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4/27/15

Capstone Final Report

Stakeholder Mindset and Ecological Impact: Do Personal Beliefs and Values of Lake Papakeechie and Lake Wawasee Residents Influence Lake Stewardship?

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<u>Supporting Faculty Mentors</u>: Professor John Sitter (English); Professor Daniel Lapsley (Psychology)

<u>Project Location</u>: Three-Lakes Region (Lakes Syracuse, Wawasee and Papakeechie), Syracuse, Indiana

Introduction

This interdisciplinary project combined fundamental limnological studies of an Indiana lake (Lake Papakeechie (LP), Syracuse, Indiana) and its surrounding watershed with social psychological studies of two contrasting, adjoining lake communities (Lake Papakeechie and Lake Wawasee (LW)). My research is composed of three parts: (1) development and implementation of new lake limnological studies in collaboration with the Lake Papakeechie Sustainability Initiative (LAPSI), an emerging lake sustainability group, (2) concurrent social psychological studies of the values and attitudes of residents about lake management/ecology in two adjoining lake communities, one in which lake environmental studies are well established (LW), and the other where these studies are under development (LP), and (3) culmination of research at an academic conference as well as educational and protocol prep for the continued use of research by lake residents. Superimposed on the difference in environmental stewardship are significant disparities in the socio-economic status of the two communities, in the size and status (public *vs.* private) of the two lakes, and in the relative environmental impacts of one lake on the other (water flows from LP into LW). These disparities have led to an unhealthy lack of communication, cooperation and collaboration between the two lake communities, resulting in the less-than-ideal management of the two lakes and their surrounding watershed. The overall aim of the project is to couple lake limnology and watershed ecology studies with social psychology work, in an effort to better understand the lake communities, facilitate improved communication between them, thus leading to the prospect of better ecological management and outcomes. All protocols will be included in this report before the Works Cited Section, as they pertain to future work.

Limnological Studies 2013

Lake Papakeechie (LP) in Syracuse, Indiana (~45 miles southeast of Notre Dame) is a private, 179-acre inland lake. LP is managed by the Papakeechie Protective Association (PPA), which was founded in 1928. In 2012, a new environmental group on LP formed with the approval of the PPA. The Lake Papakeechie Sustainability Initiative (LAPSI) is actively developing new lake-management policies on LP. The primary mission of LAPSI is to establish thorough and long-term monitoring of LP with respect to the major ecological indices of lake health. Importantly, LAPSI aims to fulfill its scientific mission through the use of lake resident volunteers (citizen-scientists) who will be trained to collect and analyze the scientific data over many years. Over the last eight weeks of the summer, I have worked in confluence with LAPSI to initiate the first systematic limnological studies of LP in its 110-year history.

Before I began measurements, I had to set up the lab. This included setting up a printer, incubator, modem, lights, and painting. I felt it necessary to have specified points on the lake in which to take samples. Professor Serianni and I decided that 50 points would give a good basis for testing now and in the future. I used Google Earth to choose my points, separating the lake into four sections and doing a stratified random sample in order to get a comprehensive sample of the lake. I then entered the points into a Lowrance Sonar/GPS Unit and took this out on the lake with me whenever I took samples. I could ensure that I was within a few feet of the test point each time I went out to do a water quality test. I made sure to thoroughly document my activities in a daily journal, write protocols for the water tests, and Standard Operating Procedures for the various machines/ applications I used. This way, others can recreate tests accurately in the future.
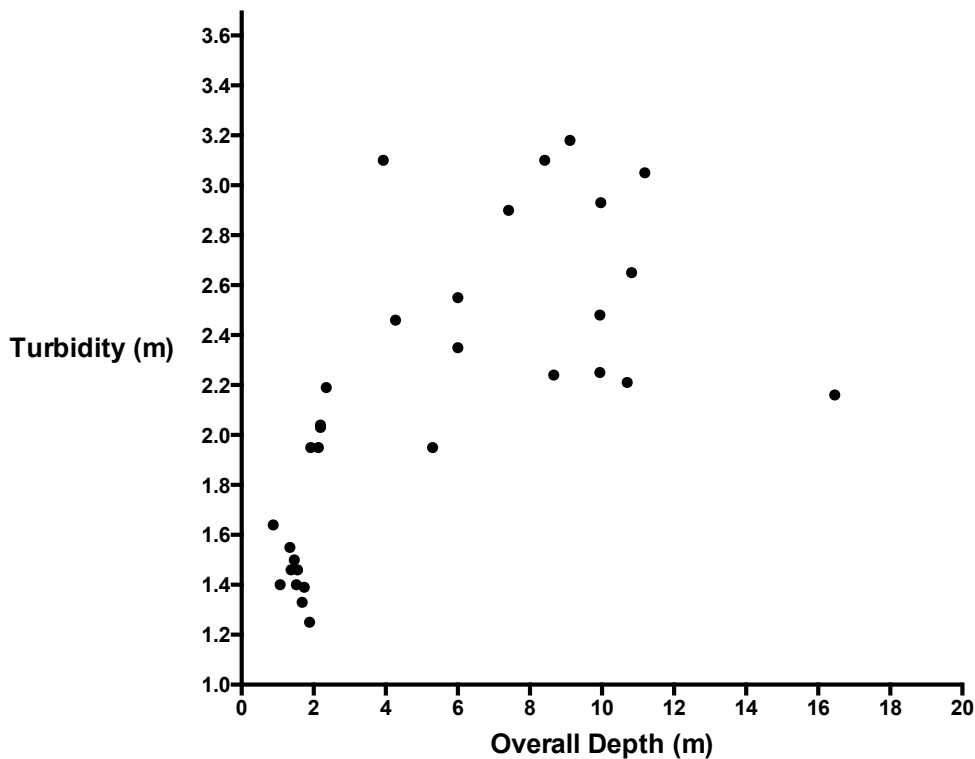
Turbidity

The amount visibility in a lake system can quickly give indications as to the health of a lake. Turbidity is the measurement of the amount of solid suspended matter in a water system. These sediments may be particulates such as leaves or soil, nutrients, or phytoplankton and algae as a result of eutrophication. (Clark 2014) Turbidity affects the amount of light penetration available to the lower levels of the lake. Plants need light to function and make use of the main nutrients required for their survival: nitrogen, phosphorous, and carbon. (*The Basics* 2014) Thus, healthy lakes need to have a low level of turbidity in order for the plants to function. Fish are also affected by the amount of solid suspended matter in water. High levels of turbidity upset "fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gill function" (*Turbidity* 2008). In lowering the visual span of fish, high levels of turbidity also affect predator aversion among fish, which can thus affect the ecological system of a lake (Ferrari 2010). The topic of turbidity has gained heightened awareness in the past few decades as "blooms of Cyanobacteria and high sediment suspension" take hold because of "progressive cultural eutrophication" as a result of industrial agriculture nutrient offsets. (Pérez 2013) More on the effects of eutrophication will follow in the next section.

Turbidity can be measured through a simple secchi test, which is what I used for my research. A secchi disk consists of a circular disk divided into black and white quarter sections. This disk is lowered into the water and a measurement is made at the point at which one can no longer distinguish between the white and black sections. It is then pulled up and a second measurement is made at the point at which one can re-distinguish the black and white sections. These two numbered are averaged for the turbidity measurement. Secchi measurements should

be taken when the sun is directly above, to ensure that light angles are optimum and constant. Midday, 10:00 AM – 2:00 PM is the best window to conduct such a test. (Michigan's 2008)

Every lake has a particular level of turbidity. Some lakes are extremely clear while others are quite murky. In general, turbidity is an unhealthy aspect as it cuts off sunlight to the aquatic plants, disrupts fish eggs, and damages the gills of fish. As movement increases in a particular area, turbidity levels are heightened. I expected the points closest to shore to have high turbidity levels as they churn up more material from the bottom of the lake. This was proven in my measurements. In the graph below, as overall depth increases, so does the depth at which I can see the Secchi disk.

Comparing Overall Depth to Secchi Turbidity for Summer 2013

This data shows that Lake Papakeechie is quite turbid, but also has a proliferation of weeds in the lake. It also has a slight current as water empties into LP and then out into Lake

Wawasee, which adds to water movement and turbidity levels. My graphs throughout this report are made using the system PRISM 6 Graphpad. I worked with Chelsey Fattal, Notre Dame undergraduate, to learn this system and incorporate my data into its interface to create more professional graphs than the excel version.

Dissolved Oxygen

Dissolved oxygen is also another vital element of lake health. It is used through gill oxygen gas diffusion to blood to aid in proper fish health, as well as creating an oxygen rich environment for other organisms. (Clark 2014). DO testing is extremely important as it is "one of the most popular and oldest methods to determine organic contaminant content in water and wastewater" (Seo 2007). Oxygen enters the lake in one of two processes. The first involves the photosynthesis of plants, as oxygen is a by-product of this process. The second involves the transfer of oxygen in the air through the surface of a water body into the lake itself. Dissolved oxygen levels may be higher on windy days, as movement allows for more diffusion to take place. However, the warmer the water, the more difficult is it for the oxygen to dissolve into its liquid form. ("Chap 2 20014) There are other factors that affect dissolved oxygen rates as well. During the phases of decomposition, oxygen is essentially sucked up into the dead organism through a chemical process. This depletes the amount of oxygen in a body of water. (Shimizu 2012) When certain lake organizations are conducting weed remediation efforts, they need to be careful and cognizant of the fact that when they kill off the weeds, the amount of dissolved oxygen in a system will plummet if not controlled for properly. This is why many places sweep the dead plant matter from the bottom of the lake to ensure proper fish health. (Jewell 1971)

Water is fluid and thus always changing. Another factor that can completely change the amount of dissolved oxygen is seasonal stratification. Lakes contain three distinct layers: the epilimnion on top, metalimnion (mixing layer) in the middle, and the hypolimnion on the bottom. These layers shift as the seasons change. Warm water floats, and as the lake nears its heat peak in the summer, these layers are extremely distinct. This is when the distinction between high and low DO occurs. However, as the weather cools off, there is a mixing of the two layers as the upper layer cools and sinks. ("The Basics 2014) (Dodds 2002) In the cooler seasons, dissolved oxygen is universally mixed throughout the lake. Thus, when conducting tests it is best to measure them in the summer seasons, when the stratification is the highest. From this information and with the knowledge that Lake Papakeechie and Lake Wawasee are considered deep lakes, they would be classified as highly stratified. (Schofield 1993)

Dissolved oxygen is tested using a meter at different depths in the lake. It can either be calibrated using the dissolved oxygen in the air (setting the altitude of the region) or with a set DO measured water sample. DO should be taken at every meter depth to ascertain the level of stratification. It is either measured in parts per million or by percentage. (Michigan's 2008) Depending on the region, there may be programs set up for public use of these meters through colleges such as the Indiana Clean Lakes Program sponsored by Indiana University. Looking into these resources give stakeholders the power to investigate their own lake health. (Clark 2014)

PPA is currently in the process of a new weed remediation effort. They add a chemical, Avast, to the water around May 1st. They give time for the weed to die and sink to the bottom. Some weeds are later removed while others are left to decompose. I hypothesized that the high

levels of decomposition have caused Lake Papakeechie to be extremely low in amounts of dissolved oxygen.

To conduct this test, I borrowed a YSI Environmental 550A Dissolved Oxygen meter from the Indiana Clean Lakes Program. This meter has a probe attached to a 50-meter cord that digitally reads the dissolved oxygen and temperature levels. I chose to record in percent saturation. This is the amount of oxygen in a liter of water relative to the total amount of oxygen that the water can hold at that temperature. When I arrived at my desired location, I took temperature and dissolved oxygen readings every meter to get a sense of the overall lake quality.

My results were somewhat contradictory. There are supposed to be higher levels of dissolved oxygen as depth increases, but my results presented the contrary. When I did further research, most lakes have this trend. Because oxygen enters the water at the top, it is hard for it to saturate fully to the bottom and thus the S-curve that is on figure two is the regular trend of most lakes. I attribute this result with the fact that there is a large amount of decomposition on the lake floor.

Dissolved Oxygen Versus Overall Depth
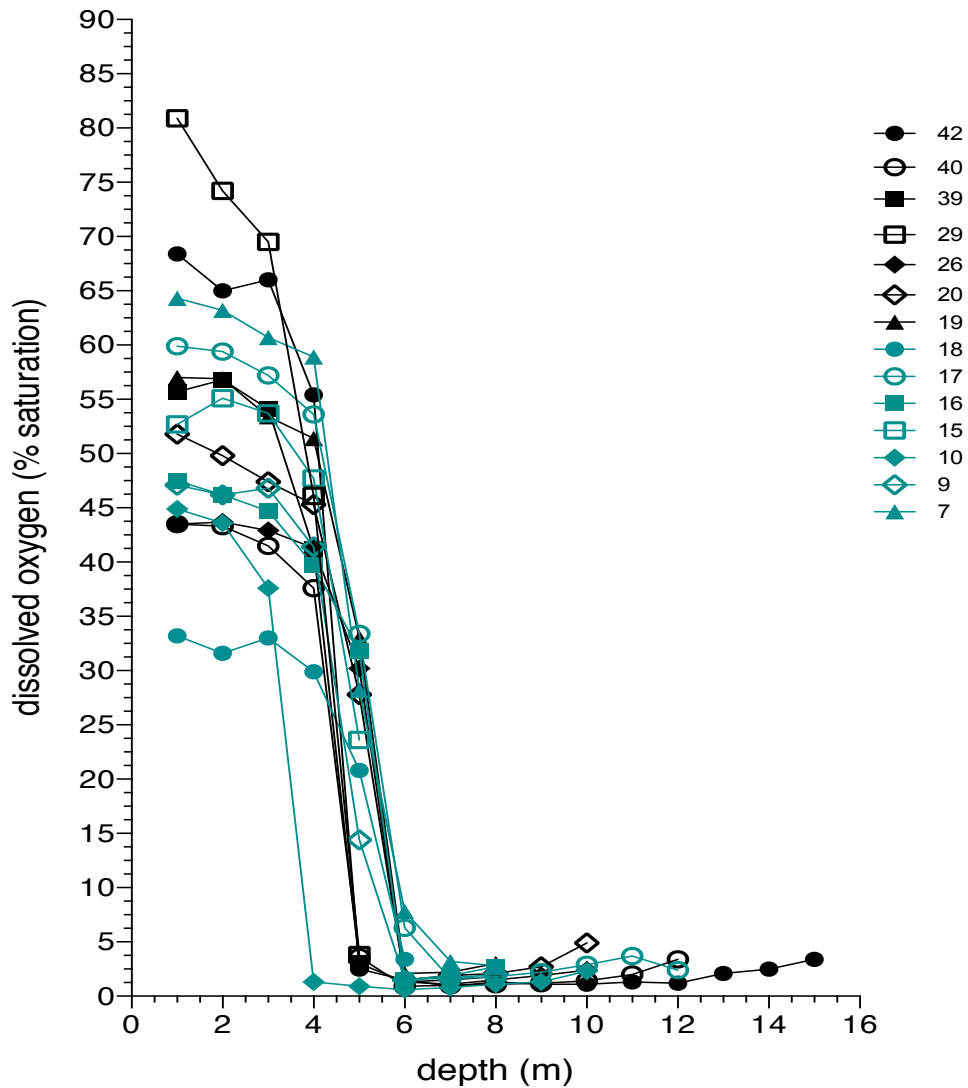
Lakes are also known for their severe temperature stratification, and many who have

swam in one "feel" the layers of temperature. As I was taking samples I noticed a trend begin. At

I reached roughly 4-5 meters below the surface, temperatures shot from roughly 20-25° C to 15-

5°C. At this layer, percent saturation of dissolved oxygen also decreased significantly (Figure 3).

This depth is labeled as the thermocline: an area in lakes that exhibits rapid changes in

temperature at roughly 4-5 meters. In the graph below, one can easily see this layer form.

Dissolved Oxygen Versus Temperature
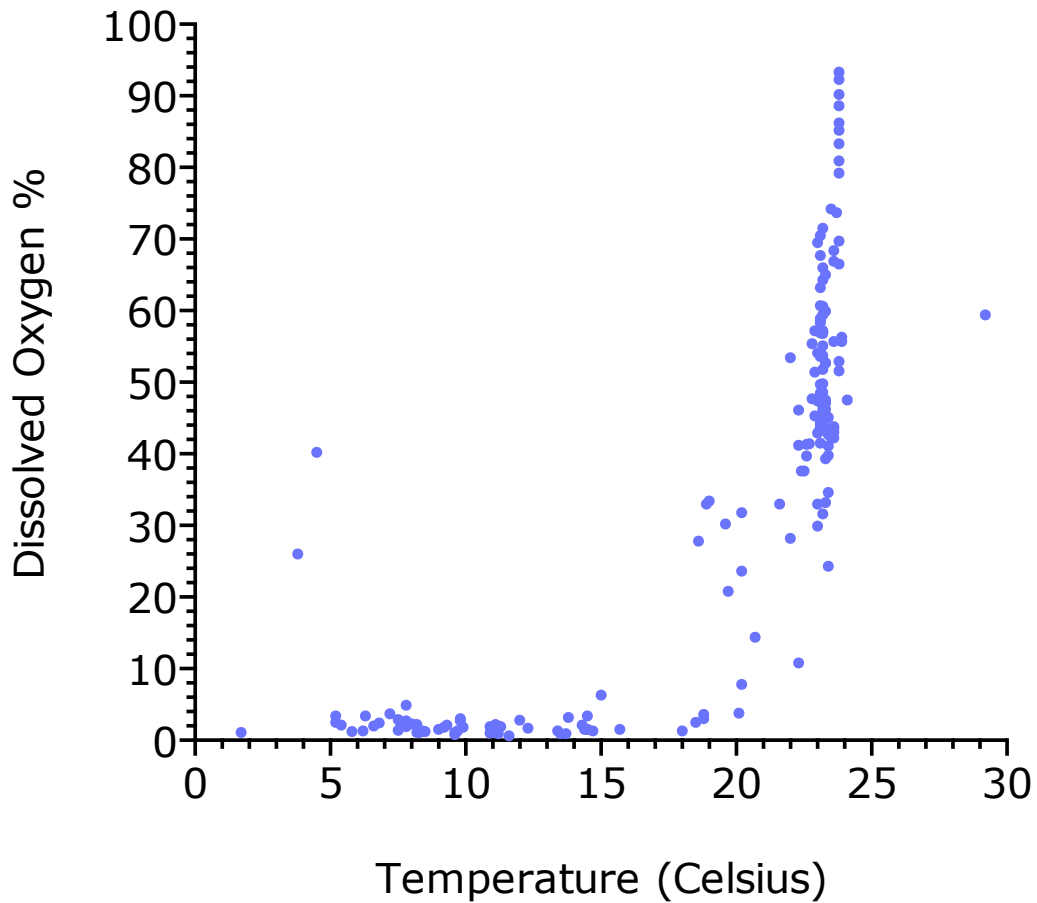
Healthy lakes have on average roughly 75% or more oxygen. As shown by the data, the

levels are all over the board, with few results above 75%. I recommend that we change some of

our techniques for weed remediation in the area, as I feel this is the reason for such low levels.

E. Coli

Particulates and nutrients aren't the only danger of lakes. Bacteria can pose a problem as well, especially to the people who have to live off of the coastline. Swim advisories, unless dependent on weather properties, have much to do with the amount of health hazards such as density of E. coli. (Francy 2006). E. coli is a form of bacteria found in the lower intestine of warm-blooded mammals. "Coliform bacteria are members of the family Enterobacteriaceae and are defined as gram negative, non-spore-forming rods which ferment the sugar lactose with the evolution of gas and acids" ("Coliscan 2014). Thus, they can be found in the digestive system of animals and humans. Not all forms of E. coli are harmful; many of them live comfortably in our own gut. However, some forms of E. coli are pathogenic and thus can be fatal in humans. In measuring the amount of this bacterium in lake water, one can judge the level of other pathogens and bacteria in the water, as they come from the same source. E. coli can cause several different symptoms in humans such as diarrhea, severe abdominal cramps, belly pain, vomiting, and fever. It is especially dangerous for young children and the elderly, who do not have as strong of immune systems to fight it off and it is this subgroup that E.coli can kill easily. ("Escherichia 2012).

An easy way to measure E. coli levels is through a water sampling and lab test with a test kit such as Coliscan Easygel. This formula dyes E. coli populations for easy distinction from other bacteria formations. One just takes a sample to bring back to the lab. Then they add in the agent that will help E. coli grow and put the water sample into a petri dish to incubate for 24 hours. The spots should appear as blue or purple and easy to distinguish from other forms of bacteria. ("Coliscan 2014) There are also quick, technological fluorescence meters that measure the fluorescence of the water. Living organisms, such as E. coli bacteria will light up (shown as

fluorescence) during energy consumption. This machine has a short incubation time of 30 minutes. (Wildeboer 2010) These tests are imperative to help lower the number of water-borne illnesses due to E. coli poisoning.

For this test I used Coliscan Easygel, sold by Micrology Labs in Goshen, IN. I went to the 50 points on the lake and gathered water samples. I then went to the lab and mixed the water with the solution, poured it in petri dishes, and let the cultures grow overnight. The next day, I counted the number of blue/purple spots in the dishes and did a calculation to determine the number of Colony Forming Units there would be in a 100 mL sample. Any number less than 125 CFU/100mL is deemed to meet recreational standards and any number above 235 CFU/100mL is deemed un-swimmable. Only one out of the 50 plates had E. *coli*, and this was at an acceptable level of 50 CFU/ 100mL. E. *coli* levels can change from season to season or between changes in weather, so further testing is necessary in the off season and next summer to truly see Lake Papakeechie as a healthy lake.
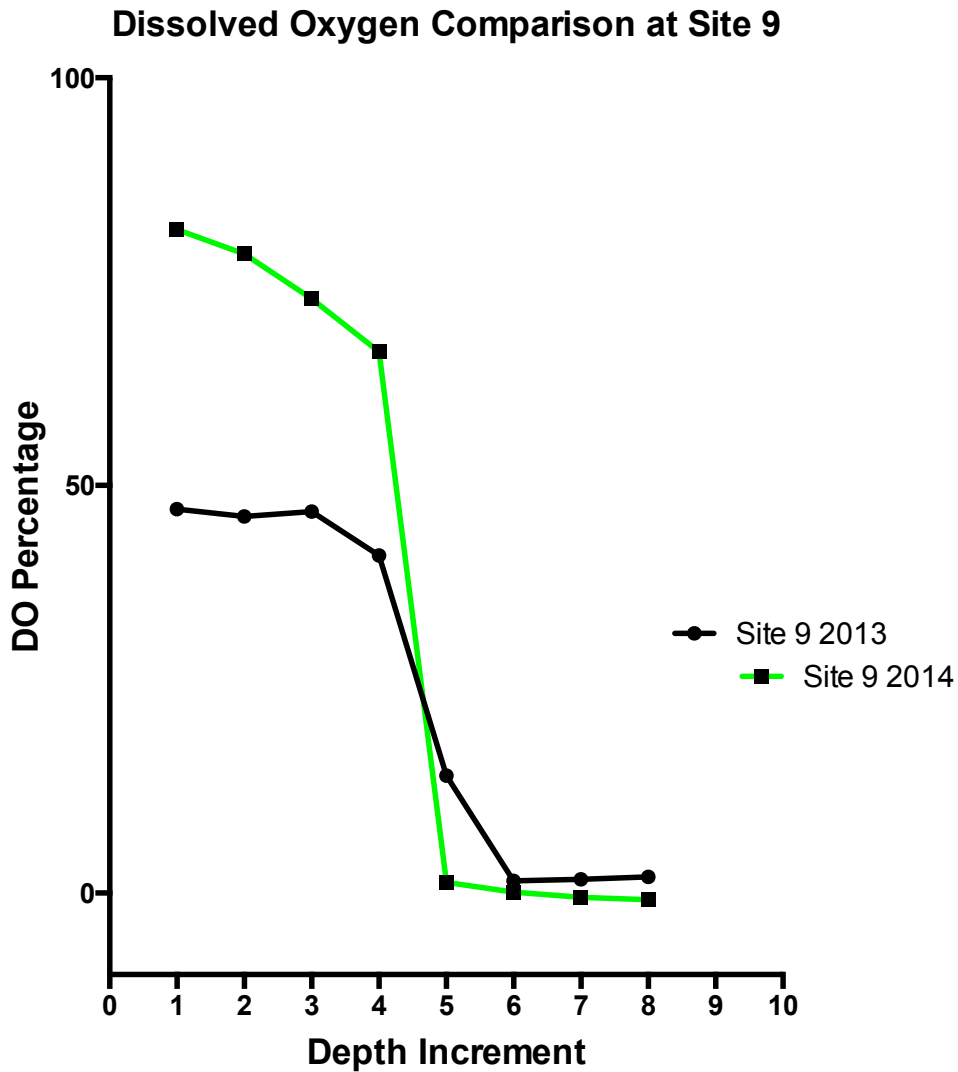
Limnological Studies 2014

In the summer of 2014, peers Brian Roddy and Matthew Williams took over my research in Syracuse. They conducted dissolved oxygen, E. coli, and secchi tests as I had done. They also added phosphorus and nitrogen. They cut down the number of test points to around 10-20 sites depending on their specific test. Because all this research is preliminary, comparing from one summer to another is interesting but not extremely telling of lake health. From my research, I have noticed that lake research has to be done for several years to understand trends in lake health. However, I can compare with this understanding.

E. coli levels are still at a safe reading with 6 out of the 19 sites showing 1 or 2 spots which translates to 33-66 CFU/100 mL. This is still completely within safe range for swimming. There were more spots than Summer 2013, but that may just depend on the day of testing (geese nearby) or measuring error. Secchi readings were much more turbid in 2014 than 2013. The lake was cloudier in 2014, and I am unsure why this is. Movement in the lake can stir up particles and also the weed remediation project that was started in 2013 may come into play here. As there are fewer weeds to keep the soil in tact, more will be suspended in the water, making it more turbid. Below is a graph comparing the levels of turbidity from on year to the next.

Turbidity Comparison 2013/2014
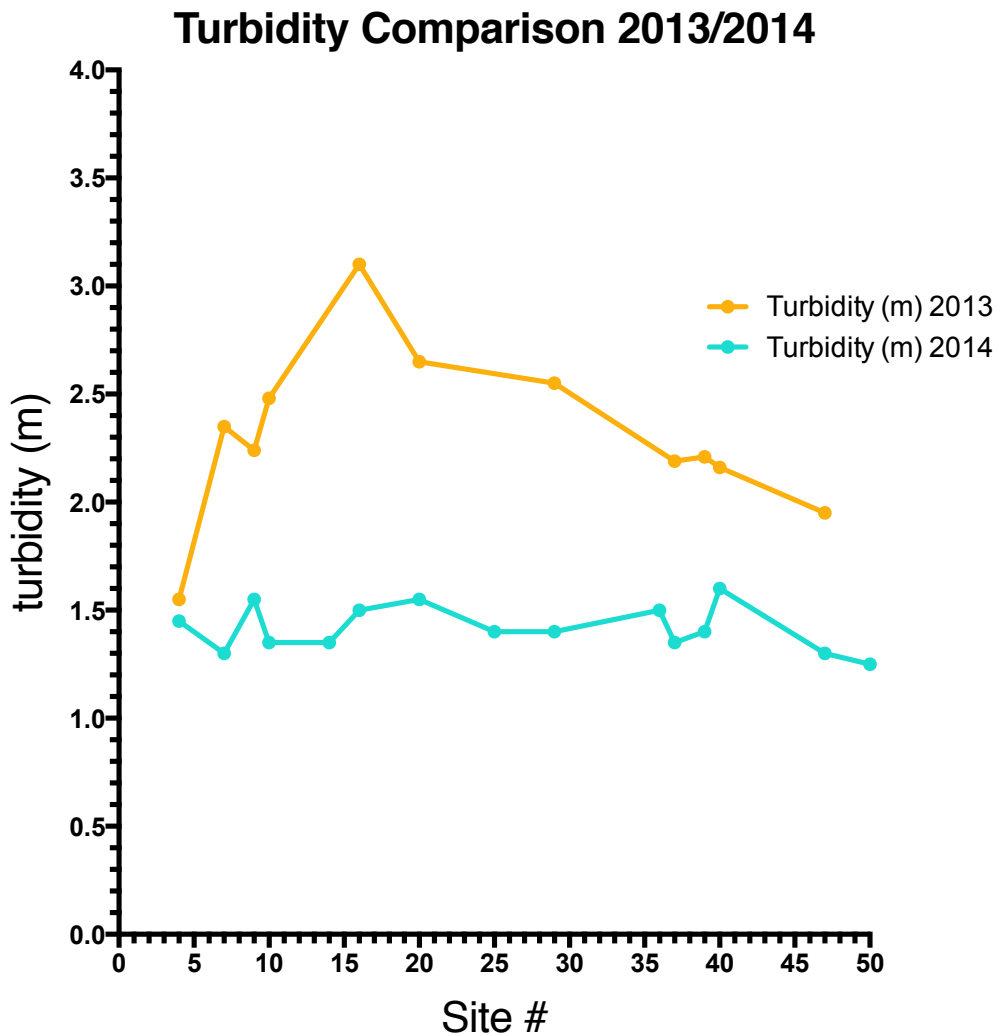
Dissolved Oxygen was a more interesting test comparison. I am still trying to understand how lake stratification works, as it is coming into play here. Levels in 2013 were lower in the epilimnion and metalimnion than the Summer 2014. However, once the DO meter reached the lower end of the hypolimnion, the levels were higher in 2013 than in 2014. Perhaps this also has to do with the about of weed decomposition in 2013 compared to 2014. There were more dead weeds in the lake in 2013, thus sucking a lot of dissolved oxygen to the bottom of the lake for decomposition purposes. Below is a graph of site #9 to show how these two years differed. As you can see, there is a larger amount of dissolved oxygen stratification in 2014.

Dissolved Oxygen Comparison at Site 9

Here is another graph of all sites compared together. Sites done in 2014 are indicated with a B following the site number.

Dissolved Oxygen Comparison 2013/2014

Sociological Studies 2013

Stakeholders are a huge part of what makes a natural area healthy or unhealthy. I felt that to get a better grip on the current situation on Lake Papakeechie and the neighboring feeder Lake Wawasee, I needed to learn ore about the residents themselves, as they are they foundation of proper lake health. I worked mainly with LaPSI, but got some help with my testing techniques from WACF. I had to first gain some background about the area.

Syracuse, Indiana evokes some interesting dialogue about stakeholder impact on water quality testing. Every place is different, and the people involved in sustainable action have to be passionate and informed in order for data results to become social results. Syracuse, IN lies within Kosciusko County and is part of the Turkey Creek water reserve. Some of the lakes that lie within this system and thus affect one another through the flow of water include Lake Papakeechie, Lake Wawasee, Hammond Lake, Allen Lake, Shock Lake, Spear Lake, and Rothenberger Lake. Syracuse has a population of 95.73% white males and females with the age majority between 18-64 years (61.74%). ("Syracuse 2014)

Lake Papakeechie is a private lake that feeds into the public Lake Wawasee. Because of this difference in ownership, Lake Wawasee has more historical knowledge and data analysis of its water as regulated and funded by the state. People who live on Lake Wawasee tend to use these residences as second homes for seasonal use. Their foundational lake organization is the Wawasee Area Conservancy Foundation (WACF), established in 1991. This conservancy was "created to protect, preserve, and enhance the Wawasee Area Watershed for present and future generations" and has made a lot of ground by buying up 700 acres of property in the watershed as well as 10 miles of shoreline to protect. ("About 2014) The average income of people on this

lake is a bit higher than that of Lake Papakeechie and thus they are able to be a more prominent and progressive group in terms of sustainable action such as buying up land to conserve. The members of WACF and participants from Grace College complete data analysis annually.

Lake Papakeechie is a private lake run by the Papakeechie Protective Association (PPA). Many of its residents live there year-round and the main efforts of this group in the recent past have been the dam levee project and weed remediation. As a private lake, the money for this project had to come from the residents themselves, which has been a significant economic endeavor. An offshoot from the PPA group is known as LaPSI, the Lake Papakeechie Sustainability Initiative. Their mission is to "promote a healthy, vibrant, and sustainable ecology at Lake Papakeechie and its environs, including its watershed, through vigilant, up-to-date scientific methods" (Serianni 2012) Some of the ongoing goals of this group include a depth map of the lake through a GPS Lowrance system, coalition with other lake groups/representatives, invasive plant monitoring system, engaging public with educational speakers, and ongoing water quality testing conducted in the summers. I was a part of many of these projects .

In 2013, I conducted surveys of the residents of both Lake Papakeechie and Lake Wawasee. I wanted a comparison of the residents, as there seems to be a lack of communication and negative stigmas associated with each. In conversation with the residents, I noticed a general misunderstanding or dislike of their neighbors on the other lake. I made a ten-question poll that focused on demographics, sustainable action, and future endeavors. I had this format reviewed by Professor Sitter and Dr. Lapsley. I then handed this out at the annual meetings of both LP and LW lake associations. I received 54 responses from the LP meeting and 34 responses from the LW meeting. The results were quite interesting because I expected there to be a stark difference between the LP and LW residents. A high majority of both groups (85%) expected to live on the

lake for the next ten years, spend more than 40 weeks on the lake (LP 54% / LW 60%), and have no children still living with them(LP 85% / LW 91%). These residents have a lot invested in their lake houses. Quite a few live there year-round and see themselves staying in the region in the future. The average ages for both groups were LP 62/LW 63. This shows both residents being in a very similar mindset when it comes to chronological factors. Both groups of residents admit to low levels of composting, but high levels of recycling and reuse of materials. They are unsure of how healthy they perceive the lake to be. These residents are open to the sustainable action and their uncertainty of lake health shall be pliable in learning how to better the lake. These responses prove to be positive in future conservation educational endeavors.

I also noticed differences between the residents that may be causing some of the communication errors. The LP residents (89%) admit to attending far less educational seminars than the LW residents (52%). I find this response to be totally predictable after attending both annual meetings. The LW meeting was more calm and welcoming with a focus on lake health and education. I can see this sparking the members to attend additional meetings. The LP meeting was extremely political with heightened emotions as the main focus was with financing the new dam and weed remediation. This probably stunted any enthusiasm of attending additional meetings outside the scope of the annual meeting. A majority of the LW residents (62%) said they did not know people on Lake Papakeechie. The response was less severe among LP residents (22%). There are significantly less people on Lake Papakeechie, so perhaps this skewed the results of these questions. LW residents can use motorized vehicles on the lake whereas LP residents are not allowed, which divides the two groups in their daily actions on the lake. The LP residents do more paddle boating, kayaking, and canoeing as compared to their LW neighbors. They see the lake in a slightly more natural, calm, and quiet state.

In all, the residents of both Lake Wawasee and Lake Papakeechie are much more similar than they may think. There are not extremely strong opinions but strong feeling about staying on the lake. This data could have been quite skewed though. In handing out the surveys at public meetings, I was already preselecting for those interesting in learning more about their lakes. I knew back in 2013 that if I were to get a better idea of the residents, I would have to reformat the survey and have it available to all residents.

I also interviewed two women on Lake Papakeechie and Lake Wawasee that have been living on the lakes since the 1940s. Jean McCarty has been coming to Lake Papakeechie since she was a child and took me through her life on the lake. She grew up in the region and noticed several changes in the environment. There is now more development, less tress, a larger avian population, less weeds, and erosion of the area. She sees herself as a very "green" person: no fertilizer, recycling, using plants to stunt erosion, etc. Jean McCarty also caught an E. *coli* infection from swimming off her dock and finds it strange that few E. *coli* tests have been done in the past. I also interviewed a woman on Lake Wawasee who wishes to remain anonymous. She moved from Los Angeles, CA to Fort Wayne when her father got a job in Indiana. She has seen a change in the health of the lake. To her, the large and fast boats of today are much more destructive than those in the past. Their props dig up the bottom of the lake. She has seen a drop in the levels of snails, clams, and minnows in the lake. Additionally, she sees an increase in the weed population. Both women express a change in the lake environment. Neither of them is crying out for a rapid change as they see the lake as unhealthy but not ruined. However, we can learn from these women and what they have seen over the years and turn around the levels of destruction.

Survey Formatted for 2015

      I decided to reformat the survey for use in 2015 with the help of Dr. Lapsley and Dr.

Sitter. In 2013, I was communicating with them through email, and thus felt that I could have

learned a lot more if I spoke with them in person. I was able to have one-on-one meetings in

which we discussed goals for the survey and proper survey format. Here it is below along with

the email portion which explains the survey.

Dear Lake Resident:

My name is Hannah Becker and I am a Senior at the University of Notre Dame. With the help of LaPSI (Lake Papakeechie Sustainability Initiative), I completed lake water quality testing on Lake Papakeechie in the Summer 2013. You may remember me speaking at the PPA annual meeting that summer. I want to collect some information about lake residents and particular opinions/actions surrounding the lake. If you could fill out this quick, 5-minute survey I would appreciate it. Your responses will be completely anonymous. You may complete the survey online by going to: http://goo.gl/forms/vzieK2NXeS or return by mail to: Residential Poll, 9465 E. 1000 N. Syracuse, IN 46567. This data will help me to write a final report about my research done on the lake! Some of the information may also be used by your lake sustainability team to help with the planning of future activities. Thank you very much.

Sincerely,
Hannah Becker

<div align="center">Residential Poll</div>

1) How many years have you owned a house on the lake?
   a) Less than 1 year_____.
   b) 1-5 years_____.
   c) 6-10 years_____.
   d) 10+ years_____.

2) How likely are you to live on the lake for the next 10 years?
   1= Not likely   2= Slightly likely   3=Unsure   4=Very Likely   5= Extremely Likely
   Answer:_____

3) In which type of environment have you spent most of your life?
   a) Urban_____.
   b) Rural_____.
   c) Suburban_____.

4) Roughly how many weeks out of the year do you live on the lake?
   a) 0-5 weeks_____.
   b) 6-10 weeks_____.
   c) 10-25 weeks_____.

d) 25+ weeks_____.

5) How many children live at home with you? (children: under age of 21 years old)_____.

6) Have you attended any educational seminars that address lake habitat management? (PPA and LAPSI do not count)
   a) Yes_____.   b) No_____.

   b) If so, how many seminars have you attended in the past year?_____.

7) What type of relationship do you have with Lake Wawasee residents? Rate the following responses on a scale of 1-5 with
   1= Not true at all   2= Slightly true   3=No opinion   4=Very true   5= Completely true
   a) I have friends who live on Lake Wawasee._____
   b) I have acquaintances who live on Lake Wawasee._____
   c) I have family members who live on Lake Wawasee._____
   d) I do not know people who live on Lake Wawasee._____

8) How important do you consider the following topics? Rate the topics on a scale of 1-5 with
   1= Not at all important   2= Slightly un-important   3=No Opinion   4=Slightly important   5= Extremely important
   a) Climate change_____
   b) Environmental Conservation_____
   c) Lake management_____
   d) Water pollution   _____
   e) Spread of invasive species_____

9) How important is upstream monitoring of the lake's watershed?
   a) Not at all important_____.
   b) Slightly un-important_____.
   c) Neutral_____.
   d) Slightly important_____.
   e) Extremely important _____.

10) How often do you do each of the following? Rate the actions on a scale of 1-5 with
    1=Never   2=very infrequently   3=Sometimes   4=Frequently   5=Almost always
    a) recycle_____
    b) compost_____
    c) reuse bags/ boxes/ packaging materials_____
    d) buy plastic water bottles_____
    e) use paper/ plastic utensils and plates_____
    f) conserve water by taking short showers/ doing large loads of laundry/ full loads in the dishwasher

       _____

11) How often do you do these things? Rate the actions on a scale of 1-5 with
    1=Never   2=A Few times a year   3=A couple times a month   4=A few times a week   5=Daily
    a) kayaking_____

b) canoeing_____
c) paddle boating_____
d) swimming_____
e) fishing_____
f) other:_____.

12) On a scale of 1-5, how healthy do you think the lake is?
   1=Very unhealthy   2=Slightly unhealthy   3=Neutral Opinion   4=Slightly healthy   5=Very healthy

   Answer: _____

13) Are you interested in learning more about lake health?   a) Yes _____   b) No _____

14) If yes, how would you like to receive information? You may check more than one.
   a) _____Newsletters
   b) _____Website
   c) _____Email
   d) _____Guest Speakers
   e) _____Interactive workshops
   f) Other:_____.

15) Are you interested in getting involved with a lake sustainability group?   a) _____Yes   b) _____
   ____No

16) If you would like to receive information about lake health through newsletter or email or would like to become part of a lake sustainability group, please provide your email and/or home address below. If you wish to remain anonymous for this poll, you may send a separate email to Diane Tulloh at dtulloh@gmail.com indicating your interest in receiving more information.

   Email:_____Home:

17) If you would like to receive more information through guest speakers or workshops, when is the best time of year, day of the week and time of day for these to be held?

   Time of Year:_____Day of the Week:_____Time of Day:_____
   ____

18) Age _____Highest Level of Education_____
   ____
   Gender_____Marital Status_____Ethnicity_____.

Survey 2015 Results

I wanted to get more comprehensive results from the residents of Lake Papakeechie this time. I know that an online form would be easier to collect and it would reach the most people. I had to speak with the PPA at their spring meeting to gain access to resident emails as well as ask permission to disseminate the survey. They seemed excited about the idea, and I made a google survey form with the help of Brian Roddy and Matthew Williams. I only received 17 responses from residents. I was disappointed with this small turn out but I do understand it. Not all residents had given their email addresses to the PPA. Some of the addresses given bounced back. Also, I feel like this also tells me something about the communication style of residents for the future. I would have liked to do the same with Lake Wawasee Residents, but by the time I got permission from the PPA I had gotten too close to the Capstone date to start communication with WACF. It was my fault for timing it wrong, but I am unsure if I could do a true comparison with only 17 responses from Lake Papakeechie.

I don't feel it to be scientifically accurate to compare these results to those of Summer 2013, because the low level of responses is not necessarily indicative of any shifts or resulting differences. Of those who responded, I looked at the responses independently. Residents seem to be very invested in the lake, with 88% likely or extremely likely to live on the lake for the next ten years. Many of these residents have been living on the lake for 10 or more years (52%). Residents come from a split between suburban and rural backgrounds. Only 60% of residents live on the lake for 6 months or more out of the year. This is a shift in my preconception, as I thought most of the residents were permanent. Roughly 23-50% of residents have friends, family members, or acquaintances on Lake Wawasee, but there is a large portion of people who responded that they know very few people. Most residents also consider the topics of climate

change, spread of invasive species, environmental conservation, water pollution, and lake management to be very important to them, however only 50% of residents have made it to an educational seminar concerning lake/ environmental quality. Results were all different for activities done on the lake. There is no majority or even half split for frequency of action. 94% of residents are white, which is probably representative of the population. A third of residents have a high school diploma and 60% have a bachelor's or master's degree. Many of the later questions asked residents about their availability and interest in educational seminars about the lake. I can pass this information on to Diane Tulloh (the current LaPSI president) so she can plan for meetings that will reach the most residents in the future. This survey was also sent out as an attachment on the email and people can choose to mail it to a resident on the lake. So, there could very well be more responses to this survey in the future and I have shared it with LaPSI so they can use it how they wish.

Lake Coalition Letter

One of my goals for my senior year was to create a coalition of lake representatives in the surrounding Kosciuscko County area. There is a lack of communication when it comes to lake research, which was apparent with the lack of conversation between Lake Papakeechie and Lake Wawasee residents. If people had a public forum or planned public meeting to discuss work done on their lake, perhaps we could have a better dissemination of data as well as a place to ask questions about water quality testing. Not all lake groups are focused on the same tests, or even doing testing at all. After writing up a proper letter explaining my idea of a lake coalition and doing some research into the surrounding lake organizations, I ran into a snag with the PPA. They were worried that I would use to forum to disseminate my data and were unsure of sending it to others. I went to their meeting in Syracuse to explain to them my goal for the project, but at

this point it was too late to start the project. One positive impact I made was convincing the PPA that the data I have collected is not at all incriminating. There is no reason for them to worry about me or another lake resident using it to discuss methods/ procedures with other lake organizations. For now, Dr. Serianni will work on this aspect with the WACF (Lake Wawasee sustainability organization) in years future. I am glad to have cleared the air with PPA, and hopefully they will be more willing to share information in the future as it pertains to the lake coalition. I would have liked one or two representatives from roughly 7-10 lakes in the area to step up and participate in a forum online or a public meeting. Hopefully this will happen in the future! Below is the letter I was intending to send to lake coalitions. It was revised by Dr. Serianni and Diane Tulloh.

To Whom It May Concern:

The state of Indiana is home to 86 natural and man-made lakes (http://www.howmanyarethere.us/how-many-lakes-are-in-indiana/), many of which are located in the northern part of the state. These lakes have associations or similar governing bodies that manage their use to insure that these valuable natural resources are maintained and preserved. Historically, this management has been largely local, meaning that each lake association conducts its business mostly independently, with only occasional formal contact with other lake associations even though some may be close by. This isolation, largely the result of tradition and the absence of a functional structure to promote communication and cooperation, can result in some groups rediscovering solutions to problems that have already been solved by other lake groups, thus wasting valuable time and resources. With contemporary scientific data indicating increasing environmental pressures on many lakes in Indiana and elsewhere, wasting time relearning or rediscovering solutions to the same problems is no longer viable when timeframes

for decisive action are becoming increasingly shorter. This proposal, for which I seek your support, aims to establish a new communication structure for lake associations in northeastern Indiana to promote the dissemination of information and expedite solutions to lake-related management problems.

My name is Hannah Becker and I am a senior at the University of Notre Dame. I am currently working on a research project concerning water quality and community outreach on Lake Papakeechie in Syracuse, Indiana. I worked on the lake in summer of 2013, generating data for the following tests: turbidity, E. coli, and dissolved oxygen. I also connected with the community through polls, interviews, and an informational speech at the annual residential meeting.

In conjunction with the WACF and LaPSI, we believe a lake coalition initiative would expand knowledge of lake health and begin conversations about sustainability. Lake Wawasee and Lake Papakeechie are proximal, and yet use different tests on the lakes. If extended between proximal lakes, this knowledge would benefit the overall lake health by extending the portfolio of residential actors. I am proposing a small lake coalition that will convene over the topics of lake health and future sustainability. I know that throughout my summer, I had several questions about my tests. If I had a group to turn to, I would have the support to proceed with confidence.

This lake coalition would be made up of representatives of several lakes in the Syracuse/Warsaw area. LaPSI and WACF would oversee the coalition operations. I am writing to you to gauge interest. I would like to start with a small group of representatives from 6-10 lakes in the area. I would create an online forum, with weekly questions posted to start up informal conversations. Representatives could converse with each other through this forum, from

the comfort of their homes. I want this to be a convenient way to share ideas. Please respond with your level of interest, or questions/concerns.

Poster Presentation at an Annual Conference

I have always wanted to present my research at an academic conference, so I looked around at different conferences in the area. I decided to become a member of the Indiana Academy of Science and apply to their poster section of the academic conference. I had to submit an abstract of my research and be accepted in order to present. I chose the subsection Environmental Quality, as I believe the motives behind my research pertain to bettering the quality of the natural environment around Syracuse, Indiana. After having my abstract accepted, I created a poster to present, which is available to anyone interested in viewing it. The meeting was held on March 21st, at the JW Marriot in Indianapolis. Throughout the day, there were 15-minute presentations under the different subsections that we as members could attend. I enjoyed the Environmental Quality subsection, but was really excited to see that Anthropology was a subsection at the meeting as well. All the posters were separated in a room and during a specific hour of the day we were to be available for questions. Many of the people I talked to knew very little about water quality, but there were a few people that asked tough questions and taught me a little more about water testing. Dr. Shirley Malcolm was the final speaker of the day with her presentation "Better Together: Addressing the Challenges in STEM Research and Education". She spoke about the necessary connection between science and everyday people and community actions. She had seen my poster earlier and was impressed by my focus on involving not just water quality studies but connecting it back to the residents. She mentioned me in her speech and it made me really proud of the work I have been able to accomplish in two years. The day was absolutely exhausting but taught me a lot about the professional science world. I was able to

learn a lot about others' presentation style, how a conference is run, and how to conduct myself

during the poster portion. Below is my abstract for the Indiana Academy of Science Annual

Conference

Stakeholder Mindset and Ecological Impact: Effect of Personal Beliefs and Value Systems of Lake Residents on Lake Stewardship

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Personal beliefs and value systems of lake residents are expected to affect the management of lakes and their surrounding watersheds. An effort to quantify these effects was

Figure 1. An aerial photograph of Lake Papakeechie showing 50 GPS-determined water testing sites.

undertaken through studies of two adjoining lakes and lake communities in northern Indiana. Located in Syracuse, Indiana, Lake Papakeechie (LP) is an ~179-acre private, non-sports lake that is hydrologically connected to Lake Wawasee (LW), the largest public all-sports lake in the state (~3000 acres). Long-term environmental work has been ongoing on LW for decades, but a similar commitment on LP has not yet been fully realized. To address the latter disparity, a long-term water-testing program was introduced on LP in the summers of 2013 and 2014. A bathymetric map was obtained and used to select 50 test sites (see Figure 1). Water testing at each site included measurements of turbidity, dissolved oxygen, temperature and microbiological (*E. coli*) load. Secchi disk measurements of water turbidity gave depths of 1.5-3.0 meters depending on the test site. Dissolved oxygen concentrations were typically 33-93 %-saturation in the epilimnion (top 4 m) and fell to near zero %-saturation in the hypolimnion (<9 m). The Secchi data were used to calculate the Trophic State Index (TSI) for LP. Calculated TSI Values were between 46-55 and indicate that LP is currently in a mesotrophic state. *E. coli* load is at or below 50 cfu/100 mL. Social mapping of LP and LW residents was initiated by preparing a written survey to collect information on demographics, geographic attachment, and personal attitudes towards lake sustainability and management practices. Efforts are underway to establish a regional lake coalition/council comprised of representatives from various lakes in northeastern Indiana. The latter body will promote communication between lake groups and encourage the sharing of information to avoid and/or solve management problems efficiently.

Again, I will bring my poster in to the final sustainability brunch as well as attach it in the email with my capstone.
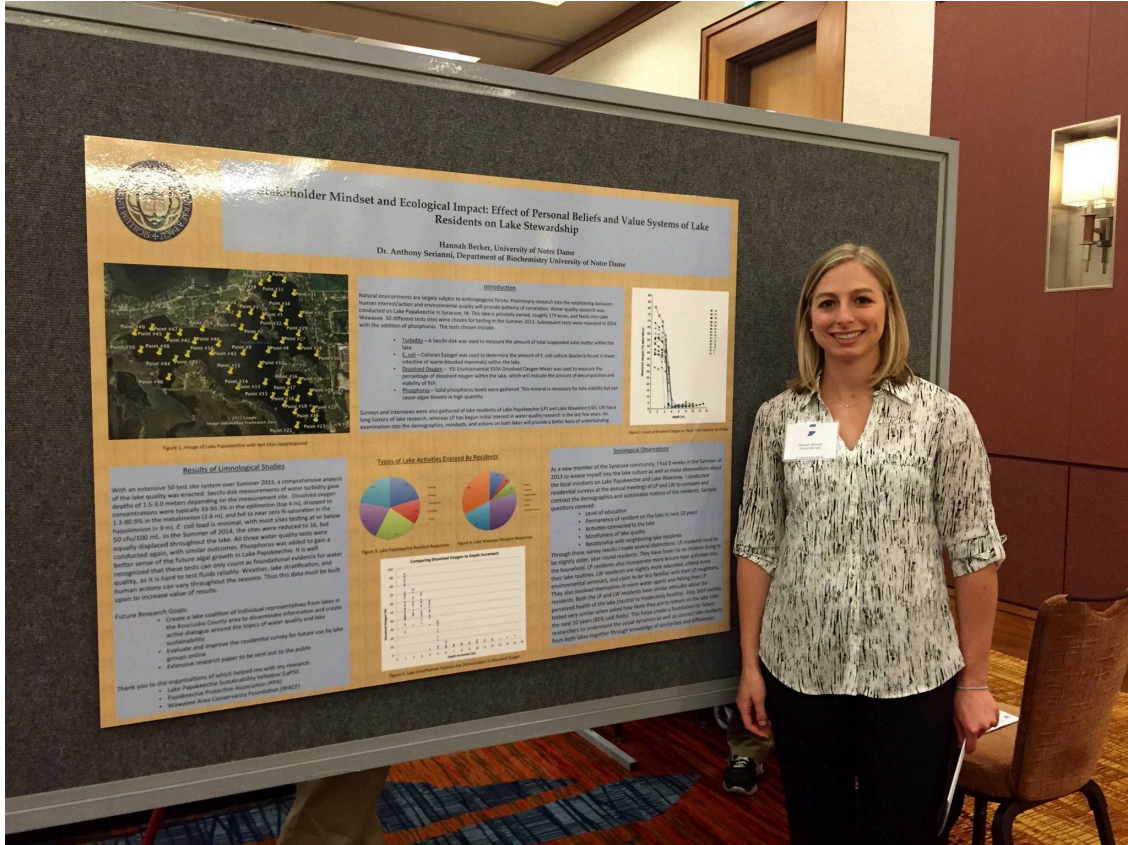
Conclusion

As an Anthropology major I am interested in the diverse, impactful human. We as a species evolved the characteristic of culture that builds civilizations and intricate groupings of people. We have the ability to completely rework nature to suit our needs. This is what interests me. There is a sense of unbridled power that can either be a good or bad factor for nature. I have always had a strong pull towards giving back to my environment. Our population is drastically increasing; we must combat this with an increase in ecological awareness. I have always been interested in research because it forces humans to think outwardly. It forces us to learn more

about the tangible and intangible aspects of the world. In this research project I have been able to place social psychological polls/interviews of the lake residents alongside water quality tests. In a way though, I have shifted my focus a bit throughout this project. I thought I could correlate the data I received about residents with the overall quality of their lakes. As testing on Lake Papakeechie is still in its preliminary phase, I can't claim very much about its lake health. Nor can I connect stakeholders' attitudes and demographics with the lake health. I am glad of another focus though. I was able to involve and educate lake residents about sustainability and proper lake health. Instead of simply graduating and leaving other students with the research, I have left all the information and techniques with the residents themselves. Many of them are already continuing testing independently, and are fascinated with the project. In speaking at PPA and LaPSI meetings, I was able to further my reach and keep this topic alive. I have not only completed research in Syracuse, I have made friends in the area. Connections are key; they keep knowledge alive and allow for unbridled passion.

Protocols

A huge part of my research is focused on the continuation of research and knowledge in Syracuse, Indiana. I hope that the residents in the area feel confident and educated enough to continue the research I have done past graduation. A large part of this was being personally present in Syracuse while I did my research. I invited residents out on the lake with me to learn about the testing. I became friends with them, and invoked passion about lake health. I also created extremely detailed protocols so anyone interested could complete proper, useable testing. Anyone who lives on the lake is a stakeholder, and should be treated as such. Hopefully with the protocols that I have included in this report and shared with the people of LaPSI and the PPA, research will continue annually.

Standard Operating Procedure for Charging Lowrance GPS Unit Battery

1. Plug in the battery charger and make sure the switch is flipped to 12V. The clips with black and red heads will be the objects attached to the battery.
2. The Lowrance GPS Unit battery is the red box on the machine. You will see two cords, one grey and one black, attached to the battery. They are attached to square metals brackets. This is where you will attach the clips from the battery charger.
3. Pull back the plastic far enough that the clips can attach to the brackets, but do not remove.
4. Attach the red clip to the metal bracket with a red base. Attach the black clip to the bracket with a black base.
5. Only charge the battery for an hour, any time over that and the battery could overheat.
6. Unplug the clips when done and unplug charger.
7. Put plastic back over the battery, tucking in the flap so it is secure.

Standard Operating Procedure for Lowrance HDS5 GPS Unit

To Get Started
1. Attach 2 black cords together (ends are square rubber, have four prongs for attaching)
2. Turn on unit by pressing Light/POWER button
3. Accept the warning by pressing ENTER
4. You will see a split screen with Sonar and Chart (GPS map)
    a. Sonar displays depth, temperature, and sonar map displaying vegetation, fish, and bottom of lake
    b. Chart displays speed, map of lake, location, GPS coordinates, compass directions, scale of map

To Highlight a Screen for Manipulation

1. Press PAGES
2. If you want to highlight Sonar Page:
    a. Toggle either left or right to Sonar

b. Make sure Chart is highlighted (to also view GPS map) and press ENTER

3. If you want to highlight Chart Page:

a. Toggle either left or right to Chart

b. Make sure Sonar is lighlighted (to also view Sonar map) and press ENTER

To Log Sonar

1. Make sure that sonar radar is secured in place on the boat

a. Clean the area of the boat that is to be suctioned with the sonar radar (back of boat, silver barrel that is under water next to grey barrel)

b. Suction sonar radar to position in which the cylindrical sonar radar is completely horizontal and underwater

c. Tie black cord around metal loop on boat for extra safety in case the suction breaks (if suction breaks, you can no longer log radar but you will not have lost the sonar radar)

2. Make sure Sonar is highlighted

3. Press MENU

4. Toggle down to Log Sonar… and press ENTER

5. Type in a file name (I suggest the date of testing)

6. Select where you would like the file to save to (Memory Card)

7. Select Bytes per sounding (3200 as default, highest bytes)

8. Check log all channels

9. Make sure to look at how much time the GPS unit can record information

a. If you need more time, reduce the bytes per sounding. Just know that this will reduce the detail of the sonar data

10. Press ENTER once Record is highlighted

11. You should now see a red flashing dot at the top left corner of the screen

To Stop Log Sonar

1. Make sure Sonar is highlighted

2. Press MENU

3. Toggle down to Stop Sonar, press ENTER
4. You should now see the word "Stopped" on the left split screen
    a. This pauses the logging, but does not completely exit the log sonar…
5. Press EXIT to again view both split screens
6. To fully stop logging, press MENU
7. Toggle down to Log Sonar… and press STOP

To View Sonar History

1. Press left arrow to toggle back through the sonar
2. Press right arrow to get back to present or press EXIT

To View Sonar File

1. Press PAGES
2. Toggle right to last option
3. Toggle down to Files, press ENTER
4. Select My files
5. Select Logs
6. Select Sonar
7. Then select the file you wish to view
8. From this screen you can either View, Copy, or Close
9. To get back to split screen:
    a. Press Close, then EXIT
    b. Toggle left to Sonar, select Chart

To Create a Waypoint at the Cursor's Position

1. Make sure that Chart is highlighted
2. Place cursor on the chart page where you want to set the waypoint
3. Press ENTER
4. Title the waypoint (Press ENTER on first highlighted box, choose name from keyboard)
5. Choose icon for waypoint
6. Select Save from the New Waypoint menu

To Create a Waypoint at the Vessel's Position

1. Make sure that Chart is highlighted
2. Press MENU
3. Select New Waypoint
4. When the New Waypoint at Vessel menu appears, select Save

To Move a Waypoint

1. Move cursor until it hovers over waypoint
2. Press MENU
3. Under heading "Waypoint" select Move…
4. Move Waypoint to desired location
5. You may zoom in and out to reach accurate position
6. Press enter when reach desired location

To Look at Recorded Waypoints

1. Press PAGES
2. Toggle all the way left
3. Select Waypoints, routes, trails
4. If you want to Navigate to a particular saved waypoint:
   a. Highlight desired waypoint and press MENU
   b. Select Go to
5. If you want to find a particular saved waypoint
   a. Press MENU
   b. Select Find
   c. Type in desired waypoint name

To Turn Off Unit

1. Press LIGHT/ Power
2. Select Power off
3. Wait for machine to go blank before unplugging black cords that you used to turn the GPS Unit on (MUST DO THIS OR BATTERY WILL RUN DOWN!)
4. You are done! The memory card is located in the slot on the bottom right hand corner of machine face, labeled HDS5 Lake Insight

      a. Press card up to release spring

Standard Operating Procedure: Paddleboat Use

      It is assumed that you know how to steer and power a paddleboat. If not, contact John Hart for appropriate instruction. The following information provides some tips on boat usage that will aid in making safe and accurate scientific measurements on the lake.*

1. If using John Hart's paddleboat: Position the GPS unit on the left table by placing the GPS base onto the screws. The screw holes in the GPS base insure that the unit remains firmly attached to the table while working on the lake.
2. Position the sonar probe attached to the GPS unit on the back pontoon using the suction cup. Make sure the black sonar probe is oriented at a ~90° angle to the flat part of the pontoon.
3. When testing, lower the anchor attached to the long rope into the water until it reaches the lake bottom.   If left unanchored during testing, the paddleboat will tend to move from the desired data collection point; anchoring minimizes this problem. If possible, tie the rope slack around the paddleboat when making measurements in shallow waters.
4. Check the GPS unit regularly to verify that you are collecting data at the desired collection point. Try to zoom in as much as possible when lining up the cursor (current GPS position) to the collection point.

*Note: A US Coast Guard Approved life vest must be worn at all times while conducting LAPSI tests on Lake Papakeechie.

Prism Protocol

Prism is an easy way to collect and analyze data into professional looking graphs. The subscription lasts one year for the student membership, but this may be different for other subscribers. Here is an easy to follow Protocol for gathering and graphing data using Prism.

1. Open the application
      a. If application is already open and you want to start a new graph:
            i. Click "File"
            ii. Click "New > Project File"

2. On left-hand side under "New Table and Graph" click "XY".

3. Select "enter and plot a single Y value for each point".

4. Select "Create" at the bottom right corner.

5. You should now see an Excel-type graph cells. Enter your independent value for your X axis in the first column.

   a. Starting in box (1,X) enter your first value. You may add more X values underneath this all in the first column.

6. In the second column, add your dependent Y values.

   a. Starting in box (1, Group A) you may add your first value. You may add more Y values underneath this all in the first column.

   b. This type of graph allows for more than one Y value to be added to the graph. You may add these in the subsequent columns.

7. Label your X and Y values by typing titles into the boxes under "X" and "Group A".

8. Prism will automatically make a graph for you. To see this, click on "Data 1" on the left-hand side of the screen under the heading "Graph".

   a. You can label this data set and graph by double clicking on the "Data 1" on the left-hand side under the heading "Data Tables" and re-typing in what you would like to name your data set.

9. Now go to your graph, and change sizing, spacing, etc. by double clicking on different parts of the graph and adjusting as needed.

Protocol for Excel

How to Enter Data:

Data should be entered the same way by every observer. This will eliminate confusion. Model tables are provided in the protocols and the end of the document. Things to remember:

1. The first row contains the titles of all columns in which data will be entered

2. Color-coding each day of data is helpful in visualization

3. If you have repeating data in a column, for example: observer will remain the same for the day, you may drag the cell down to fill in cells will above information
   a. Click desired test cell with data to be repeated. Hover cursor over test cell with data, when you see a black cross click and drag down for however many cells are desired to have repeating data.
   b. If you are repeating numbers and not names, make sure it copied the cells and did not fill the series. Click on the box next to highlighted cells that says *Auto Fill Options* and select *Copy Cells* from the bulleted list.

How to Sort All Data by Test Site #:

Looking at data with all test sites ascending will produce a better visual than that of a chronological grid. Specific ranges of test sites correlate to different sections of the lake. A simple sort will not do because this will only sort the test site column. Then all other columns would not correlate with their proper test site.

1. Highlight all cells (including header row)
2. Under the *Data* tab, click on the right arrow attached to the *sort* button
3. Of the options, select *custom sort…*
4. A box should pop up. Under *column,* select *Test Site #* from the choices
5. Then under *Sort On,* select *Values*
6. Then under *Order*, select *Smallest to Largest*

How to Sort Out Blank Values:

When you are ready to make a graph, you are going to want a set of data without blank results. For example, in the Secchi test, you will have only one overall value per two rows of data (an averaging of two tests at one test site). You will need to make a second table and delete these blank data points as they will be of no use in a graph.

1. Highlight all cells (including header row)
2. Double click and select *copy*

3. Click on a cell you wish to paste new table and then double click
4. Of the options, select *paste special…*
5. Under *paste* select *values* and press *okay*
6. Highlight all data in new pasted data table (including header row)
7. Under the *Data* tab, click on the right arrow attached to the *sort* button
8. Of the options, select *custom sort…*
9. A box should pop up. Under *column,* select the column in which the blank values are
10. Then under *Sort On,* select *Values*
11. Then under *Order*, select *Smallest to Largest*
12. Highlight all cells with blank values in the specified column and delete
13. Preferably, re-sort into ascending test site #

How to Make A Marked Scatter Graph:

To compare two sets of data, a marked scatter graph works well to show correlations. First you will need to copy and paste two columns of data into a separate data table to analyze.

1. Highlight all desired cells (including header row)
2. Under *charts*, select the *scatter* button
3. Select *marked scatter*
4. From the *Chart Layout* tab you can add labels to the graph

How to Convert Depths from Feet to Meters the Easy Way!

Your overall depth of the test site should be recorded in feet as this is the unit measurement given on the GPS unit. To stay consistent, all distances should be analyzed in the metric system.

1. Enter depth data in feet
2. Add a new column next to the *depth (IN FEET)* column and label *depth (IN METERS)*
3. In the first blank cell in the meters column, type = and then click on the correlating cell in the feet column. Then type *.3048 and press enter

4. Drag this cell down the rest of the column

   a. Hover cursor over test cell with data, when you see a black cross click and drag down

5. Excel will fill in the blank cells with the formula and the corresponding cells.

Protocol for E. coli Water Test

Overview

Escherichia coli (E. coli) is a gram-negative, facultative anaerobic, rod-shaped bacterium found in the lower intestine of warm-blooded organisms. The amount of this bacterium in lake water can be used to judge the level of contamination by other bacterial pathogens in the water. To conduct this test, Coliscan® Easygel® (produced by Micrology Laboratories LLC, Goshen, IN) is used to grow E. coli cultures on-site to quantify E. coli levels in lake water.

How the Test Works

The Coliscan® Easygel® medium contains a sugar linked to a dye that, when acted on by the enzyme, b-galactosidase (produced by coliforms including E. coli), turns the colony a pink color. A second sugar is also present in the medium linked to a different dye that produces a blue-green color when acted on by the enzyme, b-glucuronidase. Since E. coli produces b-galactosidase and b-glucuronidase, E. coli colonies produce a purple color (pink + blue). Exploiting the use of two dyes allows the test to differentiate and quantify coliforms and E. coli (i.e., total coliforms are determined by counting the pink and purple colonies).

Materials Needed

- On the lake:
  - Bottle of water (Aquafina)
  - sterile containers for obtaining test samples (10-mL is large enough)
  - Paddle boat
  - GPS device (Lowrance HDS5 GPS Unit)

- Notebook with waterproof paper (Spiral bound, Rite in Rain, Journal or Field type, purchased from Amazon)
- Waterproof Pen (Rite in Rain All-Weather #37 Black Ink Fine Point)
- permanent marker (Sharpie)
- small cooler with ice
- plastic gloves
- Tygon$^®$ tubing (located in lab) calibrated with a permanent marker in 1-ft increments

- In the lab:
  - Ice cooler containing test samples
  - color chart to interpret test results
  - plastic gloves
  - plastic petri dishes (obtained from Micrology Laboratories)
  - sterile, individually wrapped pipettes (obtained from Micrology Laboratories)
  - refrigerator
  - bottles of Coliscan$^®$ Easygel$^®$ medium (obtained from Micrology Laboratories)
  - incubator (oven)
  - bleach
  - calculator
  - Ziploc bags large enough for disposal of used petri dishes

Requirements Before Testing

- Incubator must be turned on and temperature set at 35° C (95° F) (set at ~4 on the knob)
- Keep Coliscan$^®$ Easygel$^®$ bottles in the refrigerator until use

Procedure

On the lake:

1. Arrive at desired site with the aid of the GPS device

a. Record date, time, test site number, GPS location, water depth, and observer (who conducted the test) in your notebook

b. Record number for Physical Condition (PC) of the water in your notebook:

1 = crystal clear water

2 = not quite crystal clear – a little algae/weeds visible/present

3 = definite algae/weeds – green, brown, or yellow color present

4 = high algal/weed levels with limited clarity and/or mild odor apparent

5 = very high algal/weed levels with one or more of the following present: massive floating   scum/weeds/lily pads on the lake or washed up on the shoreline; strong or foul odor; or fish kill

c. Water color: use your best judgment on color of water, two colors can be used to describe, light and dark as descriptors (examples include: light green, dark grey, light green/grey)

2. Put on plastic gloves

3. Label cap of bottle with the test site number. Unscrew cap of sterile container, making sure not to touch the inside of container/cap with your hands. Set upside down on a surface (smooth top side down).

4. Place thumb on top end of the Tygon® tubing to "seal" the tubing. Insert the tubing in the water to the 1-ft mark on the tubing. Remove thumb from top and allow the tubing to fill with water. Place thumb back on the top of the tubing and pull the tubing out of the water.

5. Aim the tube head at the open bottle, making sure not to touch the sides, take thumb off the top, and allow the water to drain from the tubing.

6. Screw top back on bottle.

7. Use the bottle of water to pour through the tube to flush out the tubing, preparing it for the next sample.

8. If you are collecting more than one sample, store containers in a cooler with ice to stunt growth/death rates of bacteria.

In the lab:

1. Return to lab after collecting all samples to start <u>Coliscan® Easygel®</u> procedure.

2. Put on plastic gloves. Label petri dishes with test site number, date, time, and number of mL to be used in the test (see   below). <u>Do not open the petri dish</u> – write this information on the bottom of the petri dish.

3. Open an individually-wrapped sterile pipette at the bulb end. <u>Do not touch the end of the pipette</u>.

4. Shake the sterile container holding test sample for five seconds.

5. Unscrew the cap of the sterile container holding the test sample. Squeeze the bulb of the pipette before inserting it into the container.

6. Insert the pipette into the container without touching the sides, and draw up <u>3-mL</u> of water. Remove the pipette and   then release bulb to avoid drawing more than 3 mL of water.

7. Open a bottle of Coliscan® Easygel® medium. Squeeze out all water into bottle without touching the sides of the   bottle or touching the tip to liquid in the Coliscan® bottle. Screw the cap on the bottle.

8. Screw the cap onto the sterile container holding the test sample.

9. Swirl the Coliscan® bottle slowly for five seconds to mix the sample. Do this gently to avoid the formation of bubbles in   the medium. Then unscrew the cap.

10. Open the labeled petri dish, holding its lid close over the top of the dish as possible (to avoid contamination fro the air).   Pour the contents of the Coliscan® bottle into the petri dish, making sure to get all of the liquid transferred.

11. Place the lid on top of the petri dish and gently swirl to evenly coat the petri dish.

12. Place the petri dish in an incubator set at 35°C (95°F) for **24 hours**.

13. After 24 hours, remove the petri dish and turn it upside down. Count the number of <u>dark blue/ purple</u> spots that are   visible on the growth medium. Do <u>not</u> count pink, white, light blue, or blue-green spots. The purple dots must have a significant

blue/purple tinge to them. It WILL be a noticeable difference. Use the color chart if necessary. Record   the results in your notebook.

14.   To calculate the number of E. coli colonies per 100 mL of water:

   a.   Divide 100 by the number of mL of water used in your sample (in this case, 100/3).

   b.   Multiply the count on your plate by the result obtained from 14a.

   c.   Record the result in your notebook as CFU/100mL.

15.   To dispose materials after testing:

   a.   Soak Coliscan® Easygel® bottles in an antibacterial/water mixture with caps unscrewed overnight and then   dispose in the trash.

   b.   Discard the used pipettes in the trash.

   c.   Pour 1 tsp of bleach into the used petri dishes and let them stand five minutes with the top in place.

   d.   Place the petri dishes in a Ziploc bag, seal, and throw into the trash.

Example of Data Table

Date	Time	Test Site #	Location	Observer	Depth	Physical Quality	# of spots	CFU/100 mL
08/16/13	10:00 AM	21	GPS coordinates	Hannah Becker	5.4 ft	3	4	133.33

Protocol for Secchi Water Test

Overview

The Secchi Disk was created by Pietro Angelo Secchi to measure the relative turbidity of slow-moving rivers, lakes, ponds, and reservoirs. Turbidity is a measure of water quality, quantifying the amount of suspended solid matter in water.

Materials Needed

- Black and White Secchi Disk measuring 20 cm in diameter attached to measuring tape with 0.1 M increments
- Notebook with waterproof paper
- Pencil or Rite in the Rain Pen
- Transportation about the lake (boat, canoe, paddles, etc.)
- GPS device
- 2 clothespins
- Calculator

Requirements before Testing

- Secchi Disk has no damage:
  - borders between white and black sections are clear
  - No cracks in disk that would interfere with color distinction
- It is between the hours of 10:00 AM and 2:00 PM
- Secchi disk is firmly attached to the measuring tape

Procedure:

9. Arrive at desired site with the aid of the GPS device
   a. Record date, time, test site #, GPS location, water color (WC), and observer (who conducted the test) in your notebook
   b. Record number of Physical Condition (PC) in your notebook
      i. CHART:

      1 = Crystal Clear Water

      2 = Not quite crystal clear – a little algae/weeds visible/present

      3 = Definite algae/weeds – green, brown, or yellow color present

      4 = High algal/weed levels with limited clarity and/or mild odor apparent

5 = Severely high algal/weed levels with one or more of the following: massive floating scums/weeds/lily pads on the lake or washed up on shore; strong or foul odor; or fish kill

10. Position the boat so that the shaded side is at the location of testing
    a. If there is no shade, position your body so that your back is to the sun, shielding the testing spot from glare
11. Remove sunglasses, but keep in contacts/on glasses
12. Lower Secchi disk into the water and lower to the depth at which you can no longer see the disk.
13. Mark the measuring tape with a clothespin at the line that coincides with the surface of the water
14. Start pulling the rope up until you can see the disk again.
15. Mark the measuring tape with the second clothespin at the line that coincides with the surface of the water
16. Remove the Secchi disk from the water and record both values at which the clothespins are located. Average these numbers and record this third value. Values should be estimated to the nearest hundredth of a meter. (calculations can also be done later on Excel)
17. Repeat steps 4-8. Take the average values from both attempts and average. Record this value

Example of Data Table

Date	Time	Test Site #	(WC)	(PC)	Depth	Location	Observer	Value #1	Value #2	Average Value	Overall Value
6/20/13	10:40	1	blue	2	4.5 ft	Lat and Long	Hannah	6.20	5.30	5.75	5.78
6/20/13	10:50	1	blue	2	4.5 ft	Lat and Long	Hannah	6.50	5.10	5.80	^

*Only one overall value will be given to a location, as it is the average of both attempts

Protocol for Dissolved Oxygen and Temperature

Overview:

Dissolved oxygen (DO) is an indicator of lake health and affects the viability of fish. Fish must have a certain percentage of dissolved oxygen to live. DO is also an indicator of the amount of decomposition occurring on the bottom of the lake, as decomposing materials consume large amounts of oxygen. More oxygen can be dissolved in water at colder temperatures. Oxygen in the atmosphere dissolves in lake water by diffusion across the air/water interface: as air hits the water, oxygen atoms transfer from the gaseous state to a dissolved solute in a liquid.

A YSI Environmental 550A Dissolved Oxygen Meter is used for this test. This meter was borrowed from the Indiana Clean Lakes Program, which is a sector of the Indiana Department of Environmental Management Office of Water Management. This group works with citizens in establishing monitoring systems on lakes in Indiana. They loan out meter systems so that local residents can take measurements. I advise reading the manual before taking measurements with the meter.

Materials Needed:

- Notebook with waterproof paper (Spiral bound, Rite in Rain, Journal or Field type, purchased from Amazon)
- Waterproof Pen (Rite in Rain All-Weather #37 Black Ink Fine Point)
- Paddle boat
- GPS device (Lowrance HDS5 GPS Unit)
- Bottle of distilled water (Aquafina)
- DO/temp meter (YSI Environmental 550A Dissolved Oxygen Meter with 50 ft probe)
- Sponge
- Rubber band
- String
- Weight (metal weight, available in PPA building)
- Nylon zip tie

Preparation:

The DO meter is equipped with a lightweight probe that measures both dissolved oxygen (in ppm or % saturation) and temperature (in Celsius). Because of its light weight, the probe can drag in the water when lowered, thus skewing the results, so an X-gram weight is attached. This silver weight, attached to a rope in the PPA building laboratory, was attached via the rope loop to the ribbing on the cord right above the probe using a zip tie. A kitchen sponge was then wrapped around the weight and secured with a rubber band. When testing, you must pick up the weight and the probe together so that the weight does not pull on the probe. Once in the water, there will be less pull, and the weight will eliminate the drag (probe will lower cleanly into the water).

Procedure:

18. Arrive at desired test site with the aid of the GPS device.
    a. Record date, time, test site number, GPS location, water color (WC), overall depth (displayed on the GPS unit screen), and observer (who conducted the test) in your notebook

b. Record number of Physical Condition (PC) in your notebook using the following codes 1-5:

> 1 = crystal clear water

> 2 = not quite crystal clear – a little algae/weeds visible/present

> 3 = definite algae/weeds – green, brown, or yellow color present

> 4 = high algal/weed levels with limited clarity and/or mild odor apparent

> 5 = Very high algal/weed levels with one or more of the following: massive floating scum on the lake or   washed up on shore; strong or foul odor; fish kill

c. Water color: use your best judgment on color of water, two colors can be used to describe, light and dark as descriptors (examples include: light green, dark grey, light green/grey)

19. Calibrate the unit. This needs to be done only at the beginning of the testing day, not at every test site.

a. The probe is inserted horizontally into the side of the meter under the screen. Carefully pull it out and <u>do not touch</u> the gold membrane at the end of the yellow tip.

b. Make sure the probe tip is wet/moist. If not, apply distilled water to the probe end, shake off the excess, and then return to the storage chamber.

c. This test is recorded in % saturation, so the "calibration in %" calibration is necessary.

d. Turn on the unit and allow the readings to stabilize.

e. Press and release UP and DOWN arrow keys at the same time.

f. Press mode key until % is displayed. Press ENTER.

g. Increase or decrease value until the number is 8. (This indicates the altitude of the region, measured in hundreds of feet. We are roughly at an altitude of 800 feet above seal-level).

      h.   Wait for the current DO readings on the main display to stabilize. Press ENTER.

      i.   Increase or decrease salinity until it reads 0 ppm. Press ENTER.

      j.   You are ready to begin testing.

20. Measurements are made every meter. Judging by the overall depth, decide how many 1-meter increments can be made. Do not allow the probe to touch the lake bottom, so only do as many increments that allow you to get close to the bottom without touching it. There are 0.3048 meters in 1 foot.

21. Take the probe out of the storage chamber and insert it into the water until it reaches the desired depth (the cord is labeled every meter).

22. Move the probe up and down roughly 1-2 inches to allow water to flow in and out of the probe head.

23. Wait until the readings stabilize and record temperature (in Celsius) and % Dissolved Oxygen for specific depth.

      a.   The numbers will not completely stabilize (remain constant). You are looking for a number to repeat several times or hover around a specific value.

24. Repeat until all depth increments have been recorded.   There is no need to take the probe out of the water between increments at a given test site.

25. Take the probe out of the water and rinse it with distilled water from the water bottle before returning it to the storage chamber on the meter. Don't forget to shake off the excess water.

26. Move to the next test site and repeat. Do not turn the meter off between sites, as this will require re-calibration.

27. When completely done with your measurements, rinse off the probe with distilled water and return it to the storage chamber. Turn off the unit.

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