DaVinci Grant Program, Summer 2014
Proposal
Institute for Scholarship in the Liberal Arts (ISLA)
University of Notre Dame
Notre Dame, Indiana 46556

Project Title

Stakeholder Values and Lake Ecology: Motivating Adjoining Lake Communities in a Common Watershed Through Improved Communication and Best Management Practices

Grant Applicants: Brian Roddy, College of Science, Astrophysics Major with an Energy Studies Minor (junior year); Matthew Williams, College of Engineering, Aerospace Engineering Major (sophomore year)

Supervising Faculty Mentor: Professor Anthony S. Serianni (Chemistry and Biochemistry)

Supporting Faculty Mentors: Professor John Sitter (English); Professor Daniel Lapsley (Psychology)

Non-Faculty Mentors: Dr. Ann R. Serianni (PhD, Psychology (social), University of Michigan, Institute for Social Research); Diana Castell, Chair, Ecology Group, Wawasee Area Conservancy Foundation (WACF)

Project Location: Three-Lakes Region (Lakes Syracuse, Wawasee and Papakeechie), Syracuse, Indiana

Local Sponsors: Lake Papakeechie Sustainability Initiative (LaPSI) (a subcommittee of the Papakeechie Protective Association (PPA)), Syracuse, Indiana; Wawasee Area Conservancy Foundation (WACF)

1. Abstract. Improving and maintaining aquatic ecosystems requires sound science and management practices, and strong "buy-in" from stakeholders who affect, and are affected by, these environments. This interdisciplinary project involves a unique three-lake watershed in northern Indiana that is populated by resident communities with disparate socio-economic character and different views and expectations of the watershed. This research venue provides an opportunity to (1) develop new testing and management practices in a complex interconnected freshwater aquatic ecosystem to improve and sustain healthy watershed ecologies, and (2) to investigate best methods to identify and motivate stakeholders with diverse backgrounds and mindsets to understand, support, and participate in lake testing and management practices.

2. Introduction. This interdisciplinary project builds on a solid foundation established in the summer of 2013 by prior Da Vinci scholar, Ms. Hannah Becker. The original project combined fundamental limnological studies of an Indiana lake (Lake Papakeechie (LP), Syracuse, Indiana) with social psychological studies of two contrasting, adjoining lake communities (Lake Papakeechie and Lake Wawasee (LW)). The 2013 project had two major goals: (1) to develop and implement new lake limnological studies in collaboration with the local Lake Papakeechie Sustainability Initiative (LaPSI), and (2) to conduct 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). The underlying rationale for goal (2) stemmed from known socio-economic disparities between the two communities that has led to an unhealthy lack of communication, cooperation and collaboration, resulting in sub-optimal management of the lakes and the surrounding watershed. The desired outcomes of the 2013 project were to achieve a better understanding of the two lake communities, to improve communication between them, and to implement improved lake and watershed management methods. We comment further on these outcomes below. During the summer of 2014, we aim to significantly and strategically extend and refine the results obtained in 2013 using new information and knowledge gained in 2013. These extensions and refinements include: (1) an expansion of the field studies to areas surrounding LP, (2) diversifying the types of water tests in LP and the surrounding watershed to gain an improved understanding of ecological driving forces, (3) partnering with the Wawasee Area Conservancy Foundation (WACF) Ecology group to implement identical testing methods on LP, LW and other smaller bodies of water in the watershed for more reliable data analysis and interpretation, and (5) improving data quality, collection, and interpretation in concurrent socio-psychological studies of LP and LW residents.

3. Background and Brief Review of the 2013 Da Vinci Project. Lake Papakeechie (LP) in Syracuse, Indiana (~45 miles southeast of Notre Dame) is a private, 179-acre inland lake (Figure 1). LP is managed by the Papakeechie Protective Association (PPA), which was founded in 1928. In 2012, the PPA completed a $1.1-mil project to replace a 2500-ft dam separating LP from the largest natural lake (3060 acres) in Indiana, Lake Wawasee (LW). Despite this huge financial investment, the PPA remains largely passive in its ecological management of LP. This posture contrasts with that of the Wawasee Property Owners Association (WPOA) on LW, which spawned the Wawasee Area Conservancy Foundation (WACF) in 1991 to manage LW and its environs. Thus, the two lake communities, LP and LW, have adopted very different attitudes about the value and importance of lake management. However, it is clear that convergence on these issues is critical to the future of these two communities. For example, while LP is ~17 times smaller than LW, its ecological impact on the latter is significant, since water flows north from LP into LW (both lakes are north of the Continental Divide), with about 20% of the water flowing into LW originating from LP. Efforts to manage LW must therefore include monitoring of the LP feed water, but since the water quality in LP is largely unknown, these efforts have been far less effective than they otherwise might be.

Figure 1. Aerial photograph of Lake Papakeechie, a 179-acre lake near Syracuse, Indiana, and the main venue of the proposed studies.

In 2012, a new environmental group on LP was formed with the approval of the PPA. The Lake Papakeechie Sustainability Initiative (LaPSI) is actively developing new lake management policies and practices 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[1]: water pH, water turbidity, water temperature, microbiological profiles, phosphate and nitrate concentrations, dissolved oxygen, and other measurables. 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. Since 2012, LaPSI has raised >$8000 in donations to support the construction of a small laboratory in the PPA Building, and to purchase scientific equipment and supplies. One of the two aims of the 2013 Da Vinci project was to initiate the first systematic limnological studies of LP in its 110-year history.

While implementation of a lake management program by LaPSI represents a major step forward for the LP/LW watershed, its long-term success hinges on the active involvement of residents and other stakeholders in the two communities. An obstacle to communication exists between these two groups, which may ultimately undermine community-based efforts to manage the watershed. It was the contention of the 2013 proposal that establishing a social psychological profile of the two communities is a productive path forward, as suggested by prior studies correlating social psychology with environmentalism,[2] lake ecology,[3] and lake management.[4] It was argued that the two communities have common environmental aspirations, but fail to work cohesively because of misguided notions about the beliefs and values each hold. The second social psychology aim of the 2013 proposal had two parts: (1) To prepare and conduct an initial survey of LP and LW lake residents to identify the beliefs and values that both hold in common and those that differ in each community. Armed with this new information, both communities may be better able to find common ground on which to build a long-term relationship involving the watershed they share in common. (2) To determine whether beliefs and values are related to (a) LP and LW residents' behaviors that impact water quality, such as the use of lawn fertilizers and pesticides, removing aquatic plants from the shoreline, constructing seawalls etc., and (b) for LP residents, measures of water quality on LP.

4. Outcomes of the Da Vinci Project in Summer 2013. By all reasonable measures, the goals of the 2013 Da Vinci project have been met. Several specific outcomes are summarized as follows:

(A) Construction of a Laboratory Facility in the PPA Building. A new laboratory was installed in the PPA Building, including laboratory benches, overhead lighting and electrical services. Scientific equipment was purchased, including an incubation oven for *E. coli* testing, Secchi disc for measurement of water turbidity, GPS mapping and sonar equipment and associated computer software for bathymetric mapping of LP, a printer/scanner connected to a wireless local network for data handling, and other ancillary equipment/supplies to support general lake studies.

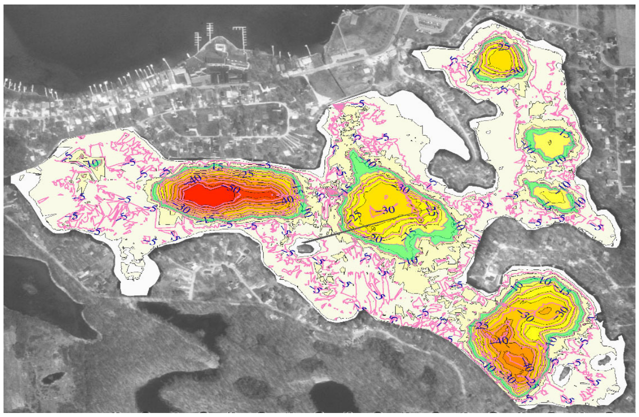


Figure 2. The first bathymetric map of LP in its ~100 year history, obtained during the 2013 Da Vinci project.

(B) Bathymetric Mapping of LP. The first bathymetric map of LP was obtained (Figure 2). This work was spearheaded by LaPSI member John Hart in collaboration with Da Vinci scholar Hannah Becker and several LaPSI members. Lake depth information was deemed a prerequisite to scientific studies on LP. While the map is not 100% complete, it provides depth information in far greater detail than has been available in the ~100 year history of the lake. For example, it is now known that LP has areas with depths in excess of 50 ft (Region 4). This information is valuable not only for fishermen but also for understanding water mixing behaviors and aquatic habitat characteristics. A secondary aim of the 2014 project is to complete this map.

(C) GPS Mapping of Test Sites on LP. Information from the bathymetric map was used in conjunction with empirical data to select 50 GPS-defined test locations on LP so that subsequent testing could be conducted at specified and reproducible locations on the lake (Figure 3). The lake was divided into four (4) Regions to facilitate data collection and reporting. These

regions were denoted Regions 1-4 (Figure 3) and were assigned based on the natural geometry and perimeter of the lake.

<u>*(D) Selection and Implementation of Scientific Water Testing on LP, and Preparation of Standard Operating Procedures (SOPs)*</u>. Since on-site water testing at LP had not been done previously and prior testing infrastructure was not in place, four tests were selected based on the type of data they provide, their relative ease of measurement, and the costs associated with their implementation given the amount of available funding. These tests included: (1) water turbidity measurements with a Secchi disc; (2) *E. coli* level measurements using a pre-fabricated petri dish testing system (Coliscan Easygel; Micrology Laboratories LLC, Goshen, IN) and a testing protocol validated by studies done at Michigan State University; (3) water temperature measurements as a function of lake depth; and (4) dissolved oxygen (DO) measurements as a function of lake depth. Measurements (3) and (4) were made simultaneously using a DO meter equipped with a dual O_2 and temperature sensor; this equipment was borrowed from the Clean Lakes Program in Warsaw, Indiana (Darci Zolman). All tests were conducted at the 50 GPS-defined sites (Figure 3) with careful recording of procedures and methods in Standard Operating Procedures (SOPs). The latter documents, prepared for each test, insure that future testing is performed in an internally consistent manner, and that future modifications to the protocols are documented in a systematic manner. An example of an SOP (DO/T testing) is provided in Appendix A.

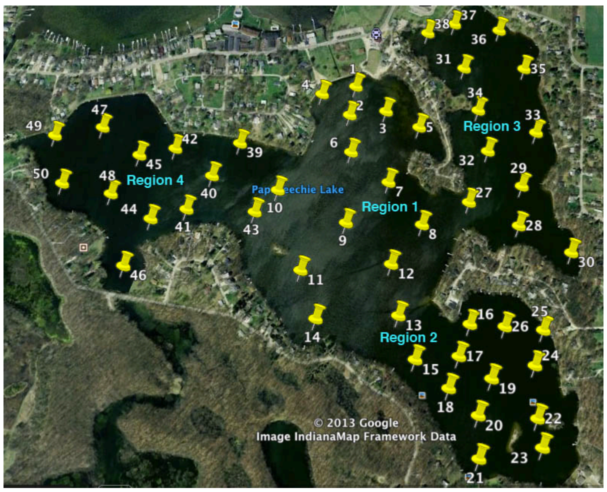


Figure 3. Identification of the 50 GPS-defined test sites on LP, distributed in Regions 1-4.

<u>*(E) Representative Results from Summer 2013 Lake Testing*</u>. A considerable number of individual tests samples were analyzed on LP at the 50 GPS-defined sites. Only representative examples of the results are presented here.

Secchi water turbidity tests were conducted on LP on several occasions during the summer 2013. The results for one dataset are summarized in Figures 4 and 5. Figure 4 shows the relationship between Secchi depth (in meters, m) and test site number. The data show that water in Regions 2 and 3 is clearer than in Regions 1 and 4. The maximum Secchi depth measured on LP was ~3.2 m (Region 2), or 10 ft, which is higher than expected.

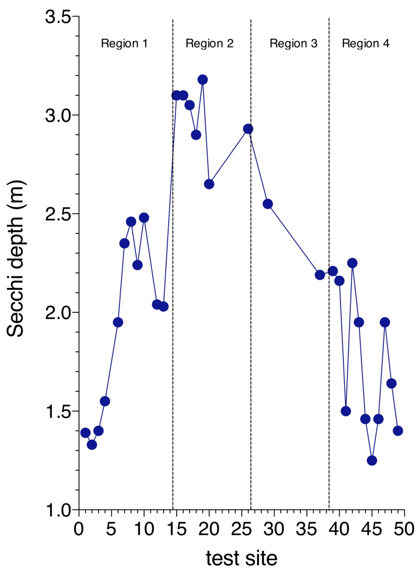


Figure 4. Secchi depth (m) versus test site number and Region number on LP (summer 2013).

Further insight into lake turbidity derives from the plot of Secchi depth versus test site maximum depth (Figure 5). These results show that, on average, water clarity increases with increased depth, although the correlation is weak, especially at the greater depths, as indicated by significant data scatter at depths exceeding 5-6 m. These findings suggest that factors in addition to lake depth influence water clarity.

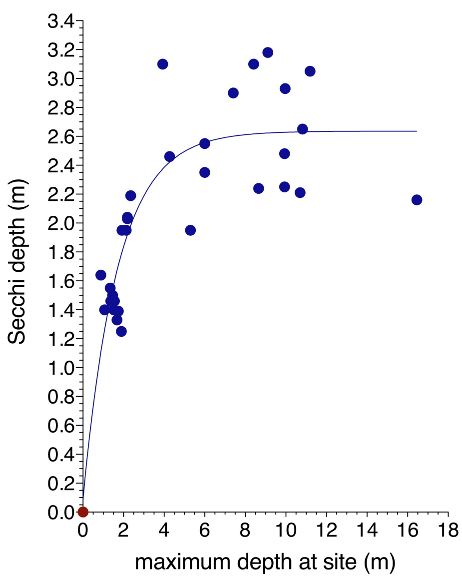


Figure 5. Secchi depth (m) versus test site maximum depth (m) on LP (summer 2013).

Figure 6 shows the relationship between test site number and lake depth. These data reveal the location of the deepest part of the lake at Site 41 in Region 4. They also reveal the significant variability in lake depth at the various test sites, ranging from shallow (~1 m in parts of Regions 1 and 4 to depths exceeding 8 m in Regions 1, 2 and 4. On average, Region 3 is the shallowest region of LP, with depths less than 4 m.

Figure 7 shows how lake water temperature varies with site location and depth. In general, the data curves overlap, and yield an overall temperature dynamic range of ~20 ^oC;

temperature near the surface was about 24 ^{o}C at all sites, and drops to ~5 ^{o}C in the deepest regions of LP. On average, water temperature is relatively constant down to ~4 m, then drops rapidly, indicating a mid-summer thermocline near the 4 m depth.

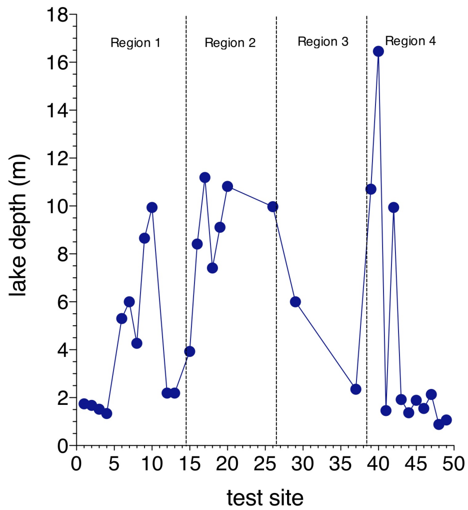


Figure 6. Relationship between lake depth (m), test site number, and Region number on LP (summer 2013).

The plot in Figure 8 illustrates how dissolved O_2 in LP depends on lake depth. These data were taken at Site 17 in Region 2 (see Figure 4). The data show a close correspondence between water temperature and DO, with both curves relatively flat down to ~4 m, and both declining rapidly thereafter. DO at depths exceeding 6 m is essentially zero, showing that the lake becomes hypoxic (or anoxic) at depths between 6 m and 12 m at Site 17; the bottom half of the water is essentially devoid of oxygen. This behavior mirrors that observed at other sites in the lake that have comparable maximum depths. These results are critical, since significant oxygen depletion can negatively affect oxygen-requiring aquatic life (*e.g.,* fish) and may suggest that the lake is moving towards an undesirable eutrophic state.

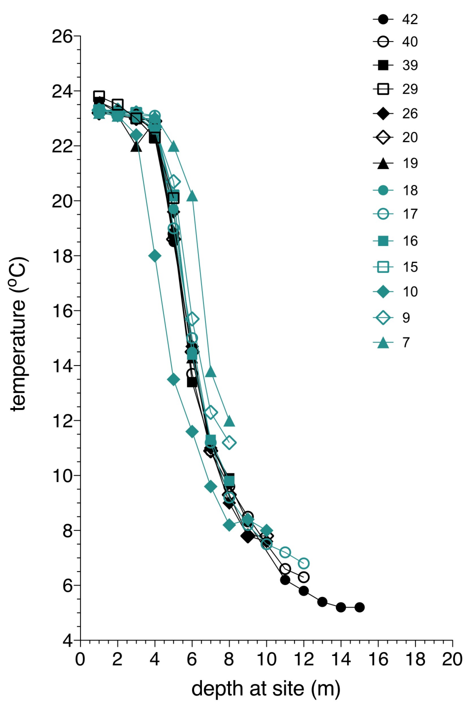


Figure 7. Relationship between water temperature (^{O}C) and test site depth (m) obtained from 14 test sites on LP (summer 2013).

(F) Representative Results from Summer 2013 Socio-Psychological Studies. Surveys were administered to two different groups of lake residents: LP and LW. A copy of the survey instrument is provided in Appendix B, and some poll results are shown Figures 9-11. We focus on three poll parameters: education level (Figure 9), time spent on lake (Figure 10), and social inter-relationships between lake residents (Figure 11). The data, while only preliminary, are revealing. As anticipated, a larger percentage of LW residents are educated at the undergraduate level or beyond (66%) than found for LP residents (49%). With respect to time spent on the lake (Figure 10), similar percentages (54% and 60%) are full-time residents or nearly so on both lakes, but a larger percentage of LP residents (30%) live on LP for <13 weeks than found for the LW residents (6%). Data in Figure 11 provide information on social inter-relationships between LP and LW residents. A sizable percentage of LP residents have some type of social relationship with LW residents (75%), whereas this percentage is 38% for the LW residents. In this case, the significant difference between the numbers of lake residents on LP and LW is an influencing factor, since there is a greater probability of LP residents developing social connections with LW residents than vice versa.

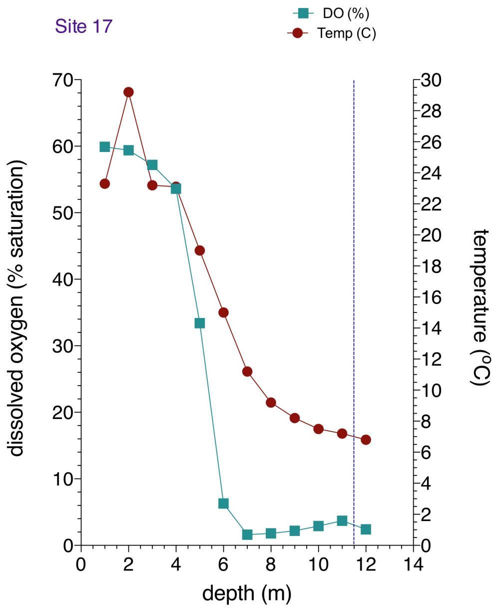
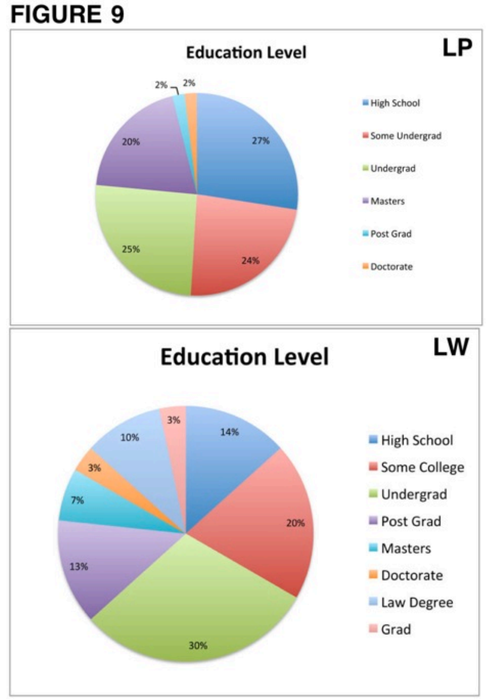


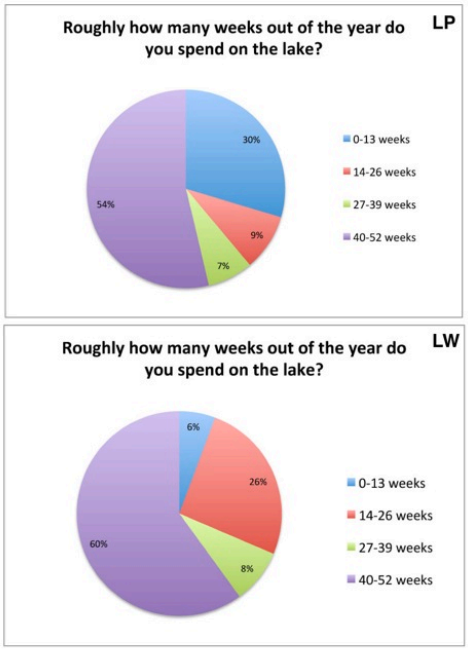
Figure 8. Relationship between temperature (ºC), DO (% saturation) and depth at Site 17 (summer 2013).

FIGURE 9



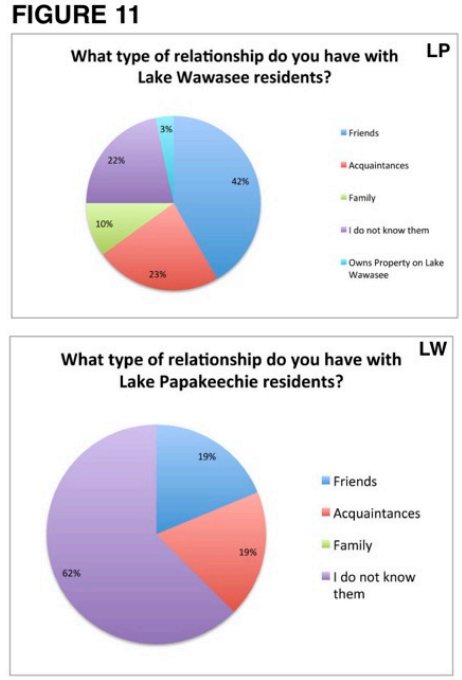
5. Methodology and Description of Work for Summer 2014. The Summer 2013 Da Vinci project built research infrastructure on LP from essentially a non-existing base. Due to extraordinary effort by Da Vinci scholar Hannah Becker, great progress was made in selecting and implementing an initial set of scientific tests of lake water, and gaining preliminary insight into the social psychology of lake management in a challenging community of lake residents. There is a solid foundation on which to build new work in summer 2014. The original 2013 Da Vinci proposal anticipated this evolution, namely, that the project would gain momentum in future years after a firm foundation was established.

FIGURE 10



While enormous progress was made in summer 2013, there are limitations and shortcomings in the data that need to be addressed. The proposed Summer 2014 project retains the two major components of the Summer 2013 project, namely, limnological studies of lake ecosystems coupled with social psychological studies of LP and LW residents. The underlying argument for this synergy remains sound: While reliable scientific data are essential to the design and implementation of effective lake management methods, the data and resulting methods are largely impotent unless the stakeholders understand, support and promote them. Changes in the scope and execution of the Summer 2014 project relative to those of Summer 2013 derive from observations and experiences gained from last summer.

FIGURE 11



AIM 1. Limnological Studies – Supervising Faculty Mentor Professor Anthony S. Serianni; Non-Faculty Mentor Diana Castell (WACF).

Six significant limitations exist and will be addressed.

(1) We learned that focusing exclusively on LP water quality is shortsighted. LP lies in a complex watershed as shown in Figure 12. Since LP lies north of the north-south continental divide, water flows northward into LP from sources south of LP. Little is known about the quality of this feed water, and there is ample cause for concern about its quality given the proximity of agricultural and livestock areas east of LP. <u>Solution</u>: *Water testing will be expanded to include some of these extra-LP water sources*.

Figure 12. Topographic map of LP and its environs.

(2) Given the concerns expressed in (1), water testing must be broadened beyond the current Secchi, *E. coli* and DO/T tests to include nitrogen (N) and phosphorus (P) analyses. <u>Solution</u>: *N and P testing will be done in LP and in some of the outlying areas shown in Figure 12, especially water sources that feed directly into LP.*

(3) We learned that borrowing scientific equipment to conduct lake measurements is cost-effective but leads to uncertainties in data quality. This concern pertains to the DO/T studies where the DO/T equipment was borrowed from the Clean Lakes Program (see Section 4C) to conduct the measurements. <u>Solution</u>: *LaPSI will purchase its own captive DO/T equipment to insure optimal calibration and maintenance. The new equipment, purchased with LaPSI funds, will yield more reliable DO/T data.*

(4) We learned that inclusion of LW in lake water studies is essential to the long-term success of LaPSI. Similar methods and approaches, and measurement timings, ought to be implemented on both lakes so that data comparisons can be made with greater confidence. Solution: *Collaborative lake water studies will be initiated with the Ecology group of the Wawasee Area Conservancy Foundation (WACF), with support from Diana Castell who heads this group. Two Notre Dame undergraduates will work as a team on LP and LW to implement common testing measurements and procedures on both lakes.*

(5) While significant new scientific data were collected on LP in the summer 2013, insufficient time and effort was spent on collecting information obtained from prior scientific measurements on LP, LW and other lakes in the Wawasee watershed.[5] We have now identified an individual in possession of this information: Mr. Ron Corson, a long-time LP resident and active participant on the PPA Board. Solution: *Time and effort will be devoted in the Summer of 2014 to collect and archive this historical information, with Mr. Corson's assistance, so that new data can be interpreted in light of prior knowledge.*

(6) The Bathymetric map of LP (Figure 2) is incomplete. Solution: *Additional data will be collected with LaPSI hardware and software to complete the map.*

AIM 2. Social Psychological Studies – Supporting Faculty Mentors John Sitter and Daniel Lapsley, and Non-Faculty Mentor Ann R. Serianni.

The social psychological survey of LP and LW residents conducted in Summer 2014 will be refined to establish human belief and value profiles on both lakes. A survey instrument has been prepared, but probably needs some refinement. Four categories of questions were designed. The first addresses demographics (*e.g.,* age, level of education, length of time on lake, *etc*.). The second probes ecological beliefs, values and ideals. The third category provides information on where the residents see themselves in the future. The fourth category addresses the socio-political differences between LP and LW. The intention of this survey is to better define the beliefs and values of the residents of both lakes, promote better mutual understanding, and thereby promote improved management of the watershed.

For data from this survey to be useful, a random sampling of residents of both lakes needs to be made, and equal percentages of the total residents of each lake must be sampled. *Herein lies the major weakness of the summer 2013 work.* The surveys were administered at annual lake resident meetings on LP and LW. Only a small percentage of the total residents participated, and the sampled population was likely skewed in favor of those most engaged in the welfare of the two lakes. This limitation is serious; while the survey instrument is fairly robust, its administration was weak.

To address the above limitations, two steps will be taken:

(1) The survey instrument will be re-examined and revised as necessary, with oversight provided by Mentors Sitter, Lapsley and Serianni.

(2) A list of email addresses will be obtained for LP and LW residents. This information is obtainable from the PPA Board and the Wawasee Property Owners Association. The survey will be administered by contacting the lake residents and asking them to log onto the LP web site to complete the survey on-line. Student interns Williams and Roddy will work with PPA web site manager, Kendall Floyd, to upload the survey and administer it. If this approach falls short, interns Williams and Roddy will go door-to-door on LP and LW to collect the needed data. Some analysis of survey statistics will also be conducted, with assistance from the project Mentors Sitter, Serianni and Lapsley, to insure that sampling is sufficient to obtain reliable results.

6. Schedule. Work will be conducted during the time period June 2nd - August 8th (10 weeks). A low-resolution breakdown of weekly activities is as follows:

Weeks 1-2: Collection and testing of laboratory equipment; consultation with LaPSI to determine water testing sites on LP and its environs; consultation with WACF to define water testing sites and other activities on LW; consultation with Faculty and Non-Faculty Mentors to review and revise survey instrument; consultation with Kendall Floyd to arrange distribution of survey on LP web site.

Weeks 3-4: First round of water tests initiated; email addresses of LP and LW lake residents obtained; survey instrument completed and installed on LP web site.

Weeks 5-6: Survey availability announced to LP and LW residents; first round of water tests completed; second round of water tests initiated (same as first round to determine effect of time-of-measurement on the results).

Weeks 7-8: Second round of water tests completed; survey data collected.

Weeks 9-10: Testing and survey data processed and analyzed; preparation of final reports.

This is a crude schedule. Weather is a key uncertainty as learned during work in summer 2013. Also, unlike summer 2013, Matt Williams and Brian Roddy will commute to LP on some work days, depending on weather and other factors. It is estimated that room accommodations in Syracuse will be needed for about ½ of the project period. Flexibility is needed because of the significant weather dependency.

7. Statement of Research Goals. This work will benefit the LP and LW communities as they develop and refine their policies and practices on lake stewardship. The results of this study will be shared with the LP and LW communities through the PPA and WACF websites, and through publication in suitable public media (general newspapers and scientific forums).

The results of this research will contribute to the Senior Capstone Project of Matthew Williams, who will enroll in the Sustainability Minor at the end of his current sophomore year of study.

8. Budget. Funds ($2000) are requested to partially offset housing costs (~$3500), food (~$1500) costs, and travel between Syracuse and Notre Dame, Indiana (~$1500) (calculated for two (2) Da Vinci students). Additional funds are available from Da Vinci funds remaining from 2013 (~$2500), and funds to be provided by LaPSI ($1000) and the WACF ($1000). Thus, a total of $2000 (2014 Da Vinci) + $2500 (remaining funds, 2013 Da Vinci) + $2000 (LaPSI + WACF contributions) = $6500 is available to offset the total estimated expenses shown above.

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2. Oisho, S.; Graham, J. Social Ecology: Lost and Found in Psychological Science, *Perspectives on Psychological Science* **2010**, *5*, 356-377.

3. Janssen, M. A., An Exploratory Integrated Model To Assess Management of Lake Eutrophication, *Ecological Modelling* **2001**, *140*, 111-124.
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5. *Comparative Study of Kosciusko County Lake Water Quality*, Supplemental Report on Lake Papakeechie, Grace College and Seminary, **2007**.

APPENDIX A

Example of a Standard Operating Procedure (SOP) for Lake Testing (Summer 2013)

Dissolved Oxygen and Temperature Test Protocol

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:

1. 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)
2. 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.
3. 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.
4. 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).
5. Move the probe up and down roughly 1-2 inches to allow water to flow in and out of the probe head.
6. 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.
7. 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.
8. 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.
9. Move to the next test site and repeat. Do not turn the meter off between sites, as this will require re-calibration.
10. When completely done with your measurements, rinse off the probe with distilled water and return it to the storage chamber. Turn off the unit.

APPENDIX B
Copy of the Resident Survey Instrument Distributed on Lake Papakeechie (Summer 2013)

Residential Poll

1) How likely are you to live on the lake for the next 10 years?

   Not Very Likely 1 2 3 4 5 Very Likely

2) In which type of environment have you spent most of your life?
   a) rural
   b) urban
   c) suburban
   d) inner city
3) Roughly how many weeks out of the year do you live on the lake?____________________________________.
4) How many children live at home with you? (children: under age of 21 years old)________________________.
5) Have you attended any educational seminars that address lake habitat management? (WACF meetings do not count)

   yes no

   a) If so, how many seminars have you attended in the past year?_________________________.
6) (Circle all that apply)What type of relationship do you have with Lake Papakeechie residents?
   a) I have friends that live on Lake Papakeechie.
   b) I have acquaintances that live on Lake Papakeechie.
   c) I have family that lives on Lake Papakeechie.
   d) I do not know people that live on Lake Papakeechie.
   e) I own a house on Lake Papakeechie
7) How often do you do each of the following? rate the actions on a scale of 1-5 with 1=very infrequently 5=very often
   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 .
8) (Circle all that apply) What types of activities do you enjoy on the lake?
   a) kayaking
   b) canoeing

c) paddle boating

d) swimming

e) fishing

f) boating/water sports

g) other:____.

9) On a scale of 1-5, how healthy do you think the lake is?

Not Healthy 1 2 3 4 5 Healthy

10) Age ___________Highest Level of Education___________________________________.

Gender__________Marital Status________________________Ethno-Racial Status

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I have left the back blank for comments or further explanation of your answers. Feel free to leave your name and number: If I want to quote you in my independent research paper, I will call to confirm your acceptance of public quotation. Graphical analysis of this poll shall be anonymous.