DOCUMENTATION TO SUPPORT LISTING OF

NUTRIENT IMPAIRED SPRINGS AND SPRING RUNS

(Volusia Blue Spring and Volusia Blue Spring Run; DeLeon Spring; Jackson Blue Spring and Merritts Mill Pond; Silver Springs, Silver Springs Group and Upper Silver River, Rainbow Springs Group and Rainbow Springs Group Run; and Weeki Wachee Spring and Weeki Wachee Spring Run)

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Richard Hicks , P. G.

Debra Harrington

Gary Maddox, P.G.

Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Protection Section (with assistance from the Springs Initiative, Watershed Assessment, and Environmental Assessment Sections and the Florida Geological Survey)

Overview

The springs and spring runs identified in **Table 1** meet the criteria of Chapter 62-303.350, Florida Administrative Code, as being impaired by nutrients. These waterbodies are recommended for listing as impaired during this cycle because of consistently elevated concentrations of nitrate (or nitrate+nitrite) and corresponding evidence of imbalance of flora and fauna in the spring basins and runs due to algal smothering. For this documentation effort, nitrate concentrations higher than 0.6 milligrams per liter (mg/L) are considered elevated.

Volusia Blue Spring/Volusia Blue Spring Run; DeLeon Spring; and Jackson Blue Spring/Merritts Mill Pond are in Group 2 Basins. Note that we have included Merritts Mill Pond, the receiving water from Jackson Blue Spring on our proposed list. This waterbody is the modified spring run of Jackson Blue and is receiving the bulk of the impact from the nitrate loading in the way of algal blooms and SAV overgrowth.

Silver Springs, Silver Springs Group and Silver River, Upper (Group 1) and Rainbow Springs, Rainbow Springs Group and Rainbow Springs Group Run (Group 4) are not due for evaluation this year but they have been proposed in past legislation for TMDL development due to ecological effects caused by excessive nutrients and are therefore recommended for listing at this time. The Silver River is the run of the Silver Springs Group springs and the upper segment of it has received the bulk of the ecological impacts due to nitrate loadings. In the same way, the Rainbow Springs Group Run, the upper segment of the Rainbow River, receives the ecological impact due to nitrate loading from the Rainbow Springs Group springs.

Weeki Wachee Spring and Weeki Wachee Spring Run (Group 5) are also not due for evaluation this year, but the Weeki Wachee spring basin and its run have well-documented extreme issues with algal smothering, has persistently high nitrate concentrations, and the spring is the centerpiece of a recently created state park.

Data and information used in this evaluation are from several sources. The Springs Initiative quarterly monitoring data from 2001 to 2008 comprises the bulk of the nitrate data used in the evaluation and biological assessment documents prepared by the FDEP Environmental Assessment Section (EAS), other published reports, and photographs were used to provide evidence of algal smothering.

The following paragraphs provide documentation for each of these springs or spring-related waterbodies and **Appendix A** contains additional documentation.

Table 1- Springs and Spring-Related Waterbodies to be Listed as Impaired By Nutrients

Basin	WBID	WBID Name	Documentation of Algal Smothering	Data for Spring Vents			
				Spring Vent	Median NO2+NO3 Concentration in Spring Vent (mg/L)	Total # Samples	# Samples > 0.6 mg/L for NO2+NO3
Middle St. Johns	28933	Volusia Blue Springs	Yes	Volusia Blue	0.51	113	**45**
	28933A	Volusia Blue Spring Run	Yes				
	2921A	DeLeon Spring	Yes	DeLeon Spring	0.84	79	**61**
Apalachicola-Chipola	180Z	Jackson Blue	Yes, by association with 180A	Jackson Blue	3.3	29	**29**
	180A	Merritts Mill Pond	Yes				
Ocklawaha	2772A	Silver Springs	Yes	Silver Main	1.1	34	**34**
	2772C	Silver Springs Group	Yes				
	2772E	Silver River Upper	Yes				
Withlacoochee	1320A	Rainbow Springs Group	Yes, by association with 1320B	Rainbow #6	1.01	40	**40**
	1320A	Rainbow Springs Group	Yes, by association with 1320B	Rainbow #1	1.3	40	**40**
	1320A	Rainbow Springs Group	Yes, by association with 1320B	Rainbow #4	1.4	40	**40**
	1320B	Rainbow Springs Group Run	Yes				
Springs Coast	1382B	Weeki Wachee Spring	Yes	Weeki Wachee	0.76	34	**34**
	1382F	Weeki Wachee Spring Run	Yes				

Notes:

NO2+NO3 concentrations based on all available in-house data for the most recent 7.5-year period of record.

Value in **RED** – Exceeds IWR Binomial Statistics Test based on 0.6 mg/L threshold (minimum 20 observations required)

Volusia Blue Spring (WBID 28933) and Volusia Blue Spring Run (28933A), Middle St. Johns Basin, Basin Group 2

Volusia Blue Spring and its run are the focal points of Blue Springs State Park, a famous winter-time haven for manatees. **Figure 1** is a photograph showing the spring vent and upper portion of the run.

Figure 1-Volusia Blue Spring (photograph by T. Scott, Florida Geological Survey)

Text describing the location and description of Volusia Blue Spring are excerpted from Scott et. al, 2004.

Location-Lat. 28°56' 50.94" N., Long. 81°20' 22.52" W. (N W ¼ NW ¼ NE ¼ sec. 8, T. 18 S., R. 30 E.). Volusia Blue Spring is 6 miles (9.7 km) southwest of Deland in Blue Spring State Park. From the junction of US 17/92 and SR 44 in Deland, travel 5.3 miles (8.5 km) south on US 17/92. Turn west (right) on CR 4142 (French Avenue) in Orange City and continue 2.5 miles (4.0 km) to Blue Spring State Park. Follow the park road to the spring parking area. The spring is at the head of Blue Spring Run about .25 miles (0.4 km) north of the parking area and is accessed by an elevated wooden boardwalk along the east bank of the spring run (excerpted from Scott et al, 2004).

Description-Volusia Blue Spring has a circular spring pool in a conical depression with a notable boil in the center. The spring pool measures 135 ft

(41.1 m) north to south and 105 ft (32 m) east to west. The depth of the spring measured over the vent is 20 ft (6.1 m). The bottom of the spring is limestone and sand. The vent is an elongated fissure in the limestone. The water is clear and blue with a greenish tinge. Algae are ubiquitous in the spring and its run. No other aquatic vegetation was observed during the October 2001 visit. The spring has steep sandy banks that rise to approximately 15 to 20 ft (4.6 to 6.1 m) above water level. The spring run also has steep sandy banks and flows south and west approximately 1,050 ft (320 m) to the St. Johns River through dense hardwood and palm forest. A limited underwater cave system has been mapped at Volusia Blue Spring (excerpted from Scott et al, 2004). Volusia Blue Spring is a historical first-magnitude spring, discharging >100 cubic feet per second (CFS).

Nitrate Concentrations-Volusia Blue Spring has been monitored quarterly by FDEP since 2001 and has previously been monitored by the St. Johns River Water Management District. Over the time period that it has been monitored under the Springs Initiative, nitrate concentrations (measured as nitrate+nitrite-nitrogen) have ranged from 0.4 to 1.1 milligrams per liter (mg/L), with a median concentration of 0.6 mg/L. Over the 7.5-year verified listing period of record the median nitrate+nitrite concentration was 0.51 and 40 percent of the samples exceeded 0.6 mg/L (**Table 1**). A plot of nitrate concentrations from the quarterly data from 2001 through the first quarter of 2008 is shown in **Figure 2**.

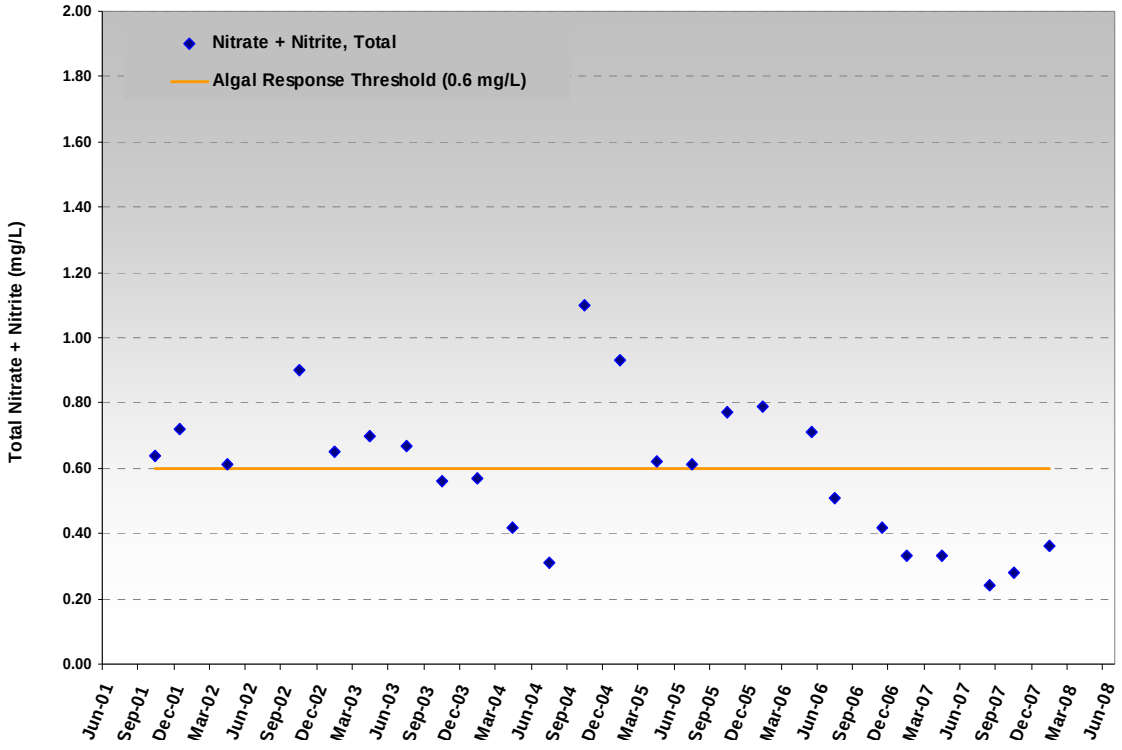

Figure 2- Nitrate+Nitrite Concentrations in Volusia Blue Spring from Springs Initiative Monitoring

Evidence of Algal Smothering-The EAS web site contains a total of 13 EcoSummaries for Volusia Blue Spring and its run that document findings of biological assessments at this spring and spring run. Of these, all of these assessments produced Stream Condition Index (SCI) scores indicative of very poor to poor conditions. Reports for 8 of the assessments specifically noted a low quality algal community containing a high percentage of blue-green algae, which was indicative of eutrophic conditions. Two assessments specifically linked the poor SCI score to algal smothering, while others stated that it was due to lack of habitat. In addition, 5 out of 9 habitat assessments conducted by the EAS, habitat scores were in the suboptimal range, with the lack of variety and availability of productive habitats and algal smothering being the main reasons (EAS, 2008).

Stevenson et al (2004) collected algal measurements from 57 spring locations using a 9-by-9-foot survey matrix that covered 300 meters of the spring runs. The biological measurements included macroalgae (algal mat thickness, algal mat coverage, and thickness of algae growing on aquatic plants [epiphytes]). Algal mat thickness in this study ranged from <1.6 centimeters (cm) to greater than 16 cm, epiphyte thickness ranged from 0 to >20 cm, and the percent algal mat coverage measured from 0 to 100 percent. Based on the ranges of these measurements, Hand (2008) incorporated these measurements into a ranking system based on quartiles which was incorporated into an overall assessment decision matrix based on algal measurements plus several chemical parameter medians. For Volusia Blue Spring Run, the macroalgae thickness was in the "high" range (50 to 75 percent) and the algal mat coverage was in the "very high" range (>75 percent coverage). The epiphyte thickness was in the "low" range <25 percent) because of the lack of aquatic plant growth in the run.

Photographic Evidence-See **Appendix A**.

References:

FDEP Environmental Assessment Section, February 2008. Monitoring Report for 18 State and Federally Managed Spring Systems in Florida Year 2000 to 2007.

FDEP Environmental Assessment Section reports web site:
http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp

Hand, J. February 2009. Florida Springs Assessment Decision Matrix. FDEP Watershed Assessment Section.

Scott, T. M., G. H. Means, R. P. Meegan, R. C. Means, S. B. Upchurch, R. E. Copeland, J. Jones, T. Roberts, and A. Willet. 2004. Springs of Florida. FGS Bulletin No. 66.

Stevenson, R. J., A. Pinowsska and Y. Wang, 2004. Ecological Conditions of Alga and Nutrients in Florida Springs: Report to the FDEP, Contract No. WM858.

DeLeon Spring (WBID 2921A), Middle St. Johns Basin, Basin Group 2

DeLeon Spring is the focal point of DeLeon Springs State Park. The spring basin is shown in **Figure 3**.

Figure 3-DeLeon Spring (photograph by T. Scott, Florida Geological Survey)

Text describing the location and description of DeLeon Spring are excerpted from Scott et. al, 2004.

Location– Lat. 29°08' 03.41" N., Long. 81°21' 45.89" W. (SW ¼ SE ¼ SW ¼ sec. 16, T. 16S., R. 29 E.). DeLeon Spring is located within DeLeon Springs State Park, 8 miles (13 km) northeast of Deland. From the junction of US 17 and US 92 in Deland, travel 5.9 miles (9.5 km) north on US 17. Turn west (left) on paved road marked by sign for DeLeon Springs State Park (Ponce DeLeon Boulevard) and travel 1.1 miles (1.8 km) to the park entrance (excerpted from Scott et al, 2004).

Description– DeLeon Spring is situated in a circular, conical depression measuring 189 ft (57.6 m) north to south and 168 ft (51.2 m) east to west. The maximum pool depth measures 28.0 ft (8.5 m) over the vent. The bottom is sand, except at the vent where some limestone is exposed. A single vent issues water

from the center of the pool. The water is clear with a light greenish color. There was a visible boil over the vent during January 2002. There are patches of algae on the bottom and suspended algal filaments and particles in the water. No other aquatic vegetation is present in the spring pool. A concrete wall with numerous access ladders and a concrete sidewalk encircle the spring pool. The spring outflow pours through a concrete weir on the west side of the spring pool, then down a 3 ft (0.9 m) drop into the wide, natural spring run. From here, the spring run flows approximately 0.25 miles (0.4 km) westward into Spring Garden Lake from the northeast. To the south and east of the spring, high ground gently slopes to approximately 6 to 8 ft (1.8 to 2.4 m) above the spring water level. To the north and west are swampy, forested lowlands of Lake Woodruff and the St. Johns River system. Surrounding land is developed and landscaped as part of the state park. Divers report a small underwater cave at DeLeon Spring (excerpted from Scott et al, 2004). DeLeon Spring is historically a second magnitude spring with discharges of between 20 and 30 CFS.

Nitrate Concentrations-DeLeon Spring has been monitored quarterly by FDEP since 2001. Over that time period, nitrate concentrations have ranged from 0.42 to 1.3 milligrams per liter (mg/L), with a median concentration of 0.795 mg/L. Over the 7.5-year verified listing period of record the median nitrate+nitrite concentration was 0.84 and 77 percent of the samples were higher than 0.6 mg/L (**Table 1**). A plot of nitrate+nitrite concentrations from the quarterly data is shown in **Figure 4**.

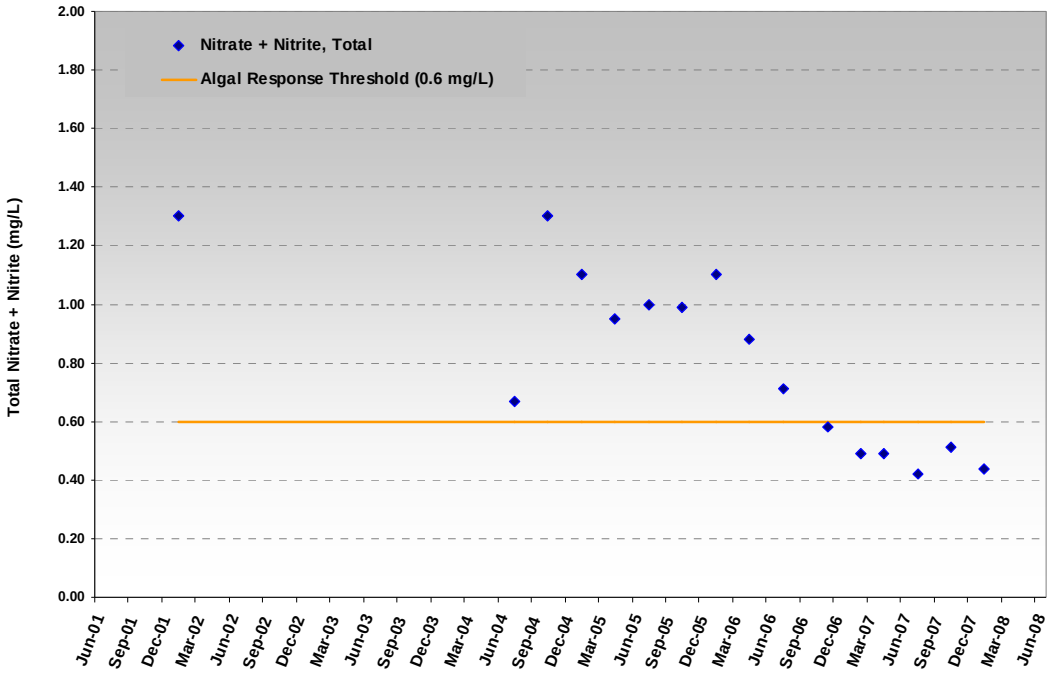

Figure 4- Nitrate+Nitrite Concentrations in DeLeon Spring from Springs Initiative Monitoring

Evidence of Algal Smothering-A total of 14 EcoSummaries have been prepared by the EAS for DeLeon Springs. Those from 2001 to 2003 specifically documented that algal smothering of the spring bottom as a persistent issue. No SCI surveys were conducted by EAS at this spring. The EAS monitoring report (EAS, 2008) provides information on water quality for this spring and general information on periphyton taxa diversity but does not include any other information on algal conditions.

Phelps et al (2006) noted that in a USGS study of select springs in the St. Johns River Water Management District that floating mats of Lyngbya wollei were observed in De Leon Spring during all sampling events in 2004 and Lyngbya was so pervasive that periphyton sampling was not possible. USGS did perform seasonal bioassessments at DeLeon Springs and found that it would have received a moderate SCI score overall for those dates.

Photographic Evidence-See **Appendix A**.

References:

FDEP Environmental Assessment Section, February 2008. Monitoring Report for 18 State and Federally Managed Spring Systems in Florida Year 200 to 2007.

FDEP Environmental Assessment Section reports web site: http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp

Phelps, G. G., S. J. Walsh, R. M. Gerwig, and W. B. Tate, 2006. Characterization of the Hydrology, Water Chemistry and Aquatic Communities of Selected Springs in the St. Johns River Water Management District, Florida, 2004. USGS OFR 2006-1107.

Scott, T. M., G. H. Means, R. P. Meegan, R. C. Means, S. B. Upchurch, R. E. Copeland, J. Jones, T. Roberts, and A. Willet. 2004. Springs of Florida. FGS Bulletin No. 66.

Jackson Blue Spring (WBID 180Z) and Merritts Mill Pond (WBID 180A), Apalachicola-Chipola Basin, Basin Group 2

Jackson Blue Spring (WBID 180Z) is one of the largest magnitude springs in the Florida panhandle and is the most significant spring in the Chipola River Basin. A aerial view of Jackson Blue Spring is shown in **Figure 5**. Jackson Blue Spring discharges to Merritts Mill Pond (WBID180A), which was once a free-flowing spring run. The northern end of Merritts Mill Pond is also shown in **Figure 5**.

Figure 5-Jackson Blue Spring and northern end of Merritts Mill Pond (photograph by T. Scott, Florida Geological Survey)

Text describing the location and description of Jackson Blue Spring are excerpted from Scott et. al, 2004.

Location—Lat. 30°47’ 25.85” N., Long. 85°08’ 24.31” W. (S W ¼ SE ¼ NW ¼ sec. 33, T. 5 N., R. 9 W.). Jackson Blue Spring is about 5 miles (8 km) east of Marianna at the northeast end of Merritts Mill Pond. From the intersection of US 90 and SR 73 in Marianna, head east 1.4 miles (2.3 km) on U.S. 90. Turn north (left) on SR 71 and travel 1.2 miles (1.9 km) to the intersection of SR 164. Turn east (right) and drive 3.3 miles (5.3 km) to the county park entrance on the south (right) side of the road. The spring is 0.1 mile (0.2 km) southeast of SR164 in a county park (excerpted from Scott et al, 2004).

Description-Numerous springs feed Merritts Mill Pond. Jackson Blue Spring is the main spring at the head of the pond. It is situated about 10 ft (3 m) west of the diving platform. Spring pool diameter is approximately 240 ft (73.2 m) southwest to northeast and 233 ft (71 m) northwest to southeast. Maximum depth over the vent is 16.5 ft (5 m). The vent is elliptical and approximately 5 ft (1.5 m) high and 25 feet (7.6 m) wide. Limestone is exposed near the vent, and it bears backhoe scars. Clear bluish water issues from the vent. A boil is slightly visible at the surface. There is approximately 40 percent algal coverage on the pool bottom and very little aquatic or emergent vegetation. The spring pool is a designated swimming area separated from Merritts Mill Pond by a chain link fence across the channel approximately 300 ft (91.4 m) downstream from the vent. The southern shore of the spring pool meets a lowland cypress-gum forest. The northern half of the pool is bordered by high ground sloping upward to nearly 20 ft (6.1 m) above water level. Most of the high ground is cleared and grassy. All nearby uplands are developed. There are buildings and a parking area constructed on the uplands. Surrounding the spring, are a concrete retaining wall near shore, slides, a diving board, and picnic tables. An extensive underwater cave system has been mapped at Jackson Blue Spring (excerpted from Scott et al, 2004). Jackson Blue Spring is a historical first-magnitude spring with discharges in excess of 100 CFS.

Nitrate Concentrations-Jackson Blue Spring has been monitored quarterly by FDEP since 2001 and has the highest nitrate concentration of all first magnitude springs in the state. Over the 2001 to 2008 monitoring period, nitrate+nitrite concentrations have ranged from 3 to 3.7 mg/L, with a median concentration of 3.3 mg/L. Over the verified listing period of record the median nitrate+nitrite concentration in Jackson Blue Spring was 3.3 and 100 percent of the samples exceeded the 0.6 mg/L threshold (**Table 1**). A plot of nitrate+nitrite concentrations from the quarterly data is shown in **Figure 6**.

Merritts Mill Pond has only two sampling episode's worth of data in the IWR database, with both sets collected in 1996. At that time, nitrate concentrations ranged from 0.85 to 1.48 mg/L. According to the EcoSummary prepared by the EAS for Merritts Mill Pond in 2002, the nitrate concentration was 1.8 mg/L. Because of its high discharge rate in comparison to the smaller springs in the pond and its very high nitrate concentration, Jackson Blue Spring is the main source of elevated nitrate in Merritts Mill Pond.

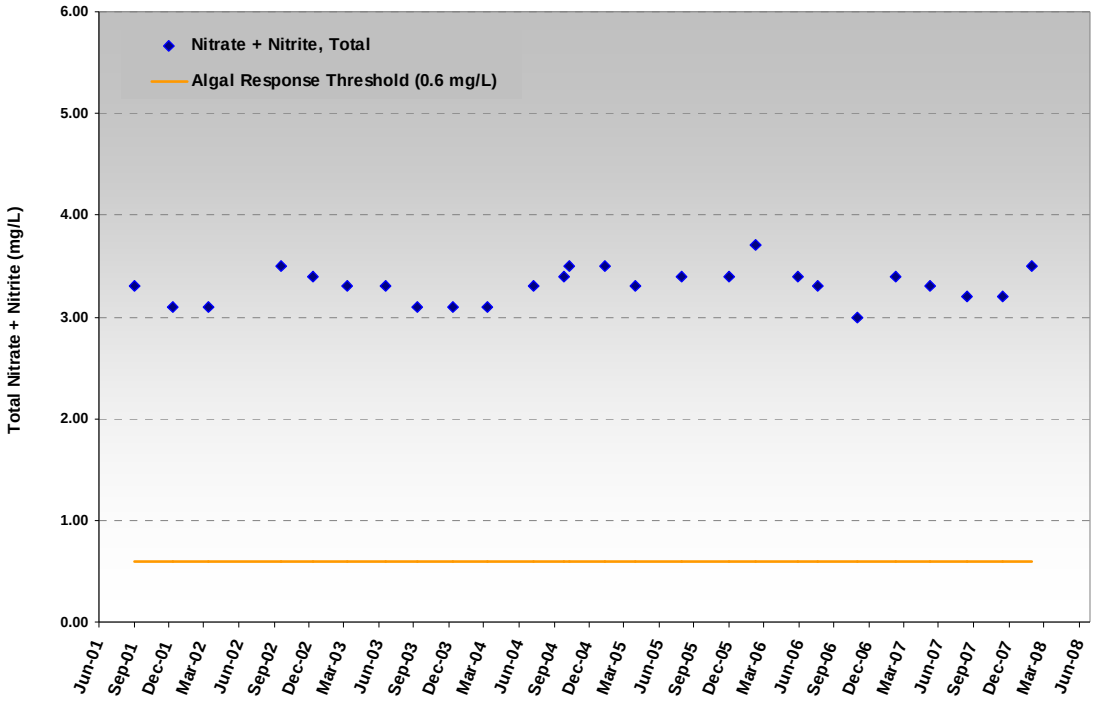

Figure 6- Nitrate+Nitrite Concentrations in Jackson Blue Spring from Springs Initiative Monitoring

Evidence of Algal Smothering- The ESA's 2002 EcoSummary for Jackson Blue Spring reports that algal accumulation was not found to be significant in the upper 100 meters of the spring run (Merritts Mill Pond), despite the excessive nitrate concentrations. However, other accounts indicate that algae is a problem in the spring basin as well as the run (Merritts Mill Pond). In the 2004 Springs of Florida publication, it was noted that there was approximately 40 percent algae coverage on the pool bottom and very little aquatic or emergent vegetation (Scott et al, 2004). Problems with algae as well as profuse overgrowth of aquatic vegetation commonly manifest themselves in Merritts Mill Pond. In the EcoSummary for Merritts Mill Pond, also in 2002, excessive submerged and floating algal mats were observed near the south end of the pond, indicating nutrient-induced imbalances of algal communities. There are also many anecdotal accounts of nuisance algae in the Mill Pond as well.

Jackson Blue Spring was included in the 57 spring locations surveyed by Stevenson et al (2004) and was included in the overall assessment of biological and chemical measurements performed by Hand (2008). Hand's assessment of Stevenson's data showed that for Jackson Blue Spring, the macroalgae thickness was in the "moderate" range (25 to 50 percent), epiphyte thickness was in the "moderate" range (25 to 50 percent) and the algal mat coverage was also in the "moderate" range (25 to 50 percent coverage). This survey included the spring run above Merritts Mill Pond.

Photographic Evidence-See **Appendix A**.

References:

FDEP Environmental Assessment Section reports web site:
http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp

Hand, J. February 2009. Florida Springs Assessment Decision Matrix. FDEP Watershed Assessment Section.

Scott, T. M., G. H. Means, R. P. Meegan, R. C. Means, S. B. Upchurch, R. E. Copeland, J. Jones, T. Roberts, and A. Willet. 2004. Springs of Florida. FGS Bulletin No. 66.

Stevenson, R. J., A. Pinowsska and Y. Wang, 2004. Ecological Conditions of Alga and Nutrients in Florida Springs: Report to the FDEP, Contract No. WM858.

Silver Springs (WBID 2772A), Silver Springs Group (WBID 2772C) and Silver River Upper (WBID 2772E), Oklawaha Basin, Basin Group 1

There are three major springs and multiple smaller, un-named springs contributing to the Silver Springs Group (**Figure 7**). Silver Spring Main (WBID 2772A) is the largest spring by volume in the group and the one with the most data. However, the other major springs and numerous smaller springs (in aggregate WBID 2772C) also contribute flow and nutrients to the system. The spring run for the Silver Springs Group is the upper Silver River (WBID 2772E).

Figure 7-Silver Springs Group, head springs of the Silver River (photograph by H. Means, Florida Geological Survey)

Text describing the location and description of the Silver Springs Group was excerpted from Scott et. al, 2004.

Group Location (excerpted from Scott et al, 2004)— Lat. 29°12' N. , 82°03' W. (sec. 6, T. 15 S., R. 23 E.). The Silver Springs Group is located approximately 6 miles (9.7 km) northeast of Ocala. From the intersection with US 301 and SR 40, drive east on SR 40 for 6.1 miles (9.8 km) to the Silver Springs theme park

entrance on the south side of SR 40. Turn onto the access road and continue 0.3 miles (0.5 km) to the parking area. The springs can also be accessed by water. Boats can be launched at a boat ramp on SR 40 at the west end of the bridge over the Oklawaha River approximately 4 miles (6.4 km) east of Silver Springs theme park.

Group Description (excerpted from Scott et al, 2004)- The Silver Springs Group, flowing from numerous vents, forms the headwaters of the Silver River, a major tributary of the Oklawaha River. There are numerous smaller springs in the bed or at the edges of the spring run within about 3,500 ft (1,066.8 m) of the main vent (Silver Main). The run is usually clear and the bottom at all locations in the springs and run is easily visible. The Silver River flows from its headspring eastward for approximately 5 miles (8 km) through a dense mixed hardwood and cypress swamp to the Oklawaha River. The Oklawaha River flows northward and is a tributary to the St. Johns River. Higher sandy terrain with pine and the Silver Springs community lie to the west of the springs.

MAIN SPRING - Lat. 29°12' 58.34" N., Long. 82°03' 09.47" W. (SW ¼ SW ¼ NW ¼ sec. 6, T. 15 S., R. 23 E.). The spring is in a steep-walled depression in the limestone. The main spring is approximately 200 ft (61 m) northeast of the glass-bottom boat loading area. This is the headspring of the Silver River and the largest spring of the group. The spring pool measures 300 ft (91.4 m) north to south and 195 ft (59.4 m) east to west. The depth measured over the vent opening is 33 ft (10.1 m). The vent opening is a horizontal oval-shaped orifice in the base of a limestone ledge on the northeast side of the spring pool. The bottom is sand with limestone pieces that have fallen from the walls. The water is clear and light blue. Aquatic vegetation is abundant across the spring bottom, and a layer of algae covers most substrates. There was no visible boil on the water surface during the October 2001 visit; however, divers observed flow coming out of the vent. Most of the pool edge is a wooden retaining wall. The west side of the pool is developed into the dock for the glass-bottom boat attraction. All nearby uplands to the north, west, and south are developed as parts of the Silver Springs theme park. An underwater cave system has been mapped at the Silver Springs Main Spring.

RECEPTION HALL - Lat. 29°12' 52.61" N., Long. 82° 03' 05.05" W. (NW ¼ NW ¼ SW ¼ sec. 6, T. 15 S., R. 23 E.). Reception Hall is now referred to as The Abyss by most theme park personnel. It is located on the south side of the Silver River approximately 1,000 ft (304.8 m) downstream from Main Spring. It is one of three side springs that form a larger, conjoined spring pool. Reception Hall Spring pool is approximately 30 ft (9.1 m) in diameter and 25 ft (7.6 m) deep. The bottom is sand with limestone exposed near and around the vent. Water discharges from a vertical crack in the limestone. The water is clear and light blue, and sand and shell particles are suspended in the spring flow. No boil was visible on the surface of the spring pool during October 2001. An old boat is wrecked and half buried on the north side of the pool. Aquatic vegetation is

common around the outskirts of the spring pool. The area near the vent is bare sand around the limestone orifice. Uplands to the south rise to nearly 6 ft (1.8 m) above the water and are forested with hardwoods. To the north, on the other side of the river, the land is developed by the theme park.

BLUE GROTTO - Lat. 29°12' 54.91" N., Long. 82°02' 59.59" W. (NE ¼ NW ¼ SW ¼ sec. 6, T. 15 S., R. 23 E.). Blue Grotto is the next spring pool east of the conjoined pool with Reception Hall. Blue Grotto is also on the adjacent south side of the Silver River. It is about 300 ft (91.4 m) east of Reception Hall Spring. The circular spring pool measures 105 ft (32 m) in diameter. The depth over the vent is 21.6 ft (6.6 m). Water discharges from a cavity in the limestone. Bare sand surrounds the orifice. Sand and shell particles are suspended in the upwelling. A boil is visible on the water surface. There is aquatic vegetation along the outskirts of the spring pool. During the October 2001 visit, a 10-12 ft (3-3.7 m) alligator was lying on the bottom near the vent with a dusting of sand and shell on its back. The water is clear and light blue. Along the south shore is a thin strip of hardwood and cypress trees. Just past the trees is a man-made spring channel called the Fort King Waterway. It flows parallel to the Silver River and eastward. South of this channel the land rises up to about 15 ft (4.6 m) above water surface. On these banks is an exotic animal zoo.

Utilization- (excerpted from Scott et al, 2004)—Land on the north side of the Silver River near the headspring is part of the Silver Springs theme park which is privately operated but owned by the state. Land on the south side of the Silver River is part of the Silver River State Park.

Nitrate Concentrations-Water quality at the Silver Springs Group has been monitored quarterly by FDEP since 2001. Over the monitoring period, nitrate+nitrite concentrations in Silver Main Spring have ranged from 0.91 to 1.4 mg/L, with a median concentration of 1.1 mg/L. Over the 7.5-year verified listing period of record the median nitrate+nitrite concentration for Silver Main was 1.1 mg/L and 100 percent of the samples exceeded 0.6 mg/L (**Table 1**). A plot of nitrate+nitrite concentrations in Silver Main from the Springs Initiative quarterly data is shown in **Figure 8**.

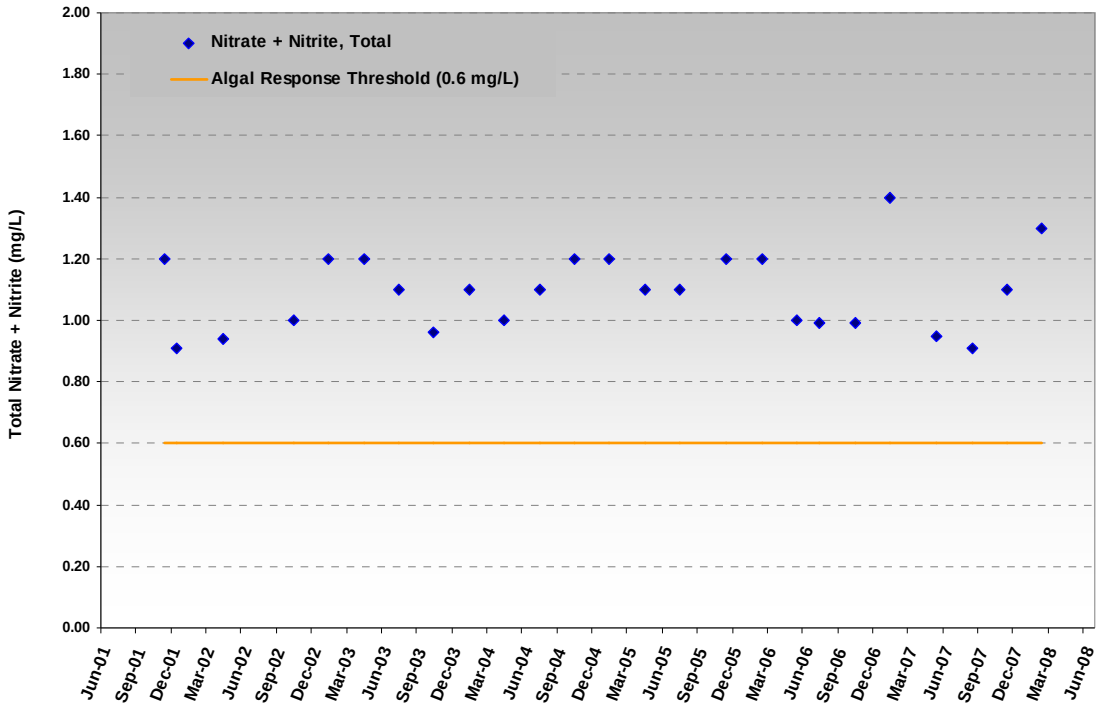

Figure 8- Nitrate+Nitrite Concentrations in Silver Main Spring from Springs Initiative Monitoring

Evidence of Algal Smothering-EcoSummaries for Silver Springs (including an upper segment of the Silver River) were prepared by the EAS from 2002 to 2007. Most of the surveys, and all documenting conditions between 2002 and 2005, noted the specific taxa of diatoms and blue green algae taxa present in the spring run as being indicators of eutrophic conditions related to elevated nitrate in the water column. Later reports, written in a slightly different format, did not discuss algae but did mention that that main stressor as being nitrate.

A 2006 Palm Beach Post article on the pollution threats to Silver Springs (Browning, 2006) documents algal growth smothering native eelgrass beds at the springs. Stevenson et al (2004) documented that the macroalgal cover in the spring run was about 70 percent in fall 2003, with 70 percent of the macroalgae being Lyngbya majuscule, a blue-green algae species.

In a survey of the aquatic communities in the Silver River in December 2003-January 2004 (Phillips and Allen, 2004 and Wetland Solutions, Inc., 2004) aquatic conditions were documented and compared to descriptions made in a survey by Odum (1957). They noted that the predominance of Lyngbya in the benthic algal assemblage was an important change in comparison to Odum's (1957) study, which did not find any Lyngbya. From this study (SJRWMD, 2006), Wetland Solutions, Inc. noted that algal blooms covered the submerged aquatic vegetation and that Lyngbya covered 100 percent of the substrate in some parts of the study area.

The research of Agnieszka and others (2007) indicates that the pattern of algal biomass in the Silver River is related to flooding, where the greatest abundance of algae is consistently near the main boil because areas downstream are periodically inundated by dark water.

Silver Springs (Silver Main) was included in the 57 spring locations surveyed by Stevenson et al (2004) and was included in the overall assessment of biological and chemical measurements performed by Hand (2008). Hand's assessment of Stevenson's data showed that for the Silver Spring Group, the macroalgae thickness was in the "moderate" range (25 to 50 percent), epiphyte thickness was in the "very high" range (>75 percent) and the algal mat coverage was in the "moderate" range (25 to 50 percent coverage).

Photographic Evidence-See **Appendix A**.

References:

Browning, M., April 15, 2006. Pollution threatens Florida landmark Silver Springs, in Palm Beach Post.

FDEP Environmental Assessment Section reports web site: http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp

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Rainbow Springs Group (WBID 1320A) and Rainbow Springs Group Run (WBID 1320B), Withlacoochee Basin, Basin Group 4

The Rainbow Springs Group consists of 4 named springs plus numerous other smaller spring vents (**Figure 9**). Only Rainbow Spring #1 (WBID 1320A) is included in the IWR database. The spring run for the Rainbow Springs Group, Blue Run (WBID 1320) in the IWR database, is the upper segment of the Rainbow River.

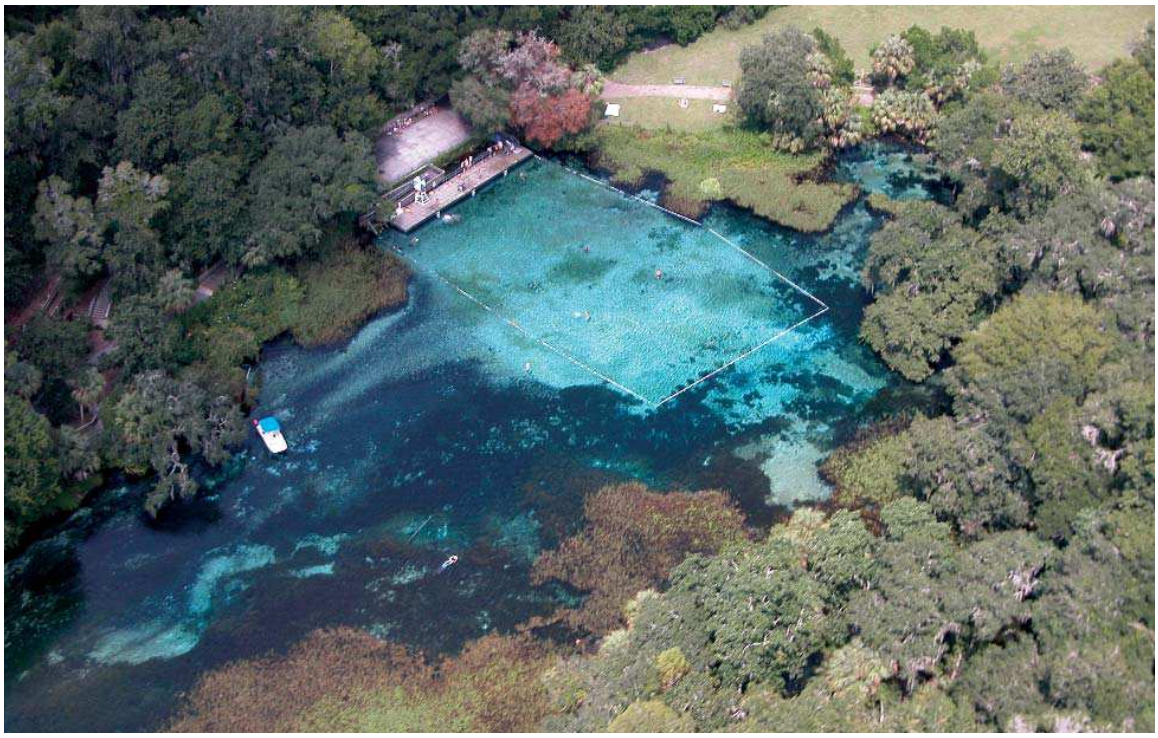

Figure 9-Rainbow Springs Group (photograph by H. Means, Florida Geological Survey)

Text describing the location, description and utilization of the Rainbow Springs Group was excerpted from Scott et. al, 2004.

Group Location (excerpted from Scott et al, 2004)— Lat. 29°06' N. , Long. 82° 26' W. (sections 7, 12, and 18, T. 16 S., R. 18 E.). The Rainbow Springs Group is approximately 3.5 miles (5.6 km) north of Dunnellon and forms the headwaters of the Rainbow River. From the intersection of US 41 and CR 484 in Dunnellon, drive north on US 41 approximately 3.7 miles (6 km) to a large sign on the east (right) side of the road indicating the entrance to the Rainbow Springs State Park, at 83rd Place Road. Turn east (right) onto 83rd Place Road and continue 0.8 miles (1.3 km) to the parking area near the head of the Rainbow River.

Group Description (excerpted from Scott et al, 2004)—Rainbow Springs Group forms the Rainbow River, which flows approximately 5.7 miles (9.2 km) south to the tannic Withlacoochee River. Surrounding land has high rolling sand hills with pine forest, agricultural fields and developed areas. Springs, in addition to those at and near the head of the Rainbow River, discharge from numerous limestone crevices and sand boils in the bed of the river and along the banks through the upper 2 miles (3.2 km).

RAINBOW NO. 1— Lat. 29°06' 08.91" N., Long. 82°26 ' 14.88" W. (SE ¼ NE ¼ SE ¼ sec. 12, T. 16 S., R. 18 E.). Rainbow No. 1 is at the head of the Rainbow River. The spring pool measures 330 ft (10.6 m) north to south and 360 ft (109.7 m) east to west. The large spring pool has multiple vents. The depth over the main vent is 9.9 ft (3 m). The bottom is sand with occasional limestone boulders. Water is clear and blue. A boil is visible over the main vent. Aquatic vegetation is patchy, including some exotic aquatic vegetation. Motorized boats are prohibited, but the area is accessible by canoe or kayak. There is a designated swimming area on the west side of pool. Land around the northern half of the pool rises sharply to approximately 25 ft (7.6 m) above the water. Rainbow Springs State Park facilities are situated on the high ground to the north. Live oak and pines are abundant on high ground. There is a dense hardwood-palm swamp forest along the pool's east and west edges.

RAINBOW NO. 4 - Lat. 29°06' 06.87" N., Long. 82°26 ' 13.77" W. (SE ¼ NE ¼ SE ¼ sec. 12, T. 16 S., R. 18 E.). Rainbow No. 4 is approximately 350 ft (106.7 m) downstream from Spring No. 1. It issues from a conical depression at the bottom of the river. The circular spring pool measures approximately 75 ft (2.9 m) in diameter. The depth measured over the vent is 10.9 ft (3.3 m). Water is clear and pale blue. A boil is not visible. Aquatic grasses sway in the current with very little exotic aquatic vegetation. Algae are present but are not dominant. This spring is located within the State Park no motorized boat zone. Land on both sides of the river is low lying and harbors pristine hardwood swamp forest.

RAINBOW NO. 6 - Lat. 29°05' 34.11" N., Long. 82°2 5' 42.83" W. (NE ¼ SE ¼ NW ¼ sec. 18, T. 16 S., R. 18 E.). Rainbow No. 6 is just off the south bank approximately 0.4 miles (0.6 km) downstream from the headwaters. It emerges from the bottom of the Rainbow River between 1 and 1.5 miles (1.6-2.4 km) downstream from the head of the river. It issues from a conical depression nearest the west bank of the river and forms a boil on the river surface. The spring pool measures approximately 60 ft (18.3 m) north to south and 75 ft (22.9 m) east to west. The depth measured over the vent is 16.9 ft (5.2 m). Limestone is evident on the bottom of the spring. River and spring water are clear and pale blue. Aquatic grasses are common in the spring pool. Exotic aquatic vegetation is present on the south side of the pool. Algae occur thinly on limestone substrate. High ground on the west side of the river rises to nearly 20 ft (6.1 m) above the water. There are some pines on the hill top. This spring is

downstream from the state park, and private houses are along the west bank. The east side of the river is low-lying and heavily forested state land.

BUBBLING SPRING - Lat. 29°06' 04.46" N., Long. 82° 26' 05.45" W. (SW ¼ NW ¼ SW ¼ sec. 7, T. 16 S., R. 18 E.). Bubbling Spring flows into the Rainbow River from the east approximately 200 ft (61 m) downstream from Spring No. 4. The spring pool measures 45 ft (13.7 m) north to south and 75 ft (22.9 m) east to west. The shallow spring pool measures only 2.8 ft (0.9 m) over the vent. Water issues from a small crevice in the limestone. The force of the boil pushes the water column approximately 0.5 ft (0.2 m) higher than the surrounding spring pool. The pool bottom is sand and limestone and the water is clear and pale blue. This spring and its run have very rich aquatic vegetation. Algae are thinly present on limestone substrate. Bubbling Spring is at the head of a spring run that is approximately 400 ft (121.9 m) long. Densely forested high ground adjoins the east side of the pool and rises to approximately 15 ft (4.6 m) above water. There is a hardwood forest canopy over the spring pool. The spring is within the state park.

Utilization- The uppermost portion of Rainbow River is part of Rainbow Springs State Park. It is developed into an interpretive and recreation area with emphasis on preserving the natural quality of the watershed. The east side of the river below the state park is state- owned and protected. The west side below the state park is subdivided into private lots, often with houses near the river's edge.

Nitrate Concentrations-Water quality at the Rainbow Springs Group has been monitored quarterly by FDEP since 2001. Over the verified listing period, the median nitrate+nitrite concentrations in the three main springs of this group, Rainbow #1, Rainbow #4 and Rainbow #6, ranged between 1.01 and 1.4 mg/L and 100 percent of the samples exceeded 0.6 mg/L. Over the 2001 to 2008 Springs Initiative monitoring period, nitrate+nitrite concentrations in Rainbow Spring # 1 have ranged from 0.96 to 2.1 mg/L, with a median concentration of 1.5 mg/L. Over the 7.5-year verified listing period of record the median nitrate+nitrite concentrations for the main contributing springs in the Rainbow Springs Group ranged from 1.01 to 1.4 and 100 percent of the samples exceeded 0.6 mg/L (**Table 1**). A plot of nitrate+nitrite concentrations from the quarterly data is shown in **Figure 10**.

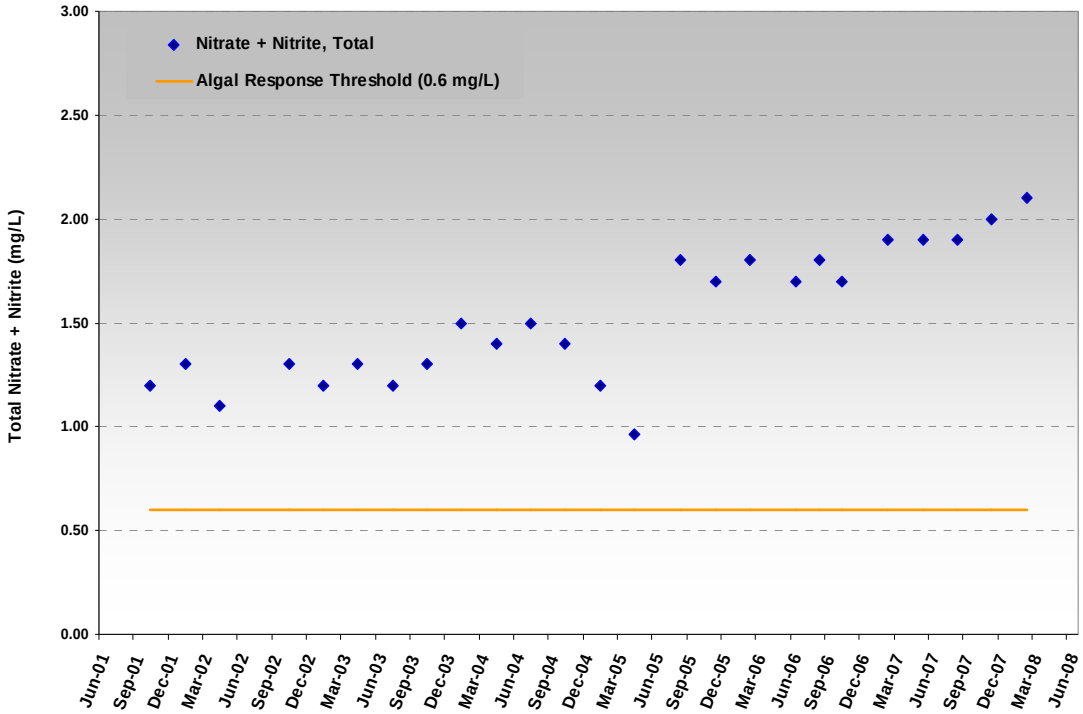

Figure 10- Nitrate+Nitrite Concentrations in Rainbow Spring #1 from Springs Initiative Monitoring

Evidence of Algal Smothering-EcoSummaries were prepared by the FDEP Environmental Assessment Section from 2001 to 2008. Some of the earlier reports documented the algal community as being dominated by diatoms with some blue-green algae, with the particular taxa indicative of eutrophic conditions. One source documented Rainbow River downstream from the springs to alternate between a *Lyngbya*-dominated ecosystem to one dominated by the invasive SAV Hydrilla (Agnieszka et. al. 2007). Scott et al (2004) also mentions some evidence of algae in their report.

The Rainbow Springs Run near Rainbow Spring #1 was included in the 57 spring locations surveyed by Stevenson et al (2004) and was included in the overall assessment of biological and chemical measurements performed by Hand (2008). Hand's assessment of Stevenson's data showed that for the Rainbow Springs Group, the macroalgae thickness was in the "low" range (<25 percent), epiphyte thickness was in the "very high" range (>75 percent) and the algal mat coverage was in the "moderate" range (25 to 50 percent coverage).

Photographic Evidence-See **Appendix A**.

References:

FDEP Environmental Assessment Section reports web site: http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp

Agnieszka, P., R. J. Steveneson, J. O . Sickman, A. Albertin, and M. Anderson, 2007. Macroalgal Relationships to Water, Sediment, and Macroalgae Nutrients, Diatom Indicators and Land Use, Deliverable for Task 1.2, DEP Contract Number S0291.

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Stevenson, R. J., A. Pinowsska and Y. Wang, 2004. Ecological Conditions of Alga and Nutrients in Florida Springs: Report to the FDEP, Contract No. WM858.

Weeki Wachee Spring (WBID 1382B) and Weeki Wachee River (1382A), Springs Coast Basin, Basin Group 5

Weeki Wachee Spring (**Figure 11**), centerpiece for an amusement park, is the source of the Weeki Wachee River (WBID 1382A).

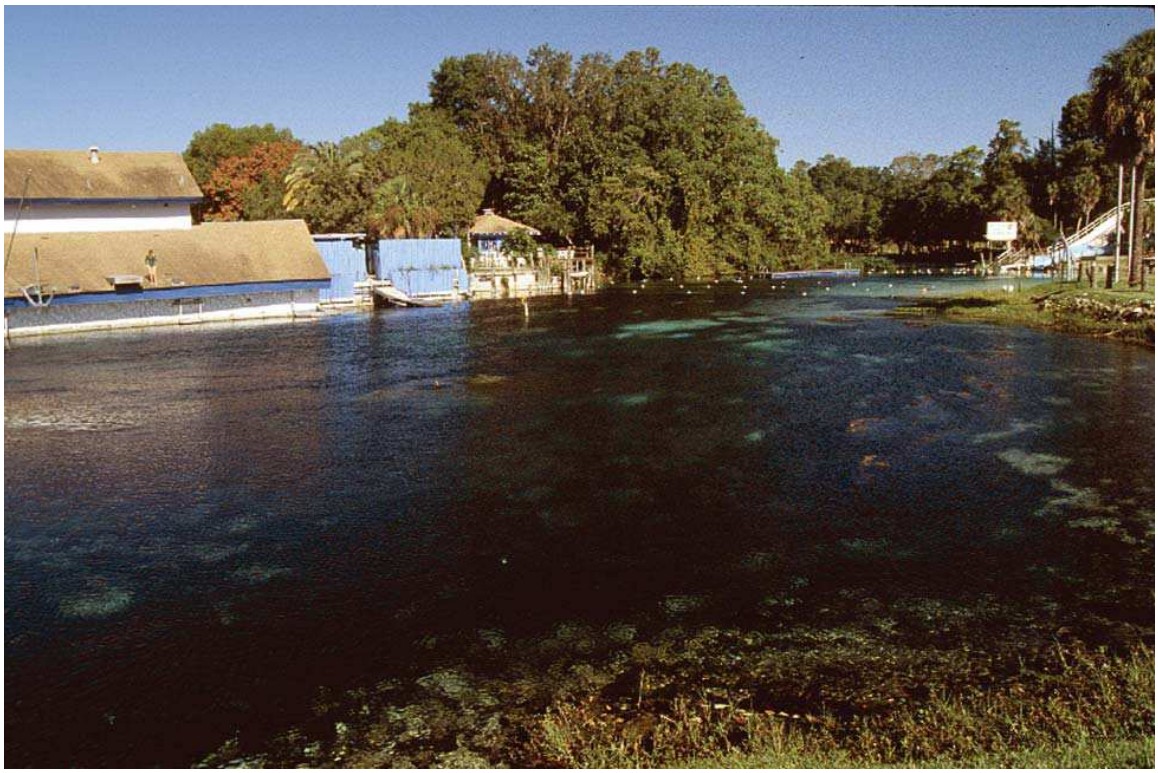

Figure 11-Weeki Wachee Spring (photograph by R. Means, Florida Geological Survey)

Text describing the location and description of Weeki Wachee Spring are excerpted from Scott et al, 2004.

Location- (excerpted from Scott et al, 2004)-Lat. 28°31' 01. 89" N., Long. 82°34' 23.40" W. (NE ¼ SW ¼ NE ¼ sec. 2, T. 23 S., R. 17 E.). The spring is located in the town of Weeki Wachee on the west side of US 19. From the intersection of US 19 and SR 50, drive south 0.2 miles (0.3 km). Turn west (right) into Weeki Wachee Springs Park parking lot. The spring vent is in the large pool used for mermaid shows.

Description- (excerpted from Scott et al, 2004)-Weeki Wachee Spring discharges from the bottom of a conical depression with gentle side slopes. The spring pool measures 165 ft (50.3 m) east to west and 210 ft (64 m) north to south. Spring depth is 45 ft (13.7 m) over the vent in the center of the pool. Bare limestone is located near the vent, but none is exposed around the pool edges.

The water is clear and light greenish blue, and a boil is visible in the center of the pool. Thick, filamentous algae cover the majority of the spring bottom, and there are some native aquatic grasses in the spring pool. The spring is rich with fresh and salt water fishes and aquatic turtles. The Weeki Wachee River flows westward approximately 5 miles (8 km) into the Gulf of Mexico. The river flows through low-lying, densely forested swamp. The nearest high ground east of the spring is rolling sand hills terrain and gently rises to 15 ft (4.6 m) above the water level. All uplands and land adjacent to spring are developed. U.S. 19 is approximately 225 ft (68.6 m) east of the spring.

Utilization-Weeki Wachee Spring is extensively developed into a tourist attraction that features underwater mermaid shows with a submerged observation area. Several years ago it was purchased from private ownership by the Southwest Florida Water Management District (SWFWMD). SWFWMD leased the land to a private firm for the continuation of the mermaid shows. In 2008, the District turned ownership of the facility over to FDEP and it is now being operated as a state park.

Nitrate Concentrations-Water quality at Weeki Wachee Spring has been monitored quarterly by FDEP since 2001. Over the 2001 to 2008 monitoring period, nitrate+nitrite concentrations have ranged from 0.66 to 0.93 mg/L, with a median concentration of 0.76 mg/L. Over the 7.5-year verified listing period of record the median nitrate+nitrite concentration for Weeki Wachee Spring was 0.76 mg/L and 100 percent of the samples exceeded 0.6 mg/L (**Table 1**). A plot of nitrate+nitrite concentrations from the quarterly data is shown in **Figure 12**.

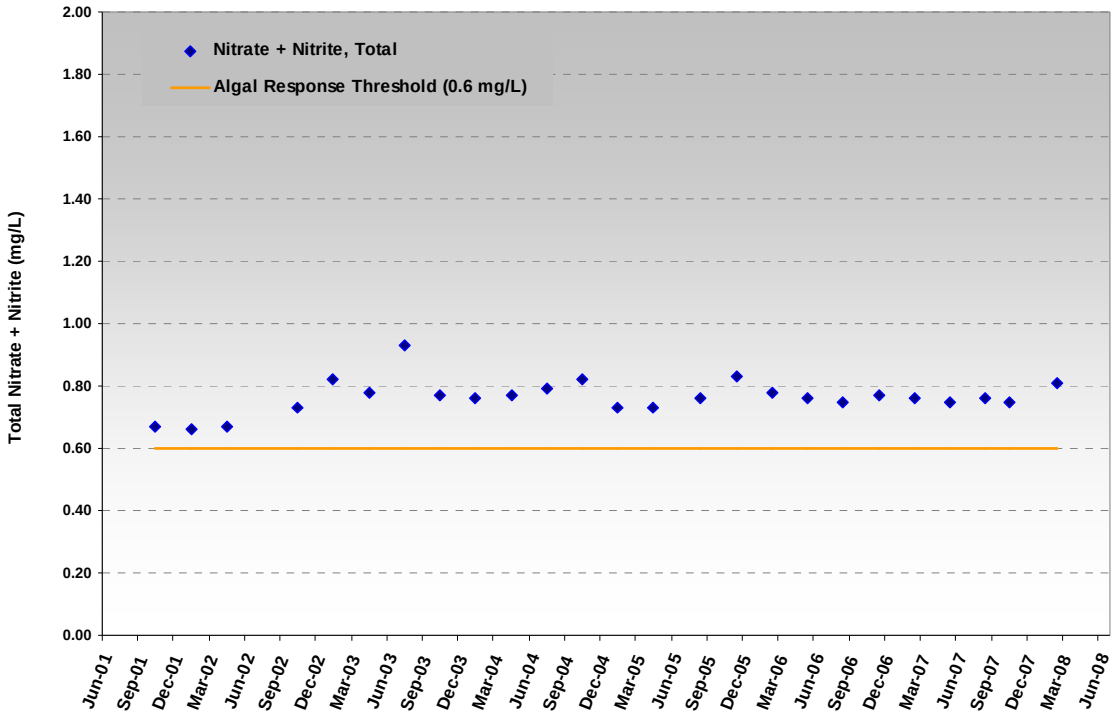

Figure 12- Nitrate+Nitrite Concentrations in Weeki Wachee Spring from Springs Initiative Monitoring

Evidence of Algal Smothering-As noted in the ***Description*** above, Scott et al (2004) documented that the spring basin is coated with thick layers of filamentous algae. Work by Agnieszka and others (2007) showed that *Lyngbya* and *Dichotomsiphon* were the two types of algae in greatest abundance near the spring vent and *Vaucheria* was the dominant form of algae further downstream in the spring run (Weeki Wachee River).

Weeki Wachee Spring was included in the 57 spring locations surveyed by Stevenson et al (2004) and was included in the overall assessment of biological and chemical measurements performed by Hand (2008). Hand's assessment of Stevenson's data showed that the macroalgae thickness was in the "very high" range (>75 percent) and epiphyte thickness was in the "low" range (<25 percent, due to lack of plants for attachment). There was no reported value for algal mat coverage in this assessment.

Photographic Evidence- See **Appendix A.**

References:

Agnieszka, P., R. J. Steveneson, J. O . Sickman, A. Albertin, and M. Anderson, 2007. Macroalgal Relationships to Water, Sediment, and Macroalgae Nutrients, Diatom Indicators and Land Use, Deliverable for Task 1.2, DEP Contract Number S0291.

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APPENDIX A

PHOTO-DOCUMENTATION OF SUBMERGED AQUATIC VEGETATION CHANGES AT SPRINGS RECOMMENDED FOR LISTING AS NUTRIENT-IMPAIRED

This Appendix contains photographs of the springs and spring-related waterbodies that are recommended for listing as impaired because of floral and faunal imbalances caused by excessive nutrients.

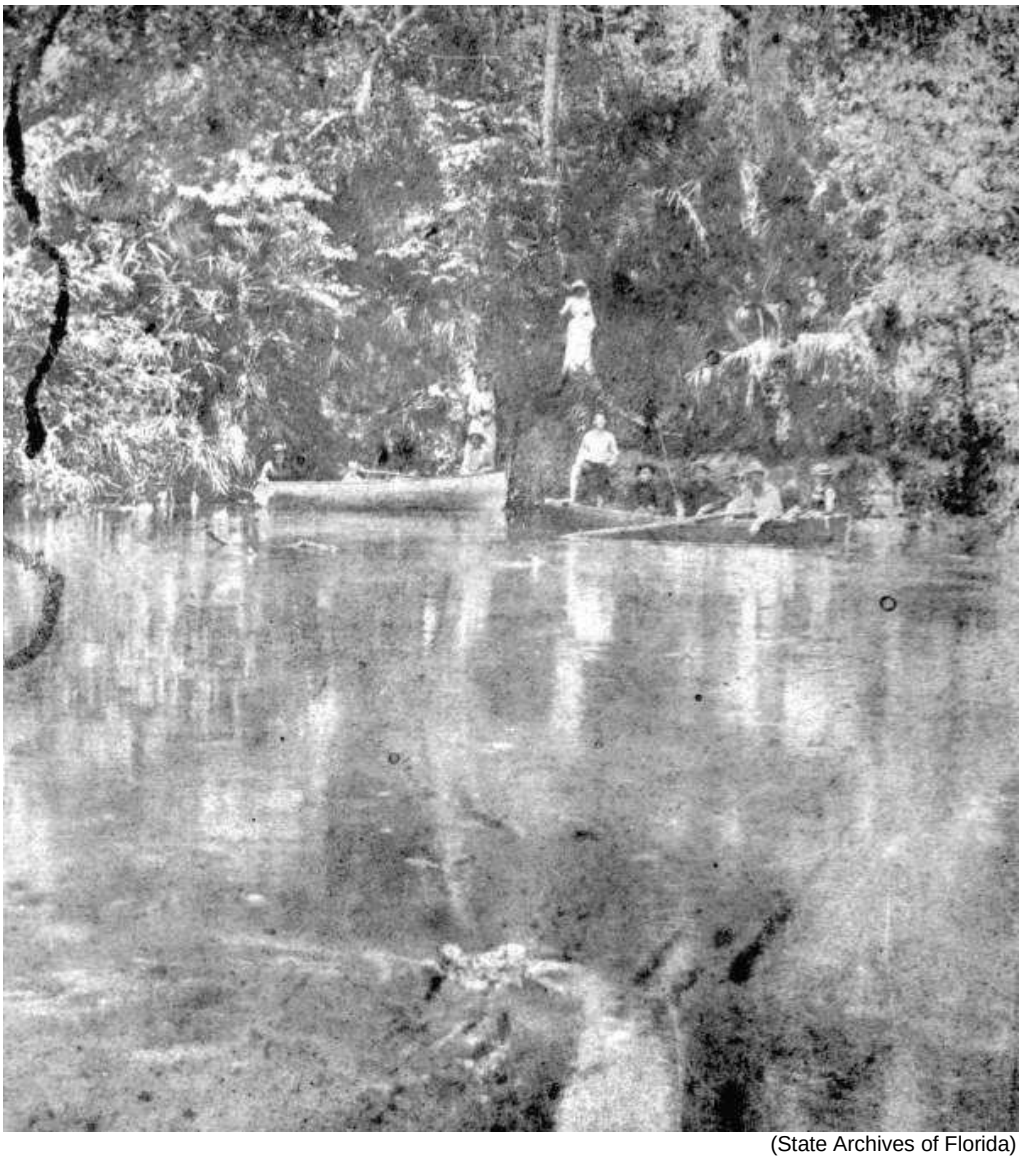
Finding historical photos from many of these springs which show underwater vegetative conditions has been a challenge, particularly for the less popular springs of yesteryear. Commercialized spring attractions have many more photos available. Sources of historical photographs include the spring attractions, various springs websites, FDEP Florida Park Service and Florida Geological Survey photo-documentation and images collected from the Florida State Archives.

Epiphytic algae have been documented on native eel grasses (primarily *Vallisnaria)* at Silver Springs, effectively blocking sunlight and decreasing photosynthesis. Mats of algae are also increasingly seen growing on sandy and rocky substrates near springs and in spring runs where they were not seen in the past.

Hydrilla verticillata is another nuisance invasive plant species which, in recent years has dramatically altered the bottom habitat within a number of springs and spring runs.

Volusia Blue Spring (WBID 28933) and Volusia Blue Spring Run (WBID 28933A)

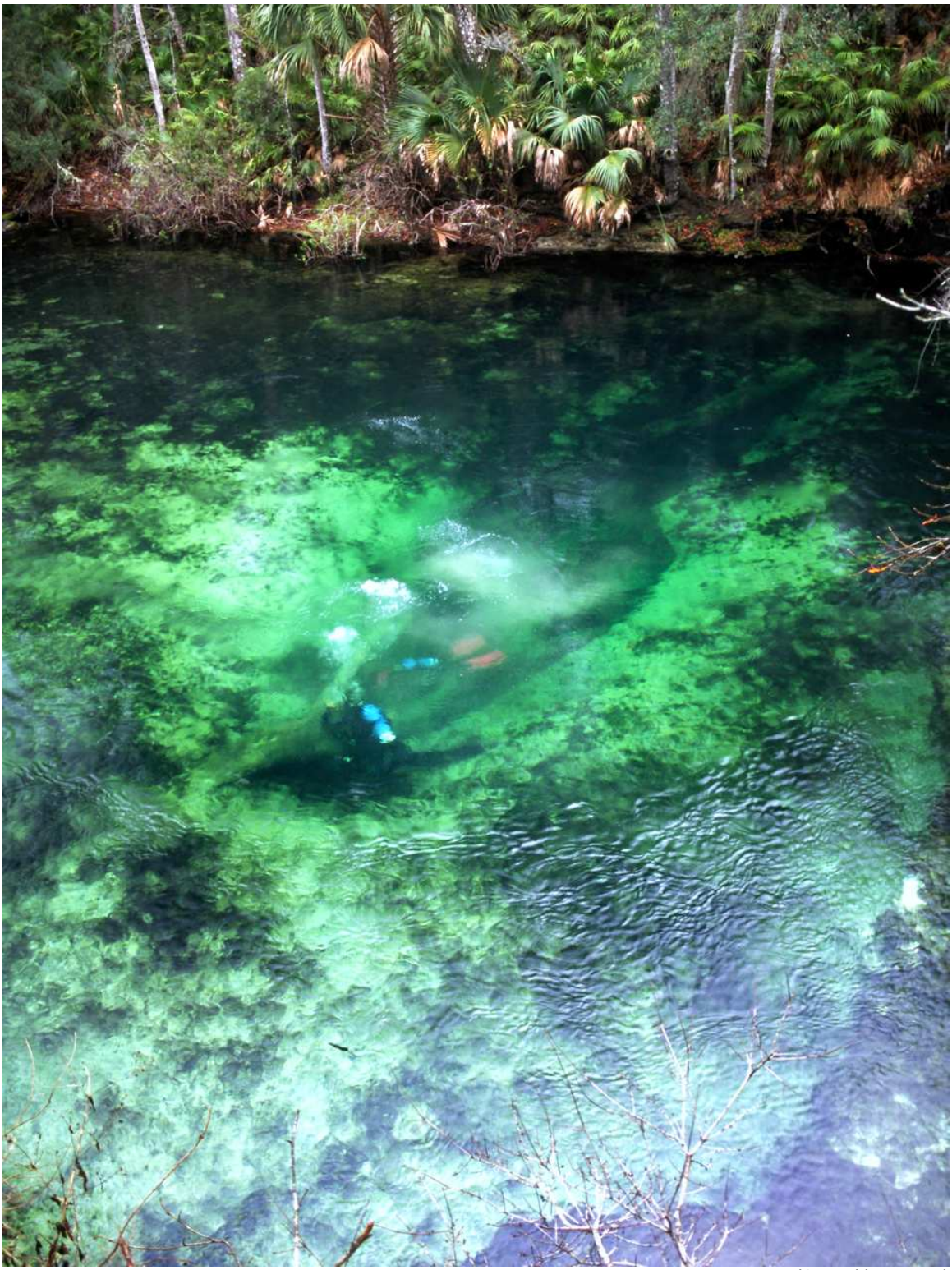
Volusia Blue Spring, a historical first-magnitude spring, has a long history of human habitation and use. The bottom of Volusia Blue Spring Run is primarily composed of sand, shell and limestone, with virtually no submerged aquatic vegetation present except for scattered patches of algae. This lack of submerged vegetation may be normal for this spring, as it is the primary overwintering site on the St. Johns River for the West Indian Manatee. Manatees feed on submerged aquatic vegetation, and the lack of such vegetation may simply reflect overgrazing during winter months. In the photo below from the 1890's, it appears that this condition has been extant for over 100 years. However, the excessive algal growth in the spring basin and run is not a natural condition.



(State Archives of Florida)

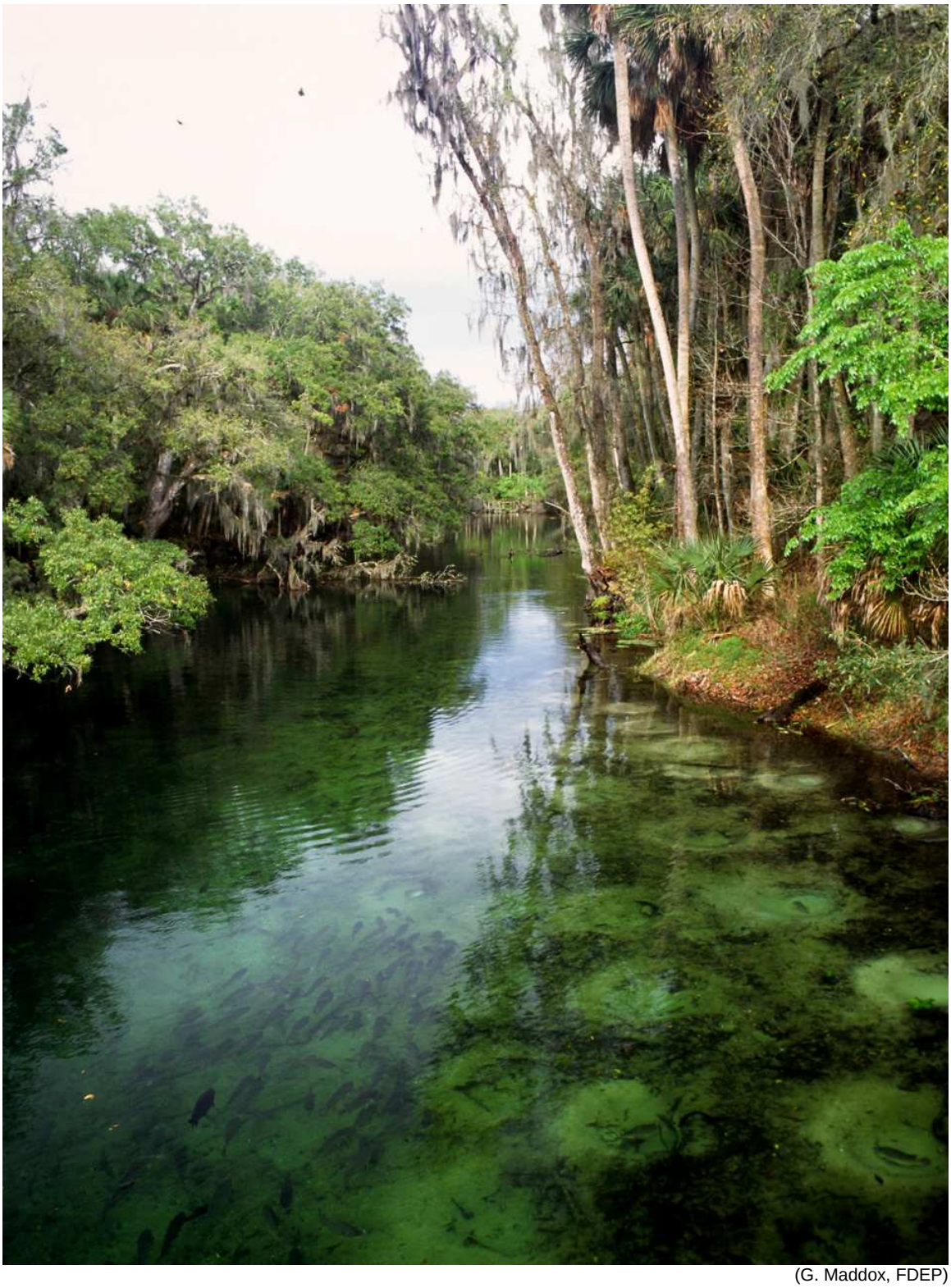
Canoeists at Volusia Blue Head Spring – 1890's

(note apparent lack of submerged aquatic vegetation)



(G. Maddox, FDEP)

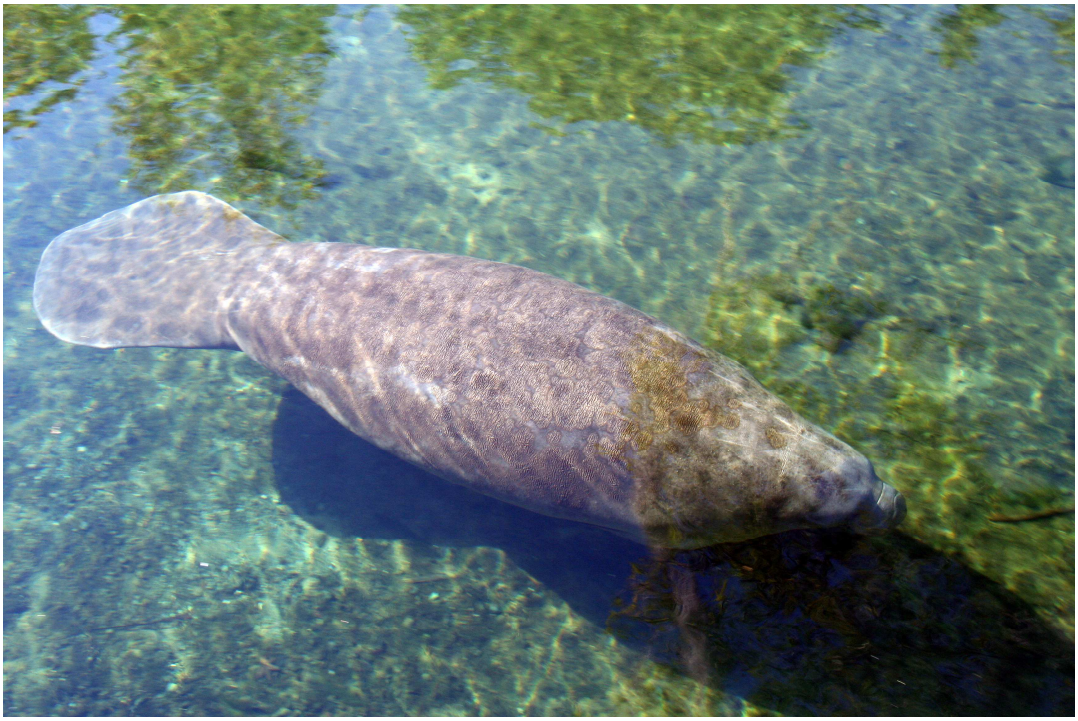
Divers at Volusia Blue Head Spring – February, 1997
(dark patches are algae and detrital plant remains)



(G. Maddox, FDEP)

Volusia Blue Spring Run – February, 1997
(note fish nests and algae)

Volusia Blue Spring Run – August, 2006
(note the lack of submerged aquatic vegetation)



West Indian Manatee in Volusia Blue Spring Run – Winter, 2007

De Leon Spring (WBID 2921A)

This historical second-magnitude spring has been developed as a tourist attraction since the 1880's, and the head spring pool has been impounded. A dam and weir separate the head spring area from Spring Garden Lake. Because of this, invasive plant species present in the lake have been largely blocked from infiltrating the head spring pool. The substrate of the head spring pool consists of sand and shell, with patches of algae, along with some algal filaments and particles suspended in the water column. Heavy visitation and foot traffic keep much of the shallow portion of the spring pool free of vegetation.

(State Archives of Florida)

DeLeon Springs – 1930

(State Archives of Florida)

DeLeon Springs – 1954

DeLeon Springs – March, 2008

DeLeon Springs discharge into Spring Garden Lake below head spring – April, 2007
(note floating algal mats and non-native floating Hyacinths)

DeLeon Springs discharge below weir – January, 2008
(note green filamentous algae on rocks)

Jackson Blue Spring (WBID 180Z) and Merritts Mill Pond (WBID 180A)

Jackson Blue, a historical first-magnitude spring, is the source for Spring Creek, a major tributary of the Chipola River. The upper 4.5 miles of Spring Creek have been impounded since the 1920's as Merritts Mill Pond. The head spring area is fenced off from the Mill Pond, and is owned by the State of Florida and is managed as a county park.

Most of the head spring area substrate is composed of sand and limestone, with little vegetation due to trampling during heavy summer use. Most of the bottom of Merritt's Mill Pond below the head spring is covered by a mixture of the invasive species *Hydrilla verticillata* and patches of green algae, as can be seen in the photos below. The Mill Pond is periodically drawn down to help control the proliferation of nuisance submerged aquatic vegetation.

(T. Scott, Florida Geological Survey, FDEP)

Jackson Blue Head Spring and Merritts Mill Pond - 2003

(Florida Geological Survey, FDEP)

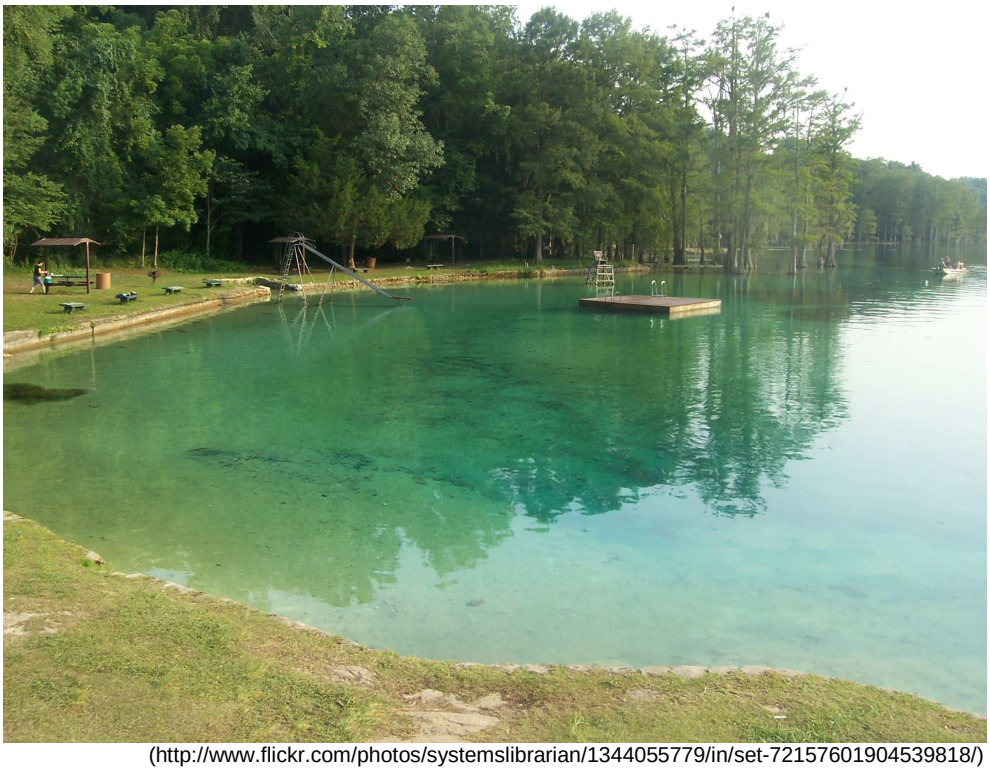
Merritts Mill Pond below Jackson Blue Head Spring – May, 2004
(note floating *Hydrilla verticillata* mats)

(Florida Geological Survey, FDEP)

Merritts Mill Pond below Jackson Blue Head Spring – May, 2004
(green algae and *Hydrilla verticillata* on bottom)

(H. Means, Florida Geological Survey, FDEP)

Merritts Mill Pond below Jackson Blue Head Spring – May, 2004
(patches of green algae on bottom)



(http://www.flickr.com/photos/systemslibrarian/1344055779/in/set-72157601904539818/)

Jackson Blue Head Spring – 2007

(J. Van Dyke, FDEP)

Algal bloom on Merritts Mill Pond, just north of the U.S. 90 dam - 2003

Silver Springs (Silver Main, WBID 2772A), Silver Springs Group (WBID 2772C) and Silver River Upper (WBID 2772E)

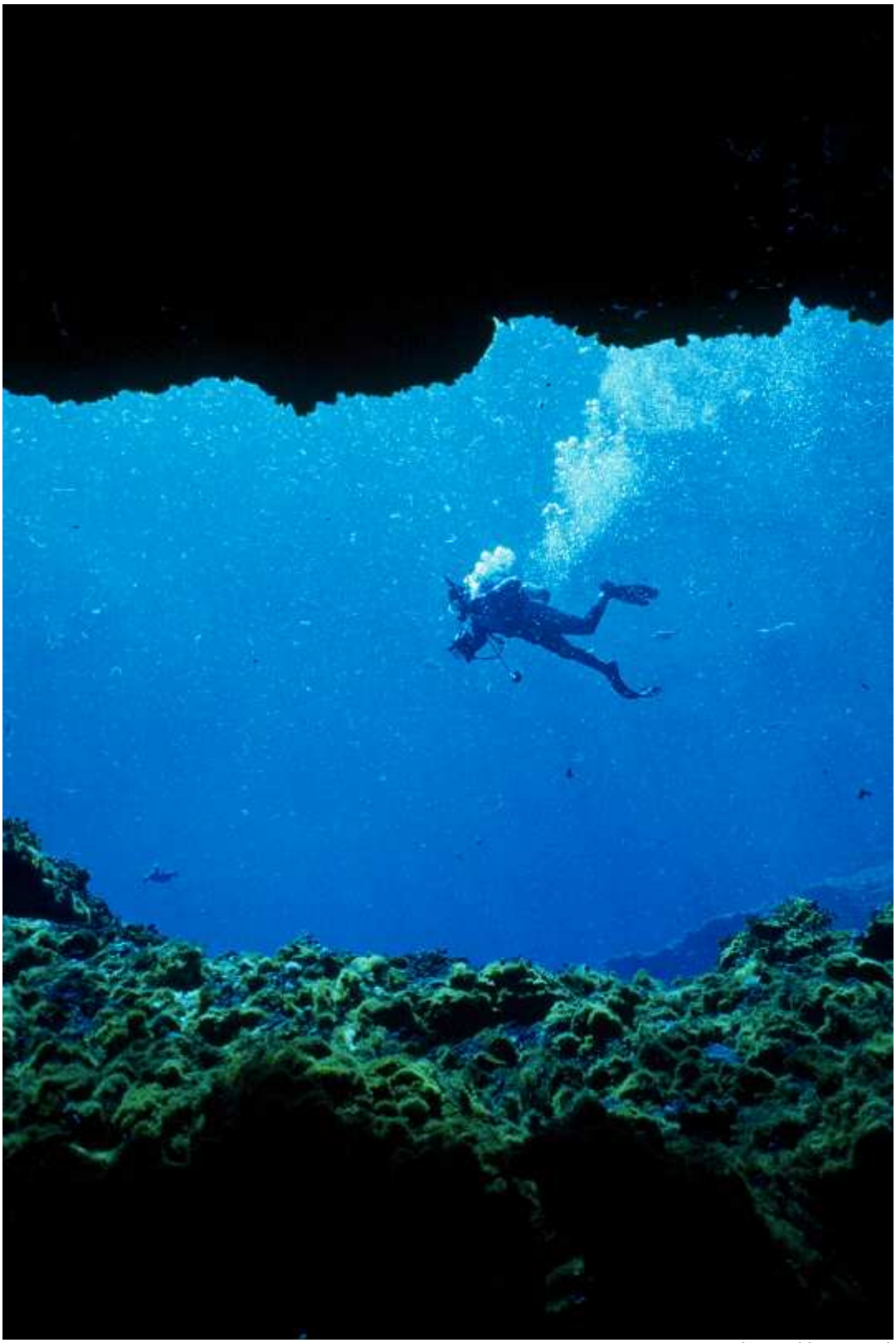
Silver Springs is perhaps the most frequently visited first-magnitude springs group in Florida. The photos below document the radical changes in the submerged aquatic vegetative makeup of the upper Silver River and springs during the last 50 years. Although *Vallisneria* beds still dominate much of the Silver River, they are being smothered by epiphytic algae, suppressing photosynthesis. This algae also becomes easily dislodged from the *Vallisneria* blades, dramatically reducing underwater visibility. Algal mats are also becoming better established, covering a significant portion of the Silver Main Spring basin.

(Bruce Mozert, University of Florida Press)

Silver Springs: healthy *Vallisneria* beds and great water visibility – 1950's

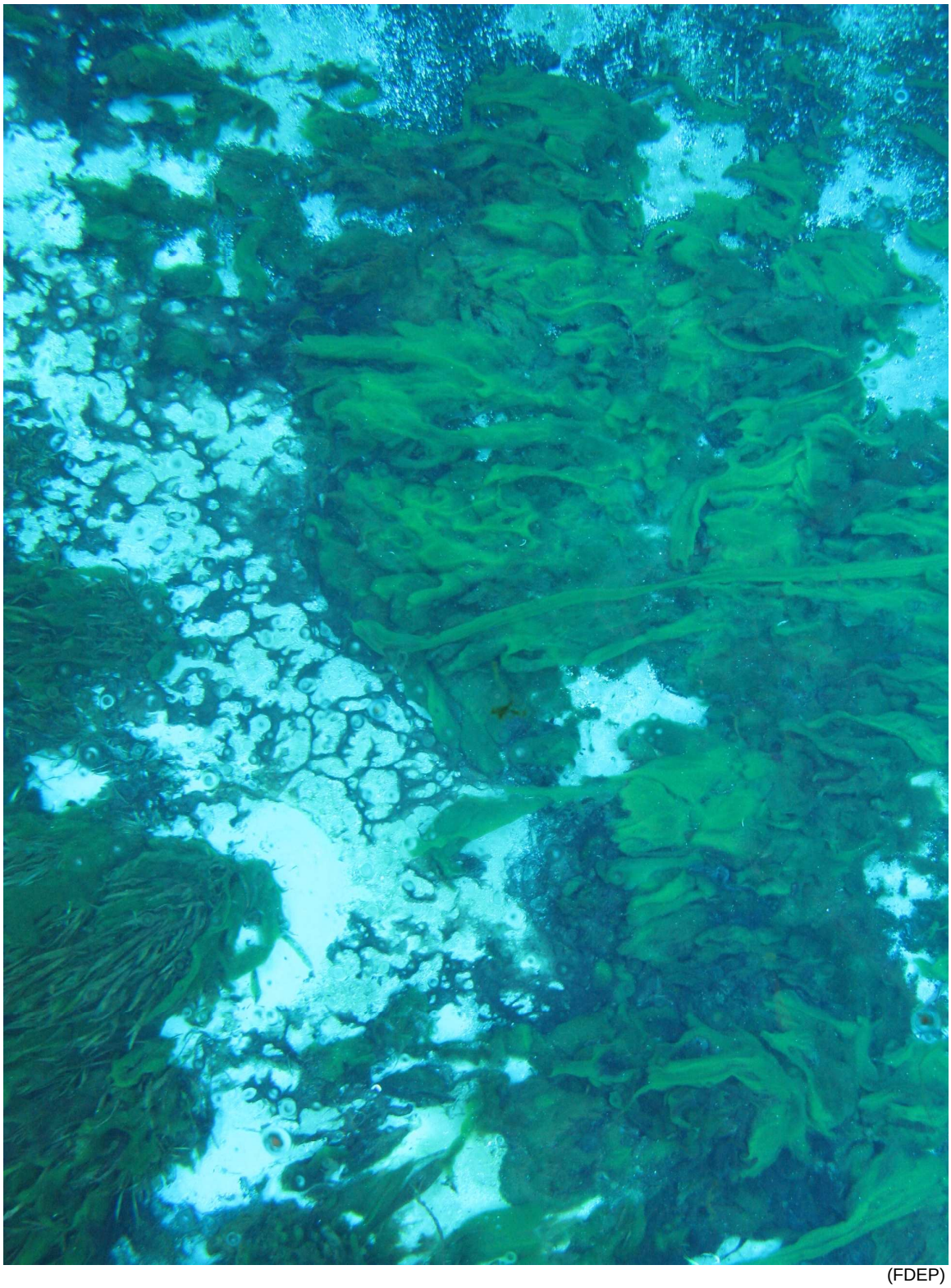
(G. Maddox, FDEP)

Silver Springs – April, 2004
(note the smothering of *Vallisneria* by brown algae and decreased visibility
due to algae suspended in the water column)



(G. Maddox, FDEP)

Silver Springs: view from within Main Spring – April, 2004
(note the algae coating rocks and decreased visibility due to suspended algae)



(FDEP)

Filamentous algae on bottom at Silver Springs – July, 2008

Rainbow Springs Group (WBID 1320A) and Rainbow Springs Group Run (Rainbow River, WBID 1320B)

Rainbow Springs is one of Florida's better-known historical first-magnitude springs due to the tourist attraction which operated at the head spring area for many years beginning in the late 1930's. The springs consist of over 60 identified vents along the Rainbow River, which discharges to the Withlacoochee River approximately 6.5 miles below the head springs. Despite heavy human visitation and use over the years, the submerged vegetative makeup of the head spring area is less impacted than other similar Florida springs; however, patches of *Lyngbya wollei* are present and *Hydrilla verticillata* is well-established in the Rainbow River.

(State Archives of Florida)

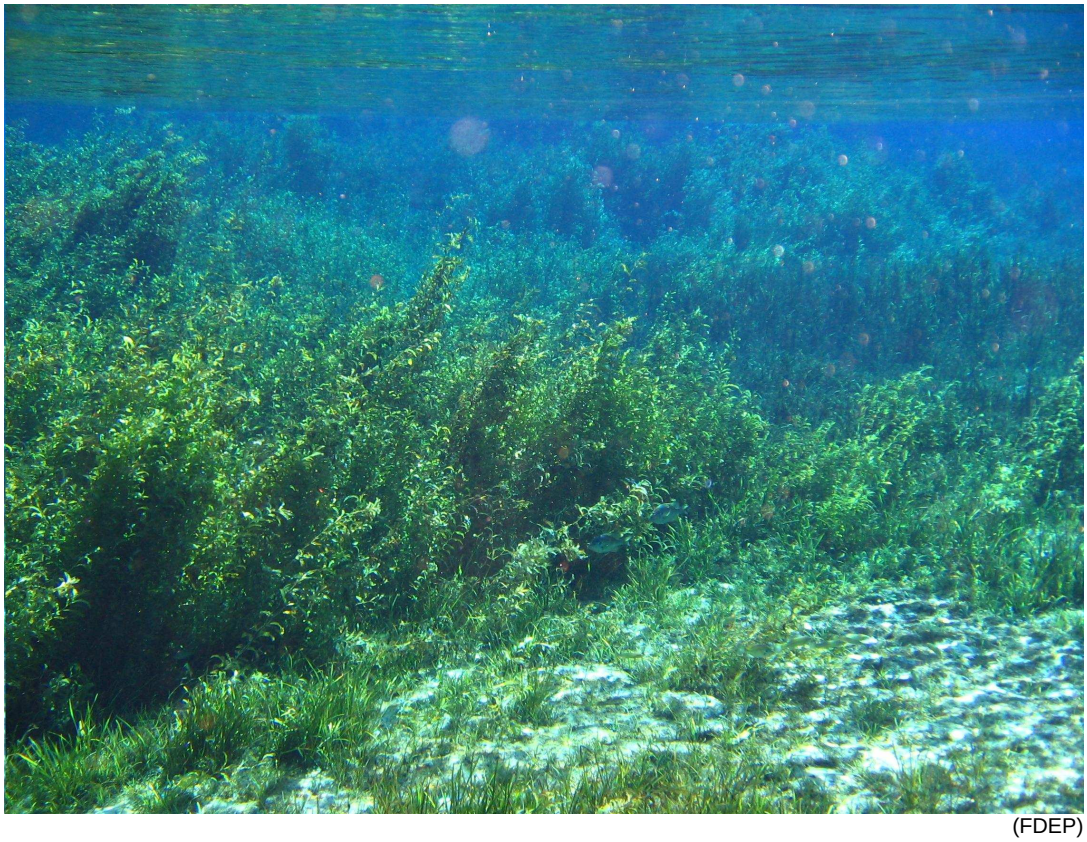
Rainbow Springs with healthy *Vallisnaria* - 1955

(State Archives of Florida)

Rainbow Springs Group with native submerged aquatic vegetation - 1955

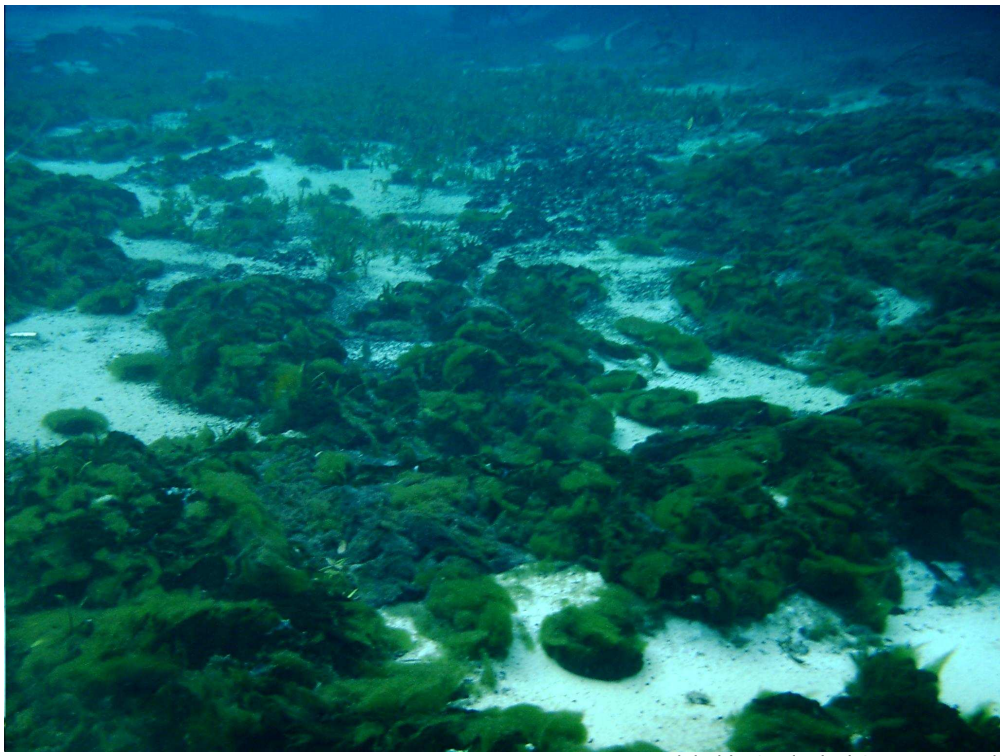
(T. Scott, Florida Geological Survey, FDEP)

Rainbow Springs Group (head spring area) - 2001



(FDEP)

Rainbow Springs - 2006



(Florida Geological Survey, FDEP)

Lyngbya wollei in Rainbow River

(Southwest Florida Water Management District)

Hydrilla verticillata in Rainbow River

Weeki Wachee Spring (WBID 1382B) and Weeki Wachee Spring Run (WBID 1382F)

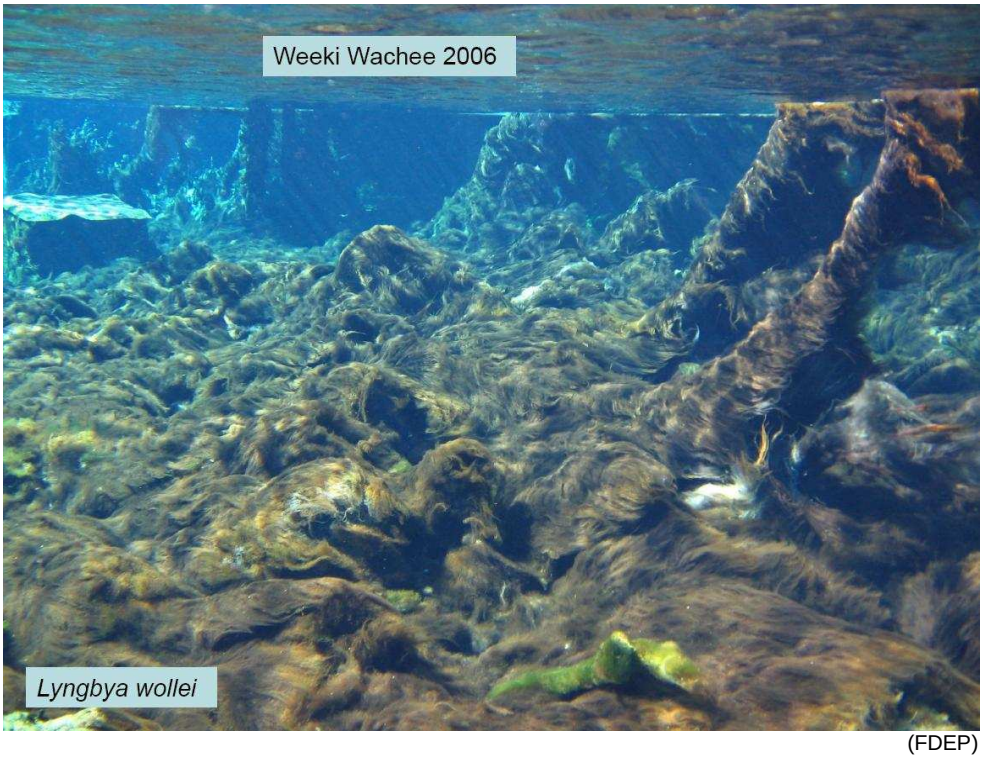
Weeki Wachee Spring is a historical first-magnitude spring. The following series of photographs documents the transition of the Weeki Wachee spring basin and run from a system dominated by natural submerged aquatic vegetation to one dominated by algae. At some point between 1976 and 1980 *Vallisnaria* and other native submerged plant species disappeared from the spring basin, replaced by algal mats primarily composed of the species *Lyngbya wollei.* Algae was physically harvested on a regular basis and either sent floating downriver or hauled away for disposal. The harvesting of nuisance algae from the spring basin continues to this day, and the original native submerged vegetation has not returned.

(State Archives of Florida)

Weeki Wachee Spring with native grass species *Vallisnaria* - 1949

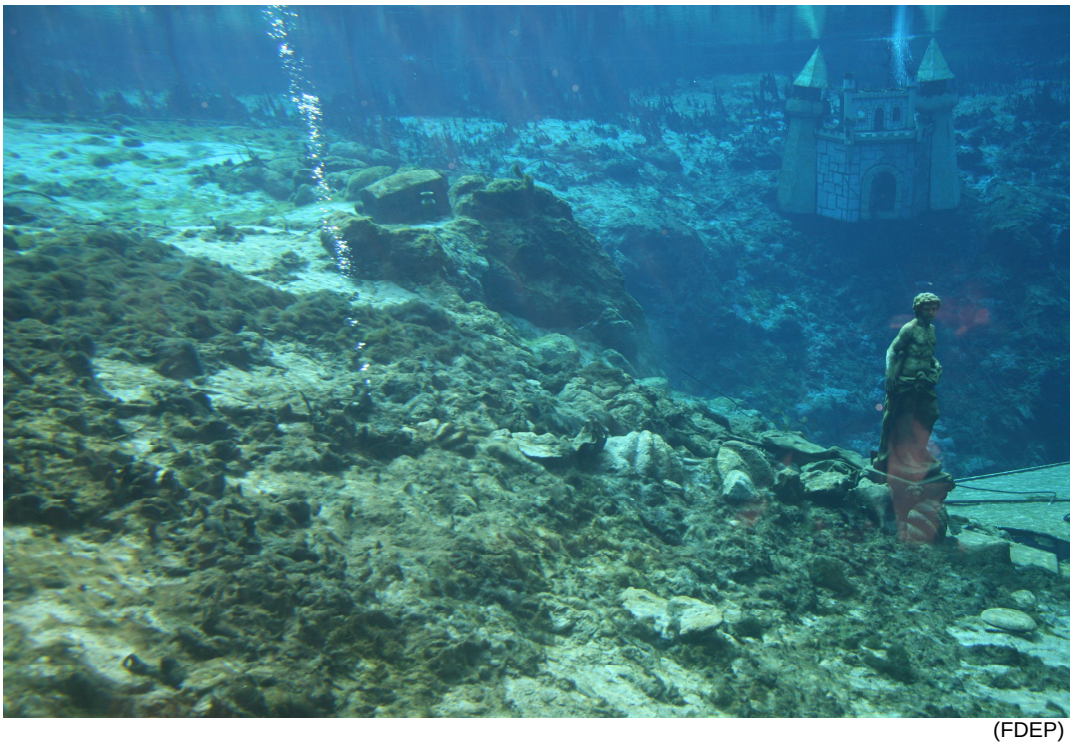
(State Archives of Florida)

Weeki Wachee Spring with *Vallisnaria* – 1951



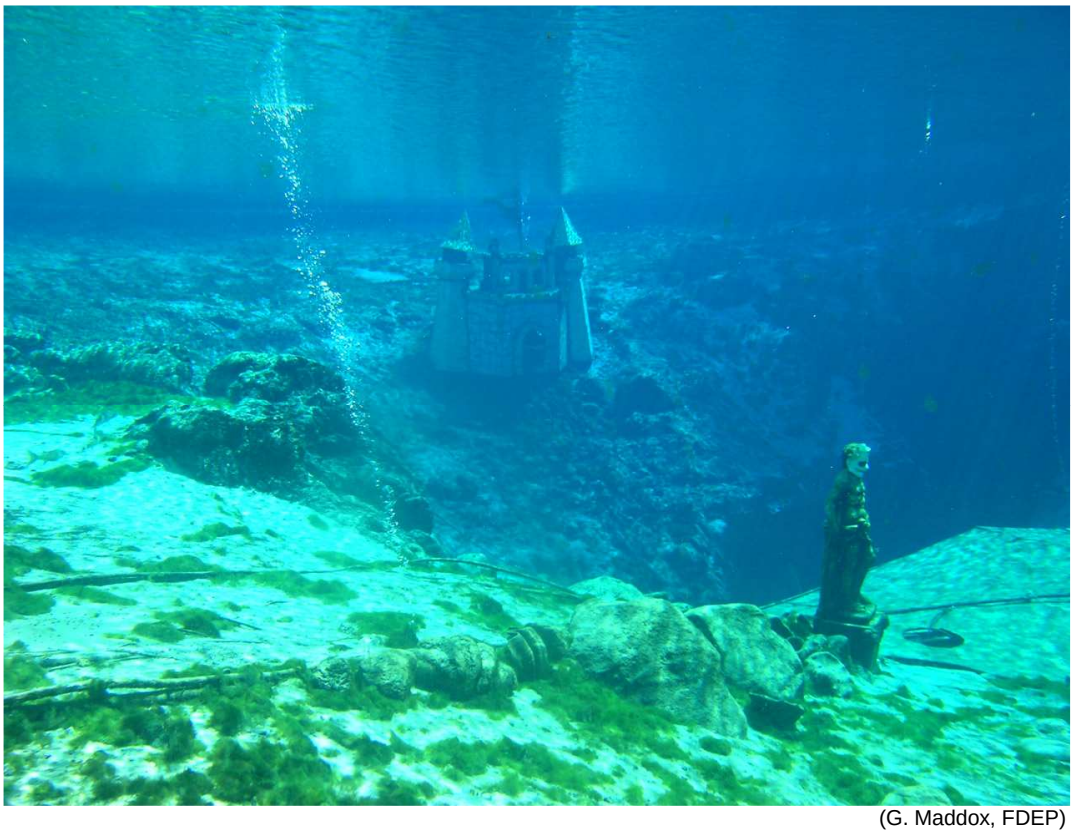
(FDEP)

Weeki Wachee Spring covered with algal species *Lyngbya wollei* – 2006



(FDEP)

Weeki Wachee Spring with algal species *Lyngbya wollei* – July, 2007



(G. Maddox, FDEP)

Weeki Wachee Spring – October, 2008 (after algae harvesting)

(FDEP)

Epiphytic and floating algae in Weeki Wachee Spring Run – July, 2007