New York State CSLAP Program Effectiveness at Achieving Water Quality Improvement

By

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Abstract

This study intended to evaluate the performance of the 262 Lakes that participate in the New York State Citizen Statewide Lake Assessment Program (CSLAP), to determine if CSLAP participation could be used as a surrogate indicator of lake water quality improvement. In order to determine the directionality of sustained quality change over time, only those lakes for which CSLAP data had been continuously collected for 5-or more years were investigated, which amounted to 68% of the total number of participating lakes (n=178). While approximately 1/3 of these continuously-monitored lakes showed improvement in the amount of Chlorophyll-A over their monitoring period (n=59), less than half as many showed improvement in clarity (n=24). Unfortunately, very little correlation was shown to exist between these two standard measures of eutrophication, with only 8% lakes exhibited simultaneous improvement in both measures (m=14). These data suggest either that Chlorophyll-A readings may be more prone to Type-1 errors in through this program, or that Clarity, could be more prone to Type-2 errors. As a result, this study considered more closely only those 14 continuously-monitored lakes which showed improvement on both measures as well as 6 other lakes which degraded in both measures. These lakes were then statistically analyzed to determine any differences between the two groups. Statistical testing determined that there is no statistical difference between these two groups. These results were also analyzed for any spatial autocorrelation, but there were no patterns. Citizen Science programs can be very beneficial to governmental organizations when their results are accurate.

Acknowledgement

Thank you to Dr. George Kraemer, Dr. Allyson Jackson, all other member of the Purchase College Environmental Studies Department, and especially Dr. Ryan Taylor.

Introduction

In recent centuries, the anthropogenic impact on the environment has significantly altered natural ecosystems. One major change to the natural environment is the nutrient enrichment of waterbodies occurring as a result of human activity, otherwise known as cultural eutrophication. This excess of nutrients comes from sources like fertilizer and fossil fuel combustion and leads to excessive plant and algal growth (19). In small amounts these nutrients are beneficial and necessary for the system but in excess they can cause algae and bacterial colonies to grow exponentially and can create algal blooms. It is now highly researched and well documented that due to cultural eutrophication there are more algal toxins, areas affected, fisheries resources impacted, and higher economic losses in comparison to several decades ago (2). High levels of nitrogen and phosphorus in waters increases plant growth and decreases water clarity and the recreational value of a waterbody (13). Eutrophication can be detrimental to plants and animals as well as the economies of populations surrounding estuaries (18). As climate change is becoming more of a pressing issue, eutrophication is escalating. The combination of increased nutrient inputs and increased temperature will intensify eutrophication. By worsening storms, altering rainfall patterns, warming temperatures, and melting glaciers, climate change will increase nutrient loading and all of its effects (11).

The NYSDEC Water Quality Assessment Program has compiled a list of the top ten water quality issues in the state, based on which issues are the most prevalent sources of water quality impact or impairment (17). Not only is cultural eutrophication one of the ten top water quality issues, but it is the issue which most frequently impairs water bodies in the state (17). According to the New York State Department of Environmental Conservation (NYSDEC), the reason almost 1/4 of the waterbodies considered impaired in the state are impaired is due to excessive nutrients and eutrophication (17) Almost 1/3 of the waterbodies considered impaired in the state cite excessive nutrients and eutrophication as a contributing source of their impairment (17). The major sources of excess nutrients in the state are municipal wastewater discharges, urban/storm runoff, agricultural runoff, inadequate onsite septic systems, and non-point sources (13). In order to maintain and monitor waterbodies with the potential threat of eutrophication the NYSDEC has state programs in place aimed at reducing nutrient loadings (13).

New York has over 7,500 lakes ponds and reservoirs, more than can be sampled solely by state officials (5). The Citizen Statewide Lake Assessment Program was founded in 1985 and is a volunteer based program intended to monitor New York State lakes and conduct educational outreach programs. (5).Other states, such as Vermont, Maine, Illinois, and Minnesota have similar programs, which were used to model CSLAP (20). The program is managed by the New York State Department of Environmental Conservation as well as the New York State Federation of Lake Associations (NYSFOLA).All lake associations are members of NYSFOLA, a non-profit coalition of lake associations serving over 200 associations as well as other individuals and groups (20)(5). CSLAP has three main objectives,

- collect lake data for representative lakes throughout NYS
- identify lake problems and changes in water quality
- educate the public about lake conservation
  (5).

The program works towards these objectives with the assistance of over 400 trained volunteers who sample the lakes biweekly June through September (20). Volunteers are funded and trained in the field by NYSDEC and NYSFOLA to utilize standardized sampling and processing techniques and equipment. Some water quality data is collected by the volunteer's right at the lake and some data is collected when volunteer-retrieved water samples are sent to an Environmental Laboratory Approval Program certified laboratory for analyses (20). The parameters measured by citizen scientists at the lake include water temperature, Secchi transparency, and the presence of harmful algal blooms (20). Each CSLAP sample sent to the lab is analyzed for nutrients – phosphorus, several forms of nitrogen, chlorophyll a (a measure of algal densities), water color (a surrogate for dissolved organic carbon), pH, and conductivity. (8). CSLAP also has several sub-programs that lake associations can chose to enroll in which include aquatic plant sampling, invasive species monitoring, and angler surveying (20).

CSLAP concentrates on eutrophication indicators, like phosphorus, Chlorophyll-A and Clarity (8). Phosphorus is a common limiting nutrient for primary production in aquatic systems, and its concentration is typically used as an indicator for assessing the trophic status and water quality of lakes and reservoirs (16). Phosphorus concentration is a determinant of Chlorophyll-a levels in aquatic ecosystems (16). Increased phosphorus in lakes will also intensify algal growth, therefore increasing Chlorophyll-a, a measure of algal density in a waterbody. (13). Increased algae often decreases water clarity, resulting in shallower Secchi disk readings (3). The deeper a Secchi disk reading is, the deeper the individual measuring clarity can see into the waterbody. Something very unique about this particular program is the application of perception as a water quality indicator, specifically Citizen Scientists' Perception of Recreational Quality. The NYSDEC emphasizes the lake perception portion of this program, explaining that "volunteers have familiarity and experience with the conditions on their respective lakes and can provide valuable insight to periodic changes that may be overlooked in most professional monitoring programs" (8).

Methods

Data Collection and Coding

A sample group was selected from the entire population of CSLAP participating lakes. Only lakes with five or more years of data were selected in order to find trends in water quality and maintain a significant sample size. The most recent CSLAP Report in the NYSFOLA database (7) was used to determine how many years each lake had been enrolled in the program (years in the program is a factor listed on each CSLAP Report). Of the 10 different water quality parameters recorded through CSLAP, this study focused only on the four which are used as measures of eutrophication. The parameters being analyzed were Total Surface Phosphorus, Clarity, Chlorophyll-A, and Citizen Scientists Perception of Recreational Quality. The data from each of these parameters was obtained from the most recent CSLAP reports in the NYSFOLA database. All lakes in the sample were coded for each of these four parameters.

Total Surface Phosphorus

Total Surface Phosphorus record was binary coded as either 0 or 1. A value of 0 indicates that a lake is not Phosphorus eutrophic or did not become Phosphorus eutrophic during its five or more years in the program. A value of 1 indicates that a lake is Phosphorus eutrophic or became Phosphorus eutrophic during its five or more years in the program.

Clarity

Clarity was coded with either -1, +1, or 0. A value of -1 indicates that water quality was degrading. A lake received this code if the Secchi disk reading of its final year of monitoring was at least two meters shallower than the measurement in its initial year of monitoring. A value of +1 indicates that water quality is improving. A lake received this code if the Secchi disk reading of its final year of monitoring was at least two meters deeper than the measurement of its initial year of monitoring. A value of 0 indicates no change in quality, or less than two meters of change in either direction during the period being monitored.

Chlorophyll-A

Chlorophyll-A was coded with either -1, +1, or 0. A value of -1 indicates that water quality was degrading. A lake received this code if Chlorophyll-A concentration in its final year of monitoring had increased by at least five micrograms per liter from its initial year of monitoring. A value of +1 indicates that water quality is improving. A lake received this code if Chlorophyll-A concentration in its final year of monitoring had decreased by at least five micrograms per liter from its initial year of monitoring. A value of 0 indicates no change in quality, or less than a five microgram per liter increase or decrease in concentration during the period being monitored.

Perception

Recreation perception is measured by CSLAP in intervals. It was coded with either a -1, +1, or 0. A value of -1 indicates that recreation perception was degrading. A lake received this code if perception in its final year of monitoring had degraded by at least one interval from its initial year of monitoring. A value of +1 indicates that recreation perception was improving. A lake received this code if perception in its final year of monitoring had improved by at least one interval from its initial year of monitoring. A value of 0 indicates no change in perception, or less than a one interval increase or decrease in perception during the period being monitored.

Top-Down Analysis

Next, this data was used in a top down analysis to visualize trends in water quality. In environmental policy, the initial focus of a top down analysis consists of a central government decision (15). The overall focus in a top down analysis is, how one might steer this *system*, as a whole, to achieve its specifically stated intended results. (15). The overall focus in a top-down analysis of the CSLAP program then is, how well is this program as a whole improving water quality in participating lakes?

Search for Spatial Autocorrelation

First, the data was analyzed for spatial patterns using ArcCatalog 10.4.1 and ArcMap 10.4.1. In spatially distributed datasets it is important to determine if location is a confounding variable affecting the results of the study. It is fairly common for observations in close proximity in space to actually be related or show some correlation (10). To test for spatial autocorrelation the National Hydrography Dataset was used to make a base-map of New York State waterbodies. To organize those waterbodies by the 17 New York State watersheds recognized by the New York State Department of Environmental Conservation (Table 1), the watersheds in the National Hydrography dataset were merged. Then the Citizen Statewide Lake Assessment Program shape file from the New York State GIS data inventory was acquired and any additional points needed for lakes which were added to the program more recently were added to the CSLAP dataset, referencing Google Maps and the ESRI street map base map for the precise location of the additional points added. Maps were produced for three of the parameters, Clarity, Chlorophyll-A, and Recreation Perception, and then symbolized on the type of change recorded for each lake. This allowed any possible spatial trends within the data to be observable. Next, two additional maps for each of the three of the parameters, Clarity, Chlorophyll-A and Recreation Perception were made. One map for each parameter showed only the Phosphorus eutrophic lakes and the other showed only the non-Phosphorus eutrophic lakes.

Alleghany River Watershed	Lower Hudson Watershed
Atlantic Ocean/Long Island Sound Watershed	Mohawk River Watershed
Black River Watershed	Niagara River/Lake Erie Watershed
Chemung River Watershed	Oswego River/Finger Lakes Watershed
Delaware River Watershed	Ramapo River Watershed
Genesee River Watershed	St. Lawrence River Watershed
Housatonic River Watershed	Susquehanna River Watershed
Lake Champlain Watershed	Upper Hudson River Watershed
Lake Ontario Watershed	

Table 1: 17 New York State Watersheds recognized by the NYSDEC

Bottom-Up Analysis

Next, the data was used to complete a bottom-up analysis, which focused on trends within specific groups of lakes instead of trends within the entire sample. In environmental policy, the initial focus of a bottom-up analysis consists of the implementation of a local structure (15). The overall focus in a bottom-up analysis is to determine, what interactions between the smaller actors in this system affect change in the system? (15). The overall focus in a bottom-up analysis of the CSLAP program is, in which lakes is water quality improving, in which lakes is it not, and what is causing these different patterns?

Statistical Testing

First the filter function in Excel was used to find the lakes improving in all three of the non-binary perimeters, Clarity, Chlorophyll-A, and Recreation Perception, versus those degrading in all three non-binary perimeters, Clarity, Chlorophyll-A, and Recreation Perception. Next the filter function in Excel was used to find the lakes improving in the two instrumented parameters, Clarity and Chlorophyll-A, and lakes degrading in the two instrumented parameters, Clarity and Chlorophyll-A. The lakes in the latter group were used as two new samples, because of the need for a significant sample size. RStudio was then used to run a non-parametric Mann Whitney test on these two groups. The different parameters tested, to find a significant difference between the two sample groups, include surface area, watershed area, watershed/lake ratio, number of years enrolled in the program, number of volunteers, percent of agricultural area in the watershed, percent of forest, shrub and grasses in the watershed, percent of urban area in the watershed, retention time, max depth, mean depth, existence of a management plan, wetland area, wetland/lake ratio, perimeter, and perimeter/lake ratio.

Results

Data Collection and Coding

Only those lakes for which CSLAP data had been continuously collected for 5 or more years were investigated, which amounted to 68% of the total number of participating lakes (n=178). 35% of the population was found to be phosphorus eutrophic (Table 2). 79% of the sample showed no change in clarity, while only 13% improved in clarity (Table 3) (Figure 1). 47% of lakes showed no change in chlorophyll-a concentration, 33% improved in chlorophyll-a (meaning decreased concentration of chlorophyll-a), and 20% degraded in chlorophyll-a (meaning increased concentration of chlorophyll-a) (Table 4) (Figure 2). 75% of lakes showed no change in citizen scientist's perception of water quality, and an equal amount of lakes, 12%, showed an improvement and degradation in citizen scientist's perception of water quality (Table 5) (Figure 3).

Total Surface Phosphorus

Score	Number of Lakes	Percent of Population
1 (Eutrophic)	63	35%
0 (Non-Eutrophic)	119	67%

Table 2: Total Surface Phosphorus Scores

Clarity (Secchi Disk Measurement)

Score	Number of Lakes	Percent of Population
-1	19	11%
1	24	13%
0	140	79%

Table 3: Clarity Scores (Based on Secchi Disk Measurement)

Chlorophyll-A

Score	Number of Lakes	Percent of Population
-1	35	20%
1	59	33%
0	84	47%

Table 4: Chlorophyll-A Concentration Scores

Citizen Scientists Perception of Recreational Quality

Score	Number of Lakes	Percent of Population
-1	21	12%
1	22	12%
0	134	75%

Table 5: Scores of Citizen Scientists Perception of Recreational Quality

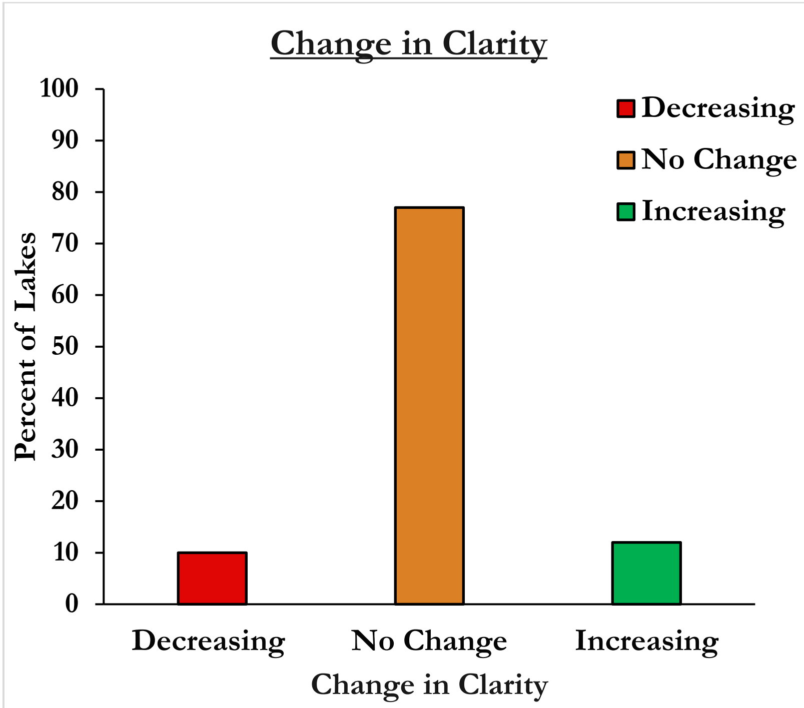

Figure 1: Percent of lakes in the CSLAP program experiencing changes in Clarity.

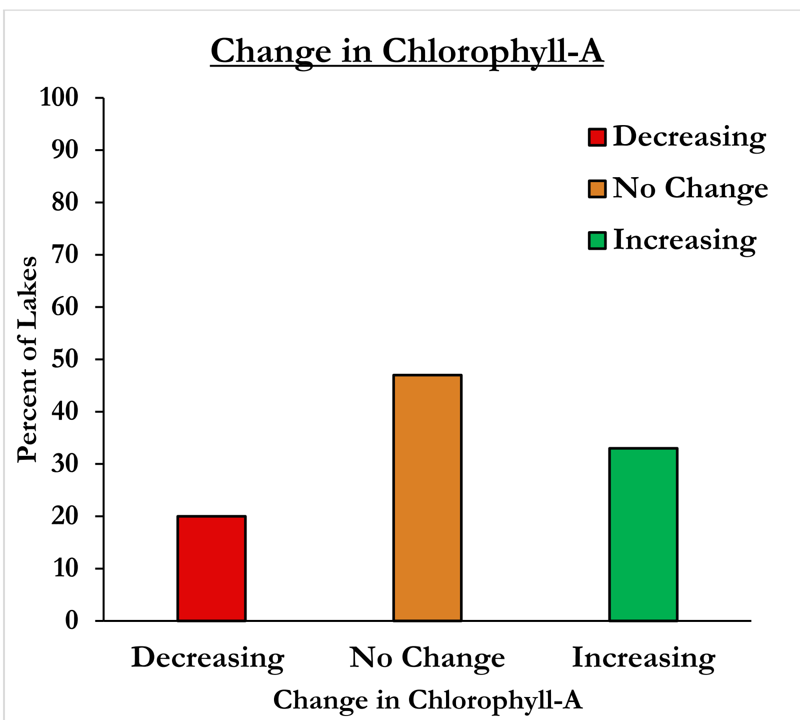

Figure 2: Percent of lakes in the CSLAP program experiencing changes in Chlorophyll-A concentration.

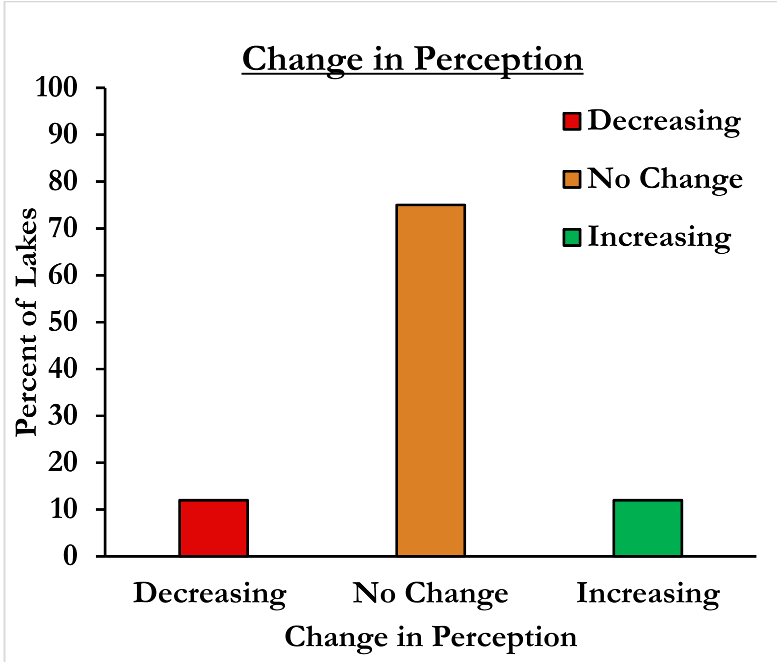

Figure 3: Percent of lakes in the CSLAP program experiencing changes in citizen scientist's perception of water quality.

When the two instrumented parameters, Clarity and Chlorophyll-A, are examined in terms of citizen scientists perception of water quality, the reality of water quality and the perception of water quality are not correlated. When there is improvement or degradation in either of the two parameters, clarity and chlorophyll-a, citizen scientists are not receptive of any change (Figure 4 & 5). In most cases where citizen scientists do not agree with the instrumented parameters it is due to the fact that they are not seeing any change when water quality is in fact changing. About 2/3 of the time, perception and clarity are in agreement. Of that 2/3, 92% of the time clarity and citizen scientists' perception measure no change in water quality (Figure 6). About 1/3 of the time perception and chlorophyll-a are in agreement. Of that 1/3, 80% of the time chlorophyll-a and citizen scientists' perception measure no change in water quality (Figure 7). The predominate reason for disagreement in both parameters, clarity and chlorophyll-a, is that citizen scientists almost always perceive no change even when water quality is actually changing.

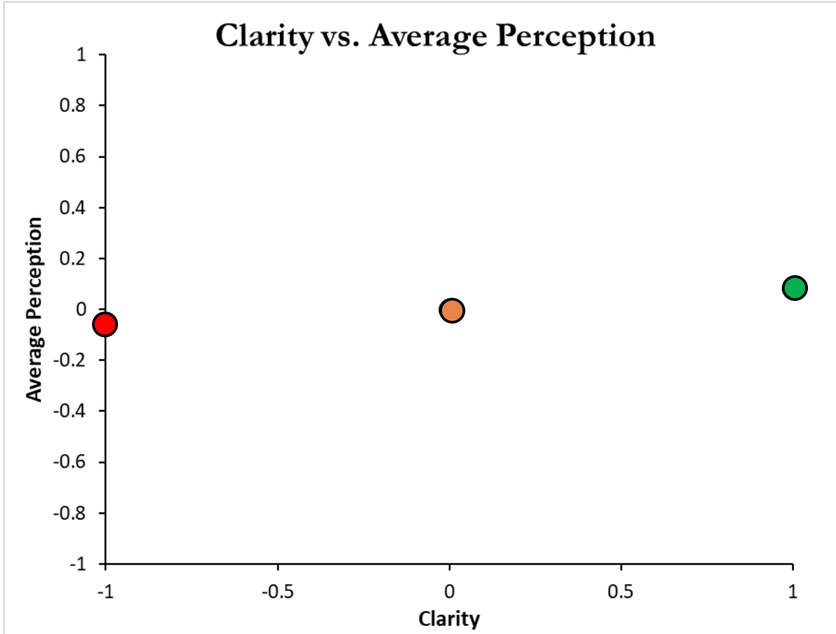

Figure 4: Change in clarity versus average change in citizen scientists perception of water quality change shows that the two are not correlated.

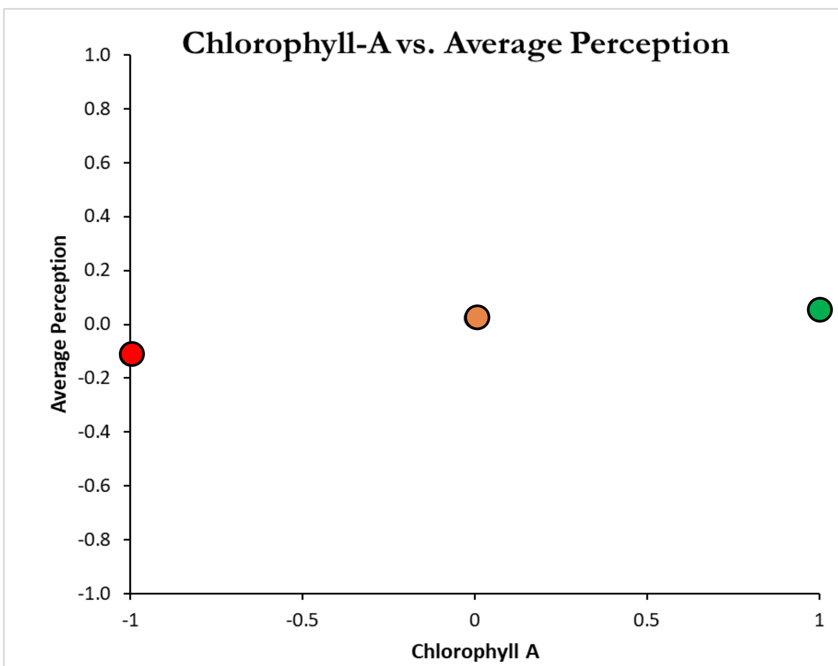

Figure 5: Change in chlorophyll-a versus average change in citizen scientist's perception of water quality change shows that the two are not correlated.

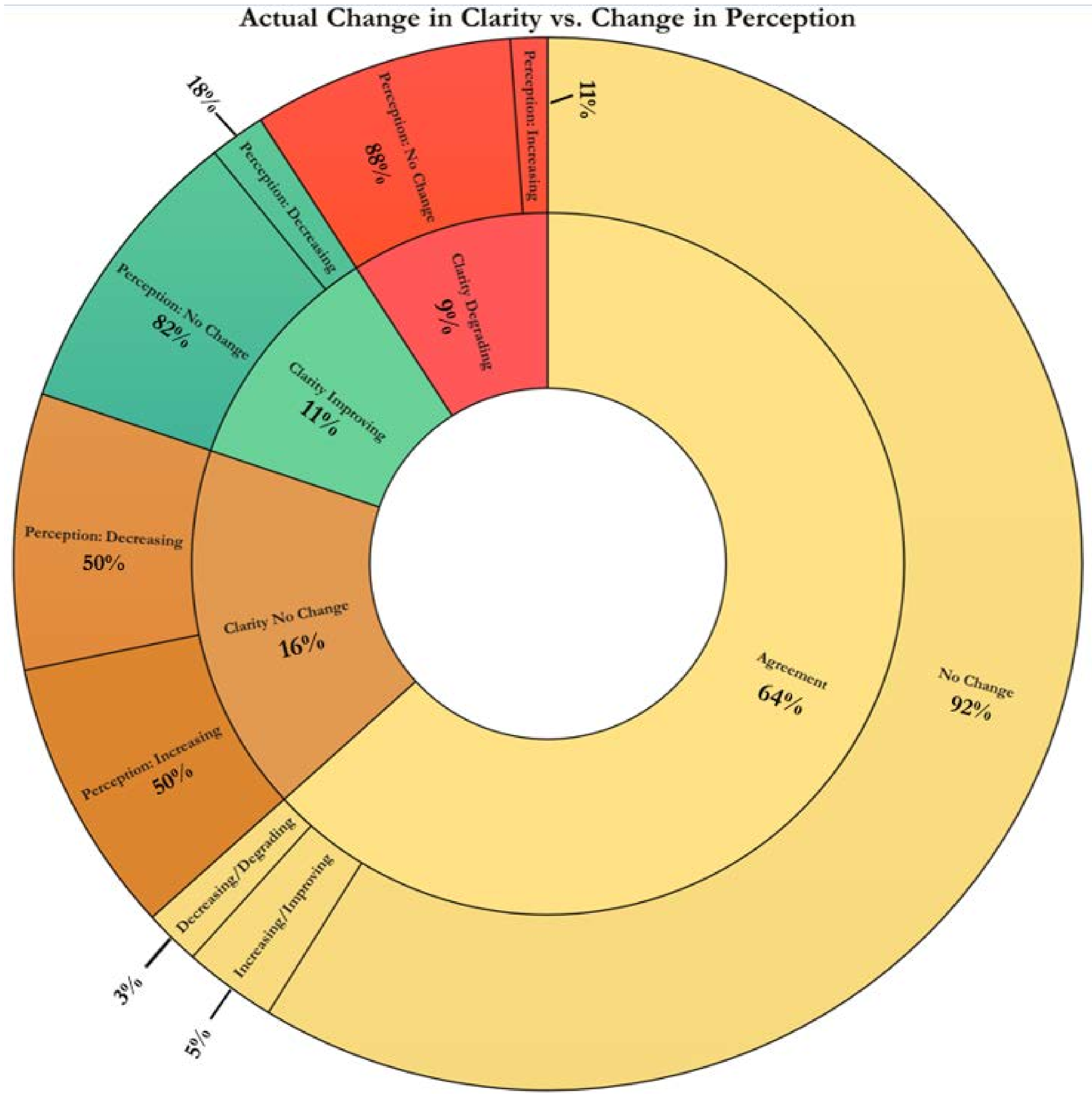

Figure 6: Change in the instrumented water quality parameter, clarity, does not coincide with citizen scientist's perception of water quality.

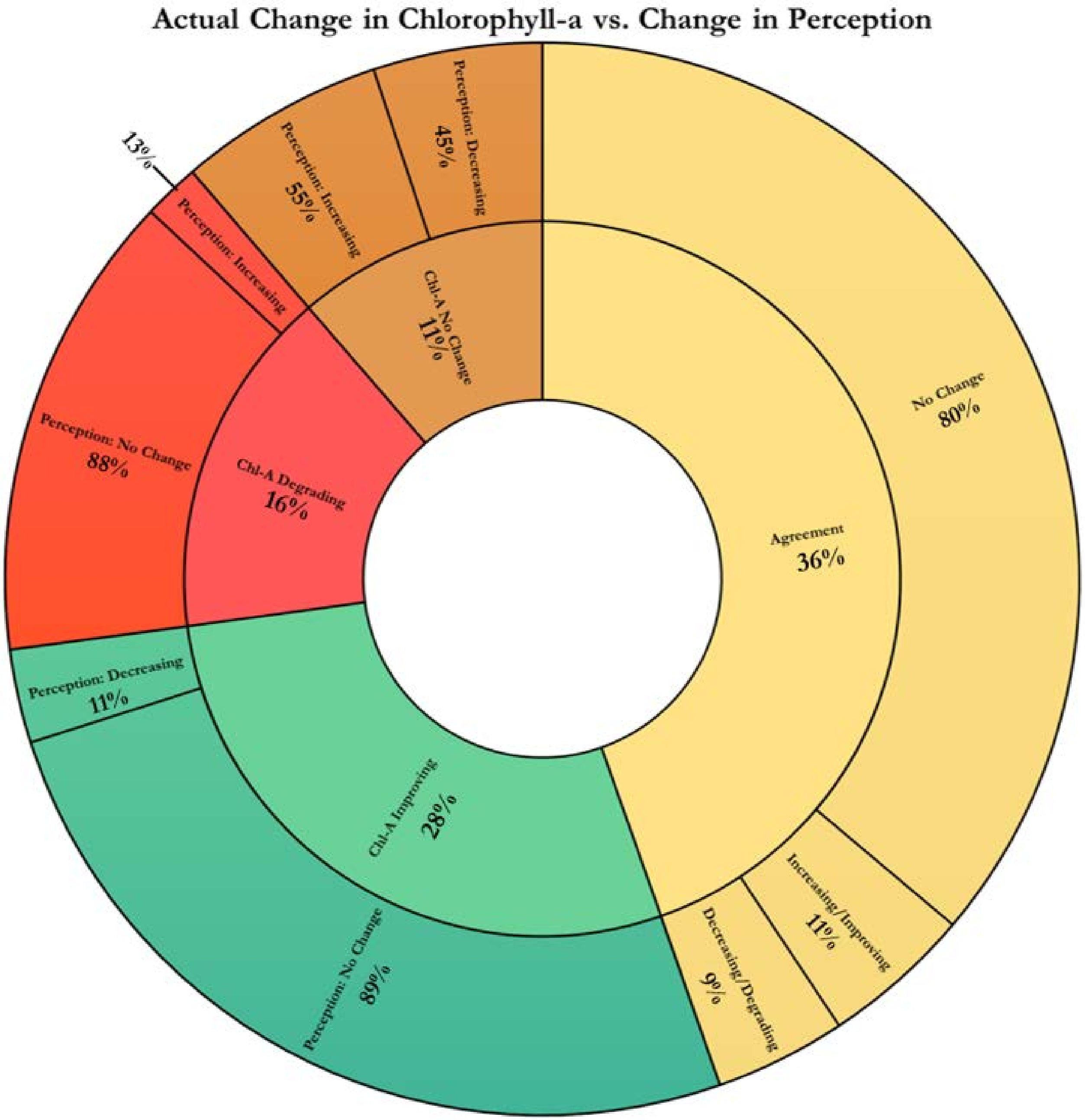

Figure 7: Change in the instrumented water quality parameter, chlorophyll-a, does not coincide with citizen scientist's perception of water quality.

<u>*Search for Spatial Autocorrelation*</u>

The first three maps illustrate water quality change based on three of the parameters, Clarity (Figure 8), Chlorophyll-A (Figure 9), and Recreation Perception (Figure 10), and then symbolized on the type of change recorded for each lake. In all the maps red squares are representative of water quality degradation, yellow circles represent no change in water quality, and green triangles represent an improvement in water quality. All small black points are representative of the population, or lakes not included in the sample.

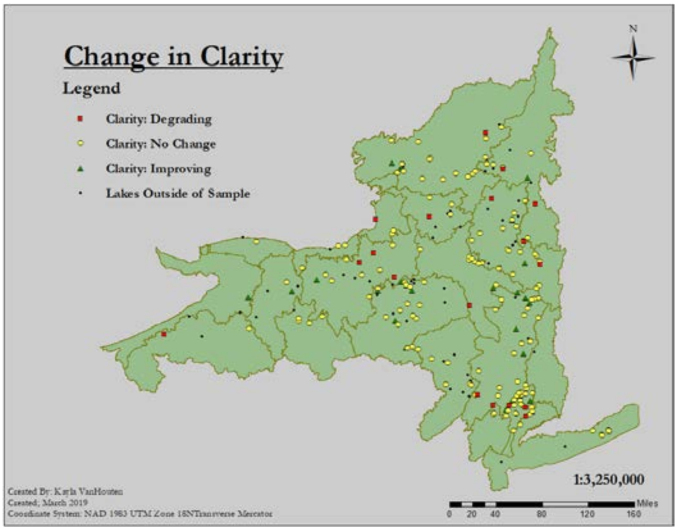

Figure 8: Change in clarity fo CSLAP lakes within the 17 NYS Watersheds.

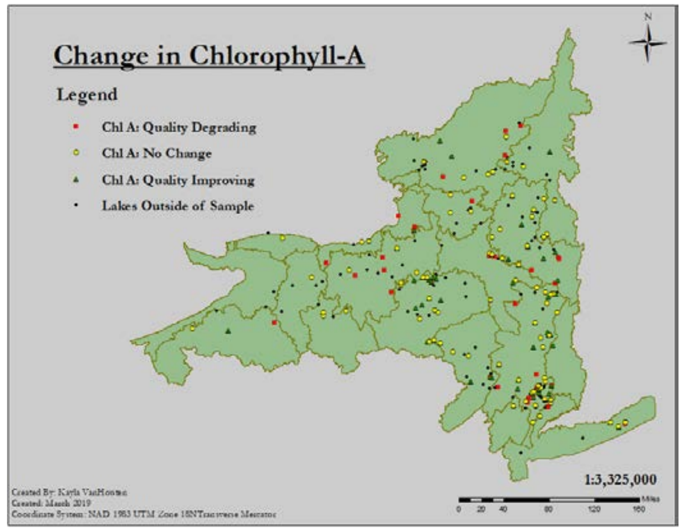

Figure 9: Change in Chlorophyll-A concentration in CSLAP lakes in the 17 NYS watersheds.

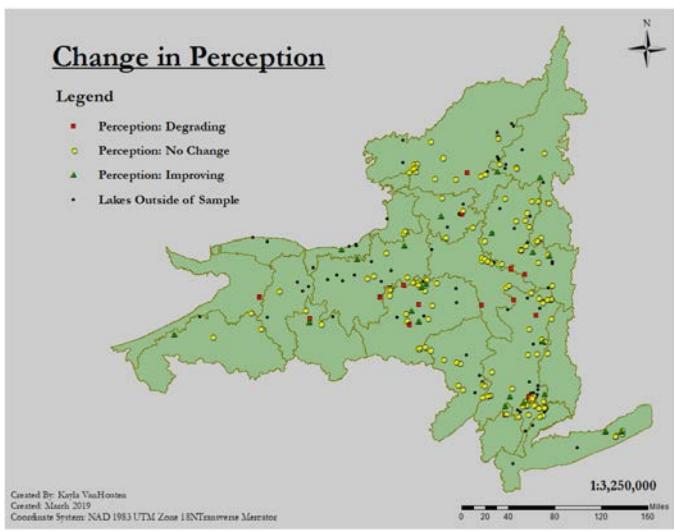

Figure 10: Change in citizen scientist's perception of water quality in CSLAP lakes in the 17 NYS watersheds.

The next maps display the data split into two groups, phosphorus-eutrophic lakes and non-phosphorus-eutrophic lakes. Figure 11 and 12 show the change in clarity in lakes considered phosphorus-eutrophic and those considered not phopsphorus eutrophic as two separate groups. Figure 13 and 14 show the change in chlorophyll-A in lakes considered phosphorus-eutrophic and those considered not phopsphorus eutrophic as two separate groups. . Figure 15 and 16 show the change in citizen scientists perception of water quality in lakes considered phosphorus-eutrophic and those considered not phopsphorus eutrophic as two separate groups.

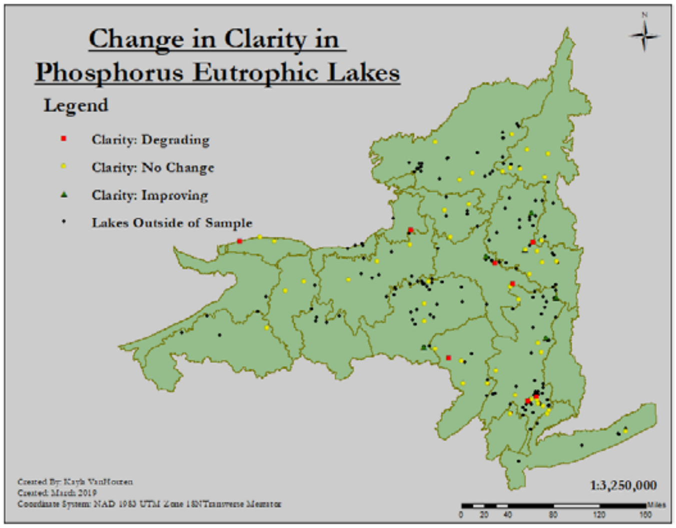

Figure 11: Change in Clarity only in lakes in the CSLAP program considered phosphorus-eutrophic

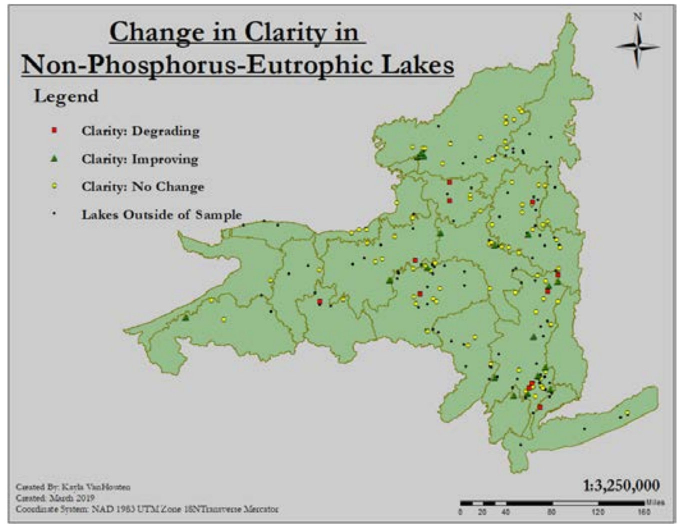

Figure 12: Change in Clarity only in lakes in the CSLAP program considered non-phosphorus-eutrophic

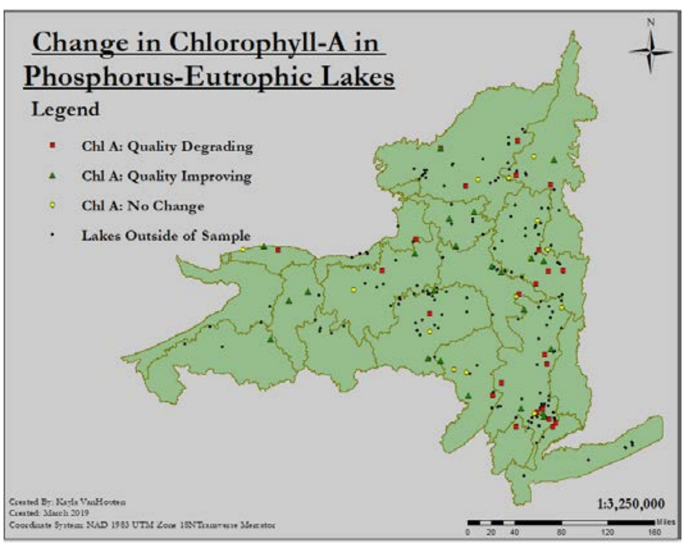

Figure 13: Change in chlorophyll-a concentration only in lakes in the CSLAP program considered phosphorus-eutrophic.

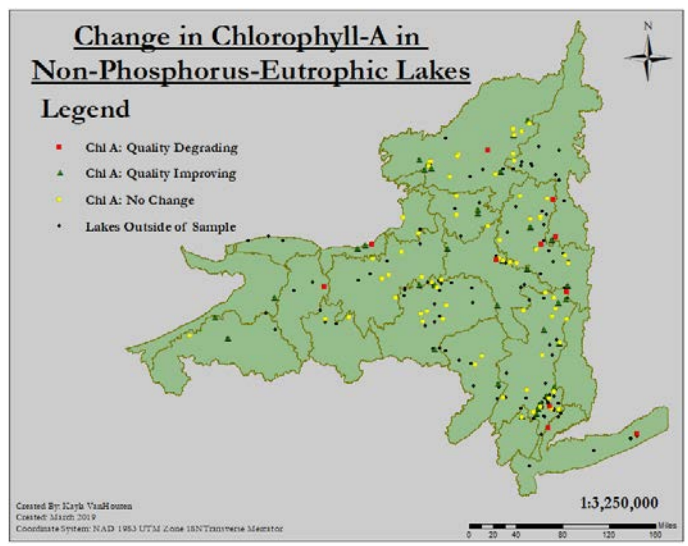

Figure 14: Change in chlorophyll-a concentration only in lakes in the CSLAP program considered non-phosphorus-eutrophic.

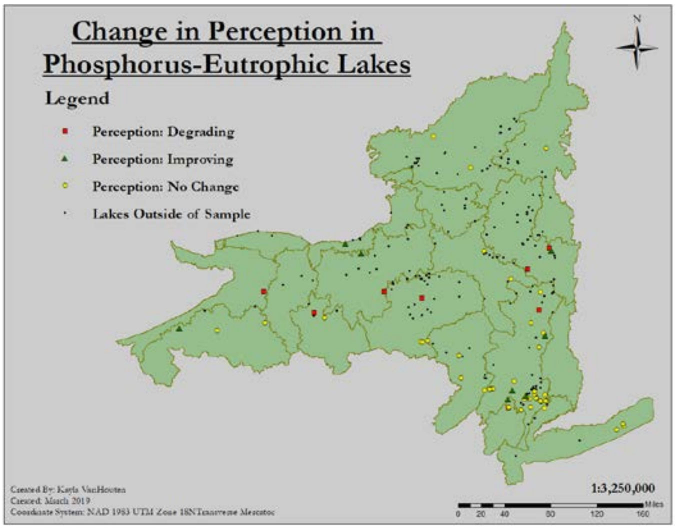

Figure 15: Change in citizen scientist's perception of water quality only in lakes in the CSLAP program considered phosphorus-eutrophic.

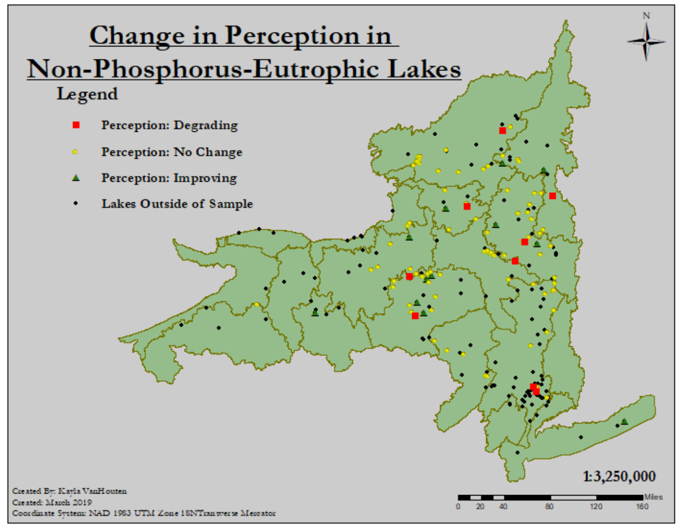

Figure 16: Change in citizen scientist's perception of water quality only in lakes in the CSLAP program considered non-phosphorus-eutrophic.

Statistical Testing

Only 2% of the lakes in the sample were improving in all three of the non-binary perimeters, Clarity, Chlorophyll-A, and Recreation Perception (n=4). Less than 1% of lakes were degrading in all three non-binary perimeters, Clarity, Chlorophyll-A, and Recreation Perception (n=1). 8% of lakes were improving in the two instrumented parameters, Clarity and Chlorophyll-A (n=14). 3% of lakes were degrading in the two instrumented parameters, Clarity and Chlorophyll-A (n=6). The results from the Mann-Whitney test, which was run on the two latter groups, returned almost no statistically significant differences between the lakes improving in the two instrumented parameters, Clarity and Chlorophyll-A and the lakes degrading in the two instrumented parameters, Clarity and Chlorophyll-A. (Table 6). The two parameters which returned the lowest p-values were the number of years enrolled in the program (p=0.05162), and Retention Time (p=0.05679). The lakes that were improving in both instrumented parameters, were mostly lakes with more years in the program (Figure 17). The lakes that were improving in both parameters also mostly had a longer retention time (Figure 18).

Table 6: Results from Mann-Whitney test being used to search for a difference between lakes in the CSLAP program improving in the two instrumented parameters, Clarity and Chlorophyll-A and the lakes degrading in the two instrumented parameters, Clarity and Chlorophyll-A.

Parameter Being Tested	P-Value
Surface Area	0.5092
Watershed Area	0.274
Watershed/Lake Ratio	0.3849
Number of Years Enrolled in the Program	0.05162
Number of Volunteers	0.9566
% of Agricultural Area in Watershed	0.6932
% of Forest/Shrub/Grassland in Watershed	0.7028
% Urban Area in Watershed	*ALL 0% URBAN AREA IN WATERSHED*
Retention Time	0.05679
Max Depth	0.7586
Mean Depth	0.2115
Existence of a Management Plan	0.8111
Wetland Area	0.6331
Wetland/Lake Ratio	0.775
Perimeter	0.3119
Perimeter/Lake Ratio	0.968

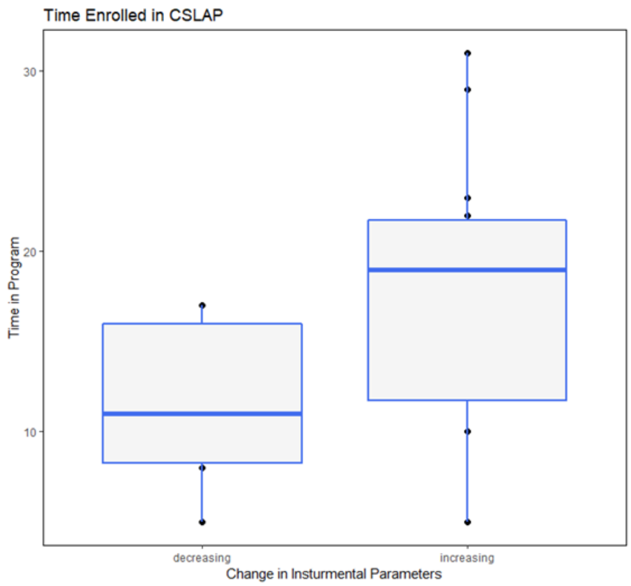

Figure 17: Boxplot showing the difference in years enrolled in the CSLAP program for two groups, those improving in Clarity and Chlorophyll-A and those degrading in Clarity and Chlorophyll-A.

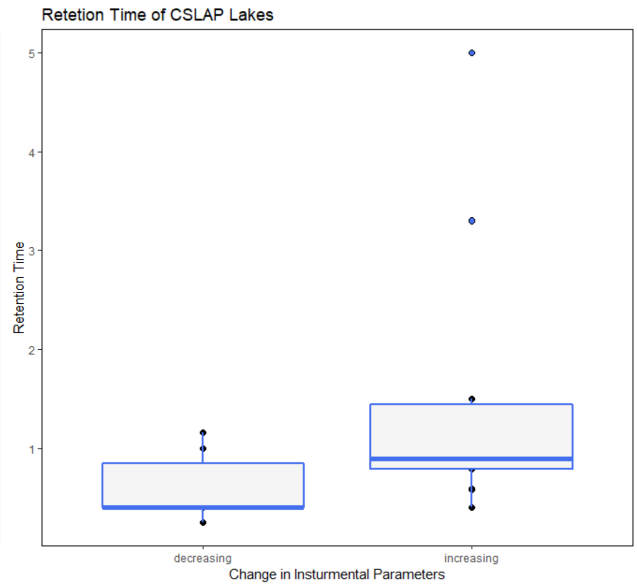

Figure 18: Boxplot showing the difference in retention time of CSLAP lakes in two groups, those improving in Clarity and Chlorophyll-A and those degrading in Clarity and Chlorophyll-A.

Discussion

Of the three non-binary perimeters, Clarity, Chlorophyll-A, and Recreation Perception, Chlorophyll-A was the most sensitive to change, followed by Recreation Perception, and Clarity. One possible reason for this is that Chlorophyll-A is the only parameter in this study that is sent to a lab for analysis, while the other two parameters are recorded in the field by citizen scientists. There is a greater chance for discrepancies in the data when some parameters of water quality are measured in the field and others are measures in a separate lab. It is not uncommon for citizen science observation to be less objective than those which are measured in a lab.

One study on the accuracy of citizen science data determined that the data had low overall accuracy, meaning that it was not a good representation of the population being studied, and that researchers should consider collecting reference data as a means to easily identify doubtful citizen science data (1). Without periodic reviews of citizen scientists' data or reference data, the accuracy of citizen scientist data is hard to determine. In programs like CSLAP, where the data being collected is being used to support other government programs, such as the Impaired Waterbodies List (303d List), Priority Waterbodies List, and the 305b Water Quality Report, it is critical that the data be accurate and precise to construct effective government programs (8).

However, citizen science can be a very effective way for government agencies to conduct scientific monitoring. These programs offer government agencies a cost-effective way to conduct fieldwork over large areas, during non-office hours (6). Data collection can suffer from data fragmentation, inaccuracy, and even lack of participant objectivity. Lack of objectivity can be a big issue in programs, like CSLAP, which record citizen Scientist's perception of water quality as an indicator for actual water quality conditions. Citizen Scientists' Perception of Recreational Quality contributes to developing New York State water quality standards and the development of nutrient criteria (8). This study demonstrated how different citizen scientist's perception of water quality can be from actual water quality. The main reason that perception did not align with reality in most of these circumstances is because citizen scientists are not as sensitive to change as the two instrumental measures. In fact, 75% of the time citizen scientists perceived no change in water quality, even when there was change occurring. It is not uncommon for perception of water quality to vary from the actual water quality. One study, in Newfoundland Canada, examined the associations between perceptions of public drinking water quality and actual drinking water quality (14). The study found that there was no association between public satisfaction level and actual water quality, even though the water quality condition reports were made available to the public (14).

Utilizing Geographic Information Systems to assess changes in water quality allows researchers to monitor changes in water quality parameters over temporal and spatial scales that are not necessarily readily apparent from other forms of measurements (4). Analyzing the change in water quality of CSLAP participating lakes for spatial autocorrelation returned no patterns. CSLAP participating lakes are spread throughout all 17 New York State watersheds, but have varying degrees of change for each of the parameters. My analysis concludes that geographic location is not a contributing factor of water quality improvement in CSLAP participating lakes.

The statistical analysis did return some significant findings. The group that was improving in both of the two instrumented parameters, Clarity and Chlorophyll-A, appeared to have been enrolled for more years in the CSLAP program. On average, lakes improving in both parameters had been enrolled in the program for approximately 20 years, while those which declined, had only been enrolled in the program for an average of 10 years. This long-term time commitment can quickly become a stumbling block for lake communities attempting to achieve improved water quality as NYSFOLA requires a yearly Participation Fee of $370 for shallow lakes and $470 for deeper lakes (20). If it takes 20 years to achieve water quality improvement, the overall cost of improved Clarity and Chlorophyll-A concentration in smaller lakes amounts to $7,400 and in larger lakes the cost amounts to $9,400. The cost combined with the fact that 400 volunteers are expected to take measurements and water samples approximately 16 times each year means that there is a significant amount of time and money being put into this program that is not effective for the first 19 years (21).

Lakes that were improving in both of the two instrumented parameters, Clarity and Chlorophyll-A, also had a slightly greater retention time on average. Retention time, the length of time water stays in a lake before exiting, can affect the exposure of a lake's ecosystem to the different pollutants it contains (9). The longer amount of time that dissolved nutrients are able to remain in the epilimnion, the greater the likelihood those nutrients will be absorbed by algae and eutrophication rates will increase. This means that conversely lakes with a shorter retention time should have improved water quality because there is less time for buildup of contaminants. For example, if nutrients in a lake are being cycled out more frequently there is less of a chance for excessive chlorophyll-a growth, meaning that there will be improved clarity. In this case, the opposite seems to be true, longer retention time and improved water quality are correlated.

One possible reason for this correlation could be that the retention times listed for each lake in the CSLAP reports may be inaccurate. Two primary lake dimensions necessary to calculate retention time are mean and maximum water depth. Unfortunately, for many lakes, either, or both of these measurements were not disclosed. Likewise, the specific method used to determine retention time are not documented in the program descriptions so it is difficult to evaluate how accurate their measurements are.

The most difficult part of completing this analysis was the lack of similar structure and missing data within the dataset. During the initial data collection the first issue was with the formatting of the various types of CSLAP reports. The program has changed report format seven times since its first year in 1985, changing between Five-Year Reports, CSLAP Reports, Q&A Reports, Regional Reports, Scorecards, Statewide Reports, and Whole Lake Reports. These changes in format resulted in inconsistencies in the types of data provided. For example the later forms of reports such as CSLAP Reports or Scorecards summarize the data but provide and analyze all of the data from each year like previously used report formats did. The NYSFOLA database can be difficult to maneuver due to spelling errors in the names of lakes, incorrect dates for the year the sampling was completed, or files being completely mislabeled. Even if the data were completely accurate, if it is not accessible to the lake associations, governmental organizations, or the general public who need to utilize it, it is not effective.

Conclusion

Knowing if current management policies are efficient aids in the development and implementation of new and more effective strategies. It is also important to track and analyze the changes in our water systems over time. Water bodies in New York State provide drinking water supplies, flood control to protect life and property, and support recreation, tourism, agriculture, fishing, power generation, and manufacturing and provide habitat for aquatic plant and animal life (12). The only possible predictor of success in the Citizen Statewide Lake Assessment Program is enrollment in the program for approximately 20 years. To gain a better understanding of how the Citizen Statewide Lake Assessment Program is effecting the overall quality of enrolled New York State waterbodies additional studies must be completed.

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