Abstract

Tracking Water and pollutants flowing from Karst Lakes and Streams in the Wakulla Springshed

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Wakulla Springs, a first magnitude spring and one of the largest and deepest fresh-water springs in the world, discharges an average of 260 million gallons per day. The spring pool is huge, 315 feet in diameter, 185 feet deep, and connects to an underwater cave system with over 26 miles of explored submerged caves. This Springshed is riddled with caves and is currently the longest mapped underwater cave system in the world. Wakulla Springs is currently in a federal cleanup program, with a Total Maximum Daily Load (TMDL) establishing a goal of 0.35 mg/L nitrate (nutrient) as a monthly average for the Upper Wakulla River. This is a 56.2% reduction in nitrate. Wakulla Springs is in the Basin Management Action Plan (BMAP) phase of the cleanup and has almost achieved this goal with monthly averages of nitrate fluctuation between 0.35 mg/L and 0.45 mg/L for the past two years. However the cleanup does not address the dark water problem, which will be discussed in this paper, and is getting much worse. Furthermore, currently, with a Minimum Flow and Level (MFL) determination underway, the North West Florida Water Management District (NWFWMD) has announced that the Annual average discharge at Wakulla Spring has increased approximately 176% from 2004-2019. This is totally wrong, because as our results show, the clear base flow is actually much less and any increase in flow is replacement with surface water, many non-potable: tannic river waters; green chlorophyll laden lake water; and saline marine water.

Sinking streams in the springshed were found to be the source of the tannic water in Wakulla Springs. These dark brown pigments result from forested wetlands draining into the aquifer. Statistical analysis shows that the tannic waters only explained a fraction of the visibility problem. The other factor we examined was green chlorophyll laden eutrophic urban lake water appearing in the aquifer. There is also a suspended solids problem, to which algal cells which contain chlorophyll contribute, but also is derived from flow reversal events in the southern caverns leading to the Gulf of Mexico which periodically causes salinity spikes at the spring and a great deal of turbulence in the aquifer. This seems to be primarily caused by sea level rise, but over pumping is probably a contributing factor. The NWFWMD purported increase in flow is problematic because it would lead to more pumping and more ‘bad’ water problems at Wakulla Spring.

MLI found the sinkhole lakes in the Springshed to be the source of algae (chlorophyll) in Wakulla Spring. The water flowing underground from the sinkhole lakes contains chlorophyll, which does not normally occur in groundwater or springs. There is seasonality to the life cycle of the plankton in lentic aquatic systems. Seasonality of algae blooms in the sinking lakes corresponds to chlorophyll maximums in late summer (low visibility) and brief moments of crystalline clear episodes in the early spring (good visibility).

MLI traced the flow of water from the sinkholes of each lake to Wakulla Springs with dye studies. Four dye studies were performed and each showed definite connections to Wakulla Spring. The longest dye study was from Lake Iamonia (near the Georgia Florida border) to Wakulla Springs; the dye traveled 29 miles underground, with a speed of 1.7 miles per day. We also documented the flow from the sinkhole in Upper Lake Lafayette for 16 miles at a speed of 0.65 miles per day. At Lake Jackson the dye traveled 19 miles to Wakulla Springs, the average travel time of the dye, of 0.55 miles per day, indicates extensive large underground caverns or conduit flow.

MLI also used DNA sequencing technology to traced the algae from the sinkhole lakes to Wakulla Springs. Lake Iamonia, Lake Jackson, Lake Lafayette, and Lake Munson, all had species algae unique to that lake that were also found in Wakulla Springs. These were: Cyanobacterium spp.; Cyanothece spp.; Prochlorococcus spp. and Synechococcus spp. Furthermore several species of algae occurred in all the samples and were potentially toxic species. These were: Asterionella; Chrysosphaera; Dinophysis; Guillardia; Heterosigma; Nannochloropsis; Ochromonas; Rhodomonas; Stephanodiscus and Thalassiosira. The potentially toxic bluegreen nuisance algae, Microcystis spp. was also found in all samples. Interestingly, a potentially toxic diatom, Nitzschia and other marine algae were also found at the spring, proving a connection with the sea.

New Innovative Technology: Chlorophyll Factor: green algae pigments measured by spectral radiometry insitu in surface waters. New methods for Red Algae Biomass: phycoerythrin analysis (red algae pigment). Blue Green Algae Biomass: phycocyanin analysis (blue green algae pigment). We are currently working through the method development process with the Florida Department of Health, Bureau of Laboratories, patents pending.

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