MARION COUNTY PARK AND LAKE CITIZEN SCIENCE PROJECT REPORT

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Introduction

Preface

In an effort to collect data at Marion County Park and Lake for the eventual development of a lake management plan, we propose to initiate a citizen science program. However, this is a complex proposal and does have its obstacles with deployment, implementation, data quality, and a few other issues. In this we will address the concerns and will elaborate on what it is to use citizen science as a tool to collect scientific data. First we will describe and characterize the lake, then summarize water quality issues that affect Kansas lakes and streams, explore issues that affect Marion County Park and Lake and similar bodies of water, and identify issues facing the Marion Reservoir now known as Marion Lake. We will then provide an overview of the proposed citizen science project. We will summarize potential water quality sampling kits and summarize literature related to citizen science projects related to water quality and other fields of science. In doing so, we will identify potential curriculums, activities, and programs, along with identifying potential groups near Marion Lake who could be recruited as contributors for this project. Lastly, we will address activities and efforts that can be done in the future that could augment citizen science data-gathering efforts.

Description of Marion County Lake

Marion County Lake and Park is a 153 ac (62 ha) lake with a maximum depth of 40 ft within a 300 ac (121 ha) park. The lake is located one and a half miles east and two miles south of Marion, Kansas near highways U.S. 256 & U.S. 77 (Marion County Park and Lake History, 2011). Marion County residents voted in the petition to create the lake in the 1934 election and in 1935 plans went through for construction. By February of 1936, 300 workers from the Civilian Conservation Corps moved in to start work. The materials, site, and construction inspection costs were furnished by Marion County, while the federal government supplied equipment, labor, and supervision. Construction of the dam was finished by the end of 1937 at which point the growing lake was stocked with fish and work on the grounds continued. On May 26, 1940, the park and lake were officially opened to more than 10,000 waiting people including approximately 2,000 registered fishermen. Since then approximately 275 houses have been constructed around the lake with more scheduled to be built. The number of year-round residents is approximately 235 and growing. The lake features 5 miles of hiking trails, a 1,400 foot swim beach, two boat ramps, a museum, a heated fishing dock, public showers and toilets, two picnic shelters, camping amenities, a dump station, and a lake concession. The lake also features a four mile paved road that encircles the entire lake with rock inlet roads providing easy access to every part of the park and lake.

Water Quality Problems in Kansas

Nonpoint source (NPS) pollution refers to the transport of natural and man-made pollutants by rainfall or snowmelt moving over and through the land surface and entering lakes, rivers, streams, wetlands or groundwater (Kansas, 2011). Atmospheric deposition and hydrologic modification are also sources of nonpoint pollution. To gain a better understanding of the effects of NPS pollution the Kansas NPS Pollution Management Program Highlights are covered in the following paragraph.

NPS highlights start with the development of watershed-based Total Maximum Daily Loads (TMDLs) for impaired water bodies through the Kansas TMDL program. Followed by the establishment of a targeted component of the State Conservation Commission (SCC) Cost-Share programs to address high priority TMDL watersheds and development of the Kansas Water Quality Buffer Initiative. Next is the development of the Kansas Surface Water Nutrient Reduction Plan. Then the completion of a statewide Source Water Assessment for public water supplies. Finally, the development and implementation of the Kansas Watershed Restoration and Protection Strategy (KS-WRAPS) Program.
In recent decades, nonpoint sources of pollution have received increased attention (Nejadhashemi, 2006). In particular, runoff from agricultural lands has been cited as a primary contributor of sediments, nutrients, and pesticides into the nation's waterbodies. Despite years of effort and hundreds of millions of dollars spent on best management practices aimed at reducing these nonpoint sources of pollution, challenges remain. In Kansas, nearly 39% of stream miles and 76% of lake acres were deemed impaired for one or more of their designated uses. The question is how can conservationists and extension professionals use tools from science, combined with the knowledge and participation of local stakeholders, to address water resource issues at the watershed scale? Nejadhashemi describes an adaptive approach used for watershed modeling and economic analysis activities in agricultural watersheds.

Chapter 4 of the EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters covers pollutants, sources, and indicators (United States, 2018). This handbook helps communities, watershed organizations, and environmental agencies develop and implement watershed plans to meet water quality standards and protect water resources and should be particularly useful to organizations that work to restore impaired or threatened waters. This handbook supplements existing watershed planning guides that have already been developed by agencies, universities and other nonprofit organizations. The handbook is generally more specific than other guides with respect to guidance on a) quantifying existing pollutant loads, b) developing estimates of the load reductions required to meet water quality standards, c) developing effective management measures, and d) tracking progress once the plan is implemented.

The Kansas Water Resources Planning Act provides statutory authorization for addressing water quality management in the Kansas Water Plan (Conforti, 2015). This Act established long-range goals for the management, conservation and development of the waters of the state, including protection and the improvement of the quality of the water supplies of the state and prevention of the pollution of the water supplies of the state. Water quality management falls into two general categories - surface water quality and groundwater quality. Differing laws and policies govern each category, although the Kansas Water Appropriation Act governs both. Kansas has primacy for implementing the Federal Clean Water Act (CWA), which is administered by the Kansas Department of Health and Environment (KDHE) with important roles played by other state agencies. This administration includes enactment of state statutes and administrative regulations consistent with federal policy and the various assessment and reporting requirements involved.

Problems known for Marion County Lake

Kansas provides TMDL and 303d listings for every stream and lake in Kansas that has been tested (Impaired Surface Waters of Kansas, 2016). The Marion County Lake ID number is LM012101, and its HUC 8 number is 11070202. The site also includes a large list of different point and nonpoint source pollutants. The two water quality impairments identified for Marion County Lake are dissolved oxygen, shown as medium concern, and eutrophication, shown as medium concern. The impairments provided

are not an exhaustive list for Marion County Lake but it provides a good starting point. It does provide streams that feed into the Lake from elsewhere in the Neosho Basin as well as their pollutants.

The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the Kansas Water Plan (KDHE, 2002). The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a "Medium Priority" consideration. Primary participants for implementation will be agricultural producers within the drainage of the lake. Future work in 2007 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage total row crop acreage, cultivation alongside lake, drainage alongside or through animal feeding lots, livestock use of riparian areas, and fields with manure applications. Implementation of agricultural best management practices will likely improve water quality in Marion County Lake. Some of the recommended agricultural practices would include implementing soil sampling to recommend appropriate fertilizer applications on cropland. Next would be maintaining conservation tillage and contour farming to minimize cropland erosion. Then, the installation of grass buffer strips along streams. Followed by the reduction and even elimination of agricultural activities within riparian areas. Finally, implementing nutrient management plans to manage manure application to land.

Problems facing similar water bodies

Funding for a Harmful Algae Bloom (HAB) pilot project will be utilized by the KDHE to investigate and demonstrate in-lake treatment options such as ultrasound superoxide or other chemical treatments in the vicinity of the Clay County Park at Milford Lake (2018 Kansas Water Authority, 2017). The objective of this pilot project is to assess the effectiveness in lake treatment options and their ability to minimize the impact of HABs around the city of Wakefield. Approximately $350,000 dollars in FY2018 will be used for such demonstrations. These demonstrations could include, but are not limited to identified strategies such as sonar, additional circulation, phosphorus harvesting, etc. Another $50,000 would be utilized to develop a long-term HAB mitigation strategy for Milford Lake to evaluate the best mitigation practices throughout the United States and preferred long-term options for Milford and possibly other Kansas lakes impacted by HABs. Additional management actions are also being evaluated such as lake level and activities within the watershed.

Council Grove Lake is a 2,589 ac lake, located in the Flint Hills region of Kansas (Neosho River Basin TMDL, 2009). It was constructed by the Tulsa District Corps of Engineers in 1960, by damming the Neosho River to control flooding, and reached its normal pool level in 1964. Council Grove Lake lies within a 259 mi2 watershed that is predominantly grassland (67%). Cultivated row crop accounts for 18% of the watershed, while pasture and hay occupy 3% of the total land area. Council Grove Lake is a Class A primary contact recreational water for public swimming. Other designated uses include aquatic life support, drinking water, industrial water supply, and food procurement. Water quality data collected from 2000 to 2007 revealed that Council Grove Lake ranks third for total phosphorus (TP) concentration of 24 federal reservoirs in the state. The average concentration is 198 µg/L (ppb), which is 10 times greater than the reference value of 19 µg/L suggested for the Flint Hills region and twice larger than the national average 100 µg/L of the EPA's Survey of Nation's Lake in recent years. Similar to TP, the total suspended solids concentration, indicative of turbid condition, is high and averages about 21 mg/L (ppm). Because of the appearance of high turbidity values, the lake has low water clarity. The average

Secchi depth value is 54 cm, ranking 20th among the 24 federal lakes in Kansas. Eutrophication along with siltation is the most pressing water-quality problem in Council Grove Lake and throughout the Midwest. Though eutrophication occurs naturally, it can be accelerated through an anthropogenic process that causes reservoirs to become more productive or eutrophic due to excessive nutrient additions from their associated watersheds. Chlorophyll a concentration has been used as a general trophic indicator of a waterbody. The lake's Chlorophyll a concentrations average 7.4 µg/L, which ranks 20th in the state. The occurrence of low Chlorophyll a concentrations is closely associated with low water clarity or high turbidity conditions. The high turbidity due to suspended particles negatively affects phytoplankton communities and light penetration.

Problems facing Marion Lake (Reservoir)

Water quality of Marion Reservoir has been identified as impaired due to nutrients, pesticides, sediment, and bacteria (Andersen, 2011). These impairments have caused the lake to be non-supportive of contact recreation and only partially supportive for drinking water. The Marion County Conservation District and others determined that an assessment should be done to look at water quality problems in the lake and watershed. This assessment would be further used to determine which best management practices (BMP''s) would be affective in solving the reservoir's water quality impairments. The grant was used to contract with USGS and Tabor College to collect data from the reservoir and its watershed. Additionally, an information and education campaign was conducted to build public awareness on water quality issues in the watershed. This project was completed by the end of 2000; however details of the project's accomplishments and additional actions would be needed to fully understand its effect.

The purpose of this Watershed Restoration and Protection Strategy (WRAPS) report for Marion Lake is to outline a plan of restoration and protection goals and actions for the surface waters of the watershed (Barnes, 2009). Watershed goals are characterized as "restoration" or "protection". Watershed restoration is for surface waters that do not meet water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection is needed for surface waters that currently meet water quality standards, but are in need of protection from future degradation. The WRAPS development process involves local communities and governmental agencies working together toward the common goal of a healthy environment. Local participants or stakeholders provide valuable grass roots leadership, responsibility and management of resources in the process. They have the most "at stake" in ensuring the water quality existing on their land is protected. Agencies bring science-based information, communication, and technical and financial assistance to the table. Together, several steps can be taken towards watershed restoration and protection. These steps involve building awareness and education, engaging local leadership, monitoring and evaluation of watershed conditions, in addition to assessment, planning, and implementation of the WRAPS process at the local level. Final goals for the watershed at the end of the WRAPS process are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, and timber production. Other crucial objectives are to maintain recreational opportunities and biodiversity while protecting the environment from flooding, and negative effects of urbanization and industrial production. The ultimate goal is watershed restoration and protection that will be "locally led and driven" in conjunction with government agencies in order to better the environment for everyone.

What's Been Done

Water quality and citizen science

Citizen science programs have become an increasingly important tool utilized by environmental researchers. The implementation of these programs can help researchers to lower costs required to collect large volumes of data, also help to engage the community in the stewardship efforts. When these programs are well developed and managed, they can provide scientists with meaningful and useful data points to further their research without having to make extensive field visits to collect samples of their own. The importance of selecting volunteers from a proper audience, and tailoring instructions and test parameters to that specific group can ensure that the data points are properly collected and will not artificially skew the results of the study. (Sarnelle et al., 2010). In this 2010 study of citizen science data collection in regards to eutrophication and invasive mussel species, a citizen science program partnered with the Cooperative Lakes Monitoring Program (CLMP) of Michigan to collect data samples which were then sent to labs and analyzed by professional scientists. This collection scheme proves useful in eliminating the potential bias against the evidence collected by non-scientist citizens. This was done by ensuring that the sample collection methods were clear and simple, and the in depth scientific analysis was performed by trained professionals. This particular study showed that citizen science programs are in fact capable of collecting meaningful data for scientific research. This bodes well for our implementation of a citizen science program at Marion Co Lake. Combined with the local resident population and their interest in preserving the lake and land resources, with careful planning an effective lake management strategy can be developed in partnership with the offices of Marion Co Lake and Campground.

There have been efforts to incorporate citizen science into the process of gathering data to monitor water quality. For example, in an article published by NASA they discussed why researchers and scientists should favor citizen science programs to help them capture data for water quality research. The author uses the Chesapeake Bay watershed for an example stating that that area has a hundred and fifty different streams and rivers, so it would be an overwhelming and lengthy task for an individual group or team together all that day to themselves. Using citizen science, the same researcher could have people who have a vested interest in the health of the Water Systems who volunteered to go out and grab that data could gather it faster and get a larger amount of that data (Bardar et al., 2018). So, this is a definite win for researchers who are studying lakes and river systems over large periods of time. But what about the current state of citizen science in the field of hydrology? One of the very first few things is that the cost for the equipment needed for these projects has declined over the years. For us this would mean that it could soften the financial blow that might hit the budgets that would go towards paying for the program. Also note that there are ways or methods that these projects can be done, that being we don't have to stick to the method of just sending people out to gather data. However, that due to past expense the field of hydrology doesn't have a lot of these programs. But as stated earlier costs are going down so this can be remedied. The big issues highlighted here is that the scope of hydrology Citizen Science projects are limited to water quality testing as well as the role of the non-scientist is focused around data collection (Buytaert et al., 2014). Lastly, look at an example that Iowa State University has put forth in their water quality citizen science program. Their method of data collection amounts to a simple paper test that they dip the paper in the water they put it against a sheet and take a picture of it. The observer or the citizen scientist then uses an app that they download to get a precise measurement. These results are then uploaded the database. (Jones, 2018).

Other examples of citizen science projects

These projects are not just limited to the scope of water quality. We can also see how they will affect other fields of science. One thing that someone may point out is that those who are collecting data can sometimes be very vague with their responses and their observations. However, this is more of a historical problem. We should note that citizen science as a whole is not anything new and that it has been around since the 1900s and has changed and evolved over time. But to combat the problem mentioned before, one method that could be suggested is to pair volunteers with trained staff (Cohen, 2008). This is a solution to one issue with citizen science. However, let take a look at how these projects have helped out in the field of ecology. One positive note is that citizen science allows the pairing of field work with educational opportunities. Also, several techniques have been developed to aid in the whole project process. There are also different ways in which citizens science has been used to benefit other field such as landscape ecology, climate change, and even agriculture. Citizen science has also been beneficial in finding rare species because there are simply a larger number of observers. This creates the "many eyes" effect which increases the probability of finding that species (Dickerson, 2012). Another application for this could extend beyond the immediate reach of the project. This would be in the form of biodiversity databases that would take a lot of the data collected by citizen scientists and pool it together for biodiversity research. This is a research tool that is in high demand in the world of biodiversity. To further this point private participation can out compete, through private donations, government funded studies. They also can have more man-power behind them than a government funded study. However, very little of this data makes it to peer reviewed journals. This would be a good example of what we could do with data that is gathered (Theobald, 2015).

Citizen Science Curriculum and Programming

Examples of curriculum, activities, and programs

One example for a citizen science, although not in the realm of water quality, this is a good example of a program and curriculum designed for grade school children. The curriculum centers on discovering bugs that live around the school in which the program is to be taught (Wouter, 2014). Now keep in mind they use the term bugs to mean not just insects but arthropods as a whole. For example, one of the day's curriculum centers on spiders and arachnids. On top of insects they also talked about Crustaceans as well as centipedes and millipedes. The citizen science part comes in after the learning portion. They find "bugs" and upload them to iNatrualist. This also includes tags for location and species.

The curriculum as a whole, not only has the educational element, but breaks it up into crafts and games as well. Not only to break up the material and allow for more digestible bites but also to reform the learning experience instead of it just being a straight lecture. As stated before, this curriculum comes with its kit and it provides a list of materials as well as the login information for the iNaturalist website that they partner with to report the found information (Genentech, 2017). However, if we were to entertain generating our own curriculum then we should follow create programs that are not dumbed down versions or upgraded versions of what we give out to a specific group. Instead we should create different programs that are tailored to different groups (Beck, Cable, 2011). So, one good source material would be Project Wet. This is a curriculum guide that shows different activities that students K-12 can do. The focus of the curriculum and activities is around water conservation and education. These activities educate children on a number of different environmental concepts. A big focus of the book is

using play and other forms of activities to promote learning. The main areas being: Physical and Chemical Characteristics, Water in relation to Life, Water and Earth Systems, Water as a Natural Resource, Water Resources Management, and Water in relation to Social Constructs (Project Wet Foundation, 2011). While we would not fully rely on this guide, we can use it as a tool to generate curriculum suited for a wide range of age.

Existing Citizen Groups near Marion County Lake

List and description of known citizen groups near Marion County Lake

For this citizen science project, the demographic for potential volunteers is focuses largely on local citizen groups. These groups include K-12, Boy and Girl Scouts of America, FFA, 4H as well as residents of Marion County. Possible K-12 schools located in Marion County include; USD #397 Centre School District, Lost Springs, KS, USD #398 Peabody-Burns, Peabody, KS, USD #408 Marion- Florence, Marion, KS, USD #410 Hillsboro, Durham, Lehigh, Hillsboro, KS, USD #411 Goessel, KS. The ability to incorporate our lesson plan and curriculum with each schools' current science program makes K-12 schools' perfect candidates for volunteer data collection.

Along with K-12, the FFA an extracurricular programed aimed at preparing students for a career in agriculture. A list of local contacts of FFA groups are as followed. FFA Chapters in Marion County; Lost Springs, KS, Chapter: Centre, Phone: 785/983-4321 Name: Laura Klenda, Cell Phone: 785/366-3575, Email: lklenda@usd397.com. Peabody, KS, Chapter: Peabody, Phone: 620/983-2196, Name: Alex Walters, Cell Phone: 785/303-0341, Email: awalters@usd398.com. Marion, KS, Chapter: Marion-Florence, Phone: 620/382-3111 Name: Mark Meyer, Cell Phone: 620/381-0161, Email: meyermar@usd408.com. Hillsboro, KS, Chapter: Hillsboro, Phone: 620/947-3991, Name: Sonya Roberts, Cell Phone: 620/338-0600, Email: sonya.roberts@USD410.net. Goessel, KS, Chapter: Goessel, Phone: 620/367-2242 Name: Alicia Oard, Cell Phone: 785/643-2906, Email: oarda@usd411.org. ("Kansas FFA Association Website" n.d.). A possible FFA event that could be applied is The Environmental and National Resources Career Development Event (CDE), in which competing students are given the opportunity to gain awareness and demonstrate knowledge in areas that affect our air, soil and water. Competitors interpret data; use measuring devices in the field and work through real-life scenarios involving environmental threats in pursuit of scoring the highest as a team and individual. (Ortiz n.d.)

Another viable option is the Boy and Girl Scouts of America, Marion county lake is currently active with local troops. Troop 0108 Peabody United Methodist Church, and Troop 0129 American Legion Post 366 are both potential groups for volunteer water quality data collection. To move up in rank in Scouting, one is required to gain merit badges, if we were to establish a volunteer network with the Scouts it would be beneficial to both parties, in that, some merit badges can be, or are, directly related to this project. Examples of these badges include Environmental Science, Citizenship in Community, Wildlife Management, Soil and Water Conservation ("Merit Badges" n.d.)

In addition, the local 4-H Marion County, KS chapters have possible projects that can be applied to collection of water quality data. The Citizenship (CS100) project is focused on personal development and becoming a better citizen in the community. Subsections of this project are subject to specific age groups which is helpful because of the limited amount of volunteer citizens in Marion County, My Neighborhood (ages 9-11), The World Around Me (ages 12-14), Public Adventures (ages 12-14), Service Learning - Agents of Change (ages 12-14). ("Citizenship | Personal Development | Projects | Kansas 4-H Youth Development" n.d.)

Citizens Science Overview

Sample scheme

Ultimately, the overall goal is to implement a new citizen sciences program into local classrooms, extracurricular programs, community organizations, and the general public. Citizen volunteers would be used in the collection of water quality data at Marion County Park and Lake in Marion County, Kansas. The lake office will provide a Hach water quality testing kit, along with a data worksheet, to be fill out, and a map with sampling points, marked in red, for guidance to the sampling points around the lake. The Lake will also be equipped with physical sampling markers set up around the lake to assure the quality and consistency of the data collected.

K-12 Groups

The idea was to find local citizen groups that would be interested in contributing to the collecting of watershed data. One aspect of the data collection process, for this citizen science project, is focused on developing a curriculum that benefits the citizen volunteers. When considering potential citizen groups, K-12 seemed the most practical. The curriculum, similar to a high school biology class, can be applied to many different age levels. Not only will the data that is contributed help improve the community, volunteers are also given the opportunity to engage in concepts learned in a classroom while developing hands on experience. Below is a list of administrators for the local K-12 in the Marion County area.

Table 1: Local K-12 Schools & Contacts

School	Location	Principal	Phone	Email
USD #398 Peabody-Burns,	Peabody, KS	Mr. Scott Kimble	620-983-2196	skimble@usd398.com
USD #397 Centre	Lost Springs, KS	Donald Raymer	785-983-4321	N/A
USD #408 Marion-Florence	Marion, KS	Travis Rogers	620-382-2117	rogertra@usd408.com
USD #410Hillsboro, Durham, Lehigh	Hillsboro, KS	Clint Corby	(620) 947-3184	N/A
USD #411 Goessel	Goessel, KS	Scott Boden	620-367-2242	bodens@usd411.org

FFA Chapters in Marion County

Another citizens group considered is the FFA (Future Farmers of America), this organization is associated with local school groups and allows the youth to develop the skills to reshape the future of agriculture. A possible FFA event that would be similar in curriculum would be The Environmental and National Resources Career Development Event (CDE) which provides students an opportunity to gain awareness and demonstrate knowledge in areas that affect our air, soil and water. Students interpret data; use measuring devices in the field and work through real-life scenarios involving environmental threats. Below is a list of local FFA chapters in the Marion County area.

Table 2: Local FFA Chapters & Contacts

City	Chapter	Phone	Contact	Cell Phone	Email
Lost Springs, KS	Centre	785/983-4321	First: Laura Last: Klenda	785-366-3575	lklenda@usd397.com
Peabody, KS	Peabody	620/983-2196	First: Alex Last: Walters	785-303-0341	awalters@usd398.com
Marion, KS	Marion-Florence	620/382-3111	First: Mark Last: Meyer	620-381-0161	meyermar@usd408.com
Hillsboro, KS	Hillsboro	620/947-3991	First: Sonya Last: Roberts	620-338-0600	sonya.roberts@USD410.net
Goessel, KS	Goessel	620/367-2242	First: Alicia Last: Oard	785-643-2906	oarda@usd411.org

4-H Marion County, KS

Kansas State plays an important role in the organization of the local 4-H community, because local 4-H groups are associated with Kansas State University, 4-H is a great option for a volunteer citizen group. A possible project involving the data collection of the water quality, that can be applied to a variety ages is Citizenship (CS100): My Neighborhood (ages 9-11), The World Around Me (ages 12-14), Public Adventures (ages 12-14), and Service Learning - Agents of Change (ages 12-14). The purpose of these projects is for kids to learn the value their community, while developing hands on experience in a science-based background. Contacts for 4-H can be found in the chart below.

Table 3: Local 4-H Contact Info

Contacts	Email	Phone	Address
Courthouse Annex	MN@listserv.ksu.edu	620-382-2325	Courthouse Annex 202 S. 3rd, Suite A Marion, KS 66861
Tristen Cope Family and Consumer	tcope@ksu.edu	N/A	N/A
Rickey Roberts Agriculture & 4-H	rroberts@ksu.edu	N/A	N/A

Boy Scouts

Marion county lake is currently active with local scouting troops. Troop 0108 Peabody from Peabody middle/high school is a potential group for volunteer water quality data collection. The best way to contact the scout troop is through the Marion County Park and lake office or contact the troop through Facebook at https://www.facebook.com/PeabodyBoyScouts/. Current merit badges that are similar in curriculum to water quality data collection are as followed, Environmental Science, Citizenship in Community, Wildlife Management, or Soil and Water Conservation. Each merit badge has

requirements that can be completed by implementing the process of water quality data collection. Thus, the citizen science project being beneficial to both citizens and the environment.

Map

Figure 1: Potential Sampling Points ("Google Maps")

Above is a map of Marion County Park and lake. Marked in Red, are the proposed spots for water quality data collection. Each testing spot is based on a set of factors including; lake front accessibility, suspected pollution outlets, areas with high human traffic, and areas with low human traffic, for comparison. Using the map, one can find the physical markers that will be put in place to mark each testing site.

Data Management

As for data management, initially the plan is to have volunteers collect data and write it down on a worksheet provided by the Lakes Main office. In the beginning, one could input data into an online database, or turned into the lakes main office. Eventually the goal is to create an app that would allow volunteers to enter data on their smartphones, going directly to an online data base. Once enough data is entered to the database and data can be analyzed on year-to-year basis, then long-term recommendations can be made.

HACH Kit Rational

In choosing a water quality assessment kit for our citizen science project, the goal was to find a kit of reasonable cost which covers all essential aspects of freshwater quality testing without being too in depth or scientifically complex. There are many companies which offer a multitude of water quality testing kits which are tailored to specific aquatic ecosystems such as salt water, freshwater, or residential systems. The three main companies whose kits were evaluated were Hach, LaMotte Inc, and Carolina Scientific. LaMotte offers a number of comprehensive test kits which are combined with educational materials and meant to be integrated into existing environmental education programs.

These educational supplements added significantly to the cost of the kits, and without being able to evaluate the included materials before purchasing, these kits were given second priority, as we are aiming to create a wide-ranging program which will involve students as well as adult community members at Marion County Lake and Campground. The kit which appears to be the best option is the Hach water kit. The Hach kit is used by many professionals and researchers and cover the major bases of water quality testing. The Hach kit includes assays for ammonia, chlorine, nitrate, dissolved oxygen, phosphorous, and temperature. These tests provide key information about the quality of water in a freshwater system and can give clues as to its suitability for aquatic life and recreational use. The cost of the Hach kit is $365 which is $100 less than the next cheapest kit that was researched. The Hach kit covers the basics without being too in depth and will allow us to develop our own sets of instructions and supplemental literature to be included in our report and citizen science project. (Jollymore, Haines, Satterfield, & Johnson, 2017)

Recommendations for Implementation

Regular Sampling

The majority of samples that will be taken using the kit will be from individuals or groups checking them out from the lake's head office. What's the kit has been checked out they'll be handed a form for each point that they plan on visiting. The front side of this form will have the data collection the reverse side of the forum will have a map of the lake to show where the points are. On top of this there will be a quick demographic survey that will be included so that the program can ascertain how many people are using the kit and who is using the kit. Both of these will not only help the kit remain stopped but will aid in future developments of the citizen science program and allow it to expand. The points we'll all be on docks that are around the lake so they should be easy to locate and easy to access. There are instructions for each test provided in the kit and if these instructions are ever lost, destroyed, or otherwise unusable they can be downloaded and reprinted at the website provided here: https://www.hach.com/surface-water-test-kit/product-downloads?id=7640218498. It should be taken into consideration that some groups will not be able to interpret the instructions without some guidance. Personnel should assist in instructing groups on how to perform each test. Interpretive literature in which would have the instructions interpreted to target certain age groups. While it is not a necessity, this would go a long way to help groups who may not understand the instructions.

Events

One proposed method of getting the community actively involved would be to have either the Lake management body itself or a program like the boy scouts or FFA to host an event in which they get members of the community to take mass samplings at the points. This would be a very effective way to gather large quantities of data as well as get new people involved so that they'd be more willing to be more comfortable with sampling around the lake at other times in the year. This would also be a good way to show those who would be investing into this citizen science program what their money is going towards. It also allows for the public to see what the process of building a lake management plan looks like. Or at least a small window into that process. There should be some funds be set aside for promotion this could be a simple as flyers and banners and can ranges complex as other forms of advertisements such as using radio airtime in paid segments such as that. These are a few examples to promote the event. Other expenses should include snacks for the volunteers and participants,

refreshments and water, and finally extra kits to accommodate the increase of uses of the kit for that day.

Recommendations for Future Capstone Classes

The more we dive into this, the more possibilities we can see. One practical future project would to set up some interpretive signs in the park that would act as a method to attract park visitors to gather data. This would also include an "exhibit" or interpretive display that would house the data collection method, which in our case would be pH strips and instructions. One idea that our group has discussed is that we could put an interactive display and some signage that would center on water quality and how the scientific research that is being conducted is carried out and what happens to the data and its significance. There would also be signs that would teach about limnology and hydrology as well as what could affect the overall health of a watershed. One thing that interpretation can provide is a way of finding common ground with a visitor and that resource (Beck, Cable, 2011). If we can do this, we can create a passive method to generate data without reaching out to science clubs or other organizations, we still would but we would also have a higher volume of data. The process would be similar to the Iowa State water quality program. We would provide instructions and a pH strip, and they would photograph the results and upload them to a database (Jones, 2018). For this we can also incorporate technology, such as phone apps or audio instruction for example, this would be fine for the exhibit so long as they do not interfere with the data collection or the interpretive experience, and that they are not a distraction to the objectives of the exhibit (Beck et al., 2018).

Another thing that a future group could do in the future is contact enthusiast programs such as local drone groups or wildlife spotting enthusiasts like birders. Having them gather data in the form of either around the health of the local ecosystem or to use technology to observe and monitor things would be a great way to gather data faster. Now this would not be for original intended goals for this semester of taking pH of the water or the mineral content. But it would offer a great way to gather data on the flora and fauna in the health of these categories. This would be a great way to utilize the community that visits Marion County Park and Lake and what this will do is help target the communities of people who have the most in invested interest in the lake.

Another thing that can be done in the future is that another group to develop an app that could be used to gather this would allow for a faster quicker collection of data. This would allow for a faster quicker collection of data when people are out using the kits instead of submitting papers that then have to be interpreted. They could be immediately sent and interpreted automatically in a database. This could also eliminate human error in the interpretation of the data or in the recording of the data as the app would have pre-selectable fields to put the data into. The form that has been suggested, the one that they fill out for when they run the kit, would be a good template for the sap as well as the survey of the demographics that will be handed out to them as well. Finally, this would provide an easy way to track the inventory of the kits and how often they are used. Those who wanted can get ready access to how many times in a certain the kit has been used. That can give volunteers or staff a definite mark of how often the kit needs to be restocked without contacting the office at the lake.

An idea that a future capstone class could do is put some research into the outlet flow area of the lake. This could involve setting up some citizen science-based efforts in order to get quantitative data of the overall health of this isolated area or a group could just spend the semester collecting data and samples. With either approach the focus should be on outlet flow and water quality. What would be

ideal for this project would be to have both long-term data collection in the form of community members taking consistent samples of the area also having an immediate health assessment done by small team.

Another project idea that could be proposed is installing more waste disposal units. From our recon that we performed on the site we noticed that there were few areas to dispose of waste. A group could also tag onto this a pollution-based research project in which they could track how many pollutants, whether solid or chemical, are being introduced to the lake. This could be done with physical counting of litter and debris as well as taking samples of water checking for pollutants such as human waste and other chemical pollutants.

One thing that was discovered when the map and its points that were plotted, was that the map appeared to be a little basic and maybe even out of date. One thing that a future capstone course could work with is to update the map flush it out a little better and fully integrate our sampling points so that when the citizen science component moves to an app platform the basic map in which is handed out to all visitors and guests can have all the information they need to participate.

The next big step that needs to be done for the citizen science project for future classes is that they need to contact and coordinate with the NGOs and student groups that we identified in this report. While having a kit in the office that people can check out was really going to get us a lot of data is having these groups come out to the lake or coordinating days for them to collect data for us. Doing so this would allow the student groups schools and NGOs to adapt what we want them to do into their curriculum or just set up lessons that center around what we will have them do. It will also allow us to create a more sustainable relationship with them because then we can start to tailor-craft the instructions and curriculum for our kits to give to them so that we can create a program that best suits their needs as well as ours.

Another project that a future capstone course could take on would be the setup implementation and promotion of a COCORAHS station and get volunteers to participate. COCORAHS is an acronym for Community Collaborative Rain Hail and Snow Network. This would be a simple jacked in which precipitation gauges are set out and we would ask members of the community to periodically check them and send us their findings. This would allow after years of this being implemented those who are crafting the lake management plan to understand the exact yearly precipitation on the lake as well as information on the overall climate of that area.

Appendix

Sample Point Data Sheet

Enter information into the below fields.

Name:

Date:

Time:

Sample Point Number:

Data:

Test	Result	Units
Chlorine		mg/L
Dissolved Oxygen		mg/L
Ammonia		mg/L
Nitrate		mg/L
Phosphorus/ Orthophosphate		mg/L
pH		N/a

Notes (Anything else to add about the water at the point you tested):

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