Chapter 14
Surface Water Information Collection:
Volunteers Keep the Great Lakes Great

Mark Gillingham
Hermit's Peak Watershed Alliance, USA

ABSTRACT

This chapter's starting premise is that for decades the United States Environmental Protection Agency region subsuming most of the Great Lakes watershed has been partially monitored by private citizens, but collected data have been underutilized by water managers, scientists, and policymakers. Today, citizens with only a smartphone can dramatically increase our understanding of surface water, help managers and policymakers, and educate the general public about the quality of water. The US Clean Water Act and National Strategy for Civil Earth Observations have helped to coordinate citizen scientists and direct funds to surface-water monitoring. And more contributors are being solicited and trained to help with the enormous task of monitoring lakes and streams. At the same time, technology allows citizens with a smartphone to accomplish what previously required experts in a lab: to act for clean water!

INTRODUCTION

The Great Lakes watershed of the United States serves 51 million people with drinking water (United States Environmental Protection Agency, 2016, May 29). For decades the Great Lakes have been partially monitored by private citizens, but these data have been underutilized by scientists and policymakers. However, today, citizens with only a smartphone can dramatically increase our understanding of surface water, help policymakers, and educate the general public about the quality of water in the region. Trained volunteers are able to perform important water quality measurements and use increasingly sophisticated phone applications. With governmental budgets cut, what is needed is a call for citizens to act for clean water!

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PAST CITIZEN EFFORTS TO MONITOR THEIR GREAT LAKES WATERSHED

In the upper Midwest of the United States are five very large fresh-water lakes including Superior, Michigan, Huron, and Erie and tens-of-thousands of smaller lakes and streams in its six states. This area, designated by the Environmental Protection Agency as Region 5, includes the states of Ohio, Michigan, Indiana, Illinois, Wisconsin, and Minnesota (from east to west). Individuals have been monitoring these local lakes for as many as 8 decades. Each of these states began lake and stream monitoring programs at different times through various agencies but mostly as a consequence of the Clean Water Act of 1972. The following describes each state's lake and stream monitoring programs individually.

Ohio

Ohio law ensures that citizen volunteers are qualified to sample and measure lake and stream water. The state's Environmental Protection Agency requires volunteers to use approved study plans and become Qualified Data Collectors, who are authorized to submit data to the state's site where the data can be used by all interested parties and combined with data from other states (Ohio Environmental Protection Agency, 2016).

Ohio has three levels of credible data. Level 1 was designed with educators in mind and targets conservation districts, parks, health departments, and the general public. The purpose of Level 1 is primarily to promote public awareness and education about surface waters of the state.

The Level 2 group was designed with watershed groups in mind and appears to be closer to other Region 5 states' first tier or basic level. Level 2 information can be used to evaluate the effectiveness of pollution controls, to conduct initial screening of water quality conditions, and to promote public awareness and education about surface waters. Level 2 groups monitor long term surface water quality trends in a watershed.

Level 3 provides the highest level of scientific rigor and incorporates methods which are equivalent to those used by Ohio Environmental Protection Agency personnel. By Ohio law, only Level 3 information can be used for regulatory application (Ohio Environmental Protection Agency, 2016).

Of all the states in Region 5, Ohio rejects most volunteer data collection for research purposes. Whereas most states rely on project coordinators, who are usually government agency employees, for training, Ohio depends on nonprofit and educational organizations to train volunteers and collect data. For instance, the Ohio Watershed Network within Ohio State University Extension (Ohio Watershed Network, 2016).

Michigan

The state of Michigan has been using citizen volunteers to monitor lakes since 1974 and streams since 1992. Since then, the combined program has been called Cooperative Lakes Monitoring Program and more recently has been subsumed under the Michigan Clean Water Corps (MiCorps), which is Michigan's volunteer surface water monitoring network. Like other states, Michigan's volunteers monitor lake and stream water over time, reduce costs to the state, and provide important baseline data. Volunteers also educate their communities and build public support of clean and ecological practices near lakes (Michigan Department of Environmental Quality, 2016).

Indiana

Indiana has a two-tiered volunteer approach. Tier 1 volunteers sample lake water for transparency using the Secchi method in which a disc is lowered into the water until it is just visible at which point the depth is measured. Tier 2 volunteers also perform chemical analyses of lake water. The state understands that without volunteers there would not be enough financial support to monitor all of the lakes in Indiana (Indiana Clean Lakes Program, 2016). Volunteers can become credible information monitors and earn a certificate in watershed leadership from Purdue University.

Illinois

The state of Illinois created the Volunteer Lake Monitoring Program within its Environmental Protection Agency in 1981. Volunteers help gather more information about Illinois lakes than professionals alone could, which adds more information with less cost and allows better lake management (Illinois Environmental Protection Agency, 2016a). The Illinois program also creates an environment for citizen education of the local environment and lake ecosystems.

Illinois has basic and advanced volunteer programs. Basic volunteers monitor lake transparency using the Secchi method twice per month from April to October and they also monitor Zebra Mussels. Advanced volunteers add chemical analysis tasks by collecting lake samples and sending them to a state lab for analysis (Illinois Environmental Protection Agency, 2016b).

Wisconsin

Wisconsin's Citizen Lake Monitoring Network has 1000 citizen volunteers who for 40 years have been working with the Wisconsin Department of Natural Resources to monitor 40,000 sites. The Network's goals are to collect high quality information, to educate and empower volunteers, and to share this information and knowledge with the public (University of Wisconsin Extension, 2016).

Wisconsin provides volunteers with equipment and training to conduct water monitoring. The data are shared with the Wisconsin Department of Natural Resources and university biologists and researchers, university extension offices, and the interested public through a state site (University of Wisconsin Extension, 2016). Wisconsin volunteers measure transparency of lakes using the Secchi method. Some volunteers are also trained to monitor water chemistry, aquatic life, ice on and off a lake, and native aquatic plants (Wisconsin Department of National Resources, 2016).

Minnesota

In 1973, the state of Minnesota was the first to train citizens to use the Secchi method (Minnesota Pollution Control Agency, 2008). Soon, the neighboring states in Region 5 followed suit. Eventually each state created an agency to oversee training, monitoring, and information storage. Minnesota's Citizen Lake-Monitoring Program claims to be the longest running volunteer lake monitoring program in the United States and, like other states, has spawned a stream monitoring program, too. Citizen Lake-Monitoring Program requires their 1200 volunteers to conduct regular seasonal lake sampling. The state supports volunteers with training, discs, and information storage. Training consists of learning to use a Secchi disc, choosing locations, recording information, and sharing it with the state.

The volunteers contribute to the goal of improving water quality by adding to the Minnesota Pollution Control Agency and Environmental Protection Agency information stores and by learning about water quality and lake degradation.

An Example of Volunteer Water Monitoring Data: Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency oversees volunteer water monitoring for the state of Minnesota. Once data are collected, they can be viewed on a public site with common information for each lake or stream. For instance, the information for Upper Prior Lake in Scott County in the Lower Minnesota River watershed (site 70-0072-00, http://cf.pca.state.mn.us/water/watershedweb/wdip/details.cfm?wid=70-0072-00) and Elk Lake in Sherburne County in the upper Mississippi watershed (site 71-0141-00, [cf.pca.state.mn.us/water/watershedweb/wdip/details.cfm?wid=71-0141-00]) is provided by both volunteers and professionals. The volunteers are members of the Citizen Lake Monitoring Program or Advanced Citizen Lake Monitoring Program groups.

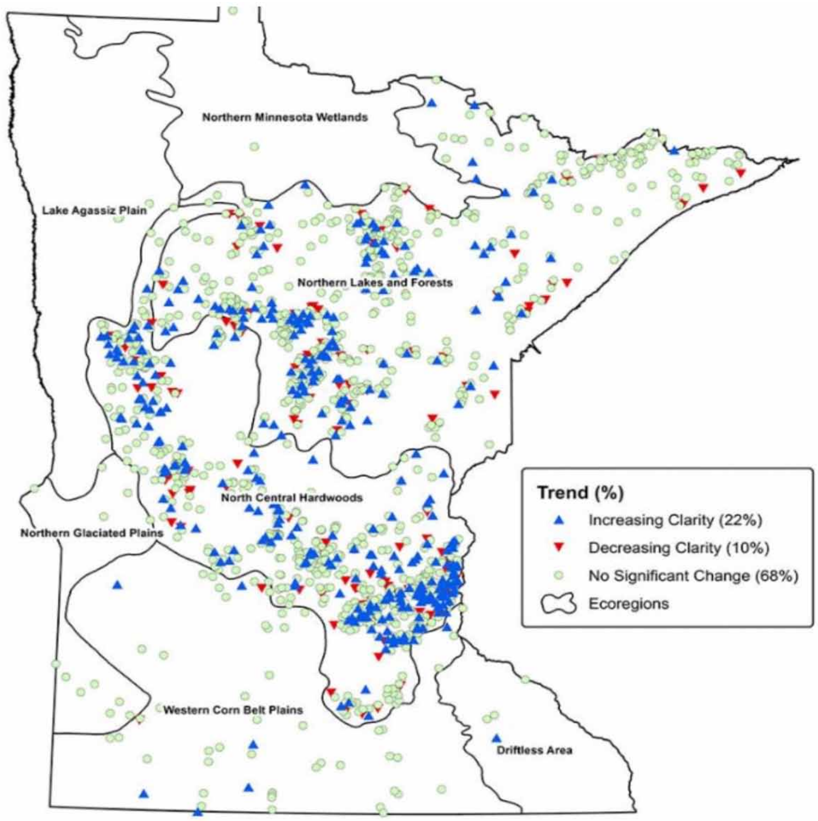
The Minnesota Pollution Control Agency (2016b) provides the public with lake data of various types (e.g., transparency, trophic state, chlorophyll-a, and Phosphorus). For instance, one can find a statewide view of transparency data for monitored lakes in Minnesota (see Figure 1). Figure 1 shows lakes that have increased, decreased, and remained the same transparency. Arrows that point up show lakes that have increased transparency (22%) and those with arrows that point down show lakes that have decreased transparency (10%). Circles show lakes with no significant change in transparency (68%). Lake managers can use this information to quickly understand which lakes need more attention.

This information has mostly been collected by volunteers over the years (c.f., [http://cf.pca.state.mn.us/water/watershedweb/wdip/details.cfm?wid=71-0141-00]). Volunteers have been very important in documenting many years of data which are needed to detect trends. The baseline data collected by volunteers helps professionals know when to do further testing and recovery planning and action.

IS VOLUNTEER-COLLECTED INFORMATION OF ANY USE TO SCIENTISTS?

Volunteers are important to the United States federal and state agencies, which have begun using more volunteer-collected information. The United States has initiated a wide-ranging use of volunteer-collected information throughout agencies including the Bureau of Land Management, Department of State, National Archives, National Science Foundation, National Oceanic and Atmospheric Agency, United States Geological Survey, and United States Environmental Protection Agency (Office of Science and Technology Policy, 2014; Office of Science and Technology Policy, 2015). As part of the effort to increase citizen innovation, the U. S. Government issues challenges within agencies with prizes (c.f., Challenge.gov). Many of the challenges are directed to students, school teachers, and college and university faculty. For instance, after it was determined that farm runoff was the major contributor to the algal bloom that closed Toledo Ohio's water supply in August, 2014, the United States Environmental Protection Agency developed a challenge for college students to create an easy way to visualize and predict algal blooms using existing data (Challenge.gov, 2016). United States Government agencies clearly see the value of citizen help with its water quality challenges.

Figure 1. Statewide view of transparency data for monitored lakes in Minnesota (Minnesota Pollution Control Agency, 2016b)



Use of Volunteers in Minnesota

The Minnesota Pollution Control Agency, along with other state government agencies and organizations, has been making greater use of volunteers to collect lake and stream information.

Volunteer-collected information is the main source of data used in state assessments. The Minnesota Pollution Control Agency uses information collected by volunteers of the Citizen Lake Monitoring Program, which monitors lake transparency with the Secchi method, combined with nutrient data to determine the health of lakes and identify impairments. Since 2000, a second-level monitoring program, Advanced Citizen Lake Monitoring Program has been collecting nutrient data on lakes and providing this information to the Minnesota Pollution Control Agency. In 2006, Minnesota Pollution Control Agency began using tubes to assess the turbidity of streams, primarily with the assistance of volunteers. The tubes are a modification of the Secchi method in which water from a stream is poured into a long tube with a small Secchi disc at the bottom. When the disc is just visible, the height of the water in the tube is measured (see Figure 2).

Finally, the volunteer-collected Secchi-based transparency information is the principal source for lake transparency trend analysis in Minnesota. Data for nearly every lake in the state is viewable by the public including lake transparency trends (Minnesota Pollution Control Agency, 2011).

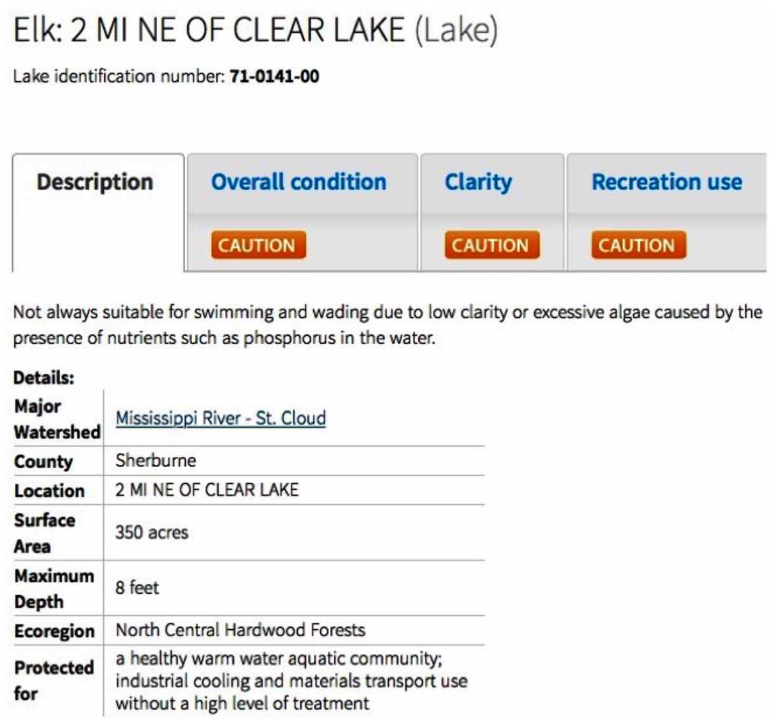
Figure 2. Secchi tube
(pca.state.mn.us/sites/default/files/tube1.jpg)

Example of Elk Lake. The Minnesota Pollution Control Agency (2012) publishes watershed reports periodically to inform the public of the condition of surface water. Elk Lake (site 71-0141-00, [*cf.pca.state.mn.us/water/watershedweb/wdip/details.cfm?wid=71-0141-00*]) is a medium-sized shallow lake in the farmland of central Minnesota northwest of Minneapolis and in the Mississippi watershed. Lake quality information has been reported since 1978 (see Figure 3). Over this period of 4 decades, volunteers have collected transparency measures every year. In addition, chemical analyses have been performed and reported for 15 of those years. Elk Lake is being carefully watched by the state because it is rated as hypertrophic (containing excessive nutrients). Citizens are cautioned against eating fish or bathing in Elk Lake.

COMPARATIVE ANALYSIS OF PROFESSIONAL AND VOLUNTEER-COLLECTED INFORMATION

Studies have shown that information collected by volunteers is robust—nearly indistinguishable from information collected by experts. Ashley Shelton (2013) found that volunteer-collected water quality

Figure 3. Description of Elk Lake in the Upper Mississipi Watershed, Minnesota (Missesota Pollution Control Agency [cf.pca.state.mn.us/water/watershedweb/wdip/details.cfm?wid=71-0141-00])



Elk: 2 MI NE OF CLEAR LAKE (Lake)

Lake identification number: **71-0141-00**

Description	Overall condition	Clarity	Recreation use
	CAUTION	CAUTION	CAUTION

Not always suitable for swimming and wading due to low clarity or excessive algae caused by the presence of nutrients such as phosphorus in the water.

Details:

Major Watershed	Mississippi River - St. Cloud
County	Sherburne
Location	2 MI NE OF CLEAR LAKE
Surface Area	350 acres
Maximum Depth	8 feet
Ecoregion	North Central Hardwood Forests
Protected for	a healthy warm water aquatic community; industrial cooling and materials transport use without a high level of treatment

parameters were indistinguishable from that of a skilled professional. Shelton was careful to reduce variability that was not attributable to data collectors, for instance sampling at the same location at the same time and using the same equipment and calibration technique. More specifically, Shelton found four of the five water quality parameters to be indistinguishable between the volunteers and the professional including water temperature, pH, conductivity, and discharge measurements. Only dissolved oxygen was different between the volunteers and professional and may not be a suitable parameter for volunteers to measure. Shelton speculated that measuring dissolved oxygen in the field is prone to error from several variables including water temperature, plant growth, field procedures, and characteristics of the water source (p. 76).

Other studies in a variety of settings have found that when given proper materials and training, volunteer information collection is comparable to professionals (Au, et al., 2000; Canfield, Brown, Bachmann, & Hoyer, 2002; Fore, Paulsen, & O'Laughlin, 2001; Obrecht, Milanik, Perkins, Ready, & Jones,1998). As budgets have been cut, volunteers have been asked to do more to monitor lakes and streams in both the United States and Canada. Each government provides volunteers with training and procedural guidelines (United States Environmental Protection Agency, 2016; Oceans and Fisheries Canada, 2015). Europe is also organizing volunteer citizens to collection information on water and other resources (*European Citizen Science Association, 2016*).

To summarize, with adequate training and simple procedures, volunteer monitors can collect credible information. Volunteers also need the structure and guidance that a governmental body or organization can provide. Also, volunteers must understand the importance of following procedures that they have been taught and to be vigilant during the collection process so that their data can enhance the work of professionals.

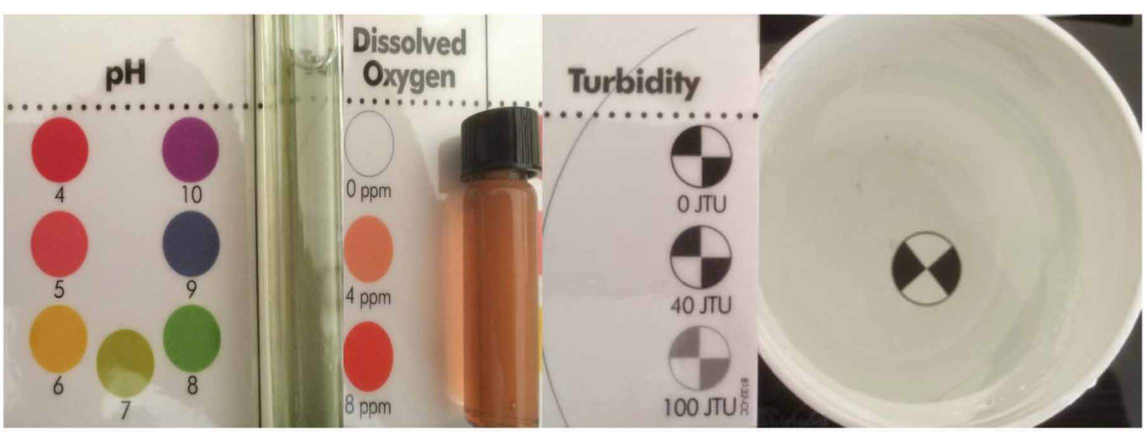
Even without much human intervention, permanent on-site electronic monitors can collect flawless data constantly for days and weeks at a time. It may be possible to give similar equipment to volunteers to add more sampling locations. The question is to ascertain how simple procedures and equipment need to be to collect good information? Is a $2000 electronic water meter that requires careful calibration suitable for volunteers? If so, how much training does a volunteer require? Considering that training can be more expensive than equipment, it seems wise to create equipment that can perform the most difficult processes and calculations automatically. For instance, an instrument that adjusts for water temperature while measuring another parameter (e.g., dissolved oxygen). Yet, there are important procedural aspects that cannot be built-into a device such as locating an appropriate water site.

Examples of Water Monitoring Processes by World Water Monitoring Challenge and EyeOnWater

Below are two examples of entry-level water-monitoring processes. The first is a portable lab created through Philippe Cousteau's EarthEcho International called *World Water Monitoring Challenge* (EarthEcho International, 2015). The second is a phone app (EyeOnWater) which was created through the work of the Citizens' Observatory for Coast and Ocean Optical Monitoring (Citclops, 2016a).

World Water Monitoring Challenge (EarthEcho International, 2015; Scientific American, 2013) grew out of a single day in 2012 in which organizers challenged volunteers around the world to collect water samples using their portable test kit (c.f., http://map.monitorwater.org). Now, the *World Water Monitoring Challenge* (EarthEcho International, 2015) is a program used by governmental agencies, school programs, clubs, and organizations for all ages around the world. Participants can purchase a test kit at a reasonable cost to measure basic water quality parameters including temperature, acidity (pH), transparency, and dissolved oxygen. Each kit contains instructions and supplies for 50 tests (Figure 4). Results can be added to an international database (c.f., http://map.monitorwater.org) and participants can share videos of their work with one another around the world.

Figure 4. World water monitoring challenge kit
(EarthEco International, 2015)



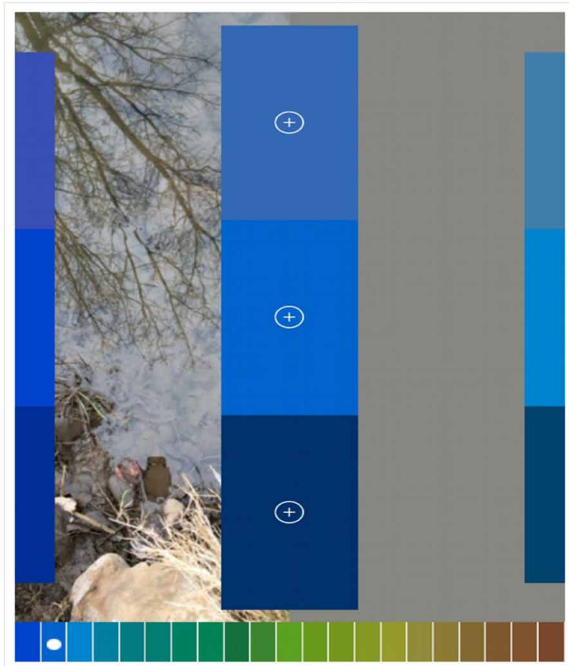
The World Water Monitoring Challenge Kit is a great way to teach novices about water quality parameters but is prone to error because of its many physical and chemical measurements in the field. Each measure requires collecting a water sample and taking several readings with it. A collection container is used to retrieve water from a lake or stream at a depth of 1 foot (⅓ meter). If not cleaned well, this container may have contaminants from prior collections that interfere with transparency or chemical measurements (e.g., acidity and dissolved oxygen). Also, tests must be performed quickly to maintain the original temperature of the sampled water. Transparency is measured with a highly modified Secchi procedure in which a small black and white disc is affixed to the bottom of the collection container, and the water color is compared to a standard (see Figure 4). Other errors can be introduced by contaminants in the collection vials, which are used to measure acidity and dissolved oxygen (see example of vial in Figure 4). Another point of possible error is when one must compare colors in the vials to a chart to estimate the values. Finally, the supplied strip thermometers can be difficult to read. Two are supplied with the kit: one for lower water temperatures and one for higher air temperatures. Both the water and air temperatures are to be recorded, so having high and low reading thermometers is important. Considering all of these error points, one must use the information carefully and perform quality control tests on it.

The Forel-Ule method is a simple means of approximating water quality based on water color. Created in the 1890s by Swiss scientist and medical professor, Francois Alphonse Forel and German geologist and limnologist, Willi Ule (Wernand & van der Woerd, 2010), the Forel-Ule method compares the colors in 21 glass tubes to the current state of the surface of a body of water. This simple handheld method correlates very highly with optical water quality, trophic level state, other measures of color (i.e., colored dissolved organic material), and can be used as a proxy for these measurements (Garaba, Friedrichs, Voß, & Zielinkski, 2015). Also, the method can be used to evaluate streams in addition to lakes and seas. In addition, Forel-Ule can be approximated using satellite imagery, fixed automated stations, and phone apps (Wernand, M., & van der Woerd, H., 2010).

The *EyeOnWater* phone app (eyeonwater.org) incorporates the Forel-Ule method into an easy to use app that has built-in protections against collecting poor information which makes it a good tool for novices and students. To use the *EyeOnWater* app, one takes a photo of the surface of a body of water and compares the processed image of the photo with the 21 Forel-Ule colors. Once the collector chooses a matching color strip (see Figure 5), the collected information is immediately sent to an international database where other data integrity processing is performed. *EyeOnWater* only measures surface water color, but it has few of the drawbacks of the World Water Monitoring Challenge Kit because water does not have to be collected nor tests processed and recorded. In addition, the phone app can record the geolocation of each measurement and allow a contributor to remove a bad data point, further reducing error. Because a Secchi disc is not required, boaters can collect information underway. For instance, sailors on the Barcelona World Race have collected information around the world from their sailboats (Ceccaroni, et al., 2014).

EyeOnWater is easy to use, but there is still a learning curve. One must take a good initial image and then select a good color match from one of the 21 standard colors to the processed image. For instance, my initial attempts had to be discarded. In the first attempt to photograph the Pecos River in New Mexico, the photo had too much shore grass because the river was high with snow melt from the Sangre de Cristo Mountains. The photo should have been taken from a nearby bridge so the center of the river was in view. One can check on observations sent to EyeOnWater by looking at the online map (map.

Figure 5. EyeOnWater application screen to compare processed photo color strip with Forel-Ule color strip (Author)

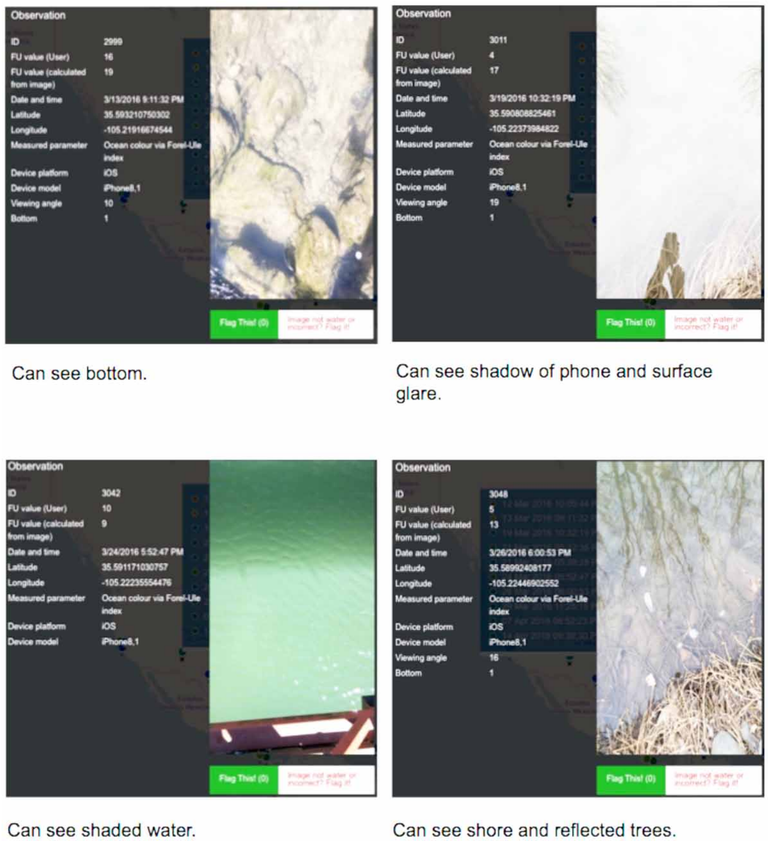


eyeonwater.org, see Figure 6). The first observation depicted in Figure 6 (labeled "Can see bottom") had a calculated Forel-Ule value of 19 and I entered a value of 18 (all observations in Figure 6 are from the Gallinas Creek, Las Vegas, New Mexico). EyeOnWater calculates a Forel-Ule value from the uploaded image so that each entry has an entered value and a calculated value. For instance, I entered Forel-Ule values ranging between 4 to 16 and the calculated values were from 9 to 20. Obviously, the creek was not changing color so much from one observation to the next within the same month. What was I doing wrong? Taking poor photos and making poor comparisons. Light and shadow effects the observation a great deal. Different light and shadow conditions can be seen in the observations depicted in Figure 6. According to EyeOnWater directions, one should place the sun behind and over ones left or right shoulder and hold the phone between 0 and 30 degrees to the surface of the water (Citclops, 2016b). However, each of my photos had objects from the shore or bridge casting shadows or overhanging tree limbs causing a reflection. Obviously, training is important even for a simple-to-use phone app.

How is Volunteer-Collected Information Being Used?

Volunteer-collected information is increasingly being used to monitor watersheds in Region 5. After decades of volunteer lake monitoring with Secchi discs, this information has finally been added to databases and used for management and planning by state and national agencies. As the technology to store and upload information to central and distributed repositories has improved, states have increased volunteer training. At the same time the technology to test water quality has improved.

Figure 6. Uploaded image data from phone application, EyeOnWater, entrees by the author on Gallinas Creek, Las Vegas, New Mexico during March, 2016
(eyeonwater.org)



Lake Trend Analysis

The most common use of volunteer information in Region 5 is for analyzing lakes over long periods of time. Like the example of Elk Lake (above), many lakes have decades of information from which to create an analysis. If a lake's transparency begins to decrease, other measures (e.g., chemical and nutrient) can be taken by volunteers or professionals to create and execute an abatement plan.

Calibration of Satellite Measurement Devices

Since Landsat 7 was launched in 1999 to take photos of the Earth, states have had access to useful ground images suitable for observing water color. Satellite imagery allows a state to cover remote and large lakes that are not easy to access. However, the satellite images have no meaning until they are calibrated with known information about the transparency of some of the lakes in the area. Olmanson and his colleagues (Olmanson, Bauer, & Brezonik, 2002) calibrated images of Minnesota lakes taken from Landsat 7 by comparing them to transparency information that was collected by volunteers on the ground.

How Much Data is Available?

The United States Environmental Protection Agency and the United States Geologic Survey have been adding information to a common store since the 1960s (i.e., STORET, United States Environmental Protection Agency, 2016, February 10). Since 2000, volunteers who have appropriate credentials have added information to this store, which allows the public to access 80 million water quality records. Federal and state agencies access STORET to allow the public to access information about lakes and streams sorted by state or watershed (e.g., United States Geological Survey WaterWatch, Minnesota Pollution Control Agency).

The Water Quality Portal (www.waterqualitydata.us) is a service of the United States Geological Survey, the United States Environmental Protection Agency, and the National Water Quality Monitoring Council. Information collected by over 400 state, federal, tribal, and local agencies is available (www.waterqualitydata.us). The information store contains over 265 million records from over 2.2 million monitoring locations beginning in the 1960s.

The Water Quality Portal allows the public to view how much information has been collected in a state or watershed over the past 1 or 5 years by either the Environmental Protection Agency or United States Geological Survey (National Water Quality Council, 2016). This information combines volunteer and professional contributions.

THE RISE OF ORGANIZED CITIZEN SCIENCE

Government and Nonprofit Organization Support in US and Europe

Monitoring is necessary to ensure that our waters can continue to support the many different ways we use these resources and to track whether protection and restoration measures are working. The information gained from monitoring helps with prioritizing the issues to be addressed and choosing the geographic areas in which to concentrate, thus helping to ensure cost-effective water-resource management (United States Geological Survey, 2016).

The United States Environmental Protection Agency is in charge of the United States water quality. During the 1970s and 1980s, the number of employees increased dramatically from circa 4,000 to over 16,000. This coincided with the passage of the Clean Water Act in 1972. The crystallizing event of that time occurred in 1969 when the Cuyahoga River in Cleveland, Ohio burned because a passing train cast a spark that set the oil on the surface of the river ablaze. Subsequent to Cuyahoga River fire, the number of employees of the United States Environmental Protection Agency increased steadily until it peeked in 1999 at 18,110. Today, the number of employees has dropped to about 15,000, but demand for water monitoring continues to rise (United States Environmental Protection Agency, 2016). Agencies find they must reduce the number of lakes and streams they sample. For instance, in Minnesota, goals for monitoring surface water were set shortly after the Clean Water Act was passed in 1972, but the goals were never reached. By 2006 few lakes had been monitored so a new strategy was created that included incorporating more volunteer monitors (Minnesota Pollution Control Agency, 2016b).

In addition to governmental agencies, a nonprofit organization, CitSci.org, seeks to assist citizen scientists because most researchers find it difficult to use volunteer-collected information unless it follows some scientific etiquette. CitSci.org aims to collect and generate diverse public datasets. CitSci.

org helps volunteers document their process and, most importantly, add other information (metadata) to the content to allow others to use the information, too.

The European Citizen Science Association is an association supported by organizations from over 17 EU and other countries (European Citizen Science Association, 2016) to create an outline and procedures to help the countries in Europe collect and share volunteer-collected information. The European Citizen Science Association purpose includes the following statement:

Citizen science is defined as organised research where the balance between scientific, educational, societal and policy goals varies across projects. It is a growing worldwide phenomenon recently invigorated by evolving new technologies that connect people easily and effectively with the scientific community. New technology provides a valuable tool for citizens to play a more active role in sustainable development. Through collaboration with scientists in organised research projects citizens can contribute valuable information that can be used to develop and deliver policies, improve understanding and respond to many of the challenges facing society today.

THE FUTURE OF CITIZEN SCIENCE WATER MONITORING

New technology for smartphones, sensors, and imagery is changing the way volunteers can monitor water and contribute to public information. Additionally, more researchers are using big data and visualization tools to analyze the vast quantities of information. Now the Secchi disc may be enhanced or substituted by a phone app, which has the advantages of being easy to use with little instruction, with built-in quality control, geolocation for both finding and reporting a site, and automatic uploading to a common information store.

The percent of U.S. adults who have a smartphone is 68% (Pew Research Center, 2015). Technology add-ons to smartphones have become increasingly sophisticated and affordable. Research labs have created phone add-ons to measure standard chemical and nutrient water parameters (e.g., acidity, Nitrates) at a fraction of the cost of non-phone-based portable sensors (Hossain, et al., 2015; Carnegie Mellon Create Lab, 2016, Colorimetrix, 2016, Gunda, et al., 2014). The future for phone technology used for water monitoring is bright.

CONCLUSION

The Great Lakes of Region 5 supplies drinking water to 51 million people. This drinking water is increasingly threatened by pollution. The enormity of the problem is such that no government agency can monitor all of the streams and lakes. The Federal Government and states are using volunteer citizen scientists to help monitor the water quality of the lakes and streams in Region 5 so that water recovery plans can be made and executed. More citizens must become involved in watershed monitoring to cover more lakes and streams at more locations. Technology can help make better volunteers and can automate monitoring processes. To encourage more volunteers, governments and organizations should incorporate social networking into their recruitment strategies.

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KEY TERMS AND DEFINITION

Clean Water Act: A United States law passed in 1972 that governs water pollution.

Environmental Protection Agency: The United States Environmental Protection Agency (USEPA or EPA) was created to protect citizens health and protect the environment by enforcing federal laws.

Great Lakes: A series of large interconnected freshwater lakes in the northeastern United States bordering Canada that drain into the Atlantic Ocean.

Region 5: EPA Region 5 consists of six states in the upper Midwest of the United States: Ohio, Michigan, Indiana, Illinois, Wisconsin, and Minnesota. EPA has 10 regions.

Secchi Disc: The Secchi Disc was created in 1865 by Angelo Secchi to measure the transparency of bodies of water. The circular disc is lowered into water by a calibrated line and a measurement (Secchi Depth) is taken at the point the disc is no longer visible.

Surface Water: Surface water is lake, stream, wetland, and ocean water.

United States Geological Survey: The United States Geological Survey (USGS) is a scientific agency that studies land and natural resources. USGS is concerned with natural hazard such as floods and droughts.

Watershed: The land and everything upon it on which water drains to a common point. Larger watersheds are made from smaller watersheds just as streams flow into rivers.