QN
QUAESTIONES NATURALES

VOLUME 3, 2015

UNDERGRADUATE RESEARCH IN SCIENCE

Lakehead UNIVERSITY
Faculty of Science and Environmental Studies
lakeheadu.ca

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"Quaestiones naturales" is a Latin term referring to investigations into the natural world, or today what we call scientific research, especially those studies of a multidisciplinary nature. The term was originally used by the Roman philosopher Seneca the Younger for a series of books on meteorology and other natural processes.

Table of Contents

Welcome Message from the Dean

This is the third issue of *Quaestiones Naturales*, our annual publication of the research achievements of undergraduate students in the Faculty of Science and Environmental Studies at Lakehead University. Student engagement is a top priority in our faculty and involvement of our students in exciting research projects is central to our focus. This year in *QN*, we feature nine students whose research interests range from the applied to the pure sciences and who use both field- and laboratory-based approaches. Subjects range from modeling the effect of climate change on fire risk in the boreal forest to examining how silicon binds to organic molecules, and from the ability of mine tailings to increase the amount of mercury in our waterways to developing new ways to construct aerial maps of archeological sites. We take pride in being able to offer motivated students meaningful opportunities to work with leading scientists on projects that are current and of real interest to the student. In a typical year, our faculty's researchers spend close to half a million dollars from individual grants to support students on research projects throughout the summer. Research inspires learning and this magazine allows us to showcase just a fraction of the great work being done by some of the future generation of science alumni at Lakehead University. Enjoy!

Todd A. Randall, PhD, P.Geo.
Interim Dean of Science and Environmental Studies

Todd A. Randall, PhD, P.Geo.

Featuring research performed by undergraduate students in the Faculty of Science and Environmental Studies at Lakehead University.

Ideally, science is a method by which information is gathered using evidence and physical models. It may then also extend to developing that knowledge for beneficial purposes. Part of the mandate of every university is the creation of new knowledge, and part of the educational experience for students in Science and Environmental Studies programs is the study of new knowledge and how it is gained. As part of this training, many students have the opportunity to take part in research projects under the direct supervision of a professor. As you will see, these projects are truly scientific – the students are creating new knowledge while they learn the skills to become researchers themselves.

In this magazine, we profile nine students and their projects. They performed the research when they were undergraduate students and each made interesting and significant contributions to their areas of research.

Researcher	Program	Hometown	Supervisor(s)*
Robert Baidoc	Environmental Studies (Geography)	Mississauga, ON	Dr. Adam Cornwell
Jocelyn Bel	Applied Bio-Molecular Science	Thunder Bay, ON	Dr. Kam Leung
Janelle Benallick	Environmental Sustainability	Fergus, ON	Dr. Gerardo Reyes and Dr. Florin Pendea
Carly Chantler	Environmental Sustainability	Parry Sound, ON	Dr. Nanda Kanavillil
Kara Cox	Environmental Science (Earth Science)	Thunder Bay, ON	Dr. Philip Fralick
Kevin Gagnon	Chemistry; Mathematics minor	Thunder Bay, ON	Dr. Robert Mawhinney
Sara Mackie	Biology	Thunder Bay, ON	Dr. Peter Lee
Katrina Shwedack	Biology; English minor	Thunder Bay, ON	Dr. Janice Hughes
Jason Stephenson	Anthropology	Thunder Bay, ON	Dr. Scott Hamilton

*for supervisors' contact information, please consult https://www.lakeheadu.ca/faculty-and-staff/directory.

Complex Coordination

Examining how silicon combines with organic molecules

Kevin Gagnon

Life on Earth is centred around carbon atoms, which form stable bonds with other elements to create biomolecules like DNA, lipids, carbohydrates and proteins that are found in all organisms. Intriguingly, the element silicon has similar chemical properties and is present in many plants and animals. Figuring out how it might be incorporated into living things interested Chemistry student Kevin Gagnon. As he says, "In my third year I was inspired by a class I took and became interested in computational chemistry. That summer I started working with Dr. Robert Mawhinney, where I modeled silicon-based molecules. This lead up to what I am currently working on for my honours thesis."

He explains that like carbon, silicon in nature is normally bonded to four other atoms. "Silicon can also complex with five or six other atoms. These are called hypercoordinate silicon complexes. I am looking at the factors that influence the number of other atoms silicon can bind with." Kevin uses a model molecule, ethylene glycol, which is a primary component of vehicle antifreeze. By adding different substituent groups onto the ethylene glycol and using a computer program, he can see how their presence affects the binding of ethylene glycol to silicon. While he is still working on the project, he says that "so far, I have found that the electronic properties of the substituent influences formation of the hypercoordinate silicon complexes." His work may help to identify biomolecules involved in silicon transport in mammals and determine whether this intriguing element is important in animal metabolism. As silicon-based molecules may have also played a role in pre-biotic chemistry, understanding how silicon binds to other molecules may provide clues on how life developed on Earth.

"I really appreciate the opportunities available to do research here as an undergraduate student."

Kevin has a long history working with researchers at Lakehead. "I really appreciate the opportunities available to do research here as an undergraduate student, because I was able to get a summer job when I was just out of first year, and return every summer since." While he has considerably developed his lab skills doing his research projects, another valuable skill he has picked up is becoming an effective presenter and conveying his results to others. Kevin encourages other students to try a research project and says "Go for it! There is so much out there to learn about, and you can only benefit from doing one." ■

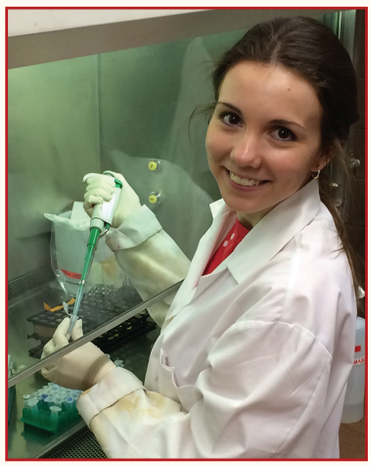
Perhiphyton Problems

Harmful bacteria can hide out in lake slime

When swimming advisories are posted, the usual culprit is a high level of bacteria in the water. This happens fairly often at Boulevard Lake, a popular beach in Thunder Bay. The cause may seem obvious: contamination by animal or human waste. But what if the bacteria come from another unexpected source? That was the research question that intrigued Jocelyn Bel, a student in the Applied Bio-Molecular Science program. She explains: "Some strains of the common bacterium *E. coli* can cause human disease, while others are harmless. I was interested in linking these strains to the presence of genes that cause them to be pathogenic." Work done by other students had identified the *E. coli* strains in Boulevard Lake by comparing their DNA sequences and showed that most of the bacteria came from from periphyton in the lake and not from animal waste or human sewage.

"Performing the techniques and learning how to perfect them in my project makes understanding the science easier."

"My work examined the *E. coli* in the periphyton to see whether they contained any of the harmful genes that would make humans sick. If the bacteria do not have these genes, then they are not harmful to us and the beach will not need to be closed as often." Jocelyn is still working through her data and is working towards solving this problem. Ultimately, being able to differentiate between strains of *E. coli* that are harmful and harmless to humans may have future implications on public health policy.



Joceyln Bel

Lakehead's undergraduate programs in Science and Environmental Studies stress giving students experience learning and doing tasks they need to work in their field. Jocelyn was able to work in a microbiology lab with Dr. Kam Leung during her second year and earn course credit for doing so. As Jocelyn says, "I really enjoyed learning the different microbiology theories in class, but actually performing the techniques and learning how to perfect them in my project makes understanding the science easier."

Jocelyn has many interests in science and business that she has fostered by working at Lakehead. She has been an instructor and the director of the science outreach program Superior Science. She is interested in working for the pharmaceutical industry and has recently begun the MBA program at Lakehead. Her program has prepared her well for success in her future career. As she says, "My dad went to Lakehead before me. He always talked about the professors and how being at a smaller university is better in science because it will lead to more opportunities to try things that students at larger universities wouldn't get the chance to do. He was right!" ■

The Future of Fires

Linking climate change with boreal forest health

Like for ecosystems across the world, climate change has the potential to alter Northern Ontario's eastern boreal forest. For his research project, Robert Baidoc was interested in a specific question: will this make the forest more vulnerable to forest fires?

When he chose to enter Lakehead's program in Environmental Studies with a Geography major, Robert was interested in environmental issues and sustainable development. As he explains, geography appealed to him because it bridges arts and science and "is an all-encompassing discipline that seeks to understand the human and natural complexities of how the Earth has developed. This helps us understand complex subjects such as environmental issues."

"If you give yourself the benefit of the doubt, you'll be surprised what you can accomplish."

For his project, he chose such a complex issue, asking whether climate change-induced weather phenomena like increased precipitation will offset increasing temperatures and thus lead to fewer wildfires in the eastern boreal forest. Robert says that "we were able to show statistically significant increases in fire ignition potential between the historic and future climate scenarios, presumably due to changing weather patterns related to greenhouse gas emissions." The eastern boreal forest might therefore be more vulnerable to forest fires in the future.

While he has learned a lot about environmental issues through his research, he has also learned a bit about himself. He says that completing an undergraduate project has boosted his confidence and ability to solve problems: "If you give yourself the benefit of the doubt, you'll be surprised what you can accomplish."

Robert's work at Lakehead has opened up many future possible careers. He says that "the courses I have taken at Lakehead have definitely helped spur my interests towards applying sustainable approaches to future development initiatives." One possibility is environmental consulting with communities and local stakeholders to choose scientifically sound ways of planning for the future. "I may also consider applying to Lakehead's Bora Laskin Faculty of Law to pursue a career in environmental law." Robert makes it clear that Lakehead's Environmental Studies program has helped him steer his passion for the environment into a career. ■

Robert Baidoc

Mining and Methylmercury

The environmental consequences of decommissioned mines

Recent economic challenges in western Canada's oil sands have highlighted the need to plan for the eventual decommissioning of all operating mines. The abandonment of mines at the end of their life cycle can expose waterways to contaminants, such as metals from tailings. Sara Mackie wanted to investigate how old iron mining sites might increase the concentration of mercury in the Seine River watershed in Northwestern Ontario. Sara explains that "the iron mines have been closed for many years and the open pits are filling up with water, including runoff from the surrounding tailings. The lakes forming in the open pits are projected to spill over into the watershed, impacting local communities and ecosystems." Because the water in the pits is enriched in sulphates, when it mixes with river water it may increase the concentration of bioavailable methylmercury, leading to its concentration in aquatic organisms in the watershed. This could threaten the health of predators, including humans who eat mercury-contaminated fish. Her results so far indicate that higher concentrations of sulphates from the mine increase methylmercury levels.

Sara Mackie

Sara has always been interested in biology. She says "I love the constantly surprising complexity of living systems and how they can be studied on a diversity of scales, and am attracted to how much is yet unknown about them." She also likes how biology intersects with other science disciplines such as geology, chemistry and environmental studies. Her research project is proof of this.

Doing a hands-on research project appealed to Sara, who returned to university as a mature student. As she says, "the opportunity to learn new skills, participate in important research, and make new network connections has been a valuable experience for my professional and personal growth." Lakehead programs in the Faculty of Science and Environmental Studies focus on students getting experience by "getting their hands dirty". For example, Biology students may choose to do up to 20% of their coursework as one-on-one research projects with faculty members. Developing research skills as an undergraduate gives them an advantage in the next stage of their careers.

Sara encourages students to try a research project as part of their undergraduate experience. Her project gave her an appreciation of how research works in a university and how it overlaps with industry, government and First Nations. She enjoyed doing fieldwork with people from a variety of backgrounds. "My own involvement with a project really gave me a sense of purpose, engagement and community at university that has been really motivating and positive for me personally."

"My own involvement with a project really gave me a sense of purpose, engagement and community at university."

Water Warning

Investigating industry's effects on aquatic health

When pursuing their passion doing environmental research, students at Lakehead Orillia must draw on their own skills and experience. This is certainly the case for Carly Chantler, who changed the focus of her career aspirations since she started pursuing a diploma in Environmental Technology at Georgian College. "After I graduated from college, I knew how to work in the field, but I also wanted to know why environmental changes occurred." She worked as a research intern with Dr. Nanda Kanavillil in partnership with Environment Canada, where she learned that she could transfer directly into the third year of the Environmental Sustainability program at Lakehead Orillia and complete her honours undergraduate degree in only two years.

Her honours thesis project examined the species present in periphyton to assess water quality. Anyone who has swam outdoors or canoed has likely encountered periphyton: it is the "slimy" layer of algae attached to submerged substrates like rocks. Periphyton can absorb contaminants from water and the species present can serve as an "early warning system" of water pollution. Carly collected periphyton from rivers throughout the Lake Simcoe watershed. She explains that she then "analyzed them in our lab. We wanted to identify species within the periphyton community, but we also analyzed nutrients, pH, heterotrophic bacteria, and chlorophyll." So far, she has observed elevated nutrient levels in both the Holland River, which experiences high inputs of nutrients from agricultural fertilizers, and near the outflow of Orillia's wastewater treatment plant. The ultimate goal of her work is to develop more sensitive tests to detect and monitor the effect of industries on the health of Canadian waterways.

"I knew how to work in the field, but I also wanted to know why environmental changes occurred."

Carly Chantler

Carly has always been passionate about the outdoors. "Growing up in a small town, many people look to the outdoors to find hobbies and I was one of those people. I spent the majority of my time outdoors, whether I was cross-country skiing and winter camping in the cold or swimming and boating in the warm weather. I believe this is what struck my interest in the environmental field."

Carly has fond experiences of her research while at Lakehead. "I gained hands-on skills carrying out field sample collection and laboratory analyses." The ability to work with faculty from both campuses and with the federal government has strengthened her resume. "I am looking to find a career where I can continue studying aquatic environments through a mixture of field and laboratory work. The opportunities I have been able to experience at Lakehead have certainly helped me to choose an area of focus for when I move on to start a new career." ■

Aerial Archeology

Using drones for three-dimensional landscape modeling

Jason Stephenson

Jason Stephenson has seen the future of mapping, and it involves drones and computer modeling. As a student in the Anthropology program, he knew that he wanted to do fieldwork that examined human history before written records existed. Although he started his undergraduate career in another program, he found out that archeology courses were offered in Anthropology. "I stumbled upon the Archaeological Field School offered in the spring and summer and I immediately knew that was where I wanted to work."

That hands-on experience whetted his appetite for a research project of his own. He approached Dr. Scott Hamilton with an idea of using drones as a tool for aerial surveying of archeological sites. Jason continues: "More specifically, I wanted to see what the most affordable solution would be so that small archaeology companies can begin to use them in the field." Prior to road work, building construction or other projects that disturb the landscape, the province requires an archeological survey of the site. However, these are time-consuming and expensive. Jason says: "I wanted to bring in something new and innovative that would make it easier to collect topographic and other thematic data. People are always excited to try and find the next big thing, and if you think of something really cool and innovative, it doesn't take too much swaying for people to support you."

When he modeled a riverbank on campus as part of his project, the drones he used attracted curious Lakehead students and faculty. To minimize the chance of losing his drone, Jason says that he did this "over the winter when there was no risk of crashing it into a running river." The results of his project have shown that collecting data using drones will save archeologists time and money and increase the detailed data collected during archeological surveys.

Interest in his project has been strong from both archeologists and other companies. Jason plans to partner with an industry and continue working with Dr. Hamilton for his Master's thesis. Jason is happy with how his program has turned out at Lakehead. "Initially, I wanted to move away, but I knew that I would just be a student number elsewhere. The small class sizes were perfect and I cannot say enough good things about the Anthropology professors here." ■

"If you think of something really cool and innovative, it doesn't take too much swaying for people to support you."

Cuckoo Correlation

Small egg size helps parasites fool their hosts

For the squeamish, parasites may conjure up thoughts of tapeworms and malaria. Some species take advantage of their hosts in more subtle ways. Biology student Katrina Shwedack found out about brood parasitic cuckoos when she took an ornithology course with her future research supervisor, Dr. Janice Hughes. These birds lay their eggs in other birds' nests and rely on them to raise their young. Katrina's hypothesis was that parasitic cuckoos have evolved smaller egg sizes to mimic the eggs of their often much smaller hosts. As she says, "this makes sense because brood parasitic cuckoos are large -or medium-sized birds parasitizing small songbirds. If their eggs are too dissimilar to those of the host, it may reject the eggs or abandon the entire nest."

"Biology has exposed me to a wide variety of fields and has helped me to focus on topics I find most interesting."

Katrina's project was a meta-analysis, which uses statistical methods to extract new meaning and relationships from existing data. This allowed her to combine egg size data from 102 species of cuckoo and several host species and definitively establish a link between their egg size. Her work on cuckoos may allow researchers to better understand how other parasitic invasive species like cowbirds may be causing declines in populations of native songbirds.

Katrina Shwedack

Choosing the Biology program at Lakehead was easy for Katrina. Its broad introduction to biology fit with her desire to learn about the natural world. As she says, "I'm interested in many different topics and taking Biology has exposed me to a wide variety of fields and helped me to focus on topics I find most interesting as I progress through my program."

Working on her project was challenging but rewarding. She says that she especially "enjoyed independently investigating something of interest to me at my own pace." The nature of her project meant that Katrina had to learn many new skills, from statistics and computer modeling to wildlife management and evolutionary theory. The most valuable thing she learned from her project was how much she enjoyed research. She adds, "before my thesis, I was never overly excited about a research-driven career. Now, questions surrounding evolution and ecology are of real interest to me and I found I enjoyed working on this project much more than I had expected." Over the summer she did a research internship at Lakehead focused on the evolution of small mammals. She plans on pursuing a Master's degree in Ecology and Evolution.■

Buckthorn's Bad Behaviour

Monitoring invasive species in Simcoe County

When plants and animals are introduced into a new environment, they may become invasive if they have no predators. Dandelions and Asian carp are well-known examples, but the woody shrub buckthorn is more obscure. Janelle Benallick's research project involved learning more about the distribution of this plant in Simcoe County. Buckthorn was likely introduced to North America from Europe in the 19th Century. Not only does it grow rapidly and is difficult to eradicate, it is poisonous and secretes chemicals from its roots that prevents other plants from competing with it.

Janelle worked to map the distribution of buckthorn at Scout Valley, a nature park west of Orillia. Initially, she says that "most of my work was behind the scenes to do background research on the shrub itself: understanding why it is successful in Canada, mapping its Canadian range, devising strategies to get rid of it, and detailing why getting rid of it is also a problem." She then did field work in Scout Valley, showing that while the shrub was more common at higher elevations, its prevalence did not change with distance from the trail.

"Do what makes you happy, and find a project you want to delve into. It's OK to be nerdy!"

Janelle has always been drawn to nature and been interested in knowing more about forest species. Positive experiences in outdoor education programs in high school led her to register in the Environmental Sustainability program at Lakehead Orillia. The Honours Bachelor of Arts and Science (ENSU) program interested her because, as she says, "I liked that it combined the sciences with the arts and I think it's a good balance. I was actually scared at first to take science classes since I did not do well in them in high school, but it turns out I actually really loved them."

Janelle Benallick

The most valuable part of her project for Janelle was showing herself that she was able to plan and execute a complex project from conception to conclusion. She says that "doing a research project on my own and having the support of my supervisors really helped me to believe that I am capable of completing tasks."

Her project inspired her to seek out other research opportunities, and she completed a subsequent project on water quality at Lakehead as well. She has advice for other students unsure about whether they should do a research project: "Believe in yourself, do what makes you happy, and find a project you want to delve into. It's OK to be nerdy!" ■

Realign and Restore

The effectiveness of habitat remediation for coaster brook trout

For decades, road and railway construction on Lake Superior usually meant diverting the path of intersecting waterways and replacing natural creek beds with straight cement culverts. Unfortunately, this often prevented fish from reaching their spawning grounds, reducing their population and affecting the health of coastal aquatic ecosystems. More sediment was also transported into the lake because it was not filtered out by the creek. Recognizing this, disturbed waterways are being remediated and their natural flow restored. Kara Cox, a student in the Environmental Science (Earth Science) program, was interested in restoring Kama Creek, just east of Nipigon. The Ontario Ministry of Natural Resources initiated the project to replace the existing perched culvert. She explains that "a perched culvert's outlet is significantly higher than that of the water surface downstream. This means that fish moving upstream to spawn have to first jump into and then move through the culvert, thus affecting fish migration." The purpose of her project was to evaluate the effectiveness of the remediation project by determining whether water was leaking back from the restored creek to the old artificial channel and the amount and size of sediment being transported by the stream. Kara explains that "from this data, the intention is to determine if any future work is needed to ensure that the stream remains stable and continues to provide the intended fish habitat." The results of her work will be used to inform future creek remediation projects in Ontario and may thus influence provincial environmental policy.

Kara Cox

Several aspects of her program appealed to Kara. She says that "I enjoy geology but am also very passionate about working to better protect the environment. This seemed to be the best of both worlds." She knew about the hands-on reputation of Lakehead Science and Environmental Studies programs and wanted to pick up field skills that could help her get a job. Finally, she appreciated that her program constitutes the educational portion of membership in the Association of Professional Geoscientists of Ontario, allowing her to bid on jobs after she graduates. The work she did for her research project did not disappoint. As she says, "the opportunity to work in the field independently was a fantastic chance to learn how to set up field-based studies, correctly gather data and hone my skills." Kara plans on entering a Master's program in Environmental Science and says that "being at Lakehead helped me realize what I really enjoy and what I would like to do in terms of a career in the future." ■

"Being at Lakehead helped me realize what I really enjoy and what I would like to do in terms of a career."

“Education is not the filling of a pail, but the lighting of a fire.”

- William Butler Yeats

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