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CASE STUDY

Direct and indirect analysis of contamination levels in lakes of two adjacent areas

J. Figueroa Jiménez[1,*], N. Guerrero Del Castillo[1], J.C. Musa Wasil[1], K. Malavé Llamas[2], C. Morales Agrinzoni[3]

[1] *Ana G Méndez University, Virtual Campus, San Juan, Puerto Rico*

[2] *Ana G Méndez University, Carolina Campus, Carolina, Puerto Rico*

[3] *Ana G Méndez University, Cupey Campus, San Juan, Puerto Rico*

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ABSTRACT

BACKGROUND AND OBJECTIVES: In the state of Florida there are more than 2.5 million acres of fresh water available; rivers, streams, springs, artificial canals, wetlands, and lakes. Polk and Osceola Counties are under a class III classification, which means that are considered recreational waters, and people can carry out fishing and/or swimming activities within the facility. Some of the problems these lakes face is eutrophication due to pollutants such as phosphorous, nitrogen, and growth of cyanobacteria, impacting directly the quality and public health. The aim of this analysis is evaluating the effect of the presence of Total phosphorus and Total nitrogen in the water quality, and an indirect analysis of cyanobacteria by the evaluation of Secchi Disk and Chlorophyll-a analysis, in order to identify statistically differences between two counties in Florida state, to contribute with a possible improvements and ecological buffer plan to be used to reduce pollution in the lakes of the state of Florida.

METHODS: Based on this premise, it is intended to analyze secondary data on the quality of the water in the lakes of Polk and Osceola counties by evaluating the trophic status in each lake, and statistically evaluated using ANOVA, histograms and pareto analysis.

FINDINGS: Results obtained determined that lakes from Osceola County are more contaminated that lakes from Polk County since it has three lakes in eutrophic status vs two lakes in eutrophic conditions at Polk County (from 52-69 for Osceola County and 42-59 for Polk County). Similar pattern is observed when evaluating histograms and pareto plots for each parameter between the counties. ANOVA test showed that F>F critical and p-value<α, demonstrating that there is difference between both counties.

CONCLUSION: After the analysis was completed, it is recommended an evaluation by zone and improve water quality. It has been demonstrated that there is a need of new alternatives for the conservation and preservation of lakes in the state of Florida. Buffer zones are an alternative that can be very beneficial to conservation of lakes functioning also as a natural home for the flora and fauna. For the zone studied, it is recommended the use of Riparian buffers. These systems are known to improve and maintain water quality; at the same time protecting and improving fish and wildlife habitat.

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*Corresponding Author:
Email: *janelisf@yahoo.com*
Phone: +7873428556
ORCID: 0000-0002-0883-6211

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INTRODUCTION

Lakes are one of the most important water resources and have been used as a source of water supply for human consumption and represent approximately 0.3% of the total sources of surface water bodies (Vasistha and Ganguly, 2020). For example, the Great Lakes serve as the domestic water supply for 24 million Americans. Many people in the United States rely on man-made reservoirs and lakes as their source of drinking water (Toccalino and Hopple, 2010). Lakes moderate temperatures and affect the climate of the surrounding land (National Research Council, 1992). Depending on their use lakes are classified into three groups: recreational waters which are used for fishing and swimming activities are placed in Class III whereas water used for culturing shellfish are categorized as Class II and Class I waters can be used for drinking and swimming and fishing (Florida Department of Environmental Protection, (FDEP), 2021). Eutrophication is one of the problems that lakes face, which is the process of physical, chemical, and biological changes associated with the enrichment of nutrients, organic matter, and silt from a lake (United States Geological Survey (USGS), 2021). It is considered as the main cause of the degradation of lake ecosystems causing problems such as algal blooms due to excess phosphorus and nitrogen. Other problems are the presence of bacteria harmful to human health, sedimentation, oxygen depletion, change of species, changes in water levels, and growth of aquatic plants. Human activities can accelerate eutrophication by increasing the rate at which nutrients enter the water. All these problems intervene with the water quality of the lakes and in many cases are caused by anthropogenic activities (USGS, 2021). Pollutants such as phosphorus cause excessive algae growth and are among the largest contributors to water quality problems in Florida along with Nitrogen. Nitrogen and Phosphorus are essential nutrients for animals and plants to grow and are naturally found on aquatic ecosystems (Vanni, 2002) however, excess of these nutrients can cause overstimulation of the growth of algae and aquatic plants. These nutrients cause algal blooms and can be harmful to humans and animals thus becoming one of America's most widespread, costly, and challenging environmental problems (EPA, 2017). Too much Nitrogen as Nitrate can be harmful to humans and livestock. Nitrate can enter the water directly because of runoff from nitrate-containing fertilizers. Nitrate can cause problems to marine life and human health, producing diseases such as colorectal cancer, thyroid disease, and neural tube defects (Ward *et al*, 2018). On the other hand, cyanobacteria are quite common in Florida's waters and are one of the biggest causes of pollution. For some people, blue-green algae can cause rashes, stomach cramps, nausea, diarrhea, and vomiting (Florida Health, 2019). People who are very sensitive to odors may have respiratory irritation. Also, high exposures to toxins can affect the liver and nervous system. An example of pollution in lakes is the presence of cyanobacteria. Cyanobacteria can produce neurotoxins that affect the nervous system, hepatotoxins that affect the liver, and dermatoxins that affect the skin (EPA, 2019). Exposure to contaminated lake water can cause many diseases such as gastrointestinal was experienced by more than 403,000 residents of the Metropolitan area of Milwaukee, Wisconsin, and illness from Cryptosporidium parvum parasites (Pandey, 2014). Although in developed countries there are more regulations and laws for the protection of bodies of water, pollution has not stopped being a problem (Rogers and Hall, 2003). Effective water governance (Vol. 7). Stockholm: Global water partnership. In the state of Florida there are more than 2.5 million acres of freshwater available; rivers, streams, springs, artificial canals, wetlands, and lakes. As described in an article published in Schiffer (1998), seeing the state from the air will give the impression that there is more water than land. The lakes are among the most valuable natural resources of central Florida and its economy. It has more naturally formed lakes (7,800) than other states in the southeastern United States, where many lakes are created by building dams across streams. Thirty-five of these lakes are in 4 counties, including Polk County and Osceola Count. In both counties, all lakes are class III (FDEP, 2021). Trophic states of Florida lakes range from oligotrophic to hypereutrophic, due in part to deposits of phosphatic materials in some soils (Griffith *et al*., 1997; Bachmann *et al*., 2012a). At least 70% of Florida lakes have no surface inlet or outlet (Bachmann *et al*., 2012a). The lakes are warm all year, and only some northern Florida lakes experience rare instances of overnight freezing of the lake surface (Bachmann *et al*., 2012a). Considering that lakes can be the water supply for communities and cities, the

conservation of lakes is necessary. The quality of the water must be constantly monitored, and the input of nutrients must be restricted to avoid the excessive growth of algae. It is also important to create solid water management plans and design projects for the conservation of lakes such as buffers zones. In addition, they can cause skin irritation, swelling of the lips, irritation of the eyes, sore throat, sneezing, runny nose, and fatigue after swimming in affected lakes. Many diseases are related to consumption or contact with contaminated water. For example, "Waterborne infections cause diarrhea and kill nearly a million people each year. Most are children under the age of five. Therefore, evidence is needed on the exposure and health effects of contaminant mixtures in drinking water "(Levallois and Villanueva, 2019). Water quality is paramount for public health and point source pollution has been a problem in the past because some lakes were once recipients of sewage effluents or other organic materials such as waste from citrus processing, although those point sources have been largely controlled (Bachmann *et al*. 2012a). It is not clear, due to insufficient information and documentation, the overall impact of nonpoint source nutrient enrichment on Florida lakes (Bachmann *et al.,* 2012c). Even when the state of Florida has been aggressive in nonpoint control activities (Bachmann *et al*., 2012a) currently the state faces an environmental problem in terms of its water resources. Over ten years period over 20 million dollars has been spent collecting and analyzing data related to concentrations and impacts of nitrogen and phosphorus pollution in Florida. However, they have not been able to stop water quality degradation from nitrogen and phosphorus over-enrichment and it's still a significant problem (EPA, 2017). Several groups of toxic cyanobacteria have been found in Florida waters. The Microcystis, Anabaena, and Cylindrospermopsis groups and their associated toxins occur in Florida freshwater systems, including those used for drinking water. The presence of cyanobacteria has affected many aquatic systems in Florida including lakes (Tonnessen, 2019). Some of the health effects produced by the accidental ingestion of water contaminated with cyanobacteria are nausea, vomiting, and, in severe cases, acute liver failure (FFWCC, 2019). Understanding the environmental and socio-economic importance that lakes have for the state of Florida, their conservation is imperative. Invasive aquatic species, pollution, coastal and watershed development, and storm water problems threaten the health and water quality of Florida's lakes. Water contains many nutrients and minerals and is essential for human life, nonetheless, urbanization and agricultural alteration of formerly natural watersheds has resulted in unsustainable nutrient over-enrichment with water quality decline, harmful, algal bloom, habitat loss, and loss of fisheries being well-reported symptoms of ecosystem decline and collapse (National Research Council, 1992). In recent years, strict regulations and control have increased rapidly in monitoring the surface water bodies due to their deterioration (Vasistha and Ganguly, 2020). As stated by the Osceola Lakes Management Plan (2015), the Florida Department of Environmental Protection measurements establishes that there are 47 impairments listed for Osceola County water bodies, 18 for mercury and the rest for low dissolved oxygen, high fecal coliform levels, and nutrient impairments. The Osceola Lakes Management Plan also informs that Lakes Kissimmee and Cypress in Osceola County are included on the federal list of impaired and threatened waters 303 (d) list. On the other hand, in the county of Polk, there are 67 lakes included in the 303 (d) list. Among these lakes is Lake Ariana. As reported by the EPA (2017), once a body of water has been added to the list of impaired waters, it is not removed until the state determines the total maximum daily loads (TMDL) and the EPA approved it. It is necessary to establish measures for the protection of lakes and the reduction of anthropogenic activities that affect not only the water quality of the lakes but also public health. According to a publication from Michigan State University (2019) the United States is not protecting its lakes. In fact, it is explained that, in 2010, the Convention on Biodiversity (CBD) declared the need to protect at least 17% of the world's fresh water by 2020 to avoid the rapid decline in freshwater biodiversity and services ecosystems. Let's consider that in 2010 the US Environmental Protection Agency had to set numeric nutrient criteria for Total Phosphorus (TP), Total Nitrogen (TN), and Chlorophyll a (Chl-a) for lakes in the State of Florida after the state did not establish them on its own (Bachmann *et al,* 2012b). "Several of Florida's 30 benchmark lakes (lakes with minimal human impact and meeting designated uses) were eutrophic, and there was no

significant difference between the mean concentrations of TP and TN in these lakes versus all remaining Florida lakes" (Bachmann *et al.* 2012b). By law, Florida waters are owned by the citizens of Florida. Public access to Florida's bodies of water is an important and highly protected right. The only way a lake can be considered private is if all the land around the lake is privately owned and there is no access to the water from any public area (Blackmar, 2006). Most of Florida's great lakes have public boat ramps that have been protected for many years. There are laws at the federal and state level for the conservation of bodies of water and to ensure public health (Borisova *et al*., 2021). Under section 303 (d) of the CWA, authorized states, territories, and tribes, collectively referred to in the law as "states," must develop lists of impaired waters, which are those that do not meet established quality standards (National Research Council, 2001). Assessing the TMDL approach to water quality management. National Academies Press.. The law requires states to establish priority classifications for the waters on the charts and to develop Total maximum daily loads (TMDL). A TMDL includes a calculation of the maximum amount of a contaminant that can be present in a body of water and still meet water quality standards. Additionally, as part of the CWA, states are required to establish water quality standards (WQS) for waters within the state by establishing water quality criteria to protect the body of water and adopting requirements to protect and maintain healthy waters. In addition, the Department of Environmental Protection has a series of regulations for the management of water resources. Such is the case of the rule Standards of surface water quality. This regulation establishes the minimum criteria necessary to protect the designated uses of a body of water, the surface water classification, and lists Florida's specially protected waters. EPA determined under Clean Water Act (CWA) section 303(c)(4)(B) that new or revised Water Quality Standards (WQS) in the form of numeric water quality criteria is necessary to protect the designated uses from nitrogen/ phosphorus pollution that Florida has set for its Class I and Class III waters (EPA, 2010). Counties also have their own management plans for the lakes. Polk County is managed by the Southwest Florida Water Management District and Osceola is managed by the South Florida Water Management District. Districts administer flood protection programs and conduct technical research on water resources to develop water management plans for water scarcity in times of drought and acquire and manage land for water management purposes. Delegated regulatory programs include water use management, aquifer recharge, well construction, and surface water management (Southwest Florida Water Management District, 2018). The natural diversity of lakes in Florida will make individual lakes suited for different uses (Griffith *et al.*, 1997; Bachmann *et al.,* 2012). In Osceola and Polk counties the lakes are used mainly for recreation (swimming or water sports) and fishing. This contamination is often caused by improperly treated wastewater, manure, and fertilizers. The quality of water in lakes has a direct impact on the environmental situation and public health. Based on this premise, an evaluation between the two counties will be performed to see if there is a difference between them, and the contamination can be granted to activities from a county specifically. Given the urgent need that exists to protect lakes and ensure the well-being of public health, it is important to implement new forms of conservation and protection. With this information, a possible remediation plan can be performed to improve the water quality in the area. The Null hypothesis will be that there is no difference between each county, therefore a global plan to improve water quality can be implemented. Conversely, if there is a difference, an evaluation by zone must be performed to create a mitigation plan specific for each area. Using secondary, public access data, it is intended to analyze the water quality using the parameters Total phosphorus, Total nitrogen, and an indirect analysis of cyanobacteria by the evaluation of Secchi Disk and Chlorophyll-a analysis in three lakes in Polk count and three lakes in Osceola County to evaluate the quality of these with respect to their class III water body classification. In addition, possible improvements that can be established or added to the Florida state water bodies' management plan will be identified. It is also expected to identify what type of buffer zone can be used to reduce pollution in the lakes of the state of Florida. The general objectives of this comparative study are: 1) Analyze secondary public access data on water quality using the parameters of total phosphorus, total nitrogen, secchi disk, and chlorophyll-a for cyanobacteria analysis in two lakes in Polk and Osceola counties to

evaluate the quality of these with respect to their classification as a class III water body; 2) Identify if there is a difference between the results obtained statistically to create improvements that can be made to the Florida state water body management plan; 3) Identify what type of ecological buffer/plants can be used to reduce pollution in the lakes of the state of Florida. This study has been carried out in three lakes in Osceola County and three lakes in Polk County in the state of Florida. In Osceola County the following lakes were evaluated: Kissimmee, Alligator, and Tohopekaliga Lakes. In Polk County the following lakes were evaluated: Blue, Ariana, and Cypress Lakes. The analysis of all these parameters has not been constant, so the period to be evaluated will consist of approximately 8 years that ranges from 2008 to 2015, averaging the results in a yearly basis. Since the analysis of cyanobacteria is only carried out when there is a proliferation of these that represents an environmental and health problem, the average results of each year for Secchi Disk and Chlorophyll-a were evaluated as an indirect analysis for this parameter. The information used to analyze these problems were secondary data and it is available in the public domain. This research was completed in the city of Winter Haven, Florida in 2020.

MATERIALS AND METHODS

The study area

The study deals with three lakes in Osceola and three lakes in Polk counties in the state of Florida. In Osceola County the following lakes were evaluated: Kissimmee, Alligator, and Tohopekaliga Lakes. In Polk County, the following lakes were evaluated: Blue, Ariana, and Cypress Lakes. The subtropical climate of Florida influences lake biology; warm lakes have prolonged growing seasons with a greater probability of long-lasting algal blooms (Bachmann *et al.,* 2012b). In addition, Florida has a different and limnologically important geological history. Florida lakes have deposits of phosphorus-containing minerals that underlie several areas of the state (Bachmann *et al.*, 2012b). These deposits are not distributed uniformly across the state and are related to differences in the TP content of the various orders of soils found in the state.

Study period

The analysis of all these parameters has not been constant, so the period to be evaluated will consist of a period of approximately 8 years that ranges from 2008 to 2015, averaging the results yearly. As with the majority of studies, the design of the current study is subject to this limitation. However, there is relevance of the data even though it is old because it can be used for reviewing, historical documentation, and comparisons on future analysis and researches. For the analysis of cyanobacteria, since this test is only carried out when there is a proliferation of these that represents an environmental and health problem, the average results of each year for Secchi Disk and Chlorophyll-a were evaluated as an indirect analysis for this parameter. The information used to analyze these problems was secondary data and it is available in the public domain.

Description of the sample

Secondary public access data provided by state environmental agencies were analyzed for this study. For the lakes in Polk County and Osceola County secondary data was analyzed and for Lakes Kissimmee, Jackson and Marian, in Osceola County, are included in the federal list of impaired and threatened waters known as the 303 (d) list. Lake Ariana, Cypress, and Blue Lakes from Polk County were included in the analysis.

Experimental design

In this study, no experimental tests were carried out and no equipment and/or experts are required for the study area. The data used is secondary and publicly accessible.

Statistical analysis

A comparative analysis of the following variables was carried out using independent samples; total phosphorus, total nitrogen, secchi disk, and chlorophyll-a; the last two parameters were used for cyanobacteria analysis. These variables were measured and compared between different lakes in Polk and Osceola counties in the state of Florida by evaluating and identifying their concentrations and confirming which county has the highest presence of these contaminants. ANOVA test was used to determine the difference in the quality of water between Osceola and Polk counties, and Pareto and Histograms charts were used to evaluate the frequency where these parameters are with or

without specification parameters and how the accumulative behaves per interval. In addition, the analysis was able to evaluate which county meets the parameters established at the federal level by the EPA and with the parameters established at the state level.

RESULTS AND DISCUSSION

In the current study water quality parameters using Total phosphorus, Total nitrogen, and analysis of cyanobacteria through Secchi disk were carried out to determine whether these are in compliance with standards set by USEPA for the state of Florida.

General Evaluation

The obtained results of Total Nitrogen (TN) for Osceola County lakes are discussed in (Table 1).

According to the data, sampling is not consistent for all lakes in Osceola and Polk counties. Therefore, average results were evaluated for all lakes. Two lakes conformed to the state specification for total nitrogen: Lake Alligator and Tohopekaliga for Osceola County and Cypress Lake for Polk County. These lakes, even though the results are within the specification, these values are increasing every year. Lake Kissimmee and Lake Blue had high results for TN, especially Blue Lake that triplicated the results during 2009-2011. Lake Ariana results oscillate in and out of specification with a spike in 2011 and then started to decrease by 2012 and increase again by 2013. According to Florida rule 62-302.531 effective on February 17, 2016 the state parameters are as follow: Chlorophyll a = 20 µg/L, Total Phosphorus = 0.03mg/L or 30 µg/L, Total Nitrogen = 1.05mg/L or 1050 µg/L and Secchi Disk = 2.4 m. Secchi Disk average results showed that for Kissimmee (from 2010-2012) and Cypress Lake (from 2009-2013) results conformed to the specification. The lakes had more transparency than the rest of the lakes evaluated. Osceola County had more visibility than Polk County lakes. Lake Blue had the lowest results which mean that there is barely visibility (Table 1). Chlorophyll-a average results do not have the same number of samples for all lakes. Lake Alligator and Lake Tohopekaliga are missing a significant number of samples considering the years and data used for analysis. For Osceola

Table 1: Osceola and Polka Counties TN, TP, Chl-a, and SD Average Result for each year

County	Lake	Test Analyzed	Year (Y)							
			2008	2009	2010	2011	2012	2013	2014	2015
Osceola	Kissimmee	TN ≤1050 µg/L	1521	1404	1103	1204	1228	1222	1231	1173
	Alligator		532	1035	1028	704	903	794	644	778
	Tohopekaliga		701	943	838	762	1063	734	733	895
	Blue		2655	3720	2543	3165	2370	2693	2315	2223
Polk	Ariana		1019	1108	1550	1599	1165	1285	1344	1323
	Cypress		817	712	618	717	774	7079	824	828
Osceola	Kissimmee	SD ≥ 2.4 m	1.2	1.9	2.7	2.7	2.5	2.3	2	1.8
	Alligator		2	1.1	1.1	1.2	1.2	1.6	2.2	1.5
	Tohopekaliga		0.9	0.9	1.1	1.4	0.8	1	-	0.5
	Blue		0.4	0.3	0.5	0.3	0.6	0.4	0.4	0.4
Polk	Ariana		0.9	1	0.8	0.7	0.8	0.8	0.7	0.8
	Cypress		2	2.8	4.5	4.4	2.8	2.8	2.3	3.7
Osceola	Kissimmee	Chl-a ≤ 20 µg/L	33	21	16	22	27	24	28	26
	Alligator		9	-	-	25	-	-	-	44
	Tohopekaliga		9	6	8	4	5	2	-	5
	Blue		80	133	65	78	52	64	56	65
Polk	Ariana		25	21	31	44	27	26	28	31
	Cypress		6	5	3	4	7	7	7	3
Osceola	Kissimmee	TP≤160 µg/L	53	42	42	47	54	46	49	48
	Alligator		12	23	21	17	19	16	13	18
	Tohopekaliga		23	23	22	18	25	16	16	22
	Blue		72	92	62	63	56	69	53	54
Polk	Ariana		23	23	31	28	23	26	25	24
	Cypress		10	12	7	7	10	10	9	14

County, Lakes Kissimmee and Alligator are above the established parameters. Lakes Ariana and Blue do not meet the state criteria. Even though Cypress Lake and Tohopekaliga lakes are in compliance with the parameters, the results lowered in 2010 - 2011 and then start increasing after this period. The Total Phosphorus (TP) results can be observed in. For this specific parameter, Lake Blue in Polk County was consistently out of the acceptable parameters. Lake Ariana showed a spike in TP by 2010 but the remaining years are within specification parameter but with the results close enough to have keep an eye on it since it is in a critical state. For Alligator Lake, Tohopekaliga Lake, and Cypress Lake, results oscillate. These values increase up to 2010 and then start decreasing. By 2012 there was another spike and right after, the total phosphorus results start decreasing. Per USEPA, any lake with an alkalinity >20 mg/L as CaCO3 is out of compliance if the water has an average chlorophyll concentration >20 µg/L, which would classify the lake as eutrophic by the USEPA's definition. For Florida lakes with an alkalinity ≤20 mg/L, the lake must meet oligotrophic criteria, with an average chlorophyll concentration no greater than 6 µg/L, to be in compliance. According to Bachmann et al. 2012b, when applying these criteria, 44% of Florida's lakes are considered impaired. Lakes from Osceola County are more contaminated that lakes from Polk County since it has three lakes in eutrophic status. In contrast, Polk County has two lakes in eutrophic conditions and one in mesotrophic conditions. Lake Blue is almost under hypereutrophic condition. TSI (Chl-a) and TSI (SD) are under hypereutrophic condition and TSI (TP) is under eutrophic condition (Table 2). Since this lake has the worst-case scenario, the data obtained was evaluated against the correlations table from Carlson and Simpson (1996). As per this evaluation, TSI(SD)=TSI(CHL)>TSI(TP). Therefore, phosphorus limits algal biomass (TN/TP>33:1). For this lake, TN/TP results are between 37 to 50, results higher than 33:1. After evaluating these results, the same analysis was performed for the remaining lakes (Table 3). Results showed that all lakes had the same correlation at some point during the period of analysis. For macrocystis, a provisional Tolerable Daily Intake (TDI) and guidance values have been established. The suggested drinking water guidance value, per the World Health Organization (WHO), is 1 µg L−1, and a recreational guidance value of 20 µg L−1 for activities in direct contact with water, and 100 µg L−1 for activities having indirect contact with water (Bigham Stephens *et al.*, 2009).

Comparison of results

Histograms and Pareto plots were compared for each parameter between the counties (Figs. 1-8). For TN (Fig 1 and 2), most of the results are in the first interval (618, 1652] with a 42.86%. This interval contains results below 1050 µg/L but also contains data that is above the specification.

Table 2: Trophic status for lakes of Osceola and Polk counties

Lake	Trophic status for TP	Trophic state Chl-a	Trophic state for SD	Average	Lake Status
Lake Kissimmee	61	62	49	57	eutrophic
Lake Blue	63	72	72	69	eutrophic
Lake Tohopekaliga	48	48	60	52	eutrophic
Lake Alligator	46	62	54	54	eutrophic
Lake Cypress	37	46	44	42	Mesotrophic
Lake Arianna	51	63	63	59	eutrophic

Table 3: Correlation between TN/TP

TN/TP	2008	2009	2010	2011	2012	2013	2014	2015
Kissimmee	28	34	26	26	23	26	25	24
Alligator	44	45	50	41	47	49	51	42
Tohopekaliga	30	41	38	42	43	45	46	42
Blue	37	40	41	50	43	39	43	41
Ariana	44	49	50	57	50	49	55	55
Cypress	84	61	86	104	76	80	89	58

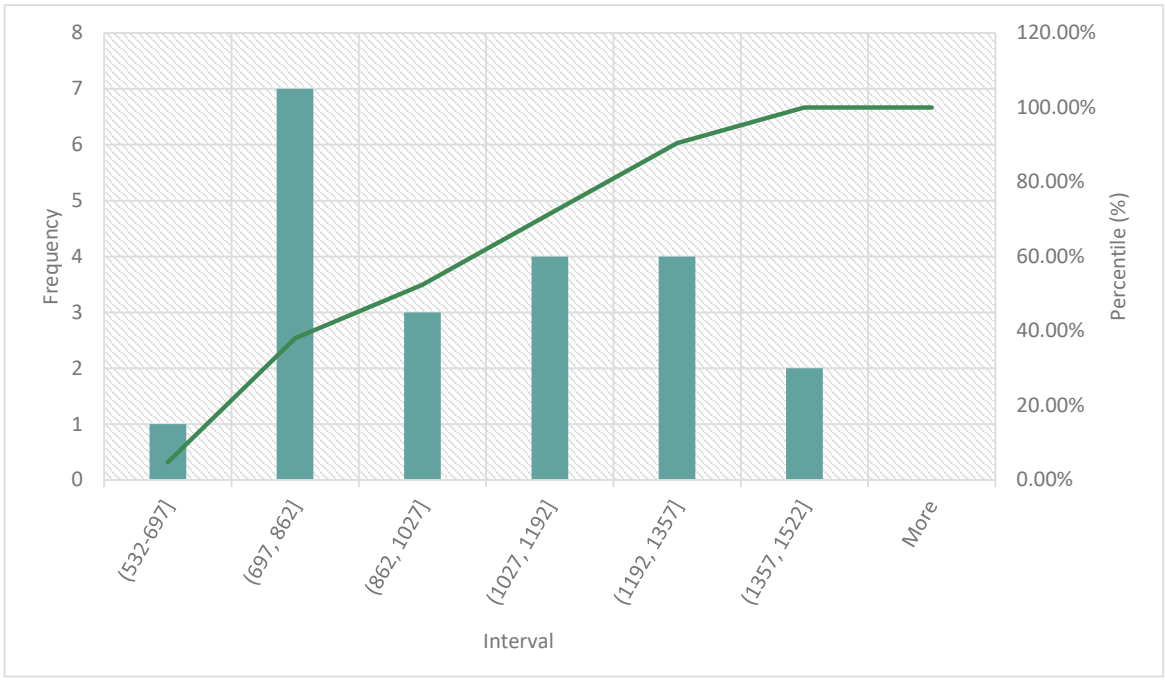

Fig. 1: Histogram and Pareto Graphic for TN Osceola County

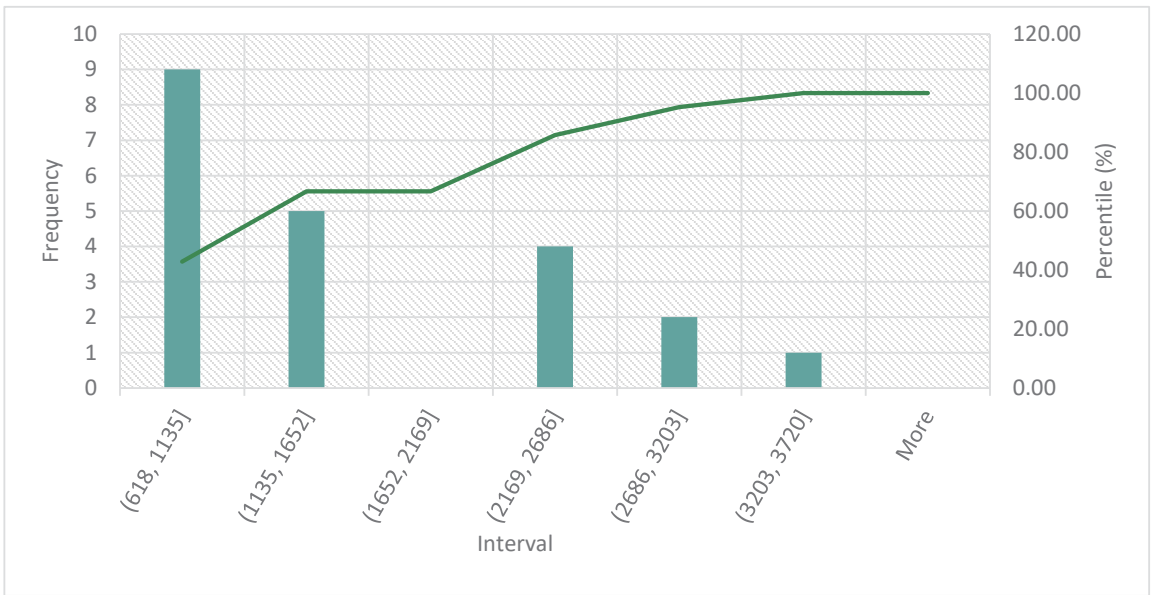

Fig. 2: Histogram and Pareto Graphic for TN Polk County

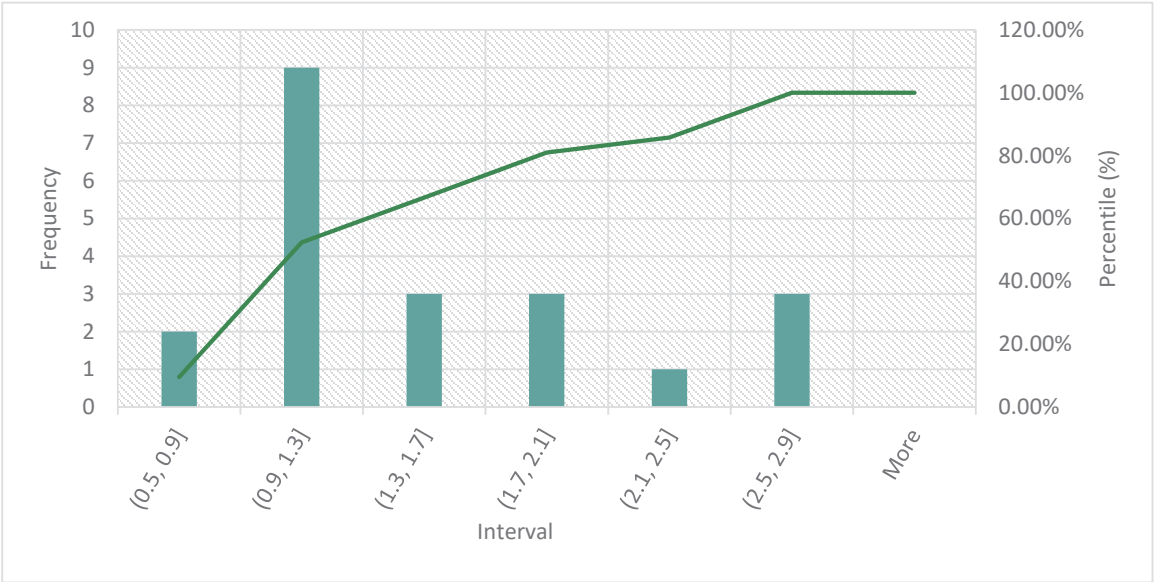

Fig. 3: Histogram and Pareto Graphic for Secchi Disk in Osceola County

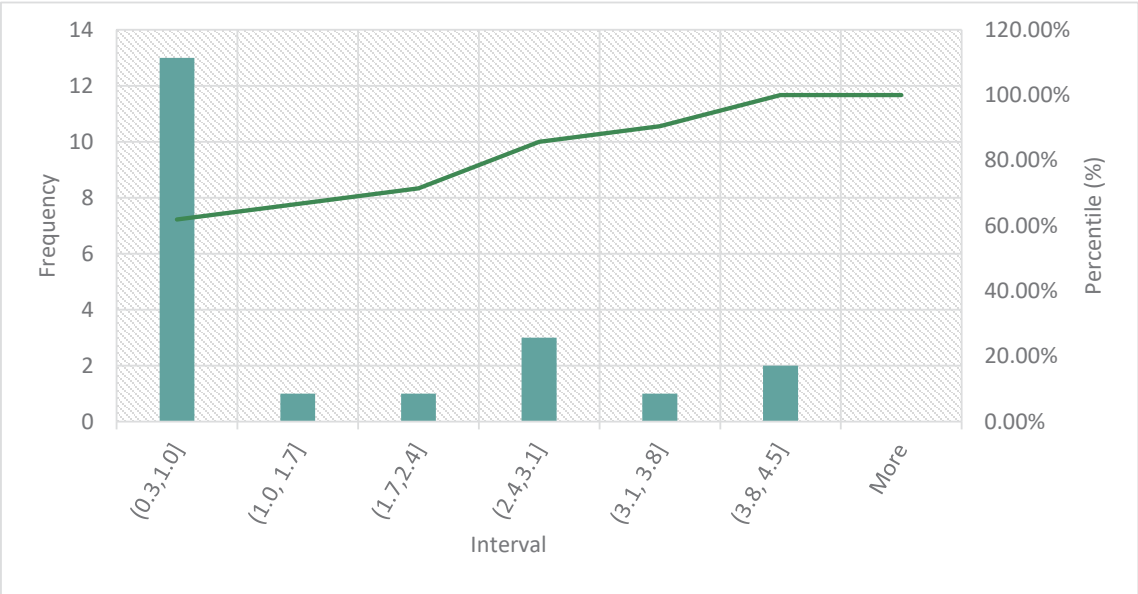

Fig. 4: Histogram and Pareto Graphic for Secchi Disk in Polk County

Therefore, 57.14% of the values evaluated are out-of-specification and are contributing to the lake's eutrophic status. For Osceola County, the second interval (697, 862] contains most of the data and contains results that are within specification. In this case, 52.83% of the results are within specification. After the interval (1027, 1192], results are out of specification. Therefore, more than 28.57% of the results obtained are out of specification. Results for Secchi disk (Fig 3 and 4), the interval that contains

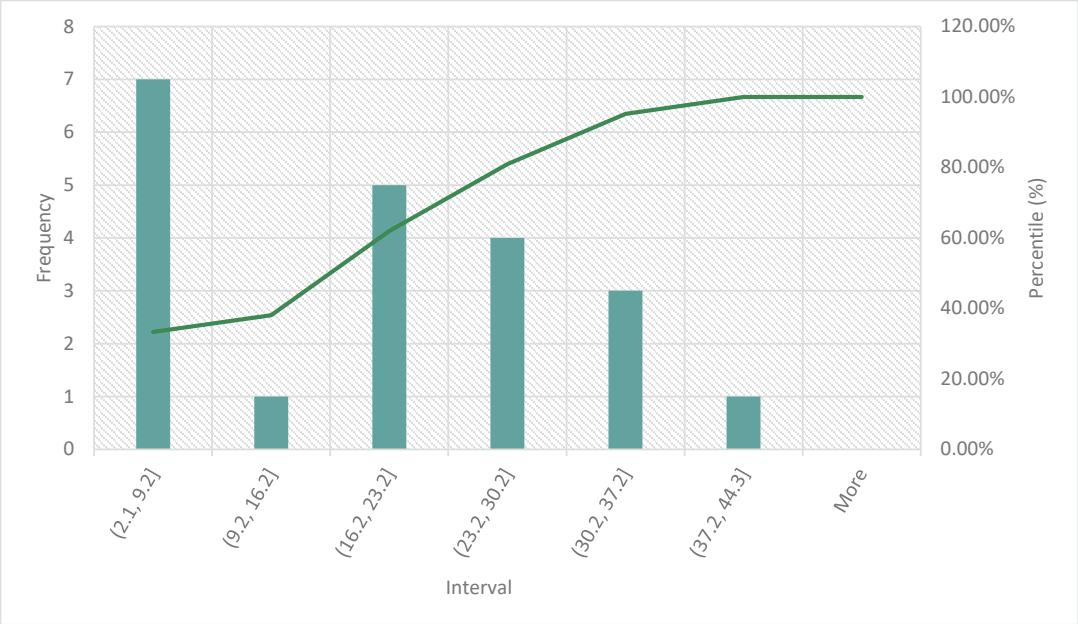

Fig. 5: Histogram and Pareto Graphic for Chlorophyll-a in Osceola County

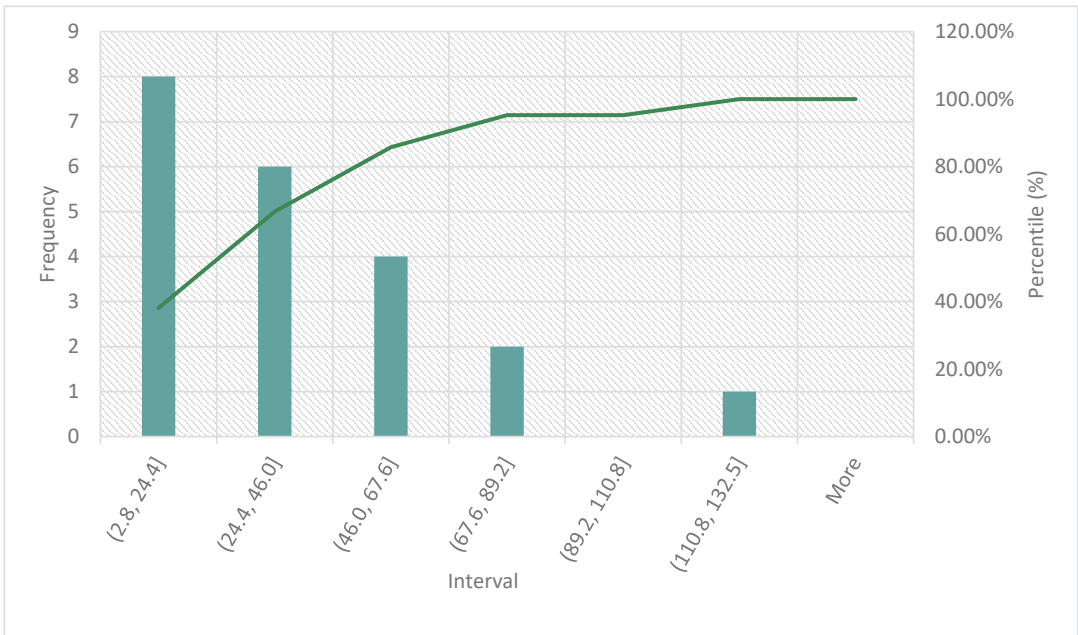

Fig. 6: Histogram and Pareto Graphic for Chlorophyll-a in Polk County

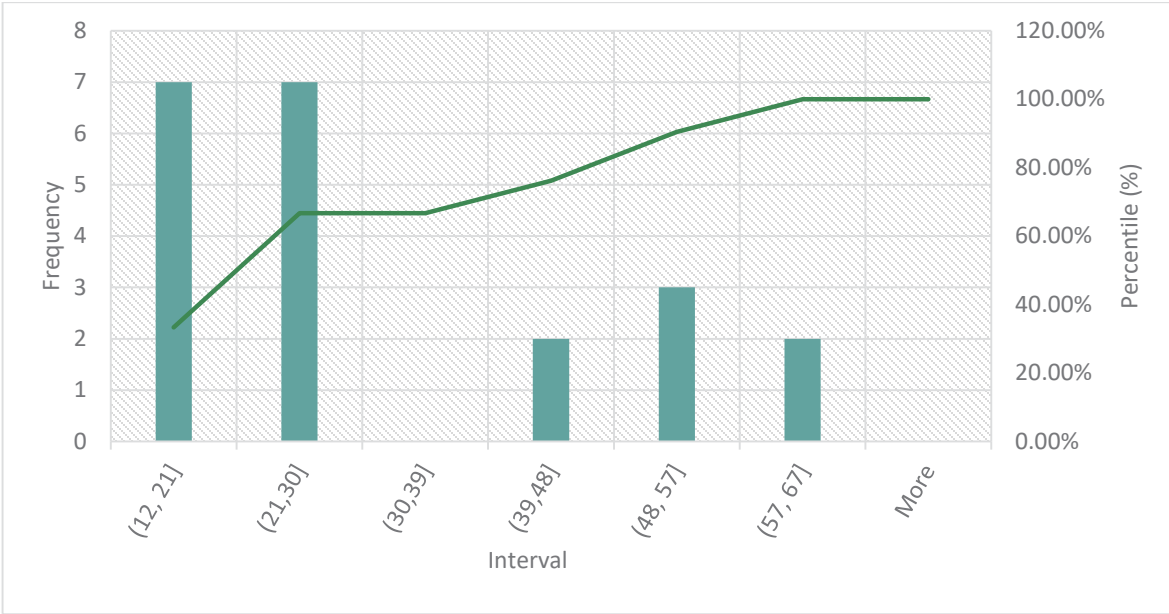

Fig. 7: Histogram and Pareto Graphic for TP in Osceola County

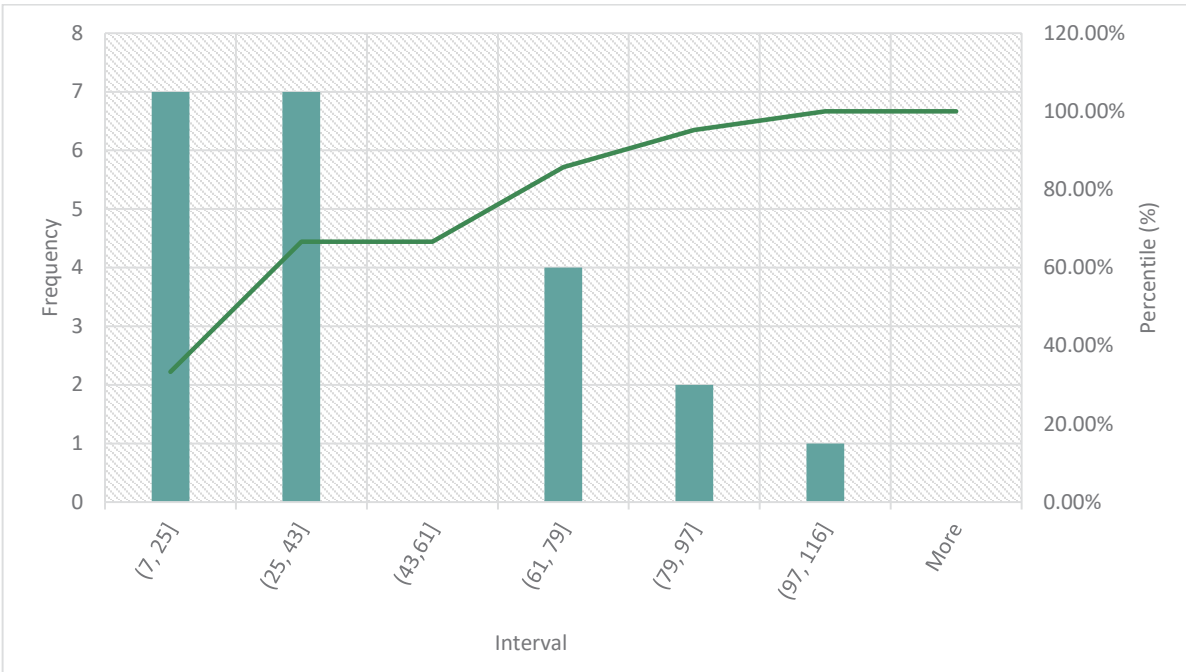

Fig. 8: Histogram and Pareto Graphic for TP in Polk County

Table 4: ANOVA: Two-Factor with Replication used to compare Osceola and Polk counties (n=168)

	Osceola			Polk			
SUMMARY	*Kissimmee*	*Alligator*	*Tohopekaliga*	*Blue*	*Ariana*	*Cypress*	Total
Total Nitrogen							
Count	7	7	7	7	7	7	42
Sum	8855.8125	5773.833	5934.840253	19367.5	9047.917	5244.752	54224.66
Average	1265.116071	824.8333	847.8343219	2766.786	1292.56	749.2503	1291.063
Variance	21142.09113	32551.71	16584.68168	264866.1	47781.1	5285.398	549511.6
Secchi Disk							
Count	7	7	7	7	7	7	42
Sum	15.07958333	9.784775	6.595905238	2.974967	5.8125	22.95878	63.20652
Average	2.15422619	1.397825	0.942272177	0.424995	0.830357	3.279826	1.504917
Variance	0.292006217	0.100929	0.079926213	0.012708	0.006138	0.881361	1.143582
Chlorophyll-a							
Count	7	7	7	7	7	7	42
Sum	169.2375	180.1	40.41740741	536.1975	205.0083	33.79282	1164.754
Average	24.17678571	25.72857	5.773915344	76.59964	29.2869	4.827546	27.73223
Variance	27.14893436	154.6224	5.924184813	695.9034	52.31287	2.727893	720.221
Total Phosphorus							
Count	7	7	7	7	7	7	42
Sum	333.0208333	127.1319	148.5	467.75	178.2658	69.44643	1324.115
Average	47.57440476	18.16171	21.21428571	66.82143	25.46655	9.920918	31.52655
Variance	24.59604415	12.16739	8.689484127	163.3065	9.352243	5.920525	424.0597
Total Count	28	28	28	28	28	28	
Sum	9373.150417	6090.85	6130.353566	20374.42	9437.003	5370.95	
Average	334.755372	217.5304	218.9411988	727.6579	337.0358	191.8197	
Variance	304187.052	134843.5	140465.2021	1497289	326369.2	108595.4	
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Sample	50893520.74	3	16964506.91	1045.645	1.68E-97	2.667443	
Columns	5653238.808	5	1130647.762	69.68999	1.01E-36	2.277044	
Interaction	14587449.53	15	972496.6352	59.94199	4.09E-54	1.736359	
Within	2336250.592	144	16223.96245				
Total	73470459.67	167					
If F> F-crit and the value of p <than α then the null hypothesis (H0) alpha is rejected = 0.05							

most of the results is the first (0.3, 1.0] for Polk County with 61.90% of the results and 71.43% of the results are out of specification; 28.57% of the results evaluated confirmed with the specification. For Osceola County, the second interval (0.9, 1.3] has most of the results and not more than 85.71% of the results are out of specification; only 14.29% are with the expected parameter. Chlorophyll-a results (Fig 5 and 6) for Osceola County has most of the results in the first interval (2.1, 9.2] with 33.33%. At the third interval (16.2, 23.2], the results contained are with and without specification. Therefore, less than 61.90% of the results conform to the specification parameters and 38.10% are out of specification. For Polk County, the first interval (2.8, 24.4) has most of the results with less than 38.10% of the results conforming to the parameters and 61.90% of the results out of specification. Total phosphorus results (Fig 7 and 8) for Osceola County are more prominent at the first interval (12, 21] and second interval (21, 30] with 33.33% and 66.67% of the results conforming to the specification. Conversely, 33.33% of the results analyzed are out of specification. During the evaluation of the data of Polk County, the first (7, 25] and second (25, 43] have the same amount of data. Since the second interval contains results above specification, is correct to conclude that less than 66.67% of the results conform to specification and 33.33% do not. ANOVA analysis was performed to evaluate if there were differences between both

counties. After evaluating the data, results showed that the results for F are higher than for F critical. Also, the p-value calculated showed results higher than the alpha value (0.05). This means that there is a difference between the activities conducted between the counties (Table 4).

CONCLUSION

In the state of Florida there are more than 2.5 million acres of freshwater available; rivers, streams, springs, artificial canals, wetlands, and lakes. Polk and Osceola Counties are under a class III classification. This means that are considered recreational waters, and people can carry out fishing and/or swimming activities within the facility. Some of the problems these lakes faces are eutrophication due to pollutants such as phosphorous, nitrogen, and the growth of cyanobacteria. The general objectives of this comparative study were to analyze secondary public access data on water quality using the parameters of total phosphorus, total nitrogen, secchi disk and chlorophyll-a for cyanobacteria analysis in two lakes in Polk and Osceola counties to evaluate the quality of these with respect to their classification as a class III water body. The analysis showed that the null hypothesis is rejected, and the alternate hypothesis is accepted. There was a difference between the counties and an evaluation by zone should be performed. Also, the data analysis shows that Osceola County has a major index of nutrient contamination vs Polk County. Nevertheless, the difference among the lakes is not substantial. A particular situation for Osceola County is the lack of samples for *chlorophyll-a.* These results are not enough to utilize to predict cyanobacteria presence in these lakes. Florida does not have a specific agency to monitor freshwater harmful algal bloom. Considering this, chlorophyll-a should be performed consistently across the board. However, TSI for these lakes reveals the high possibility of algae bloom and cyanobacteria presence. Both counties are facing high nutrient issues and lack of sampling in these areas specifically. As mentioned before, it is important to understand that when it comes to the numeric nutrient criteria issue that the state is facing, and a major factor making Florida lakes different from others in the United States, is the presence of vast deposits of phosphorus-containing minerals that underlie several areas of the state Also, these deposits are not uniformly distributed across the state but are related to differences in the TP content of the various orders of soils found in Florida.

Limitations

The data is not consistent and equal for all the lakes evaluated. Lake's monitoring does not appear to be robust enough. For example, in several lakes, the amount of sample and data was not the same and there were periods of no data at all. This means that there is no constant, centralized monitoring for all lakes. In addition, the geology and limnology of the state of Florida make the presence of nutrients such as phosphorus, naturally excessive. Another limitation within this statistical analysis is that in order to consider the parameters of the state, the alkalinity of the waters must be considered.

It is also stated in this publication that Secchi disk depth has been dropped as an indicator in FDEP's recent TSI calculations (1996 Water Quality Assessment for The State of Florida Section 305(b) Main Report). Another interesting point presented in the water atlas publication, "TSI is often misinterpreted and misused from its original purpose, which is to describe the level of biological productivity. It is not meant to rate a lake's water quality". In other words, high TSI values can be a good depending on the type of activity that will be performed at the lake. Fishing, which is a major activity that has a huge impact on Florida's economy, will require a lake with lower TSI.

Recommendation

After the analysis of secondary data for Polk and Osceola counties, it has been demonstrated that there is a need for new alternatives for the conservation and preservation of lakes in the state of Florida. Buffer zones are one of the alternatives that can be very beneficial to the conservation of lakes, and it is also a natural alternative. The use of buffer zones can help provide a vegetative filter for runoff approaching a waterway, acting to trap particulates and absorb flows to minimize the entry of contaminants into lakes. Buffers can trap fertilizers, pesticides, pathogens, and heavy metals, and they help trap snow and cut down on blowing soil in areas with strong winds. In addition, they protect livestock and wildlife from harsh weather.

Buffer zones help stabilize a stream and reduce its water temperature. Buffers also offer a setback distance for agricultural chemical use from water sources. They also help to reduce flooding, conserve energy and biodiversity. One of the most important benefits of the buffer zones is improving water quality removing sediments, pesticides, pathogens, and other contaminants. There are different financial incentives available through USDA conservation programs when buffer zones are installed. One of the alternatives is the Riparian buffer. Riparian buffers can improve or maintain water quality, and to protect or improve fish and wildlife habitat. Using a diversity of trees, shrubs, grasses, and forbs will provide shade, organic matter, and eventually woody debris to the water body. In general, wider riparian buffers provide better wildlife cover and fish habitat. Maintenance needs will vary by design.

AUTHOR CONTRIBUTIONS

J. Figueroa Jimenez performed the literature review, experimental design, analyzed and interpreted the data, prepared the text, N. Guerrero Del Castillo give support with statistical analysis, and the thesis committee of Ana G. Méndez University: J. Musa, K. Malavé and C. Morales mentored, gave recommendations, and review the final thesis report.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS

Chl-a	Chlorophyll-a
CBD	Control on Biodiversity
CWA	Clean Water Act
EPA	Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
FIG.	Figure
FWC	Florida Fish and Wildlife Conservation Commission
N	Nitrogen
µg/L	Microgram per liter
mg/L	Milligrams per liter
P	Phosphorus
SD	Secchi Disk
SWFWMD	Southwest Florida Water Management District
TMDL	Total maximum daily load
TN	Total Nitrogen
TP	Total phosphorous
UF/IFAS	University of Florida/ Institute of Food and Agricultural Sciences

USDA	United States Department of Agriculture
USGS	United States Geological Survey

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