LAKE ECOSUMMARY

Redwater Lake, WBID 2775C, Marion County, 11/03/2011 and 10/11/2017



Figure 1. Redwater Lake in Marion County.

DEP conducted water quality and biological sampling at Redwater Lake **(STORET** 20020460**)** in Marion County on 11/03/2011 and 10/11/2017 to assess attainment of designated uses. This lake was sampled as part of a nutrient reference study and the reference lake sampling project. Overall, the plant community data indicated that the lake met expectations for a healthy, well-balanced lake. The associated water quality data was inconclusive due to issues with the nutrient samples from 10/11/2017. Future water quality monitoring may be required to determine the lake's attainment with applicable water quality standards.

Background

Healthy, well-balanced lake communities may be maintained with some level of human activity, but excessive human disturbance may result in lake degradation. Human stressors include increased inputs of nutrients, sediments and/or pesticides from watershed runoff, undesirable removal of native shoreline and/or upland buffer vegetation, and introduction of nuisance (generally exotic) plants and animals. DEP has methods to evaluate if human activities have resulted in a specific waterbody exceeding water quality criteria (Chapter 62-302, Florida Administrative Code [F.A.C.]), including whether adverse impacts to biological communities have occurred. DEP water quality standards are designed to protect designated uses of the waters of the state (*e.g.,* recreation, aquatic life support), and exceedances of these standards are associated with interference with the designated use. DEP assesses the health of plant communities in Florida lakes, as one indication of whether adverse impacts to biological communities have occurred.

Site Description

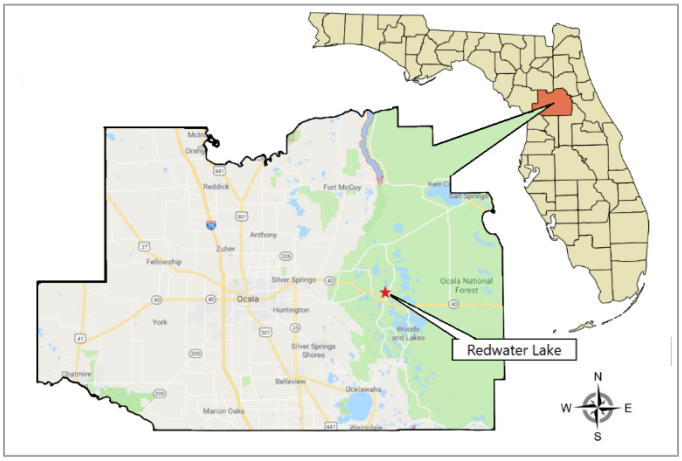


Figure 2. Location of Redwater Lake in Marion County.

Redwater Lake is located within the Ocala National Forest and may be accessed from State Road 40 (Figure 3). The lake is approximately 187 acres in size and is part of the Ocklawaha drainage basin. Water depths up to 2.1 m (7 ft) have been recorded near the center of the waterbody. The predominant land uses surrounding Redwater Lake are wetlands including hydric pine flatwoods and mixed hardwood swamps which

contribute to its tannic stained water color. This lake is not currently listed on the Impaired Waters Verified List (10/2/2019). Additional information about this WBID is available in the TMDL Tracker application (http://webapps.dep.state.fl.us/DearTmdl/tmdlReportAction.do?method=report).



Figure 3. Redwater Lake on October 2017

Methods

Water Quality

This lake was sampled on 11/03/2011 and 10/11/2017 by the DEP Central Regional Operations Center (CEROC). Surface water samples were collected from the center of the lake for analysis of nutrients, metals, chlorophyll *a*, color, alkalinity, total suspended solids, total dissolved solids, turbidity, E. coli, and chloride, fluoride, and sulfate, following DEP Standard Operating Procedures (see http://dep.state.fl.us/water/sas/sop/sops.htm). Sampling and analyses met DEP quality assurance/quality control standards. Results were compared with applicable Class III water quality criteria contained in 62-302, F.A.C., including nutrients, dissolved oxygen, and other indicators.

Chlorophyll *a* is a measure of algal biomass in the water column. Chapter 62-302.531, F.A.C., provides numeric criteria for chlorophyll *a*, total nitrogen (TN), and total phosphorus (TP) in lakes, and is dependent upon the long term mean color and alkalinity of the lake (Table 1). If the annual geometric mean chlorophyll *a* (calculated with at least four samples, representing seasonal variability) does not exceed the chlorophyll *a* value for the lake type in Table 1, then the TN and TP criteria for that calendar year shall be the annual geometric means of lake TN and TP samples, subject to the minimum and maximum limits in Table 1. If there are insufficient data to calculate the annual geometric mean chlorophyll *a* for a given year or the annual geometric mean chlorophyll *a* exceeds the values in Table 1 for the lake type, then the applicable numeric interpretations for TN and TP shall be the minimum values in Table 1.

Table 1. Numeric nutrient criteria in lakes, 62-302.531 (2)(b)(1), F.A.C. AGM = annual geometric mean

Long Term Geometric Mean Lake Color and Alkalinity	AGM Chlorophyll *a*	AGM TP Range	AGM TN Range
> 40 Platinum Cobalt Units	**20 µg/L**	**0.05 to 0.16[1] mg/L**	**1.27 to 2.23 mg/L**
≤ 40 Platinum Cobalt Units and > 20 mg/L $CaCO_3$	**20 µg/L**	**0.03 to 0.09 mg/L**	**1.05 to 1.91 mg/L**
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L $CaCO_3$	**6 µg/L**	**0.01 to 0.03 mg/L**	**0.51 to 0.93 mg/L**

[1] For lakes with color > 40 PCU in the West Central Region, the maximum TP limit is 0.49 mg/L

Dissolved Oxygen

Rule 62-302.533 (1), F.A.C., states that no more than 10 percent of the daily average percent dissolved oxygen (DO) saturation values shall be below 67 percent in the Panhandle West bioregion, 38 percent in the Peninsula and Everglades bioregions, or 34 percent in the Northeast and Big Bend bioregions. This site is in the Peninsula region for DO criteria assessment. Percent saturation takes into account factors such as temperature, atmospheric pressure, and salinity. For lakes, the daily average DO level shall be calculated as the average of measurements collected in the upper two meters of the water column at the same location on the same day.

The daily average freshwater DO criteria is preferentially assessed using daily average values calculated from full days of diel (collected over a 24 hour period) monitoring data. If diel monitoring data are not available, as was the case for this report, instantaneous samples are used to assess the DO criterion by comparing the instantaeous value with a time-of-day-specific translation of the daily average criterion (62-303.420(9), F.A.C.), and a spreadsheet calculator for this purpose is available at: http://www.dep.state.fl.us/water/wqssp/swq-docs.htm.

Lake Vegetation Index

The Lake Vegetation Index (LVI) assesses how closely the plant community of a lake resembles a native undisturbed community. The LVI was sampled and calculated per DEP SOP LVI 1000 and calculated per DEP SOP LVI 2000. Species lists were developed for four of twelve sections of the lake (Figure 4), and the following information was derived from those lists: percent native species, percent Category 1 invasive exotic species as identified by the Florida Exotic Pest Plant Council, percent sensitive species, and the coefficient of conservatism (C of C; a measure of how tolerant a species is of disturbance) of the dominant or co-dominant species. Chapter 62-303.330 and 62-303.430, F.A.C., provide that a LVI score of 43 or greater meets the expectation of a healthy, well balanced community, and scores below 43 are considered impaired.

Results

Water Quality

The water quality results are shown in Table 2. Based on the 11/03/2011 sampling event, the lake met the nutrient thresholds for high color, low alkalinity lakes; however, the thresholds represent annual geometric mean concentrations (minimum of four samples) not to be exceeded more than once in any three-calendar year period. The nutrient water quality results for the sample collected on 10/11/2017 may not be considered reliable due to improper handling and sample preservation as indicated by "O" and "Y" qualifiers (Table 2). However, results from 11/03/2011 nutrient samples do meet the applicable water quality criteria. Also, there is a significant difference between 2011 and 2017 results in Table 2 for both color and chlorophyll-a (algae biomass) results. Changes in color have been strongly linked to

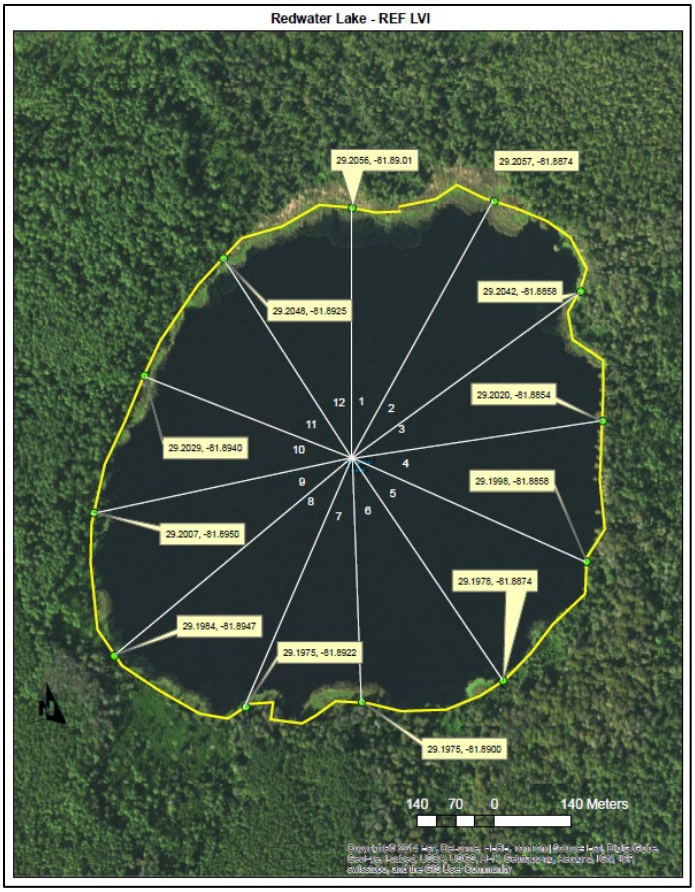


Figure 4. LVI sampling map of Redwater Lake. Sections 1, 4, 7, 10 were sampled in 2011 and sections 2, 5, 8, 11 were sampled in 2017 for the Lake Vegetation Index. The water quality sample was collected from the lake center.

seasonal rainfall and the amount of runoff that seeps into a waterbody. Tannins as well as nutrients entering the lake from adjacent hydric swamp habitat surrounding this lake may play a pivotal part of the variances. Darker tannic water (*i.e.*, higher PCU color values) limit light penetration therefore presence of algae.

DEP's Watershed Assessment Section will evaluate the complete dataset for this lake to assess compliance with nutrient criteria.

Table 2. Water quality results from 11/03/2011 and 10/11/2017 at Redwater Lake.

Analyte	Result [11/03/2011]	Result [10/11/2017]	Applicable Class III Water Quality Criteria
Field Temperature (°C)	20.6	29.4	N/A
Field pH (SU)	7.2	5.9	Within 1 SU of natural background
Field Dissolved Oxygen (% saturation)	8.6 (104%)	6.5 (84%)	*> 8.98 mg/L, > 7.64 mg/L (> 35.20%, >38.88%)
Field Specific Conductance (µmhos/cm)	122 J	87	50% above background or 1275 µmhos/cm, whichever is greater
Alkalinity (mg $CaCO_3$/L)	16	10	Shall not be depressed below 20 [or if natural alkalinity is low, shall not be reduced by more than 25%]
Color (PCU)	180	830	N/A
Chlorophyll a (µg/L)	12	0.93 I	≤ 20 µg/L for colored and alkaline clear lakes
Total Phosphorus (mg/L) as P	0.052	0.12 Y	0.05 to 0.16 mg/L
Nitrate+Nitrite (mg/L) as N	0.011	O	
Ammonia (mg/L) as N	0.020 I	0.15 Y	**< 4.14 mg/L, < 2.90 mg/L
Total Kjeldahl Nitrogen (mg/L) as N	1.3	O	N/A
Total Nitrogen (mg/L) as N	1.31	-- O	1.27 to 2.23 mg/L

* Instantaneous DO criterion calculated per DO Saturation Calculator.

** Total ammonia criterion calculated per Total Ammonia Nitrogen Calculator

I = Value is between the laboratory method detection limit and the laboratory practical quantitation limit

Y = The laboratory analysis was from an unpreserved or improperly preserved sample. The data may not be accurate.

O = Sampled, but analysis lost or not performed.

J = Values is estimated due to a failed post verification check.

Lake Vegetation Index

The 2011 LVI score for this lake was 63 out of a possible 100 points, corresponding with a "Healthy" designation. Table 3 contains the species list and occurrence information for this sampling event. A total of 2 invasive exotic plant species were observed in the lake, as indicated in Table 3 with an "*".

The 2017 LVI score for this lake was 52 out of a possible 100 points, corresponding with a "Healthy" designation. Table 4 contains the species list and occurrence information for this sampling event. A total of 5 invasive exotic plant species were observed in the lake, as indicated in Table 4 with an "*".

Table 3. Species list for the 11/03/2011 LVI at Redwater Lake. An asterisk (*) indicates an invasive exotic plant species. P = present, D = dominant, C = codominant.

Redwater Lake, 11/3/2011		Sections			
Taxon Name	**Common Name**	**1**	**2**	**3**	**4**
Acer rubrum	Red Maple	P	P		
*Alternanthera philoxeroides**	Alligator Weed		P	P	P
Aster carolinianus	Climbing Aster	P	P	P	P
Azolla caroliniana	Carolina Mosquito Fern		P		
Bidens mitis	Small Fruit Beggarticks	P		P	P
Canna flaccida	Golden Canna				P
Cephalanthus occidentalis	Common Buttonbush	P			
Cladium jamaicense	Sawgrass	P		P	P
Cyperus odoratus	Fragrant Flatsedge	P			
Fraxinus	Ash Tree	P	P		
Gordonia lasianthus	Loblolly Bay	P		P	P
Hydrocotyle	Marsh Pennywort	P	P	P	P
Hymenocallis	Spiderlily	P	P		P
Ilex cassine	Dahoon Holly	P	P	P	

Ludwigia leptocarpa	Angle Stem Primrosewillow	P	P	P	P
Magnolia virginiana	Sweet Bay			P	P
Mikania scandens	Climbing Hempvine	P	P	P	P
Myrica cerifera	Wax Myrtle	P	P	P	P
Nuphar	Yellow Pondlily	D	P	P	C
Nyssa sylvatica biflora	Swamp Tupelo	P	P	P	P
Osmunda regalis	Royal Fern				P
Pluchea	Camphorweed	P			
Polygonum hydropiperoides	Swamp Smartweed	P		P	P
Pontederia cordata	Pickerelweed	P	P	P	P
Sabal palmetto	Cabbage Palm				P
Sacciolepis striata	American Cupscale	P			P
Salix caroliniana	Carolina Willow	P			P
*Salvinia minima**	Water Spangles	P	P	P	P
Spirodela polyrhiza	Giant Duckweed		P		P
Taxodium	Cypress	P	P		P
Typha	Cattail	P	D	D	C
Vitis rotundifolia	Muscadine	P	P	P	P
Wolffiella	Watermeal				P

Table 4. Species list for the 10/11/2017 LVI at Redwater Lake. An asterisk (*) indicates an invasive exotic plant species. P = present, D = dominant, C = codominant.

Redwater Lake, 10/11/2017		**Sections**			
Taxon Name	**Common Name**	**1**	**2**	**3**	**4**
Acer rubrum	Red Maple	P	P		
*Alternanthera philoxeroides**	Alligator Weed	P	P		
Baccharis	Falsewillow	P			
Bidens laevis	Smooth Beggarticks	P	P	P	P
Cephalanthus occidentalis	Common Buttonbush	P			
Cladium jamicense	Sawgrass	P			
Hydrocotyle	Marsh Pennywort	P	P	P	P
Hymenocallis	Spiderlily		P		
Ilex cassine	Dahoon	P	P		P
*Landoltia punctata**	Spotted Duckweed	P			
Lemna	Duckweed	P	P	P	
Limnobium spongia	Frog's-Bit	P	P		

Ludwigia leptocarpa	Anglestem Primrosewillow	P	P	P	P
*Ludwigia peruviana**	Peruvian Primrosewillow	P		P	
Magnolia virginiana	Sweetbay	P	P	P	P
Mikania scandens	Climbing Hempvine	P	P		P
Myrica cerifera	Wax Myrtle	P	P	P	P
Nuphar	Yellow Pondlily	P	D	C	P
Nyssa sylvatica biflora	Tupelo	P		P	
Osmunda regalis	Royal Fern		P		
Paspalidium geminatum	Egyptian Paspalidium	P			
Polygonum punctatum	Dotted Smartweed	P		P	
Pontederia cordata	Pickerelweed	C	P	P	
Sacciolepis striata	American Cupscale	P	P	P	
Salix caroliniana	Carolina Willow	P	P	P	
*Salvinia minima**	Cat's Tongue	P	P	P	P
*Scirpus cubensis**	Cuban Bulrush	P	P	P	C
Taxodium	Cypress	P	P	P	
Typha	Cattail	C	P	C	C
Vitis	Muscadine	P	P	P	P
Wolffia	Watermeal	P			

Conclusions

Monitoring results at Redwater Lake were inconclusive due to inconstancies noted for nutrients with some parameters failing to meet applicable State Water Quality Criteria.

Water quality results were within acceptable limits for chlorophyll *a*, total nitrogen, and total phosphorus on 11/03/2011**.** Water quality results were within acceptable limits for chlorophyll *a* on 10/11/2017**,** however total nitrogen and total phosphorus results were inconclusive because the sample was improperly preserved. The Lake Vegetation Index (LVI) indicated plant communities that are consistent with expectations for a healthy, well-balanced lake on both sampling events. Although LVI results are meeting "healthy" lake criteria, the increase in number and dominance/codominance of invasive exotic plants observed may be cause for concern and caution is

needed to reduce the likelihood of spreading these plants by recreational activities.

Thank you for your interest in maintaining the water quality of Florida's lakes. Please contact us if you have any questions.

Contact and resources for more information

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DEP publications on Best Management Practices and Environmental Stewardship and Education:
http://www.dep.state.fl.us/water/nonpoint/pubs.htm
DEP biological assessment resources:
http://www.dep.state.fl.us/water/bioassess/index.htm
FWCC Aquatic Plant Management:
http://myfwc.com/wildlifehabitats/invasive-plants/
Freshwater Algal Bloom information:
http://www.dep.state.fl.us/water/bgalgae/index.htm