	0.187	38	5/18/1971	5/25/1995
	K-D	mg/L	Main Boil						0.100	0.178	0.187	0.158	0.197		0.179	0.00	1.00	0.160	64	5/2/1956	9/2/1999
			Spring 1											0.138	0.138	0.075	0.310	0.044	34	10/23/2001	4/30/2008
			Spring 4											0.138	0.138	0.075	0.190	0.027	34	10/23/2001	4/30/2008
			Bubbling Spring											0.181	0.181	0.140	0.230	0.024	33	10/23/2001	4/30/2008
			Spring 6											0.293	0.293	0.150	0.540	0.070	33	10/23/2001	4/30/2008
	K-T	mg/L	Spring 1											0.117	0.117	0.038	0.190	0.026	80	10/23/2001	4/30/2008
			Spring 4											0.126	0.126	0.055	0.190	0.027	74	10/23/2001	4/30/2008
			Bridge Seep											0.146	0.146	0.110	0.210	0.030	22	3/1/2004	12/6/2004
			Bubbling Spring											0.168	0.168	0.075	0.310	0.031	71	10/23/2001	4/30/2008
			Spring 6											0.280	0.280	0.140	0.360	0.054	71	10/23/2001	4/30/2008
			Spring Run (mid)											0.168	0.168	0.140	0.200	0.019	13	5/28/2003	11/1/2004
			Spring Run (SR 484)											0.204	0.204	0.180	0.280	0.040	10	3/1/2004	12/6/2004

TABLE 3 (CONTINUED)
Rainbow Springs water quality table for the period-of-record continued.

				Decade										POR Statistics						
PARAMETER GROUP	PARAMETER	UNITS	STATION	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Average	Min	Max	StDev	N	Period of Record
METAL	Mg-D	mg/L	Main Boil						4.50	3.02	3.32	3.41	3.45		3.36	0.00	5.50	0.756	72	5/2/1956 9/2/1999
			Spring 1											3.67	3.67	2.90	4.20	0.251	34	10/23/2001 4/30/2008
			Spring 4											5.17	5.17	4.50	5.70	0.248	34	10/23/2001 4/30/2008
			Bubbling Spring											6.32	6.32	5.80	7.20	0.247	33	10/23/2001 4/30/2008
			Spring 6											6.60	6.60	4.90	7.50	0.691	33	10/23/2001 4/30/2008
	Mg-T	mg/L	Spring 1											3.55	3.55	0.050	4.00	0.460	80	10/23/2001 4/30/2008
			Spring 4											5.12	5.12	4.50	5.70	0.265	74	10/23/2001 4/30/2008
			Bridge Seep											3.28	3.28	3.10	3.80	0.189	22	3/1/2004 12/6/2004
			Bubbling Spring											6.33	6.33	5.50	6.90	0.275	71	10/23/2001 4/30/2008
			Spring 6											6.61	6.61	4.80	7.50	0.640	71	10/23/2001 4/30/2008
			Spring Run (mid)											5.25	5.25	5.10	5.50	0.133	13	5/28/2003 11/1/2004
			Spring Run (SR 484)											5.20	5.20	5.00	5.40	0.149	10	3/1/2004 12/6/2004
	Mn-T	µg/L	Main Boil								10.9	10.6	3.35		7.89	0.00	30.0	5.75	44	5/16/1972 9/2/1999
			Spring 1											0.234	0.234	0.125	0.250	0.042	24	10/23/2001 4/21/2005
			Spring 4											0.234	0.234	0.125	0.250	0.042	24	10/23/2001 4/21/2005
			Bubbling Spring											0.553	0.553	0.125	7.90	1.57	24	10/23/2001 4/21/2005
			Spring 6											0.234	0.234	0.125	0.250	0.042	24	10/23/2001 4/21/2005
	NA-D	mg/L	Main Boil						2.80	2.14	2.25	2.18	2.42		2.28	0.600	3.40	0.456	64	5/2/1956 9/2/1999
			Spring 1											2.60	2.60	2.00	3.30	0.304	34	10/23/2001 4/30/2008
			Spring 4											2.83	2.83	2.30	3.40	0.248	34	10/23/2001 4/30/2008
			Bubbling Spring											3.25	3.25	2.70	3.70	0.235	33	10/23/2001 4/30/2008
			Spring 6											3.90	3.90	2.78	4.60	0.505	33	10/23/2001 4/30/2008
	Na-T	%	Main Boil						5.00	5.78	6.93	6.68	7.17		6.73	2.00	11.0	1.53	62	5/2/1956 9/2/1999
	Na-T	mg/L	Spring 1											2.48	2.48	0.250	3.30	0.411	47	10/23/2001 10/24/2006
			Spring 4											2.77	2.77	2.20	3.40	0.237	41	10/23/2001 10/24/2006
			Bridge Seep											2.57	2.57	2.28	4.10	0.513	22	3/1/2004 12/6/2004
			Bubbling Spring											3.19	3.19	2.60	3.70	0.239	39	10/23/2001 10/24/2006
			Spring 6											3.86	3.86	2.78	4.60	0.398	39	10/23/2001 10/24/2006
			Spring Run (mid)											3.03	3.03	2.81	3.22	0.117	13	5/28/2003 11/1/2004
			Spring Run (SR 484)											3.24	3.24	3.09	3.60	0.197	10	3/1/2004 12/6/2004
	Ni-T	µg/L	Main Boil									1.20	1.07		1.10	1.00	2.00	0.288	23	5/14/1974 9/2/1999
			Spring 1											1.02	1.02	0.500	1.50	0.207	24	10/23/2001 4/21/2005
			Spring 4											1.02	1.02	0.500	1.50	0.207	24	10/23/2001 4/21/2005
			Bubbling Spring											1.02	1.02	0.500	1.50	0.207	24	10/23/2001 4/21/2005
			Spring 6											1.19	1.19	0.500	2.00	0.425	24	10/23/2001 4/21/2005
	Pb-T	µg/L	Main Boil								2.00	3.88	1.57		2.26	1.00	7.00	1.79	28	8/29/1972 9/2/1999
			Spring 1											1.97	1.97	0.013	2.50	1.02	24	10/23/2001 4/21/2005
			Spring 4											1.97	1.97	0.027	2.50	1.02	24	10/23/2001 4/21/2005
			Bubbling Spring											1.97	1.97	0.013	2.50	1.02	24	10/23/2001 4/21/2005
			Spring 6											1.97	1.97	0.013	2.50	1.02	24	10/23/2001 4/21/2005
	SAR	ratio	Main Boil						0.100	0.089	0.113	0.100	0.105		0.103	0.00	0.200	0.025	64	5/2/1956 9/2/1999
	Se-T	µg/L	Spring 1											3.63	3.63	2.00	7.50	1.09	24	10/23/2001 4/21/2005
			Spring 4											3.63	3.63	2.00	7.50	1.09	24	10/23/2001 4/21/2005
			Bubbling Spring											3.63	3.63	2.00	7.50	1.09	24	10/23/2001 4/21/2005
			Spring 6											3.63	3.63	2.00	7.50	1.09	24	10/23/2001 4/21/2005
	Sr-D	µg/L	Main Boil							60.0	88.7	94.2	79.3		86.6	0.00	400	64.3	55	5/17/1967 9/2/1999
			Spring 1											54.2	54.2	47.0	59.8	4.32	9	10/9/2002 4/21/2005
			Spring 4											87.0	87.0	81.0	96.2	5.12	9	10/9/2002 4/21/2005
			Bubbling Spring											165	165	153	176	9.15	9	10/9/2002 4/21/2005
			Spring 6											308	308	118	455	152	9	10/9/2002 4/21/2005
	Sr-T	µg/L	Spring 1											54.0	54.0	44.0	60.0	4.79	23	10/23/2001 4/21/2005
			Spring 4											88.1	88.1	81.0	98.4	5.89	23	10/23/2001 4/21/2005
			Bubbling Spring											165	165	153	189	11.9	23	10/23/2001 4/21/2005
			Spring 6											352	352	116	503	138	23	10/23/2001 4/21/2005
	Zn-T	µg/L	Main Boil								15.0				15.0	0.00	30.0	21.2	2	5/16/1972 8/29/1972
			Spring 1											2.53	2.53	1.00	6.10	1.55	24	10/23/2001 4/21/2005
			Spring 4											3.13	3.13	1.00	8.90	2.49	24	10/23/2001 4/21/2005
			Bubbling Spring											2.78	2.78	0.500	8.60	2.31	24	10/23/2001 4/21/2005
			Spring 6											2.78	2.78	1.00	7.80	2.04	24	10/23/2001 4/21/2005

TABLE 3 (CONTINUED)
Rainbow Springs water quality table for the period-of-record continued.

PARAMETER GROUP	PARAMETER	UNITS	STATION	Decade 1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	POR Statistics Average	Min	Max	StDev	N	Period of Record	
NITROGEN	NH4-N	mg/L	Main Boil							0.003	0.021	0.025	0.017		0.020	0.00	0.110	0.016	65	9/19/1968	9/2/1999
			Spring 1											0.006	0.006	0.005	0.025	0.003	73	10/23/2001	4/30/2008
			Spring 4											0.007	0.007	0.005	0.034	0.005	73	10/23/2001	4/30/2008
			Bridge Seep											0.005	0.005	0.005	0.010	0.001	22	3/1/2004	12/6/2004
			Bubbling Spring											0.006	0.006	0.005	0.018	0.003	70	10/23/2001	4/30/2008
			Spring 6											0.005	0.005	0.005	0.011	0.001	70	10/23/2001	4/30/2008
			Spring Run (mid)											0.006	0.006	0.005	0.016	0.003	17	5/28/2003	1/9/2006
			Spring Run (SR 484)											0.015	0.015	0.010	0.022	0.006	10	3/1/2004	12/6/2004
	NO2-N	mg/L	Main Boil							0.005	0.008	0.011	0.010		0.009	0.00	0.060	0.008	69	7/29/1968	9/2/1999
	NO3-N	mg/L	Main Boil						0.040	0.180	0.252	0.310			0.235	0.00	0.630	0.140	47	5/2/1956	6/11/1987
	NOx-N	mg/L	Main Boil								0.226	0.463	0.704		0.482	0.010	1.10	0.294	53	9/17/1974	9/2/1999
			Spring 1											1.44	1.44	0.013	2.10	0.328	78	10/23/2001	4/30/2008
			Spring 4											1.55	1.55	1.30	1.90	0.181	73	10/23/2001	4/30/2008
			Bridge Seep											1.06	1.06	0.980	1.20	0.068	22	3/1/2004	12/6/2004
			Bubbling Spring											1.32	1.32	1.10	1.60	0.147	70	10/23/2001	4/30/2008
			Spring 6											1.10	1.10	0.880	1.50	0.118	70	10/23/2001	4/30/2008
			Spring Run (mid)											1.19	1.19	1.10	1.32	0.049	17	5/28/2003	1/9/2006
			Spring Run (SR 484)											1.06	1.06	0.980	1.20	0.088	10	3/1/2004	12/6/2004
	NOx-N-D	mg/L	Spring 1											1.54	1.54	1.10	2.10	0.315	33	10/23/2001	4/30/2008
			Spring 4											1.58	1.58	1.30	1.90	0.187	33	10/23/2001	4/30/2008
			Bubbling Spring											1.32	1.32	0.00	1.60	0.286	32	10/23/2001	4/30/2008
			Spring 6											1.14	1.14	0.880	1.40	0.131	32	10/23/2001	4/30/2008
	OrgN	mg/L	Main Boil							0.043	0.112	0.128	0.355		0.135	0.00	0.490	0.140	40	9/19/1968	4/26/1994
	TKN	mg/L	Main Boil								0.106	0.155	0.237		0.172	0.010	0.500	0.116	52	9/17/1974	9/2/1999
			Spring 1											0.040	0.040	0.030	0.110	0.017	80	10/23/2001	4/30/2008
			Spring 4											0.037	0.037	0.030	0.093	0.013	74	10/23/2001	4/30/2008
			Bridge Seep											0.034	0.034	0.030	0.070	0.012	22	3/1/2004	12/6/2004
			Bubbling Spring											0.036	0.036	0.030	0.083	0.010	71	10/23/2001	4/30/2008
			Spring 6											0.036	0.036	0.030	0.075	0.009	71	10/23/2001	4/30/2008
			Spring Run (mid)											0.039	0.039	0.030	0.140	0.029	17	5/28/2003	1/9/2006
			Spring Run (SR 484)											0.083	0.083	0.060	0.120	0.023	10	3/1/2004	12/6/2004
	TKN-D	mg/L	Spring 1											0.039	0.039	0.030	0.075	0.013	34	10/23/2001	4/30/2008
			Spring 4											0.036	0.036	0.030	0.060	0.009	34	10/23/2001	4/30/2008
			Bubbling Spring											0.041	0.041	0.00	0.120	0.022	33	10/23/2001	4/30/2008
			Spring 6											0.039	0.039	0.030	0.075	0.013	33	10/23/2001	4/30/2008
	TN	mg/L	Main Boil							0.350	0.363	0.496	1.06		0.462	0.190	1.50	0.256	41	9/19/1968	4/26/1994
OXYGEN DEMAND	BOD5	mg/L	Main Boil							0.300	0.296	0.280			0.294	0.00	1.20	0.272	31	5/16/1969	8/10/1983
			Spring 1											0.871	0.871	0.100	1.00	0.340	7	10/23/2001	10/17/2006
			Spring 4											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
			Bubbling Spring											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
			Spring 6											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
	cBOD5	mg/L	Spring 1											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
			Spring 4											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
			Bridge Seep											0.396	0.396	0.100	1.00	0.363	22	3/1/2004	12/6/2004
			Bubbling Spring											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
			Spring 6											0.100	0.100	0.100	0.100		1	10/23/2001	10/23/2001
			Spring Run (mid)										2.00	0.414	0.613	0.100	2.00	0.837	16	3/16/1998	11/1/2004
			Spring Run (SR 484)											0.386	0.386	0.200	0.760	0.208	10	3/1/2004	12/6/2004

TABLE 3 (CONTINUED)
Rainbow Springs water quality table for the period-of-record continued.

PARAMETER GROUP	PARAMETER	UNITS	STATION	Decade											POR Statistics					Period of Record	
				1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Average	Min	Max	StDev	N		
PHOSPHORUS	OrthoP	mg/L	Main Boil							0.018	0.030	0.031	0.028		0.028	0.00	0.060	0.009	73	3/21/1963	9/2/1999
			Spring 1											0.028	0.028	0.022	0.034	0.003	55	10/23/2001	4/30/2008
			Spring 4											0.033	0.033	0.028	0.041	0.003	55	10/23/2001	4/30/2008
			Bridge Seep											0.030	0.030	0.030	0.031	0.0004	22	3/1/2004	12/6/2004
			Bubbling Spring											0.036	0.036	0.030	0.040	0.002	53	10/23/2001	4/30/2008
			Spring 6											0.028	0.028	0.022	0.036	0.003	53	10/23/2001	4/30/2008
			Spring Run (mid)											0.031	0.031	0.030	0.032	0.0009	13	5/28/2003	11/1/2004
			Spring Run (SR 484)											0.032	0.032	0.026	0.040	0.005	10	3/1/2004	12/6/2004
	PO4-T	mg/L as PO4	Main Boil							0.053	0.108				0.073	0.00	0.190	0.055	14	3/21/1963	9/17/1971
	TDP	mg/L	Spring 1											0.029	0.029	0.024	0.046	0.004	33	10/23/2001	4/30/2008
			Spring 4											0.033	0.033	0.028	0.041	0.003	33	10/23/2001	4/30/2008
			Bubbling Spring											0.037	0.037	0.030	0.047	0.004	32	10/23/2001	4/30/2008
			Spring 6											0.030	0.030	0.025	0.043	0.003	32	10/23/2001	4/30/2008
	TP	mg/L	Main Boil							0.022	0.033	0.044	0.035		0.036	0.010	0.110	0.017	70	7/29/1968	9/2/1999
			Spring 1											0.035	0.035	0.010	0.380	0.040	79	10/23/2001	4/30/2008
			Spring 4											0.113	0.113	0.029	2.50	0.383	73	10/23/2001	4/30/2008
			Bridge Seep											0.030	0.030	0.010	0.050	0.015	22	3/1/2004	12/6/2004
			Bubbling Spring											0.037	0.037	0.031	0.050	0.004	70	10/23/2001	4/30/2008
			Spring 6											0.030	0.030	0.025	0.043	0.003	70	10/23/2001	4/30/2008
			Spring Run (mid)											0.032	0.032	0.00	0.070	0.010	71	9/8/2002	3/23/2006
			Spring Run (SR 484)											0.043	0.043	0.00	0.080	0.017	50	9/8/2002	3/24/2006
PHYSICAL	Color	CPU	Main Boil						13.0	4.00	2.46	3.42	5.00		3.54	0.00	75.0	7.01	128	5/2/1956	9/2/1999
			Spring 1											1.57	1.57	0.00	10.0	2.51	27	10/23/2001	10/24/2006
			Spring 4											1.19	1.19	0.00	10.0	2.69	21	10/23/2001	10/24/2006
			Bridge Seep											2.73	2.73	2.50	5.00	0.736	22	3/1/2004	12/6/2004
			Bubbling Spring											1.25	1.25	0.00	10.0	2.75	20	10/23/2001	10/24/2006
			Spring 6											0.500	0.500	0.00	5.00	1.54	20	10/23/2001	10/24/2006
			Spring Run (mid)										5.00	3.55	3.69	0.00	10.0	2.03	21	3/16/1998	1/9/2006
			Spring Run (SR 484)											6.00	6.00	5.00	10.0	2.11	10	3/1/2004	12/6/2004
	Depth	m	Spring 1											3.15	3.15	2.00	4.30	0.708	14	10/23/2001	10/24/2006
			Spring 4											3.50	3.50	2.60	4.50	0.539	11	10/23/2001	10/24/2006
			Bridge Seep											1.88	1.88	1.00	3.00	0.433	26	3/1/2004	12/6/2004
			Bubbling Spring											0.955	0.955	0.700	1.30	0.185	11	10/23/2001	10/24/2006
			Spring 6											5.35	5.35	4.80	6.30	0.443	11	10/23/2001	10/24/2006
			Spring Run (mid)										1.50	1.67	1.64	0.200	5.40	1.15	23	3/16/1998	12/12/2006
			Spring Run (SR 484)											0.833	0.833	0.500	1.50	0.350	12	3/1/2004	12/15/2004
	ORP	mV	Spring 1											313	313	252	374	86.7	2	1/23/2002	4/15/2002
			Spring 4											317	317	257	378	85.4	2	1/23/2002	4/15/2002
			Bubbling Spring											329	329	267	390	86.7	2	1/23/2002	4/15/2002
			Spring 6											333	333	271	395	87.0	2	1/23/2002	4/15/2002

TABLE 3 (CONTINUED)
Rainbow Springs water quality table for the period-of-record continued.

				Decade											POR Statistics						
PARAMETER GROUP	PARAMETER	UNITS	STATION	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Average	Min	Max	StDev	N	Period of Record	
PHYSICAL	pH	SU	Main Boil						7.40	7.42	7.99	7.96	7.73		7.84	5.80	9.00	0.564	138	5/2/1956	9/2/1999
			Spring 1											8.05	8.05	7.50	8.70	0.222	59	10/23/2001	4/30/2008
			Spring 4											7.58	7.58	7.30	8.18	0.172	55	10/23/2001	4/30/2008
			Bridge Seep											8.20	8.20	6.93	8.53	0.386	26	3/1/2004	12/6/2004
			Bubbling Spring											7.36	7.36	7.10	7.96	0.163	55	10/23/2001	4/30/2008
			Spring 6											7.49	7.49	7.20	7.75	0.160	55	10/23/2001	4/30/2008
			Spring Run (mid)										7.35	7.80	7.74	7.33	8.20	0.233	33	3/16/1998	12/12/2006
			Spring Run (SR 484)											7.81	7.81	7.66	8.10	0.208	12	3/1/2004	12/15/2004
	Secchi	m	Spring 1											3.05	3.05	1.90	4.30	0.836	36	10/23/2001	4/30/2008
			Spring 4											3.24	3.24	2.60	3.70	0.254	35	10/23/2001	4/30/2008
			Bridge Seep											1.74	1.74	0.200	3.00	0.626	26	3/1/2004	12/6/2004
			Bubbling Spring											0.977	0.977	0.300	2.20	0.306	35	10/23/2001	4/30/2008
			Spring 6											5.21	5.21	4.30	5.90	0.350	35	10/23/2001	4/30/2008
			Spring Run (mid)										1.50	1.72	1.69	0.00	5.40	1.23	25	3/16/1998	12/12/2006
			Spring Run (SR 484)											0.833	0.833	0.500	1.50	0.350	12	3/1/2004	12/15/2004
	SpCond	umhos/cm	Main Boil						253	150	132	143	150		144	60.0	328	40.3	202	5/2/1956	9/2/1999
			Spring 1											151	151	133	173	9.41	114	10/23/2001	4/30/2008
			Spring 4											253	253	160	276	12.8	110	10/23/2001	4/30/2008
			Bridge Seep											141	141	129	184	14.9	26	3/1/2004	12/6/2004
			Bubbling Spring											335	335	314	366	10.8	108	10/23/2001	4/30/2008
			Spring 6											324	324	234	369	29.2	111	10/23/2001	4/30/2008
			Spring Run (mid)										230	1,444	1,301	225	35,624	6,065	34	3/16/1998	12/12/2006
			Spring Run (SR 484)											263	263	258	269	3.89	12	3/1/2004	12/15/2004
	Turb	NTU	Main Boil							2.50	0.578	0.464			0.617	0.00	4.00	0.695	60	7/16/1969	7/31/1987
			Spring 1											0.091	0.091	0.025	0.600	0.077	61	10/23/2001	4/30/2008
			Spring 4											0.151	0.151	0.025	1.60	0.291	55	10/23/2001	4/30/2008
			Bridge Seep											0.159	0.159	0.050	0.400	0.100	22	3/1/2004	12/6/2004
			Bubbling Spring											0.103	0.103	0.025	0.300	0.062	53	10/23/2001	4/30/2008
			Spring 6											0.092	0.092	0.025	0.400	0.069	53	10/23/2001	4/30/2008
			Spring Run (mid)										0.200	0.214	0.213	0.100	1.00	0.199	21	3/16/1998	1/9/2006
			Spring Run (SR 484)											0.320	0.320	0.200	0.500	0.118	10	3/1/2004	12/6/2004
SOLID	TDS	mg/L	Main Boil						148	87.9	80.4	80.7	84.1		83.1	39.0	160	23.3	120	5/2/1956	9/2/1999
			Spring 1											81.7	81.7	2.50	102	13.3	61	10/23/2001	4/30/2008
			Spring 4											137	137	127	156	5.66	55	10/23/2001	4/30/2008
			Bridge Seep											80.7	80.7	70.0	97.0	7.73	22	3/1/2004	12/6/2004
			Bubbling Spring											182	182	155	200	8.80	53	10/23/2001	4/30/2008
			Spring 6											185	185	125	215	20.5	53	10/23/2001	4/30/2008
			Spring Run (mid)											146	146	135	164	6.87	13	5/28/2003	11/1/2004
			Spring Run (SR 484)											149	149	139	168	10.5	10	3/1/2004	12/6/2004
	TSS	mg/L	Spring 1											2.05	2.05	2.00	2.50	0.150	61	10/23/2001	4/30/2008
			Spring 4											2.07	2.07	2.00	4.00	0.378	55	10/23/2001	4/30/2008
			Bridge Seep											2.00	2.00	2.00	2.00	0.00	22	3/1/2004	12/6/2004
			Bubbling Spring											2.00	2.00	2.00	2.00	0.00	53	10/23/2001	4/30/2008
			Spring 6											2.00	2.00	2.00	2.00	0.00	53	10/23/2001	4/30/2008
			Spring Run (mid)										1.00	1.87	1.76	1.00	2.00	0.437	17	3/16/1998	11/1/2004
			Spring Run (SR 484)											4.00	4.00	4.00	4.00	0.00	10	3/1/2004	12/6/2004
TEMPERATURE	Air Temp	C	Main Boil									31.2			31.2	31.2	31.2		1	4/13/1989	4/13/1989
	Wtr Temp	C	Main Boil							23.4	23.2	23.2	23.2		23.3	20.0	25.5	0.635	178	11/9/1960	9/2/1999
			Spring 1											23.3	23.3	20.0	24.2	0.543	62	10/23/2001	4/30/2008
			Spring 4											23.1	23.1	20.2	23.8	0.535	58	10/23/2001	4/30/2008
			Bridge Seep											23.5	23.5	23.1	26.2	0.813	26	3/1/2004	12/6/2004
			Bubbling Spring											22.9	22.9	22.0	23.5	0.279	56	10/23/2001	4/30/2008
			Spring 6											23.5	23.5	22.2	26.0	0.604	60	10/23/2001	4/30/2008
			Spring Run (mid)										22.5	22.9	22.9	19.1	23.9	0.866	33	3/16/1998	12/12/2006
			Spring Run (SR 484)											22.1	22.1	19.0	23.7	1.64	12	3/1/2004	12/15/2004

Rainbow Springs has experienced a significant increase in nitrate concentrations over the past four decades (SWFWMD 2008). Nitrate concentrations (NO_3 as N) measured from the main pool during May 1974 were 0.16 mg/L (Rosenau *et al.* 1977). Recent nitrate concentrations at the Rainbow Springs complex are consistently above 1.6 mg/L, and on several occasions approaching 2.0 mg/L (SWFWMD 2008). Water samples (spring pool) collected by the SWFWMD Water Quality Monitoring Program from 1994 to 2008 illustrate this trend of increasing nitrate concentrations (**Figure 12**).

The source of nitrates delivered to the Rainbow Springs and River has been investigated by Jones *et al.* (1996) and inorganic fertilizer (via agricultural application) was implicated as the dominant source. Current sources of nitrate loading also include residential and golf course fertilizers as well as septic systems due to current land use (SWFWMD 2004). To date, SWFWMD monitoring has not detected any priority pollutants (*e.g.*, cyanide, mercury, heavy metals, pesticides, and volatile organic compounds) from spring vent samples (SWFWMD 2008).

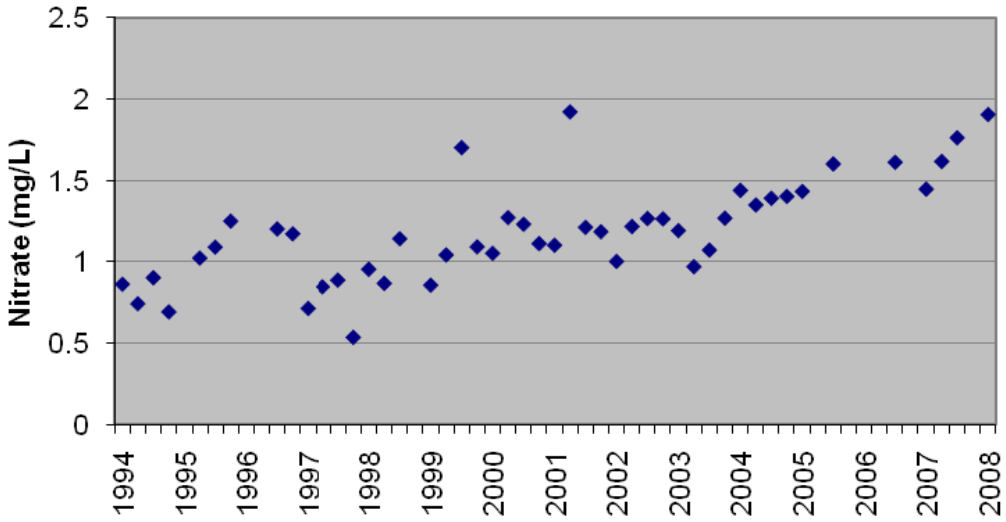


FIGURE 12
Rainbow Springs (RS#1) nitrate time series graph from 1994 to 2008 (from SWFWMD 2004).

During site reconnaissance of Rainbow Springs on the morning of August 13, 2008, field parameters were measured from the spring run starting at the State Park canoe launch and continuing downstream for approximately 3.5 km of the spring run (**Figure 13**). Temperature along the sampling path gradually increased with distance downstream and averaged about 23 ° C (**Figure 14**). Specific conductance was approximately 275 µS/cm along the spring run, with variation noted about certain spring vents (**Figure 14**). Dissolved oxygen concentrations increased with distance downstream to a maximum observed approximately 6 mg/L (70 % saturated, **Figure 14**). Field measured pH values from the spring run were about 7.5 standard units (**Figure 14**). Trends in field parameters along the spring run were masked due to the number of feeder springs, each with variable inputs.

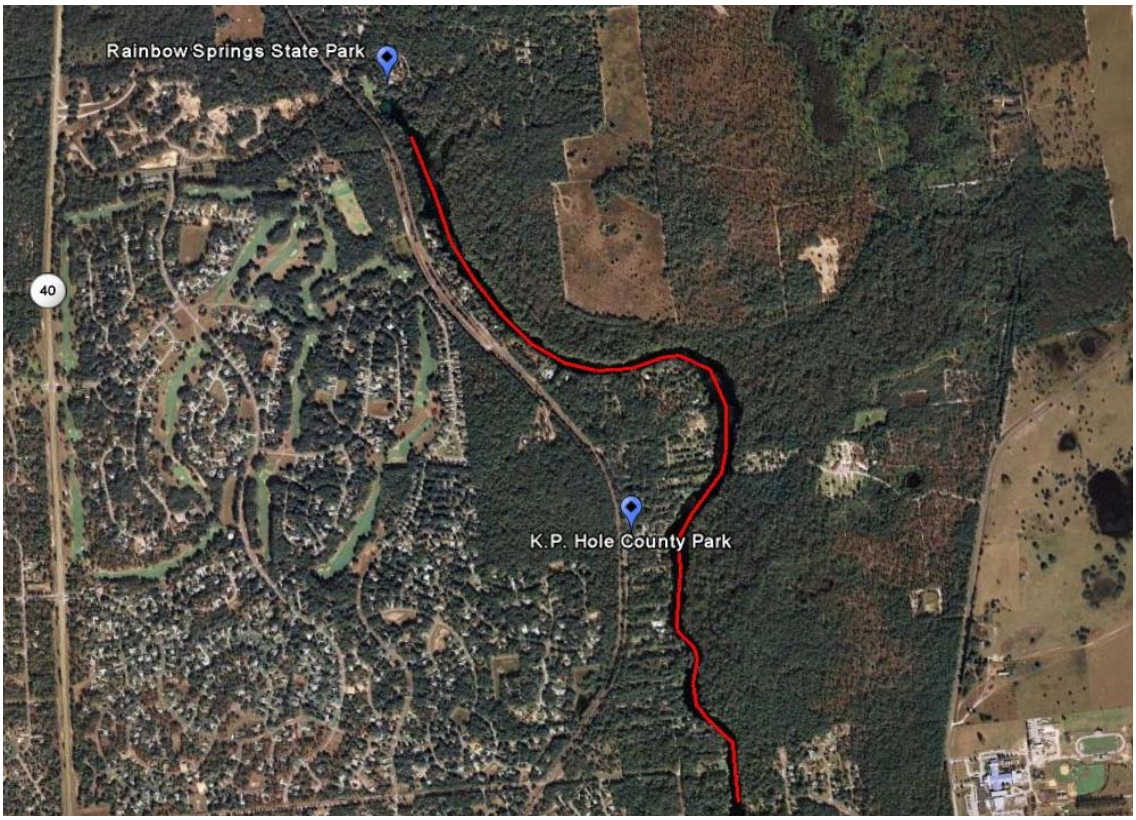


FIGURE 13
Image of Rainbow Springs with red path indicating the reconnaissance sampling locations on August 13, 2008.

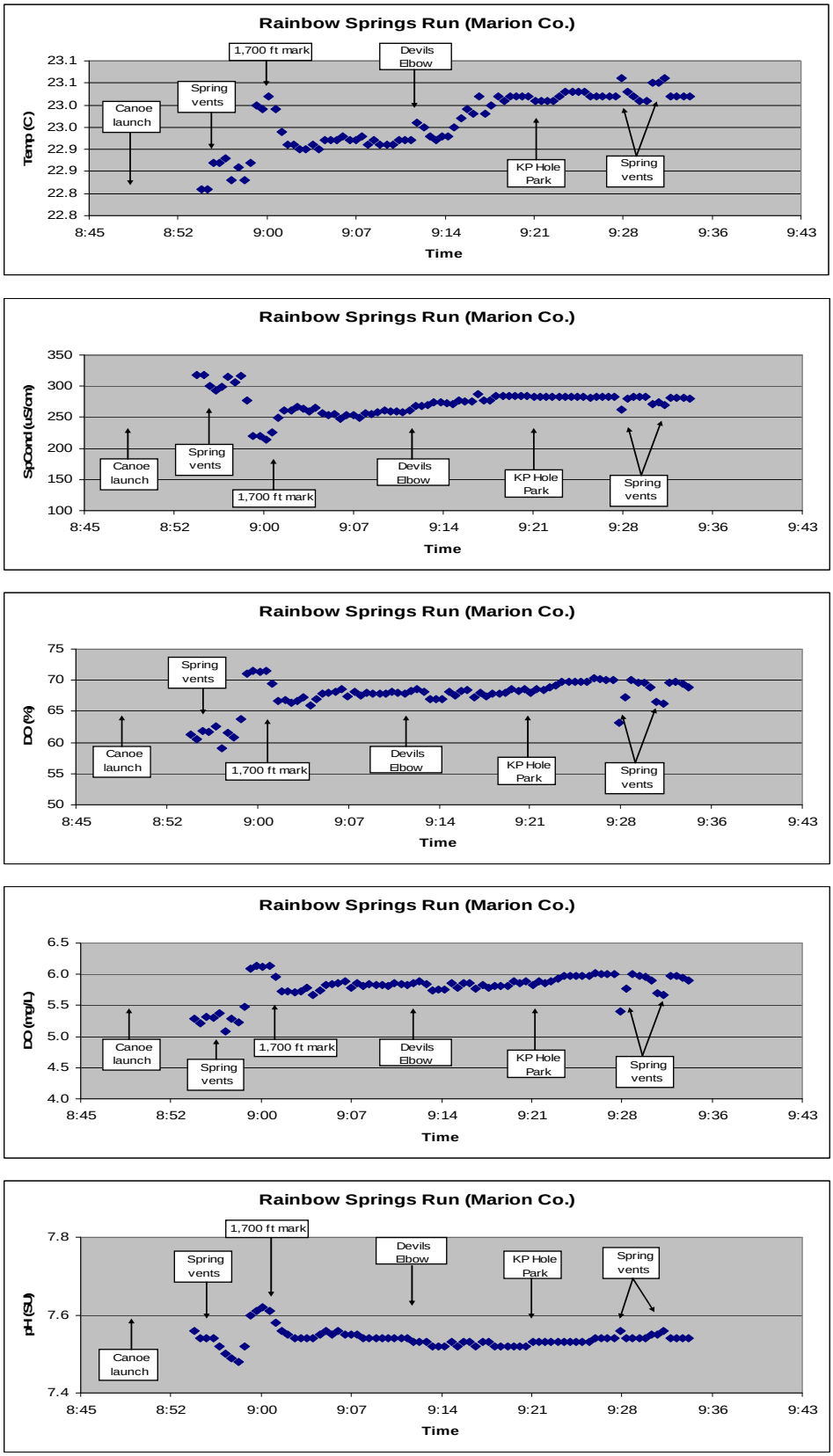


FIGURE 14
Field parameters measured at Rainbow Springs run on August 13, 2008.

Biological

Vegetation

During a reconnaissance trip made on August 13, 2008, the submersed aquatic vegetation (SAV) of the spring pool and upper 1.5 km (0.9 mi) of the spring run were qualitatively noted. Within the Rainbow Springs pool, SAV was confined to areas outside of the designated swimming zone, with strap-leaved sagittaria (*Sagittaria kurziana*) and Illinois pondweed (*Potamogeton illinoensis*) being the most common. Similarly, SAV was excluded in portions of the spring run, especially just below the aquatic preserve sign (1,700 m downstream), where recreational boats commonly anchor and in areas with rocky substrate. The percent area coverage of submersed aquatic vegetation was approximately 80 % in the upper 3.5 km (2.2 mi) of the spring run. SAV species in the spring run from most to least common were: strap-leaved sagittaria (*Sagittaria kurziana*), Illinois pondweed (*Potamogeton illinoensis*), tape grass (*Vallisneria americana*), bladderwort (*Utricularia sp.*), red ludwigia (*Ludwigia repens*), hydrilla (*Hydrilla verticillata*), and coontail (*Ceratophyllum demersum*). Hydrilla gradually becomes more common with distance downstream in this system. Benthic algae were observed growing on some sediments as well as small clumps of floating filamentous algae, but neither type of algae was abundant in the upper spring run. In the spring pool and upper spring run, emergent aquatic plants are common, with Egyptian paspalidium (*Paspalidium geminatum*) being the dominant species in these areas.

Rainbow River (downstream to Dunnellon) has been surveyed for submersed aquatic vegetation (SAV) in 1991, 1996, 2000, and 2005. For the 2005 survey, the primary objectives were to produce a GIS map of emergent and submerged aquatic vegetation and to conduct an analysis of change in SAV coverage relative to previous surveys (SWFWMD 2007). The project resulted in thorough and detailed distribution maps of SAV by species.

Findings from the 2005 SAV survey identified strap-leaved sagittaria, hydrilla, and tape grass as the three most common species in the Rainbow River (as well as for all mapping efforts in the previous 20 years); while coontail, southern naiad (*Najas guadalupensis*), and musk grass (*Chara sp*.) were observed to vary between the fourth and fifth most abundant species (SWFWMD 2007). The percent coverage of the most common SAV species, strap-leaved sagittaria, appears to have remained relatively constant during the 1996 to 2005 time period (0.3% change); while the other common species have all slightly increased coverage: hydrilla (2.6%), tape grass (1.6%), and southern naiad (1.6%, **Table 4**). The areas of bare substrate in the Rainbow River were also noted, and between the 1996 to 2005 time periods there was a decrease in bare substrate (2.9%, **Table 4**). In addition, other important landmarks along the Rainbow River during the 2005 sampling were noted: there were 238 docks on the river, 87 spring vents of varying size were identified, and of the 21.6 km (13.4 ac) of shoreline mapped, 18% was classified as hardened (SWFWMD 2007). Vegetation maps of the upper kilometer of the Rainbow Springs and River for 2005 for the four most common and the seven less common SAV species (as well as emergent vegetation and bare zones) are presented in **Figures 15** and **16**, respectively (from SWFWMD 2007). The SWFWMD (2007) vegetation report also contains detailed SAV maps for the Rainbow River (to Dunnellon) for each of the surveyed time periods as well as detailed change analyses and discussions by species between the 1996, 2000, and 2005 time periods.

Non-indigenous aquatic plants (primarily hydrilla) in Rainbow River have been managed by the state through a variety of herbicide applications. During the 2006-2007 fiscal period, 7.3 ha (18 ac) of floating aquatic plants and 17 ha (42 ac) of hydrilla were treated (FDEP 2007a). Based on the SAV mapping and change analyses completed through 2005, the SAV community

within the Rainbow River appears to be relatively stable and suggests that current management techniques are sufficient in controlling hydrilla abundance (SWFWMD 2008). The effort of FDEP personnel to reduce the abundance of hydrilla within the pool and upper spring run of Rainbow Springs appears to have been especially successful.

During April 4, and November 12, 2003 the filamentous algae community of Rainbow Springs was surveyed by Stevenson *et al.* (2007) who concluded that elevated nutrient concentrations were contributing to the abundance of filamentous algae observed. At the headsprings area, filamentous algae coverage was 40.7% with a thickness of 3.4 cm (1.3 in) in April and coverage was 24.7% with a thickness of 6.1 cm (2.4 in) in November. The average algal species percent cover during these sampling periods was 19.8% *Lyngbya sp.*, 8% diatoms, and 6.8% *Aphanothece sp*. (the tiny, ball-like structures observable in the swim area).

TABLE 4
The percent cover of SAV species and bare substrate in the Rainbow River during 1996, 2000, and 2005 surveys (from SWFWMD 2007).

SUBMERGED VEGETATION	1996 Percent Cover	2000 Percent Cover	2005 Percent Cover	96-'00 Change in % Cover	00-'05 Change in % Cover	96-'05 Change in % Cover
Ceratophyllum demersum	1.9%	1.1%	2.0%	-0.8%	0.9%	0.1%
Chara sp.	1.0%	1.5%	0.7%	0.5%	-0.8%	-0.3%
Hydrilla verticillata	16.2%	17.5%	18.8%	1.3%	1.3%	2.6%
Ludwigia repens	0.04%	0.05%	0.18%	0.01%	0.14%	0.14%
Myriophyllum sp.	0.01%	0.01%	0.01%	0.01%	-0.01%	0.00%
Najas quadalupensis	1.8%	0.7%	3.4%	-1.1%	2.7%	1.6%
Nasturtium sp.	0.002%	0%	0.01%	-0.002%	0%	0.00%
Potamogeton illinoensis	0.4%	0.5%	0.5%	0.1%	0.0%	0.1%
Sagittaria kurziana	35.7%	34.9%	35.4%	-0.8%	0.5%	-0.3%
Utricularia sp.	0.7%	0.1%	0.9%	-0.6%	0.8%	0.2%
Vallisneria americana	4.3%	4.1%	5.9%	-0.2%	1.8%	1.6%
Total bare substrate	7.6%	11.3%	4.7%	3.7%	-6.6%	-2.9%

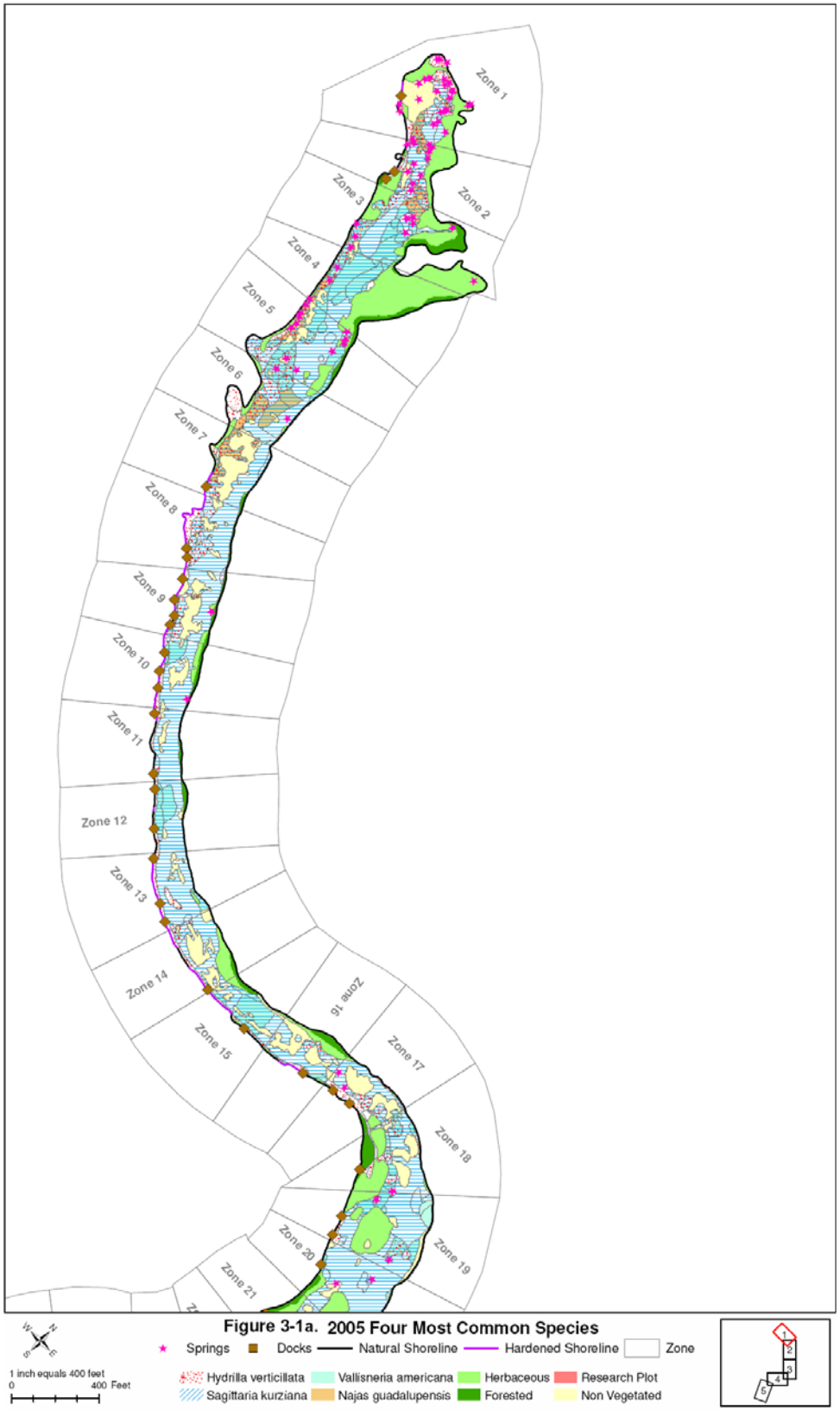


FIGURE 15
Map of 2005 vegetation for the four most common submersed species as well as emergent vegetation and bare zones (from SWFWMD 2007).

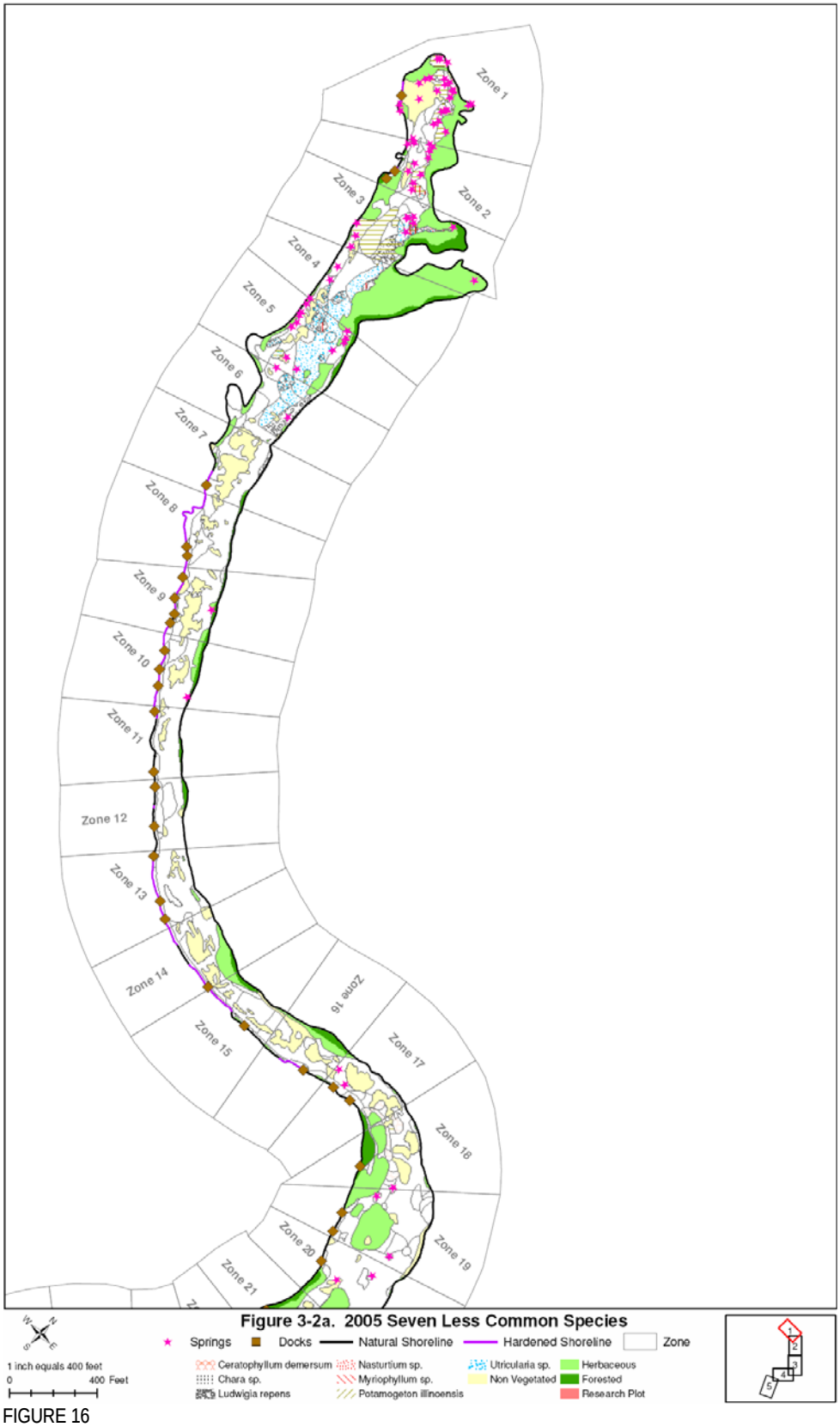


FIGURE 16
Map of 2005 vegetation for the seven less common submersed species as well as emergent vegetation and bare zones (from SWFWMD 2007).

Sediments

The sediments of Rainbow River have been characterized in terms of their importance to aquatic vegetation and nutrient cycling. Two comprehensive studies have been completed, the first conducted in 1990 by Water and Air Research (1991) focused on detecting heavy metals and organic toxins associated with the discharge of treated waste water effluent. The results of the study indicated that previous discharges by waste water treatment plants did not appear to have contributed to the deposition of heavy metals within the sediments and that the concentrations of all the organic toxins analyzed were below laboratory detection limits (Water and Air Research 1991).

The second investigation of Rainbow River sediments was completed in 2007 with the goal of delineating the type and distribution of the sediments within the Rainbow River (GARI 2007). Sediment types, sediment distribution, sources of sediment, and sediment biological communities were examined through the collection of 130 sediment cores along the river from the headspring complex to the confluence with the Withlacoochee River (**Figure 17**). Findings determined that Rainbow River was dominated by medium to fine sands although sediments in the lower portion of the river were nutrient enriched by phosphate containing soils and organic debris (GARI 2007). Organic and phosphorus enriched sediments may be correlated with the presence of hydrilla, both of which appear to increase in the lower Rainbow River (SWFWMD 2008).

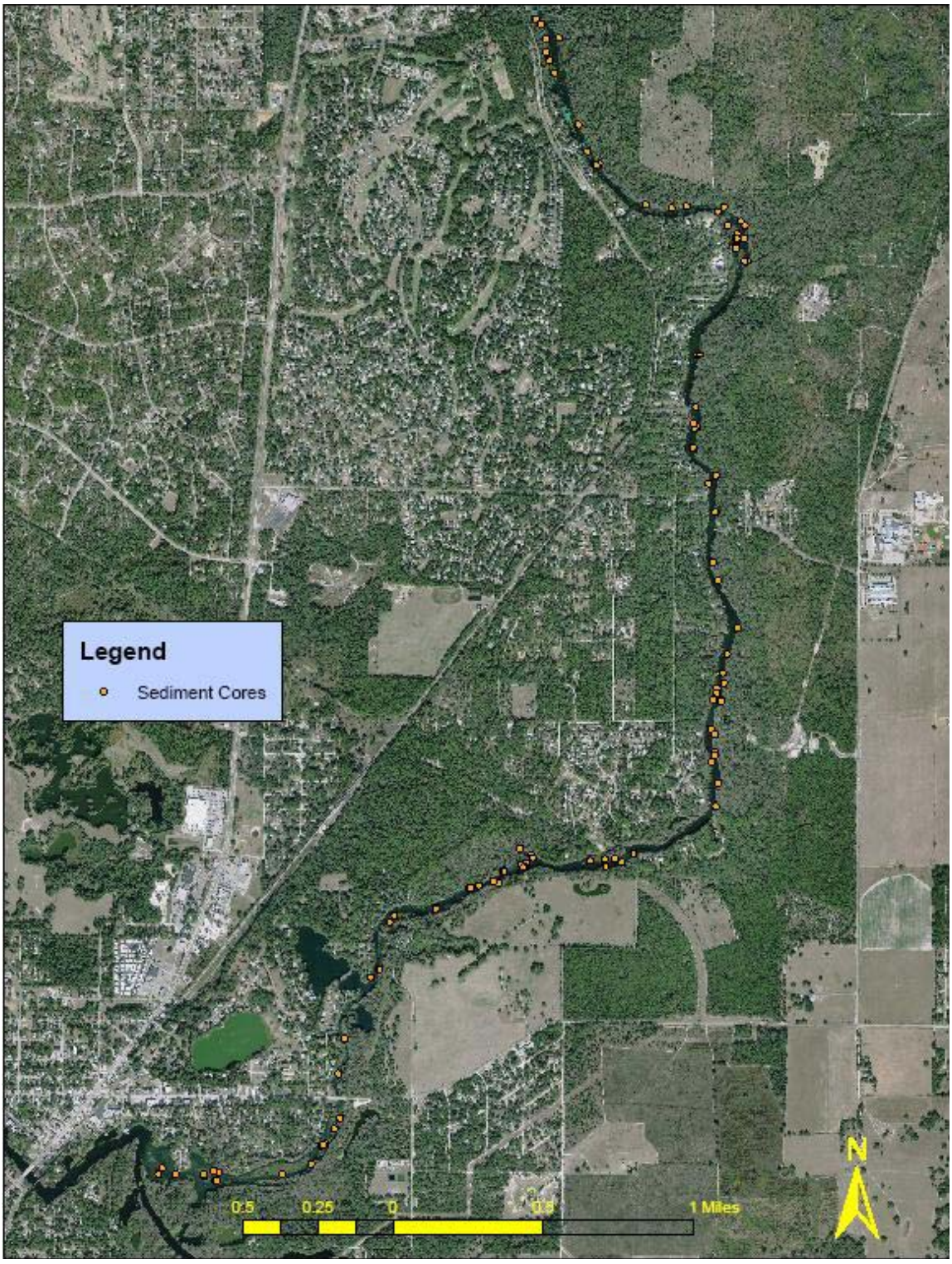


FIGURE 17
Map of benthic core locations used to characterize the sediments of Rainbow River (from SWFWMD 2008).

Macroinvertebrates

Several of the major springs surrounding the pool area were sampled for crustaceans on June 6, 2002 by staff from the Florida Museum of Natural History (Franz 2002). Crustaceans collected were the freshwater shrimp (*Palaemonetes paludosa*), amphipods (*Hyalella sp*.), and crayfish (*Procambarus fallax*). Other crayfish species which have been documented for Marion County, and therefore may inhabit the Rainbow Springs system, include: *Procambarus franzi, P. geodytes, P. lucifugus, P. paeninsulanus,* and *Troglocambarus maclanei* (Franz 2002).

Walsh and Williams (2003) surveyed mussels in the upper spring run (above KP Hole Park) at four locations, resulting in two species: an unidentified spike mussel (*Elliptio sp*.; 78%) and Florida pondhorn (*Uniomerus carolinianus*; 22 %). In the sampled locations, no specimens of the non-indigenous Asian clam (*Corbicula fluminea*) were observed or collected (Walsh and Williams 2003).

During the 2007 sediment survey of Rainbow River, mollusks collected in benthic cores were reported (GARI 2007). Seven species/types of mollusk were encountered from core samples (**Table 5**), with their relative abundance from most to least common being: quilted melania (*Tarebia granifera)*, banded mystery snail (*Viviparus georgianus)*, an unidentified spike (*Elliptio sp*.), Asian clam (*Corbicula fluminea)*, Mesa rams horn (*Planorbella scalaris)*, rams horn snails (Planorbidae), and apple snails (*Pomacea sp*.).

TABLE 5
The frequency of occurrence of mollusks collected from Rainbow River sediment cores during 2007 (from GARI 2007).

Rank Order*	Species	common name	status	cores context
1	*Tarebia granifera*	quilted melania	non-indigenous	multiple, sandy, rocky, detrital, grassy
2	*Viviparus georgianus*	banded mystery snail	native	multiple, sandy, detrital, grassy
3	*Elliptio sp.*	unidentified spike	native	multiple, sandy, rocky, detrital
4	*Corbicula fluminea*	Asian clam	non-indigenous	multiple, grassy, detrital
5	*Planorbella scalaris*	Mesa Rams-horn	native	multiple, grassy, detrital
6	*Planorbidae*	rams horn snails	native	multiple, grassy, detrital
7	*Pomacea sp.*	apple snails	native	multiple, grassy, detrital

** Rank order denotes frequency of occurrence from all cores, where 1 is the most common and 7 is the least common.*

There have been twelve assessments of the Rainbow Springs macroinvertebrate community (*i.e., EcoSummary*, FDEP 2000, 2001a, 2001b, 2002a, 2002b, 2003a, 2003b, 2004a, 2004b, 2005a, 2007b, and 2007c). The Rainbow River monitoring site is a 100 meter stretch located in the spring run, which begins approximately 100 meters south of the headspring. Over these sampling events, the habitat assessments were consistently in the optimal range, the total number of taxa collected ranged from 16 to 34, and the number of sensitive taxa ranged from one to 5 (**Figure 18**, FDEP 2008). Stream condition index (SCI) values greater than 21 were considered healthy, but after re-calibration in June 2004, values greater than 34 were rated as healthy. SCI values are typically rated as healthy in the system (**Figure 18**, FDEP 2008).

Macro fauna

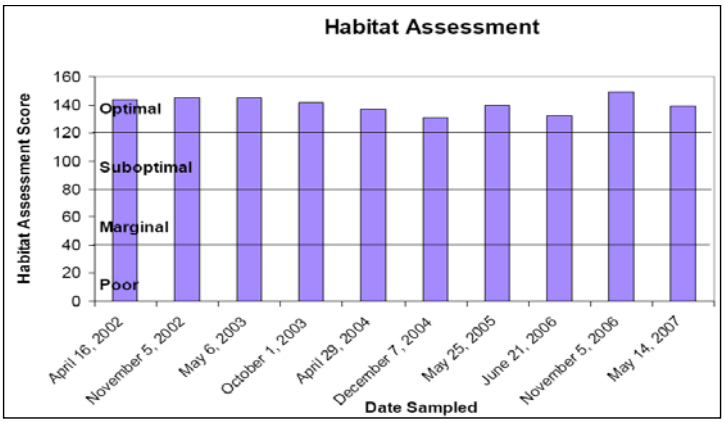
The aquatic turtle community of the Rainbow River is diverse, relatively abundant, and has a history of study including: Marchand 1942, 1945a, 1945b who provided observations of conditions in the early 1940s, Iverson (1977) for geographic variation of loggerhead musk turtles (*Sternotherus minor*), and Giovanetto (1992) who focused on the headsprings area. For one of the more common species, loggerhead musk turtles, the growth rates and age distributions of 482 individuals collected between 1990 and 1992 were reported by Onorata (1996). Results indicated that loggerhead musk turtles of five years age or less comprised approximately 65% of the population and that some of these turtles reach ages of 21 or more years Onorata (1996).

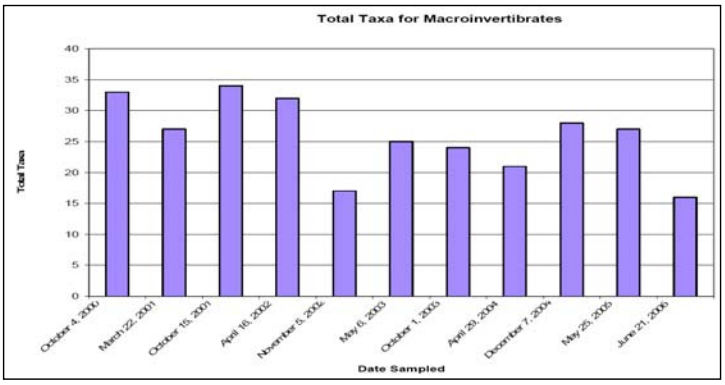
The most comprehensive study of Rainbow River turtles, with data spanning 1990 to 2003 has been conducted by Huestis and Meylan (2004, research continues to-date). Over this time period, 8 species of aquatic turtles have been collected, from most common to least: loggerhead musk turtle (*Sternotherus minor*), eastern river cooter (*Pseudemys concinna)*, Florida cooter (*Pseudemys floridana)*, common musk turtle (*Sternotherus odoratus)*, Florida red-bellied cooter

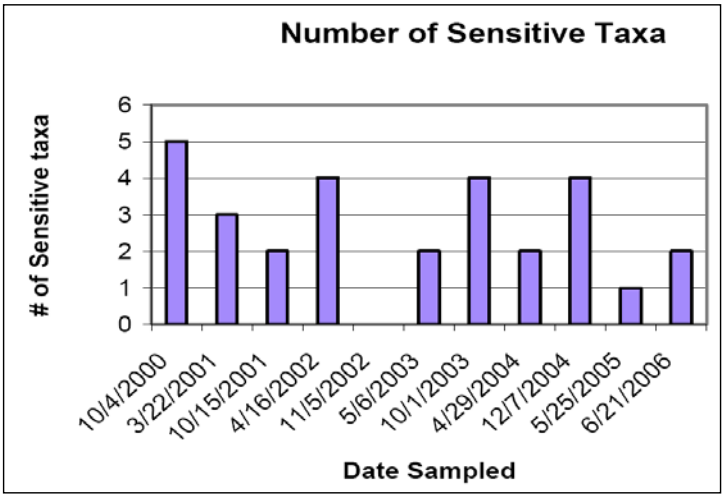
(*Pseudemys nelsoni)*, Florida softshell turtle (*Apalone ferox)*, striped mud turtle (*Kinosternon baurii)*, and chicken turtle (*Deirochelys reticularia*). Huestis and Meylan (2004) reported that there appeared to be a major shift towards smaller species (*e.g.*, musk turtles, **Figure 19**) in comparison to a survey made six decades earlier by Marchand (1942). Particular detail is given to the *Pseudemys sp*. as population estimates, growth rates, sexual dimorphism are described for this group of herbivorous basking turtles (Huestis and Meylan 2004).

During the August 2008 reconnaissance of Rainbow Springs, fish commonly observed included largemouth bass (*Micropterus salmoides*), several species of sunfish (*Lepomis*), and lake chubsucker (*Erimyzon sucetta*), less commonly observed were long nose gar (*Lepisosteus osseus*) and Atlantic Needlefish (*Strongylura marina*). While not observed during that trip, the non-indigenous sailfin catfish (*Pterygoplichthys disjunctivus*) has been observed and collected in limited numbers by park staff.

Rainbow Springs has been sampled for fish by Walsh and Williams (2003); and these researchers also summarized the Florida Museum of Natural History (FLMNH) fish collections. Based on their review of museum data, a total of 19 species of 15 genera and 7 families of fishes had previously been collected. Utilizing electrofishing techniques, Walsh and Williams (2003) collected a total of 20 species of 16 genera and 10 families from the upper spring run area. Electrofishing results of the most common families in descending order of relative abundance were: Poeciliidae (3 species; 39.4%), Centrarchidae (5 species; 24.3%), Fundulidae (2 species; 13.8%), Atherinopsidae (2 species; 8.2%), and Cyprinidae (2 species; 7.7%). Walsh and Williams (2003) noted that fish biomass was dominated by centrarchids and relatively few specimens of lake chubsucker and gizzard shad. A listing of fish species for Rainbow Springs is provided Table 6 (from Walsh and Williams 2003).







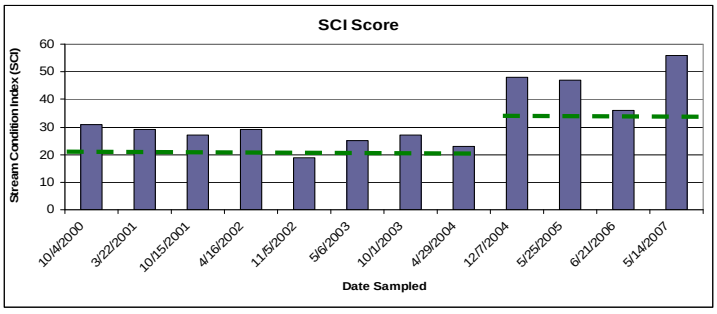


FIGURE 18
Rainbow Springs habitat assessment, total number of macroinvertebrate taxa, number of sensitive invertebrate taxa, and stream condition index (SCI) values (from FDEP 2008).

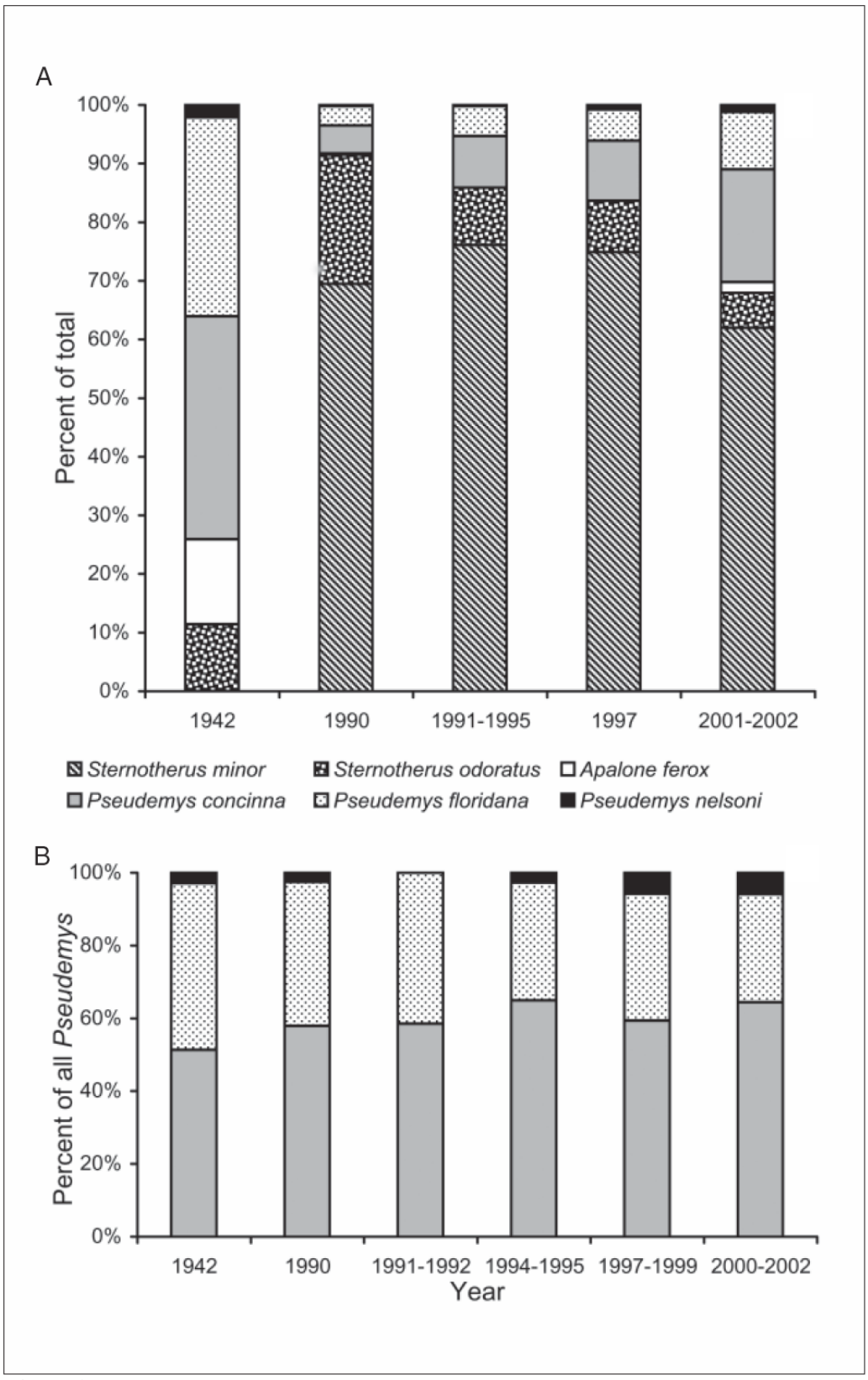


FIGURE 19
Community structure of turtles in Rainbow River, with relative abundance of all turtle species (A) and only Pseudemys sp. (B), rare species not shown (from Huestis and Meylan 2004).

TABLE 6
Fishes collected in Rainbow Springs State Park (number of specimens and relative abundance), and material in the FLMNH ichthyologic collection, including historical specimens from the spring run (number of specimens and percent of material), (from (Walsh and Williams 2003).

Family	Species	USGS		FLMNH Material	
		N	Relative Abundance (%)	Specimens	%
Lepisosteidae	*Lepisosteus platyrhincus*	2	0.5	---	---
Amiidae	*Amia calva*	1	0.3	---	---
Clupeidae	*Dorosoma cepedianum*	10	2.6	---	---
Cyprinidae	*Notemigonus chrysoleucas*	---	---	2	0.3
	Notropis harperi	24	6.1	334	43.3
	Notropis petersoni	6	1.5	6	0.8
Catostomidae	*Erimyzon sucetta*	11	2.8	---	---
Ictaluridae	*Ameiurus natalis*	1	0.3	1	0.1
	Noturus gyrinus	1	0.3	2	0.3
Atherinopsidae	*Labidesthes sicculus*	25	6.4	48	6.2
	Menidia beryllina	7	1.8	26	3.4
Fundulidae	*Fundulus seminolis*	25	6.4	15	1.9
	Jordanella floridae	---	---	1	0.1
	Lucania goodei	29	7.4	208	27.0
Poeciliidae	*Gambusia holbrooki*	115	29.4	18	2.3
	Heterandria formosa	19	4.9	15	1.9
	Poecilia latipinna	20	5.1	36	4.7
Centrarchidae	*Lepomis auritus*	20	5.1	11	1.4
	Lepomis macrochirus	17	4.3	3	0.4
	Lepomis microlophus	2	0.5	1	0.1
	Lepomis punctatus	31	7.9	14	1.8
	Micropterus salmoides	25	6.4	21	2.7
Elassomatidae	*Elassoma okefenokee*	---	---	9	1.2
	Total number of species	**20**		**19**	
	Total number of specimens	**391**		**771**	

Manatees

Although manatee fossils have been recovered from the Withlacoochee River and Rainbow Springs (Laist and Reynolds 2005), the utilization of Rainbow Springs and Rainbow River by manatees is precluded due to downstream barriers on the Withlacoochee River which prevent access. The Withlacoochee River was dammed in the 1920's to provide electric power; and as part of the Cross Florida Barge Canal project, a lock, dam, and bypass facilities were constructed in the town of Inglis during the 1960's and subsequently abandoned in the 1970's (FDEP 2005b). The lock is currently not functional and has not been operational since 1999, eliminating manatee access to the Rainbow River (FDEP 2005b).

A single modern report of a manatee occurrence in the Rainbow River has been reported from December 1976 (Powell and Rathbun 1984, Beeler and O'Shea 1988); presumably this manatee would have traveled through the Inglis lock on the Withlacoochee River to access Lake Rousseau and then Rainbow River. There has been one known manatee mortality at the Inglis lock on July 8, 1986 (Taylor 2006, from FWC manatee mortality database).

Ecosystem Functions

Based on field parameters (temperature, conductance, dissolved oxygen, and pH) measured in the spring pool and spring run during the reconnaissance trip of August 13, 2008, this spring is suitable for measuring ecosystem metabolism based on changes in dissolved oxygen following discharge from the spring vent. The FDEP deployed recording data sondes during August 10 to 24, 2004 at two stations (headsprings and state park sign at 1,700 m). These data revealed diel oxygen curve patterns, however a lack of ancillary data (*e.g.*, spring discharge, water depth, plant depth, and light availability) prevent the accurate usage of these data to calculate primary production rates.

A historic primary productivity estimate of Rainbow Springs was made about 2.1 km downstream of the pool during the summer of 1955 (Odum 1957). Results of that study, indicated gross primary production to be 23.9 g $O_2/m^2/d$. Although a relatively high production value, it was consistent with other spring systems given the amount of available light (Odum 1957).

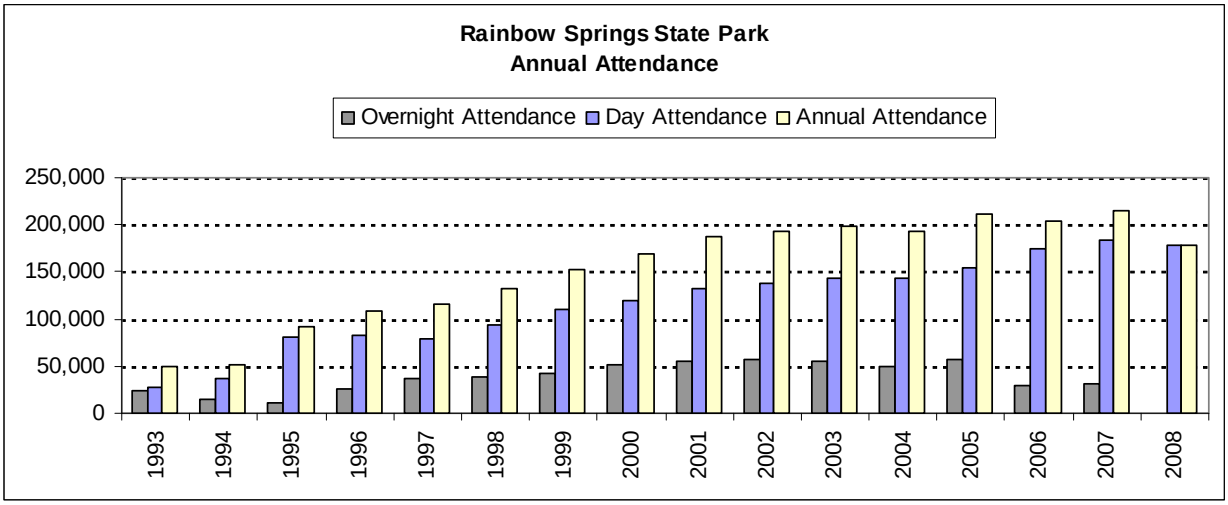
Human-Use Attendance and Activities

Recreational activities at Rainbow Springs include swimming, tubing, canoeing and kayaking, picnicking, and camping. As a state park, complete annual statistics of human attendance are available between 1993 and 2008. Peak total annual attendance occurred in 2007 (slightly more than 215 thousand people) and peak season use occurs in summer months (**Figure 20**).

Rainbow River is also utilized for recreation through the KP Hole Park (Marion Co.) as a tube, canoe and kayak rental site as well as a boat launch point. Recreational boating is popular along the river, and a Marion County ordinance (No. 88-7) has established an idle speed zone along its entire length (SWFWMD 2004).

Minimum Flows and Levels

The SWFWMD is currently in the process of establishing a minimum flow for the Rainbow River with plans for adoption sometime in 2009 (SWFWMD 2008).



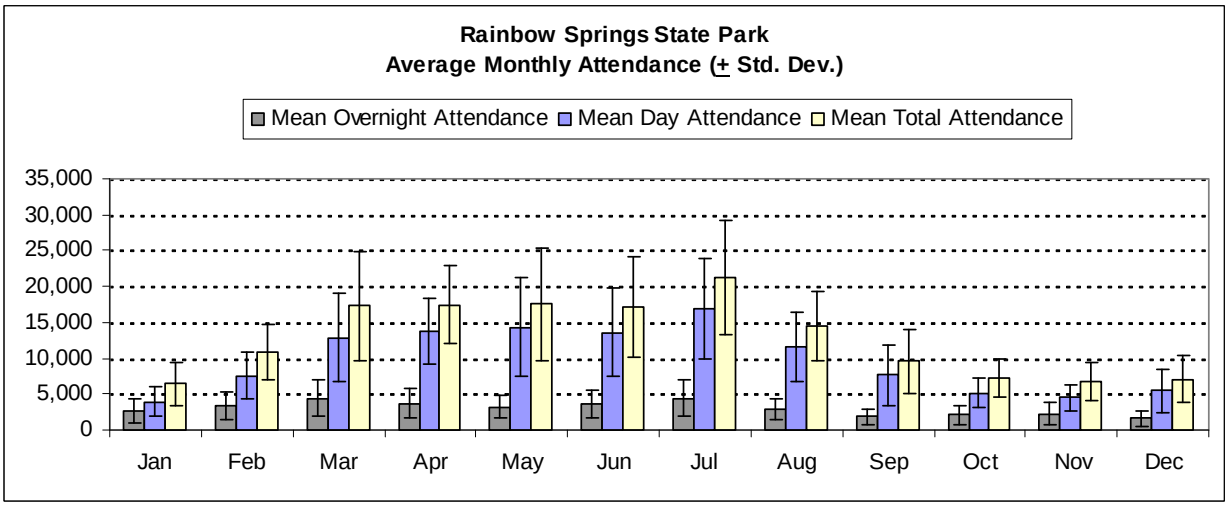


FIGURE 20
Rainbow Springs State Park annual and monthly attendance data.

Literature Cited

Beeler, I.E. and T.J. O'Shea. 1988. Distribution and mortality of the West Indian manatee (*Trichechus manatus*) in the Southeastern United States: A compilation and review of recent information. National Ecology Research Center Report No. 88-09. 2 Vol. 613 pp.

Champion, K.M. and R Starks. 2001. The Hydrology and Water Quality of Select Springs in the Southwest Florida Water Management District. Southwest Florida Water Management District. Brooksville, Fl. Final Report. 164 pp.

Faulkner, G. L. 1973. Geohydrology of the cross-Florida barge canal area with special reference to the Ocala vicinity. U.S. Geological Survey Water-Resources Investigations Report 1-73. 125 pp.

Florida Department of Environmental Protection (FDEP). 2000. EcoSummary Rainbow Springs. October 4, 2000. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2001a. EcoSummary Rainbow Springs. March 22, 2001. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2001b. EcoSummary Rainbow Springs. October 15, 2001 and November 2, 2001. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2002a. EcoSummary Rainbow Springs. April 16, 2002. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2002b. EcoSummary Rainbow Springs. November 5, 2002. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2003a. EcoSummary Rainbow Springs. May 6, 2003. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2003b. EcoSummary Rainbow Springs. October 1, 2003. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2004a. EcoSummary Rainbow Springs. April 29, 2004. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2004b. EcoSummary Rainbow Springs. December 7, 2004. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2005a. EcoSummary Rainbow Springs. May 25, 2002. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2005b. Inglis Lock Review. Report No. IA-03-21-2005-128. Office of Greenways and Trails. Tallahassee, FL.

Florida Department of Environmental Protection (FDEP). 2007a. Status of the Aquatic Plant Maintenance Program in Florida Public Waters. Annual Report for Fiscal Year 2006 –

2007. Florida Department of Environmental Protection. Tallahassee, FL. From: http://www.myfwc.com/nonnatives/InvasivePlants/docs/Aquatic_06-07.pdf . Accessed December 2008.

Florida Department of Environmental Protection (FDEP). 2007b. EcoSummary Rainbow Springs. May 14, 2007. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2007c. EcoSummary Rainbow Springs. November 1, 2007. Tallahassee, FL. 1 pp.

Florida Department of Environmental Protection (FDEP). 2008. Monitoring Report for Eighteen State and Federally Managed Spring Systems in Florida- Year 2000 to 2007. Florida Department of Environmental Protection, Environmental Assessment Section. Tallahassee, FL. 158 pp.

Florida Fish and Wildlife Conservation Commission (FWC). Florida Wildlife Research Institute Manatee Mortality Database 1974-2009. St. Petersburg, FL. From: http://research.myfwc.com/manatees/search_summary.asp . Accessed July 2009.

Florida Geologic Survey (FGS). 2007. Florida Springsheds. Geographical information system data file. Department of Environmental Protection/Florida Geological Survey. Tallahassee, Florida.

Foose, D. 2000. The Digital Drainage Basin Map for Florida Streams – History. Florida Department of Environmental Protection, Tallahassee, FL.

Franz, R. 2002. Crustacean Surveys in Spring Habitats of Seventeen Florida State Parks. Florida Museum of Natural History, University of Florida. Gainesville, Fl. Prepared for the Florida Department of Environmental Protection. Tallahassee, Fl. 12 pp.

Gulf Archaeology Research Institute (GARI). 2007. Rainbow River Sediment Study. 5990 N. Tallahassee Road, Crystal River, Florida 34428. 335 pp.

Giovanetto, L.A. 1992. Population ecology and relative abundance of sympatric freshwater turtles in the headwaters of two spring–fed rivers in western peninsular Florida. Ph.D. Dissertation, Florida Institute of Technology, Melbourne, FL.

Iverson, J.B. 1977. Geographic variation in the Musk Turtle, *Sternotherus minor*. Copeia 1977:502–517.

Huestis, D.L. and P.A. Meylan. 2004. The Turtles of Rainbow Run (Marion County, Florida): Observations on the Genus *Pseudemys*. Southeastern Naturalist. 3(4): 595–612.

Jones, G.W., S.B. Upchurch, and K.M. Champion. 1996. Origin of Nitrate in Ground Water Discharging from Rainbow Springs, Marion County, Florida. Technical Report. Southwest Florida Water Management District, Brooksville, FL. 155 pp.

Laist, D.W. and J.E. Reynolds. 2005. Influence of power plants and other warm-water refuges on Florida manatees. Marine Mammal Science 21(4):739-764.

MacNeil, F.S. 1950. Pleistocene Shore Lines in Florida and Georgia. U.S. Geological Survey. Professional Paper 22 1 -F. U.S. Geological Survey, Washington, D.C.

Marchand, L.J. 1942. A contribution to the knowledge of the natural history of certain freshwater turtles. M.S. thesis, University of Florida, Gainesville, FL.

Marchand, L.J. 1945a. Water goggling: A new method for the study of turtles. Copeia 1945: 37–40.

Marchand, L.J. 1945b. The individual range of some Florida turtles. Copeia. 1945: 75–77.

Onorata, D. 1996. The Growth Rate and Age Distribution of *Sternotherus minor* at Rainbow Run, Florida. Journal of Herpetology. Vol. 30(3): 301-306.

Powell, J.A. and G.B. Rathbun. 1984. Distribution and abundance of manatees along the northern coast of the Gulf of Mexico. Northeast Gulf Science. 7(1): 1-28.

Rosenau, J.C., G.L. Faulkner, C.W. Hendry Jr., and R.W. Hull. 1977. Springs of Florida. Bulletin 31 (revised). Division of Resource Management, Bureau of Geology, Florida Department of Natural Resources. Tallahassee, Florida. 461 pp.

Scott, T.M., Campbell, K.M., Rupert, F.R., Arthur, J.D., Missimer, T.M., Lloyd, J.M., Yon, J.W., and Duncan, J.G., 2001, Geologic map of the State of Florida: Florida Geological Survey Map Series 146, 1 map sheet. [Accessed 12/2008] http://www.dep.state.fl.us/geology/gisdatamaps/index.htm.

Scott, T.M., G.H. Means, R.C. Means, and R.P. Meegan. 2002. First magnitude springs of Florida. Open File Report No. 85. Florida Geological Survey. Tallahassee, Fl. 138 pp.

Seaber, P.R., F.P. Kapinos, and G.L. Knapp. 1987. Hydrologic Unit Maps. U.S. Geological Survey, Water-Supply Paper 2294.

Southwest Florida Water Management District (SWFWMD). 1987. Ground Water Resource Availability Inventory: Marion County, Florida. SWFWMD, Brooksville, Florida.

Southwest Florida Water Management District (SWFWMD). 2004. Rainbow River Surface Water Improvement and Management (SWIM) Plan. SWFWMD, Tampa, Florida. 72 pp.

Southwest Florida Water Management District (SWFWMD). 2007. Rainbow River 2005 Vegetation Mapping and Evaluation Report. SWFWMD SWIM Project #W419. Prepared by PBS&J (Tampa, FL) and Debra Childs Woithe, Inc. (Palmetto, FL). 117 pp.

Southwest Florida Water Management District (SWFWMD). 2008. Rainbow River Technical Summary. Brooksville, Florida. 25 pp.

Stevenson, R.J., A. Pinowska, A. Albertin and J.O. Sickman. 2007. Ecological condition of algae and nutrients in Florida Springs. The Synthesis Report WM 858 Florida Department of Environmental Protection, Tallahassee, Florida. 58 pp.

STORET. 2008. Florida Department of Environmental Protection STORET website: http://www.dep.state.fl.us/water/storet/ . Accessed December 2008.

Taylor, C.R. 2006. A Survey of Florida Springs to Determine Accessibility to Florida Manatees: Developing a Sustainable Thermal Network. Prepared for the U.S. Marine Mammal Commission by Wildlife Trust. St. Petersburg, FL. 66 pp.

United States Geological Survey (USGS). 2009. Florida Integrated Science Center (FISC).Water Resources Division. From: http://fl.water.usgs.gov/ . Accessed June 2009.

United States Geological Survey (USGS). 2008. Water-Data Report 2008. 02313100 Rainbow River at Dunnellon, FL. From: http://wdr.water.usgs.gov/wy2008/pdfs/02313100.2008.pdf . Accessed June 2009.

Walsh, S.J. and J.D. Williams. 2003. Inventory of Fishes and Mussels in Springs and Spring Effluents of North-Central Florida State parks. Final Report submitted to the Florida Park Service. Prepared by the U.S. Geological Survey, Gainesville, Florida. 94 pp.

Water and Air Research (WAR). 1991. Diagnostic Studies of the Rainbow River. Prepared for the Southwest Florida Water Management District. Brooksville, Florida. 329 pp.

White, W.A. 1970. The geomorphology of the Florida peninsula. Florida Department of Natural Resources, Bureau of Geology, Geological Bulletin 51, 164 pp.