Invited Contribution: Citizen Science Programs in Florida

Florida LAKEWATCH: Citizen Scientists protecting Florida's aquatic systems

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Abstract *Florida LAKEWATCH* is a successful example of a long-term volunteer water quality-monitoring program that started in 1986. Working with thousands of volunteers, these dedicated citizen scientists have collected reliable long-term water quality data for over 1100 lakes, 175 coastal sites, 120 rivers, and 5 springs. These data encompass water resources in 57 Florida counties. This manuscript describes the start and evolution of *LAKEWATCH*, including discussions of the following two major (of the many) hurdles to the continued success of the program: 1) demonstrating to professional groups that trained volunteers are capable of collecting credible (research and regulatory quality) data, and 2) maintaining consistent long-term funding. Funding is especially critical because trained and committed core staff is needed to work along with volunteers. Quality staff members are also important to provide direction, ensuring consistent data are collected and enough sites are monitored to answer statewide questions such as how geology impacts water chemistry in Florida. Examples are also provided on how *LAKEWATCH* data have been used to address lake management issues (i.e., "fixing" the problem) in the State of Florida. We hope the *Florida LAKEWATCH* experience assists other groups who have a vast army of citizen scientists waiting to get involved and then to best develop a successful monitoring program.

Keywords Volunteer monitoring, lakes, estuaries, nutrients, Secchi depth, chlorophyll

Background

Through time, citizens have participated in studies of their natural surroundings out of curiosity and a sense of stewardship for their land and water. Indeed, two centuries ago, most naturalists were amateurs, earning their livelihood as physicians, theologians, or other professions (Silverton 2009). Many of these individuals collected scientific data without formal academic training or financial compensation. These volunteers were eventually replaced with professionals, however in today's economy there is not enough money available to monitor the many natural resources we have with professionals and citizen scientists are reappearing in large numbers. In 1998, the United States Environmental Protection Agency (EPA) estimated that there were 900 volunteer-monitoring initiatives in the U.S. that conduct scientific investigations in conjunction with governmental agencies or universities, generally as a professional public–private partnership (EPA 1998). Objectives for such

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volunteer monitoring activities range from educational outreach to the generation of data used for regulatory purposes (Loperfido et al. 2010, Mackechnie et al. 2011). Success of these volunteer monitoring programs varies considerably with some lasting only a few years and others like *Florida LAKEWATCH* continuing for almost 30 years.

Why the longevity? *LAKEWATCH* has always focused on one important question: What is the name of the most important lake in Florida? Answer: My Lake! This question and corresponding answer gets to the core of why volunteer monitoring programs succeed. Volunteers have to be personally vested in the stewardship of the systems/organisms before they will regularly spend their time and resources to monitor these systems. For the *Florida LAKEWATCH* program that means volunteers are seriously vested in protecting/managing the aquatic resources they regularly enjoy. Volunteers also continue their diligent sampling efforts because they receive constant feedback and education on lake management issues from professionals at the University of Florida willing to work with them through both the good and bad times.

Florida LAKEWATCH began in 1986 when citizens from Lake Santa Fe and Lake Broward (Alachua County) contacted the University of Florida seeking answers on how to best manage their lakes. They approached UF because it was difficult to get answers from a myriad of governmental agencies. Dr. Daniel Canfield, a limnologist at UF, suggested that they collect and bring water samples to the water quality laboratory at UF for analyses. Through the first several months the volunteers were educated on the functioning of lakes and began to see how the nutrient concentration from the samples they collected were related to chlorophyll concentrations and eventually the water clarity of their lake. This stimulated their desire for more education and willingness to share their newfound knowledge with other lake users from around the state.

Research in the 1970s (Schindler et al. 1971, Schindler 1974) had demonstrated the two important chemical factors influencing the ecology and management of most lake systems were the primary limiting nutrients, total phosphorus and total nitrogen. Increases in these two limiting nutrients in a lake (natural or man-made increases) will increase the lake's biologic productivity. To provide a quick assessment of the lake's biological productivity, algal biomass was estimated using total chlorophyll measurements. Increases in algal biomass in a lake will decrease water clarity because it interferes with light penetration through the water. Finally, water clarity as measured by the use of a Secchi disk, was added to the citizen sampling protocol because changes in water clarity are readily noticed by lake users and users often evaluate the quality of a lake based on its water clarity. These core variables were chosen at the start of the *LAKEWATCH* Program because of their ecological scientific importance and because properly trained citizens could do the work without the expenditure of inordinate amounts of time. Measurement of these water chemistry variables continues into today after a quarter century of success.

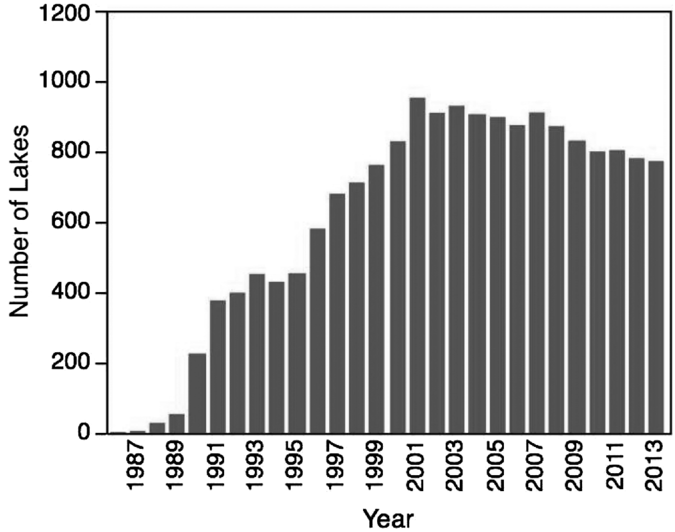

Figure 1. Number of lakes involved annually in the *Florida LAKEWATCH* program.

Success of Lake Santa Fe and Lake Broward endeavors soon spread and volunteers from all across the State of Florida were eager to join the UF program (Figure 1). Increases in volunteers and lakes to the *LAKEWATCH* started to provide state-wide data required to investigate and answer important limnological questions related to the diversity of lakes along changing geologic gradients. Before this time researchers understood the importance of edaphic factors (soil and geology) to water quality, but could not provide a concise picture for water managers due to the paltry amount of available data. It was further recognized that the establishment of a successful citizen monitoring network would set the groundwork for establishing a long-term database, which could then be used to understand natural variability in Florida's aquatic systems due to changes in rainfall and stochastic events like hurricanes and fire. More importantly, there would be a quantitative basis, rather than recollections, to determine if lakes were changing over time.

To maintain statewide volunteer sampling for establishing long-term databases, volunteers require continual feedback and communication to keep them sampling and motivated. This requires people, money, and a home. The most logical home for a statewide volunteer sampling program, based on limited history of such programs outside of Florida (i.e., Minnesota and Vermont), would have been establishment of the program within a state agency charged with managing water quality. Florida volunteers recommended the program be established at an institution with a historical devotion of helping all Floridians, Florida's land grant university the University of Florida's Institute of Food and Agricultural Sciences (IFAS). UF/IFAS with its commitments to research, teaching, and extension provided an ideal foundation for building and sustaining the *Florida LAKEWATCH* Program.

This large of an endeavor provided an opportunity to fulfill the teaching component of the land-grant mission. UF/IFAS also had the ability to hire professional staff to help the citizen scientists and the students. As the *LAKEWATCH* program grew, it was clear the future blueprint for the *LAKEWATCH* program had to follow the University of Florida's land-grant ethic of promoting teaching, research, and outreach/extension with the goal of collecting credible data across Florida's aquatic systems.

Original funding and professional work on the *LAKEWATCH* program came from residual monies and staff time available from other research activities. Soon the program grew to such an extent that residual monies would no longer support continued growth (Figure 1). Professional and public interest with citizen involvement in the program flourished to such a degree that continued requests for state funding were heard and the Florida Legislature officially established *Florida LAKEWATCH* in 1991 (Chapter 1004.49 F.S.). The Florida Legislature originally provided an annual appropriation from the Water Quality Assurance Trust Fund (the appropriation now varies from year to year and source to source depending on available state dollars) to the Florida Department of Environmental Regulation (now the Florida Department of Environmental Protection), which was directly transferred to UF/IFAS to operate the program. State funds were then leveraged with university funds, funds obtained from County governments, and donation dollars from individual Floridians.

The *LAKEWATCH* legislation reads as follows:

1004.49 Florida LAKEWATCH *Program. –The* Florida LAKEWATCH *Program is hereby created within the Department of Fisheries and Aquaculture of the Institute of Food and Agricultural Sciences at the University of Florida. The purpose of the program is to provide public education and training with respect to the water quality of Florida's lakes. The Department of Fisheries and Aquaculture* [now the Fisheries and Aquatic Sciences Program, School of Forest Resources and Conservation] *may, in implementing the* LAKEWATCH *program:*

(1) Train, supervise, and coordinate volunteers to collect water quality data from Florida's lakes.
(2) Compile the data collected by volunteers.
(3) Disseminate information to the public about the LAKEWATCH *program.*
(4) Provide or loan equipment to volunteers in the program.
(5) Perform other functions as may be necessary or beneficial in coordinating the LAKEWATCH *program.*

Data collected and compiled shall be used to establish trends and provide general background information and shall in no instance be used in a regulatory proceeding.

The last statement was placed in the legislation to insure professionals would examine and verify trends established by the volunteers and prevent erroneous data from being misused. However, over the years this statement has led to strengths and limitations for the *Florida LAKEWATCH* Program. Legislative intent permitted volunteers to collect data without the fear that their efforts would be used against them in some form of regulatory action. Therefore, agencies were assured "made up" samples would not be used by activists to initiate judicial actions (strength). However, regulatory agencies with the financial resources to support additional monitoring efforts hesitated to fund *LAKEWATCH* because they could not that use the data for their regulatory actions (limitation).

Funding is a problem for all monitoring programs, especially long-term programs. Most federal, state, and local agency leaders and professionals struggle with spending money to provide long-term monitoring of environmental factors of aquatic systems because they believe it spends money on information and not actually on "managing" or "fixing" the problems (Lovett et al. 2007, Wintel et al. 2010). However, these same agencies have complained about the lack of historical record for aquatic systems to help make management decisions and achieve desired management goals. Thus, monitoring is a necessity that has to be accomplished cost effectively yet is rigorous enough to provide information needed for management (Field et al. 2004).

While funding is always a big problem, the biggest hurdle for volunteer monitoring programs in getting professionals to accept the fact that volunteers, after professional training, are capable of collecting research quality data. To alleviate that problem, *LAKEWATCH* conducted a paired comparison study on 125 lakes where UF professionals and *LAKEWATCH* volunteers sampled the same lakes on the same day (Canfield et al. 2002). These results showed data collected by the volunteers were comparable to data collected by professionals. Mean total phosphorus, total nitrogen, chlorophyll, and Secchi depth measurements obtained by volunteer were strongly correlated ($r > 0.99$) to the values obtained by the professionals. Despite these results, other professional groups remained unsatisfied because all data were processed in the same *LAKEWATCH* laboratory, which was not a National Environmental Laboratory Accreditation Conference (NELAC)-certified laboratory in compliance with the state's QA rule. In 2011, another comparison study was conducted where the Florida Department of Environmental Protection (FDEP) professionals sampled 27 lakes and processed samples through their NELAC laboratory and *LAKEWATCH* volunteers collected samples on the same 27 lakes and processed samples though the *LAKEWATCH* laboratory (Hoyer et al. 2012). Again the comparison showed data collected and analyzed by FDEP were comparable to data collected and analyzed by *Florida LAKEWATCH*. Along with this comparison study, *LAKEWATCH* worked with FDEP to change many of the laboratory operating procedures (where feasible considering limitations of a statewide volunteer program) to meet requirements of FDEP QA rule. These two actions have opened many doors for the use of *LAKEWATCH* data. For example, FDEP can now use *LAKEWATCH* data to evaluate the effectiveness of management programs such as the total maximum daily load (TMDL). Hopefully, *LAKEWATCH* data will provide Florida with the ability to leverage limited monitoring funds with *LAKEWATCH*'s citizen scientists to provide data that are truly needed to establish trends required to tackle aquatic challenges.

From *LAKEWATCH*'s perspective, the best way to use the vast amount of data collected by citizen scientists is to use a tiered monitoring approach for the management of Florida's aquatic systems. Tier 1 monitoring should use the cost effective *LAKEWATCH* program to collect physical, chemical, and biological data on as many systems as possible for the continual examination of trends per Legislative intent. If a trend is found, Tier 2 studies by professionals using a more expensive level of QA/QC (i.e., FDEP professionals sampling and analyzing samples with a NELAC certified laboratory) can be initiated to confirm the trend, identify causes, and then develop a management strategy to restore the system. After the responsible governmental agency develops solutions to the challenge or challenges, citizen scientists can reinitiate their sampling to provide future insurance that the aquatic system is functioning properly to meet its designated uses. However, it has been difficult to get some governmental/regulatory agencies in Florida to embrace tiered-monitoring approach, because many members of their professional staff remain apprehensive of the credibility of volunteer collected data. Thus, one important goal for any volunteer monitoring program should be to continually examine and showcase to the appropriate professional groups and elected officials the quality of the data citizen scientists collect.

Florida LAKEWATCH has been and continues to be a successful volunteer water quality program. Since its start in 1986, thousands of *LAKEWATCH* volunteers have collected reliable long-term water quality data on over 1100 lakes, 175 coastal sites, 120 rivers, and 5 springs that span 57 Florida counties. For long-term trend analyses *LAKEWATCH* provides at least 20 years of monthly data on 27 lakes and at least 15 years of monthly data on 195 lakes. Currently, *LAKEWATCH* analyzes approximately 45,000 samples a year. Organizing and making data available to all interested stakeholders is another important aspect of the *LAKEWATCH* program. *LAKEWATCH* has always managed its data primarily in a statistical package called JMP (SAS 2000). After a robust in-house quality assurance check, data are distributed annually to all state agencies, county governments and/or stakeholders that request data. Data are provided in simple spreadsheet formats for ease of use. Additionally, all of these data are housed and can be downloaded from USEPA's STORET data management systems and the *Florida LAKEWATCH* website (http://*LAKEWATCH*.ifas.ufl.edu/).

There is no way to describe all of the aspects of the *LAKEWATCH* program and directions it has taken in the last 28 years. *LAKEWATCH* was continually adding different research aspects such as the role of aquatic plants, to answer questions that were continually posed by the volunteers or other professionals. *LAKEWATCH* has used the results to create information circulars to address the issues and terminology in an understandable format while maintaining scientific credibility (Appendix 1). At the same time,

Table 1. Number of publications using *Florida LAKEWATCH* data published in different peer reviewed journals.

Peer Reviewed Journal	No. Publications
Lake and Reservoir Management	11
Hydrobiologia	8
Canadian Journal of Fisheries and Aquatic Science	3
Transactions of American Fisheries Society	3
Florida Scientist	3
Journal of Aquatic Plant Management	2
Journal Fish Biology	1
Freshwater Biology	1
Limnology and Oceanography	1
Ecology	1
Lake and Reservoirs: Research and Management	1
Inland Waters	1

LAKEWATCH's committed researchers maintained a steady stream of research publications in peer-reviewed journals showcasing the quality of data collected by volunteers (Table 1). The remainder of this paper describes specific research addressing the original objectives of the *LAKEWATCH* program: 1) How is the limnology of Florida lakes impacted by changing geologic gradients everywhere apparent in Florida. 2) What variance is exhibited among and within Florida lakes, and 3) Are there trends in the water quality of Florida lakes?

The Geological Factor

Since the early 20th century, aquatic scientists have recognized the importance of edaphic factors (geology and soils) as a primary determinant of water quality (Naumann 1919). As the population of Florida began to increase during the 1960s and 1970s, water quality issues related to Florida lakes began to take center stage. The first water quality surveys by the Florida Fish and Wildlife Commission in the 1960s demonstrated individual Florida lakes could have different water quality, but the reason behind the differences were unclear (Holcomb 1968, 1969 and Holcomb and Starling 1973). In the 1970s, research by Florida scientists began to compile sufficient information and support the emerging idea that water chemistry varied by a lake's geographic location (Shannon and Brezonik 1972). By the beginning of the 1980s, a survey of 165 Florida lakes provided evidence of the importance of regional geology to the chemical and trophic state characteristics of Florida lakes (Canfield and Hoyer 1988). But, detailed patterns in different locations could not be established because there was still insufficient water quality data on large numbers of lakes – Enter *Florida LAKEWATCH*.

The USEPA in the 1990s was attempting to develop their Ecoregions approach for assessing water quality in U.S. lakes, but the three Ecoregion proposed for Florida did not work well for Florida (Giffith et al. 1997). Working with the newly obtained *Florida LAKEWATCH* water quality data and geologic and soils information, 47 distinct Lake Regions were developed for Florida. This led to the development of the Lakes Regions Map of Florida that provided managers a basis for understanding why water quality differed among groups of lakes located only small distances apart. By the beginning of the second decade of the 21st century, the establishment of science-based numeric nutrient criteria was a major issue. Due to the complexity of the patterns in water quality established by the Lake Regions of Florida, conflict developed between USEPA and FDEP regulators. A simple approach of using one criteria value for total phosphorus and total nitrogen in all Florida lakes, as is often done for water quality standards, was not feasible because many waters would be declared impacted, potentially costing the State of Florida billions of dollars in restoration costs, when the lakes high phosphorus or nitrogen concentrations naturally occurred. Here, the work of the many *LAKEWATCH* volunteers again comes to the rescue.

Bachmann et al. (2012) used data collected over 3 decades by *LAKEWATCH* to simplify the 47 Lake Regions for Florida into 6 total phosphorus zones and 5 total nitrogen zones (Figure 2). This simplification provided USEPA and FDEP regulators a basis for developing numeric nutrient criteria that took into account regional differences. More importantly, USEPA and FDEP regulators now had the scientific basis for removing waters from the presumptive Impaired List if during the professional verification process it was determined the water was functioning as expected for its designated nutrient zone. This approach was adopted by the Florida Environmental Regulation Commission and ultimately approved by the Florida Legislature (FAC 62-302.200).

Long-Term Variation and Change

Although lakes are naturally ephemeral, there is great concern of anthropogenic-driven eutrophication in freshwater systems caused by global increases in human population. Freshwater systems are especially sensitive to changes in the environment (Kernan et al. 2010); yet long-term, robust datasets providing the ability to capture such changes are not readily available. *Florida LAKEWATCH* citizen scientist efforts provide the opportunity to gain perspective of long-term (20-plus years) variance and changes in lake trophic state across a population of lakes. Here, we report on analyses from a subset of the *Florida LAKEWATCH* database to examine long-term variance and determine long-term trends in total phosphorus, total nitrogen, chlorophyll concentrations, and water clarity measurements (Bigham 2012).

Florida LAKEWATCH database includes measurements of lake trophic state (i.e., total phosphorus, total nitrogen, total chlorophyll, and water clarity measurements) for over 1100 lakes spanning the State of Florida. A 27-lake subset of the *LAKEWATCH* database has lakes that were sampled every month for at least 20 and up to 24 years. Such a lake trophic state dataset is unrivaled by government monitoring efforts and exceeds suggested frequency and duration data requirements to appropriately account for variance and detect trends in lakes (Molot and Dillon 1991, Knowlton and Jones 2006,

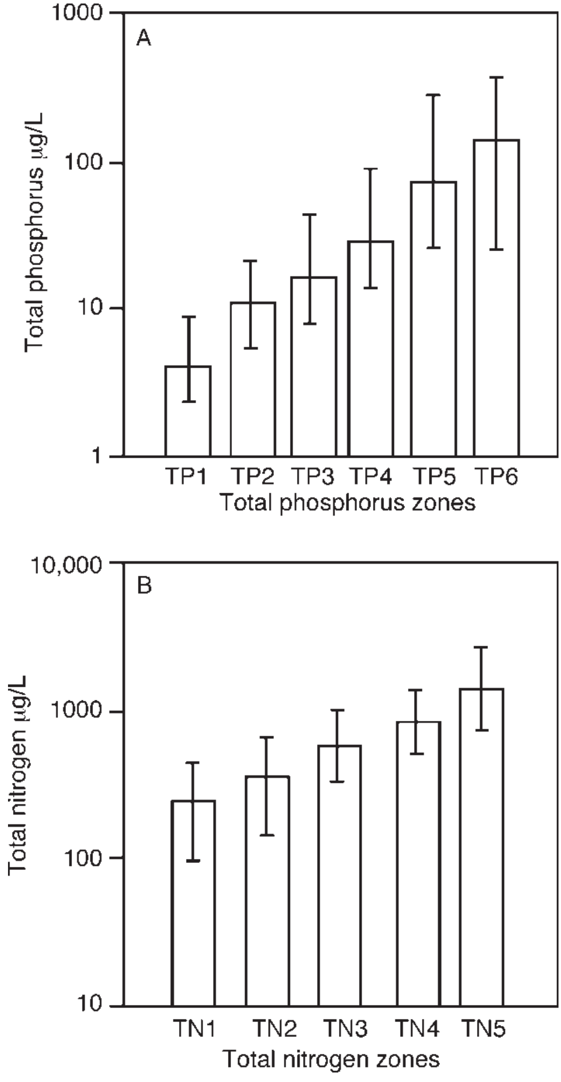

Figure 2. A. Median concentrations of total phosphorus for Florida lakes grouped into five geographic zones. Ends of the vertical lines represent the 10th and 90th percentiles. B. Similar plots for the 5 total nitrogen zones. Based on maps and data from Bachmann et al. (2012).

Howden et al. 2011). Additionally, the population of 27 Florida lakes encompassed the wide range of trophic state categories, from oligotrophic to hypereutrophic, representing the diversity of lake biological productivity found across the State of Florida (Canfield and Hoyer 1988).

Water collection and Secchi disk measurement procedures and analytical methods for total phosphorus, total nitrogen, and chlorophyll concentrations were consistent through time and followed *Florida LAKEWATCH* protocol

Table 2. Percent of variance attributed to lake-to-lake, year-to-year, month-to-month, and residual error (i.e., station-to-station and laboratory) differences for the population of 27 Florida lakes.

Trophic State Variable	% Variance Lake-to-Lake	% Variance Year-to-Year	% Variance Month-to-Month	% Variance Residual Error
Total Phosphorus	82%	9%	6%	3%
Total Nitrogen	86%	7%	5%	2%
Chlorophyll	82%	6%	10%	2%
Water Clarity	83%	8%	8%	1%

(Canfield et al. 2002, Hoyer et al. 2012). Individual lakes in the population of 27 lakes were sampled at three, open-water stations every month. There were a few missing monthly datum in some lakes due to limited sampling caused by stochastic events (e.g., hurricanes, floods, or droughts). In such instances, missing monthly values were replaced by averaging the mean month datum prior and after the missing value. Variance component analysis was used to identify factors contributing to the observed variance in total phosphorus, total nitrogen, chlorophyll concentrations, and water clarity measurements at the population level. Variance attributed to lake, year, month, station, and residual error (including laboratory error) was examined using the monthly data for the population of 27 Florida lakes.

For the population of Florida lakes, the majority of variance for total phosphorus (82%), total nitrogen (86%), chlorophyll (82%), and water clarity (83%) was due to lake-to-lake differences (Table 2). Remaining variance was attributed to either year-to-year differences (total phosphorus = 9%, total nitrogen = 7%, chlorophyll = 6%, water clarity = 8%) or month-to-month differences (total phosphorus = 6%, total nitrogen = 5%, chlorophyll = 10%, water clarity= 8%). Residual error, which includes variance attributed to station-to-station and laboratory error, accounted for less than 5% of the total variance (total phosphorus = 3%, total nitrogen = 2%, chlorophyll = 2%, water clarity = 1%).

Kendall-Tau correlation coefficients (τ) measured the association between a given trophic state variable and time (i.e., year). Kendall-Tau is a nonparametric, measure of rank correlation and uses the calculated coefficient (τ) to test for statistical dependence (equation 2-2 in Kendall 1938).

$$''\tau = ''((\text{number of concordant pairs}) \\ -(\text{number of discordant pairs}))/(1/2\ n\ (n-1))$$

With:

τ = Kendall-Tau correlation coefficient (range $-1 \leq \tau \leq 1$)
concordant pairs = (x, y) pairs from examined X and Y variables where the ranks for both elements agree
discordant pairs = (x, y) pairs from examined X and Y variables where the ranks the elements disagree

n = the number of observations
½ n (n−1) = the total number of pairs

Kendall-Tau examined the number of pairs in different orders in the two rankings (Kendall 1938). Tau coefficient equaled 1 if the two rankings were in the same order (i.e., concordant pairs) and tau equaled -1 if the two rankings were inverted (i.e., discordant pairs). A positive tau value indicated a statistically significant increase and a negative tau value indicated a statistically significant decrease over the available record of data.

Kendall-Tau evaluation indicated long-term movement in trophic state variables towards a more biologically productive system in a quarter to less than half of the population of 27 examined Florida lakes. Increasing monotonic trends in total phosphorus were detected in 37% (10 lakes) of the population of 27 Florida lakes, 44% (12 lakes) for total nitrogen, and 22% (6 lakes) for chlorophyll concentrations (Table 3). Decreasing monotonic trends in water clarity were detected in 31% (6 lakes) of the lakes. If signals of lake eutrophication are defined as concomitant increases in nutrient and chlorophyll and decreases in water clarity, then we suggest 4 of the 27 Florida lakes exhibit a 20-year pattern of eutrophication. Using the same definition of eutrophication, also suggests long-term oligotrophication of one lake.

Summary

When professionals are asked the simple question, are long-term monitoring databases needed, the answer is a definitive yes! Monitoring is needed to determine if actual changes are occurring in a system and to evaluate management efforts to restore systems that have changed. *Florida LAKEWATCH* is just one of the many examples showing that citizen scientists can significantly contribute to the monitoring of environmental systems. There is now growing support around the world to embrace these volunteers to cost-effectively collect the data needed to understand and manage these environmental systems. A key to starting and/or maintaining a volunteer program is a director and staff who understand the value of and are dedicated to working with citizen scientists. *LAKEWATCH* evolved in an academic setting, which ended up being the perfect place where the funds are used to support the citizen scientists, but can also be leveraged for teaching, research and extension. Truly a case of taxpayers getting more "bang for the buck", but the home could also be in an agency.

To be successful a volunteer monitoring program needs to be embraced by the state agencies. These agencies should use the cost effective volunteer to canvas large areas that they themselves cannot afford to sample and when a problem is found then they can bring in professionals to evaluate and hopefully manage. To ultimately be successful, there will need to be strong political support including long-term dedicated funding. To receive this political and funding support, the program must continually show that the volunteers are capable of producing research quality data and make that data available to all interested stakeholders. The last and most important component is to find

Table 3. Kendall-tau detection of trends in annual mean total phosphorus (TP), total nitrogen (TN), total chlorophyll (CHL), and water clarity as measured by a Secchi disk (SD) for 27 Florida lakes (arrows indicate direction of trends). Lakes denoted with $^{\times}$ indicate whole lake increasing trends in TP, TN, CHL and decreasing trend in SD. Lake denoted with $^{\times\times}$ indicate whole lake decreasing trends in TP, TN, CHL and increasing trend in SD.

County	Lake	N Years Data	TP	TN	CHL	SD
Alachua	Alto	23	↑	↑	–	↓
Alachua	Little Orange	21	–	–	–	↓
Alachua	Little Santa Fe$^{\times}$	24	↑	↑	↑	↓
Alachua	Santa Fe$^{\times}$	24	↑	↑	↑	↓
Alachua	Wauberg	20	↑	↑	↑	–
Hillsborough	Brant	20	–	–	–	–
Hillsborough	Magdalene	21	–	–	–	–
Lake	Beauclaire	20	↓	–	–	–
Lake	Crooked$^{\times\times}$	20	↓	↓	↓	↑
Lake	Dora East	20	↓	–	–	–
Lake	Dora West	20	↓	–	–	–
Lake	Grasshopper	20	↑	–	–	–
Lake	Harris	20	–	–	↓	–
Lake	Lorraine	20	↓	↓	↓	.
Lake	Sellers$^{\times}$	20	↑	↑	↑	↓
Marion	Charles	20	–	↑	–	–
Marion	Deerback	22	–	–	–	–
Marion	Eaton	20	–	–	–	–
Marion	Halfmoon	20	–	↑	↓	–
Orange	Georgia	21	↑	↑	–	↓
Orange	Giles	20	–	–	–	–
Orange	Ola	20	–	↑	↑	–
Orange	Sarah	20	–	–	↓	–
Putnam	Como	22	↑	↑	–	–
Putnam	Higgenbotham	20	–	–	↓	–
Putnam	Star	21	↑	↑	–	↓
Putnam	Winnott$^{\times}$	21	↑	↑	↑	↓

volunteers willing to spend time and their resources to collect samples. These volunteers can generally be found out enjoying "My Lake".

Acknowledgments We thank the dedicated *Florida LAKEWATCH* volunteers for their hours of dedicated service.

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Appendix 1. *Florida LAKEWATCH* Information circulars provided for the educational/extension aspects of the program. All circulars are available on the *Florida LAKEWATCH* web site (http://LAKEWATCH.ifas.ufl.edu/).

Florida LAKEWATCH. 1999. A beginners guide to water management-The ABCs, Descriptions of commonly used terms. Information Circular #101.

Florida LAKEWATCH. 2000. A beginners guide to water management-Nutrients. Information Circular #102.

Florida LAKEWATCH. 2000. A beginners guide to water management-Water clarity. Information Circular #103.

Florida LAKEWATCH. 2001. A beginners guide to water management-Lake Morphology. Information Circular #104.

Florida LAKEWATCH. 2001. A beginners guide to water management-Symbols, Abbreviations & Conversion Factors. Information Circular #105.

Florida LAKEWATCH. 2003. A beginners guide to water management-Bacteria. Information Circular #106.

Florida LAKEWATCH. 2003. A beginners guide to water management-Fish Kills. Information Circular #107.

Florida LAKEWATCH. 2004. A beginners guide to water management-Color. Information Circular #108.

Florida LAKEWATCH. 2004. A beginners guide to water management-Oxygen and Temperature. Information Circular #109.

Florida LAKEWATCH. 2007. A beginners guide to water management-Fish Communities and Trophic State in Florida Lakes. Information Circular #110.

Florida LAKEWATCH. 2007. A beginners guide to water management-Aquatic Plants in Florida. Information Circular #111.