UNIVERSITY OF TORONTO SCARBOROUGH

PHYSICAL & ENVIRONMENTAL SCIENCES

PhD Environmental Science

DESC VII

7th Annual Doctoral Environmental Science Colloquium, UTSC

June 20 – 21, 2024

The 7th Doctoral Environmental Science Colloquium (DESC VII)

June 20th – 21st, 2024

Venue: Catalyst Centre, EV-151,

Environmental Science and Chemistry Building,

1065 Military Trail, Scarborough, ON, M1C 1A4

DESC VII Student Organizing Committee:

Menilek Beyene
Mahendra Doraisami
Yasasi Fernando
Edina Illyes
Nayyer Mirnasl
Dale Moskoff
Akunne Okoli
Ratnajit Saha

Departmental Assistance:

Professor George Arhonditsis
Professor Stuart Livingstone
Elizabeth (Liz) Pulickeel

DESC VII Cover Art Contest Winner:

Yuening Li

Thank you to our keynote speakers, Dr Alexandra Morton and Dr. Andrea Kirkwood for giving their time to present at and attend the DESC VII colloquium and to the students who participated in the Cover Art Competition.

DESC VII Presentation Competition Categories:

Applied Science and Technology

Environmental Social Sciences

Experimental and Theoretical Science

Lightening round

Speaker evaluation form:

https://forms.gle/aDsEGssa5wnDM1dj8

DESC VII Schedule

Day 1: June 20th, 2024 (Thursday), 8:00 AM – 5:00 PM
Location: EV151 (UTSC)

TIME	SPECIFICATION	
08:00 – 09:00	**BREAKFAST**	
09:00 – 09:15	**Welcome Speech by Chair**	
09:15 – 11:15	**EXPERIMENTAL AND THEORETICAL SCIENCE**	
	Chaired by Ratnajit Saha & Yasasi Fernando	
	Presenter	**Supervisor and Co-Supervisor**
09:15 – 09:30	Nigarsan Kokilathasan	Maria Dittrich
09:30 – 09:45	Joe Kawalec	Peter Molnar
09:45 – 10:00	Diwen Yang	Hui Peng
10:00 – 10:15	Gloria H.Y. Gao	Myrna Simpson
10:15 – 10:30	**BREAK**	
10:30 – 10:45	Sarah Gigi	Carl Mitchell
10:45 – 11:00	Salwa Hajir	Myrna Simpson
11:00 – 11:15	Xiaoqing Shao	Maria Dittrich
11:15 – 12:00	**Ayesha Usman** (Student Learning and Professional Development Coordinator, DPES) will present on "Navigating Future Careers: Updates on WIL (Work Integrated Learning) and Professional Development for DPES PhD Students", followed by Q&A session. ***Zoom Meeting ID: 826 8172 4474***	
12:00 – 01:00	**LUNCH BREAK (Location: EV 140)**	
12:00 – 01:00	**POSTER PRESENTATIONS (Applied Science and Technology; Experimental and Theoretical Science)** *Note: Posters will be set up for both days, but speakers will be judged during this time and must be present near their respective posters.*	
01:00 – 02:00	**Keynote Speaker: *Dr. Alexandra Morton*** **Presentation and Q&A session *Zoom Meeting ID: 826 8172 4474***	
02:00 – 02:15	**BREAK**	
02:15 – 02:45	**EXPERIMENTAL AND THEORETICAL SCIENCE**	
	Chaired by Dale Moskoff & Mahendra Doraisami	
	Presenter	**Supervisor and Co-Supervisor**
02:15 – 02:30	Patricia Semcesen	Mathew Wells
02:30 – 02:45	Franklin Perez	Ruby Sullan
02:45 – 03:30	**ENVIRONMENTAL SOCIAL SCIENCE**	
	Chaired by Dale Moskoff & Mahendra Doraisami	
	Presenter	**Supervisor and Co-Supervisor**

02:45 – 03:00	Ichha Kaur Kohli	Laura Tozer
03:00– 03:15	Raul Salas Reyes	William Gough
03:15– 03:30	Siobhan Courtney Bonisteel	Daniel Bender
03:30 – 03:45	**BREAK**	
03:45 – 04:30	**LIGHTENING ROUND (ALL 3 CATEGORIES)**	
	Chaired by Professor Stuart Livingstone	
	Presenter	**Supervisor and Co-Supervisor**
	Dale Moskoff	Nicholas E. Mandrak
	Emmanuel Taiwo	Laura Tozer
	Shabnam Majnooni	Irena Creed and George Arhonditsis
	Janean Sharkey	Scott MacIvor
	Nayyer Mirnasl	Irena Creed and George Arhonditsis
04:30 - 04:45	**Day 1 highlights and day 2 activities; Adjourn**	

Day 2: June 21st, 2024 (Friday) from 8:00 AM – 5:00 PM
Location: EV151 (UTSC)

TIME	SPECIFICATION	
08:00 – 09:00	**BREAKFAST**	
09:00 – 11:00	**APPLIED SCIENCE AND TECHNOLOGY**	
	Chaired by Edina Illyes & Akunne Okoli	
	Presenter	**Supervisor and Co-Supervisor**
09:00 – 09:15	Coreen Daley	Elyse Caron-Beaudoin
09:15 – 09:30	Aisha Javed	George Arhonditsis
09:30 – 09:45	Adarshana Thapa	Marney Isaac
09:45 – 10:00	Syed Bukhari	Nick Eyles
10:00 – 10:15	Ratnajit Saha	George Arhonditsis
10:15 – 10:30	Phillip Ruscica	George Arhonditsis and Heidi Daxberger
10:30 – 10:45	Mahendra Doraisami	Adam Martin
10:45 – 11:00	**BREAK**	
11:00 – 12:00	**Keynote Speaker: *Dr. Andrea Kirkwood*** **Presentation and Q&A session *Zoom Meeting ID: 872 9970 6843***	
12:00 – 01:00	**LUNCH BREAK (Location: EV 140)**	
12:00 – 01:30	**POSTER PRESENTATIONS (Applied Science and Technology; Experimental and Theoretical Science)** *Note: Posters will be set up for both days, but speakers will be judged during this time and must be present near their respective posters.*	
01:30 – 02:30	**APPLIED SCIENCE AND TECHNOLOGY**	
	Chaired by Nayyer Mirnasl & Menilek Beyene	
	Presenter	**Supervisor and Co-Supervisor**
01:30 – 01:45	Yasasi Fernando	George Arhonditsis
01:45 – 02:00	Erik K. Dean	Nicholas E. Mandrak and Andrew R. Drake
02:00 – 02:15	Vincent Moxley-Paquette	Andre Simpson
02:15 – 02:30	Lamees Shah	George Arhonditsis
02:30 – 02:45	**BREAK**	
02:45 – 03:45	**APPLIED SCIENCE AND TECHNOLOGY**	
	Chaired by Nayyer Mirnasl & Menilek Beyene	
	Presenter	**Supervisor and Co-Supervisor**
02:45 – 03:00	Rosen Chang	George Arhonditsis
03:00 – 03:15	Justin Hubbard	Nicholas E. Mandrak and Andrew R. Drake
03:15 – 03:30	Akunne Okoli	George Arhonditsis

03:30 – 03:45	Menilek Sisay Beyene	Marc Cadotte
03:45 – 04:15	**BREAK**	
04:15 – 05:00	**Presentation of awards and closing remarks**	
~ 06:00 PM	**Social 7 – Bar & Grill (360 Old Kingston Rd, Scarborough, ON M1C 1B6)**	

Keynote Speakers

Dr. Alexandra Morton

Dr. Alexandra Morton is a dedicated field biologist and an activist, renowned for her groundbreaking research unveiling the detrimental effects of salmon farming in the ocean along the British Columbia coast. Her journey began with studying the communication patterns in bottlenosed dolphins, which later transitioned into the analysis of sounds produced by captive orcas at California's Marineland of the Pacific. Here, she experienced the cycle of life firsthand, witnessing the birth and subsequent death of the first orca conceived in captivity. Her focus has since expanded to include researching and communicating the harmful impact of industrial aquaculture from open ocean farm pens of Atlantic salmon into the migration routes of wild Pacific salmon and the entire ecosystem of the coast. Often referred to as "Canada's Jane Goodall," Dr. Alexandra Morton has devoted over three decades of her life to the passionate pursuit of preserving British Columbia's wild salmon, leveraging her science, the legal system, and activism.

Amongst many of her remarkable contributions to the field of aquatic science, Dr. Morton published a comprehensive report titled "Salmon Confidential: The ugly truth about Canada's open-net salmon farms" which exposes various issues resulting from salmon farming such as sea lice, the effect on lobster fisheries, bio-security challenges, salmon viruses, foreign species, and the local economy. A documentary film based on the report was recognized as the Best Canadian Environmental Documentary at the 2013 Vancouver International Film Festival.

She is the Director of the Pacific Coast Wild Salmon Society, and the founder of Lore Quest (renamed Raincoast Research Society) and Salmon Coast Society, which has provided tremendous support for a number of field workers and scientists. Dr. Morton has won many environmental awards including being granted a Doctor of Science, honoris causa by Simon Fraser University, for her research into the impact of farm salmon sea lice and viruses. She is a national best-seller author and has pioneered and co-authored more than twenty scientific papers on the impact of salmon farming on migratory salmon. Her relentless fight and environmental advocacy are inspiring and serve not only as a testament to her dedication but also as a guide for those who wish to follow in her footsteps. Her work and commitment are a beacon of hope for environmental conservation.

Title of Talk: When Humans Become a Force *With* Nature
Dr. Morton's presentation is scheduled for 01:00 PM on June 20th and on Zoom Meeting ID: 826 8172 4474

Dr. Andrea Kirkwood

Dr. Andrea Kirkwood is an Associate Professor at Ontario Tech University with a research focus in environmental biology. Her Master's research was conducted in lakes near Dorset, Ontario, and focused on mercury bioaccumulation in aquatic food webs. She then shifted gears to pursue a doctoral degree at the University of Toronto in Environmental Microbiology where she investigated the role of cyanobacteria in pulp and paper waste-treatment systems and conducted field research in Idaho, USA, and Rotorua, New Zealand. Following the completion of postdoctoral fellowships at Oklahoma State University and the University of Calgary, Dr. Kirkwood joined the faculty at Ontario Tech University, where she teaches courses in environmental biology and leads a dynamic research lab in aquatic ecology. Dr. Kirkwood has been recognized with numerous awards, including University Research Excellence Chair in Urban Water. Her lab focuses on the ecology of ponds, wetlands, rivers, lakes, and wastewater systems, with an additional focus on the biotechnological applications of algae for biofuel production, carbon sequestration, and wastewater treatment. Dr. Kirkwood is passionate about equity, diversity, and inclusion in academia. Committed to community engagement and education, Dr. Kirkwood frequently collaborates with various stakeholders for her research. The Kirkwood Lab partners and collaborates with Michi Saagiig (Mississauga Anishinaabeg), including Scugog Island First Nation and Curve Lake First Nation.

Title of talk: Urban Waters: Understanding the Diversity and Function of Aquatic Ecosystems where Most People Live.

Dr. Kirkwood's presentation is scheduled for 11:00 AM on June 21st and on Zoom Meeting ID: 872 9970 6843

Student Presentations

Day 1 (June 20): Oral Presentations

Cell Surface Properties of Freshwater and Marine Cyanobacteria under the Presence of Polystyrene Nanoplastics

Nigarsan Kokilathasan and Maria Dittrich
Year: PhD 3rd
Research Category: Experimental and Theoretical Science

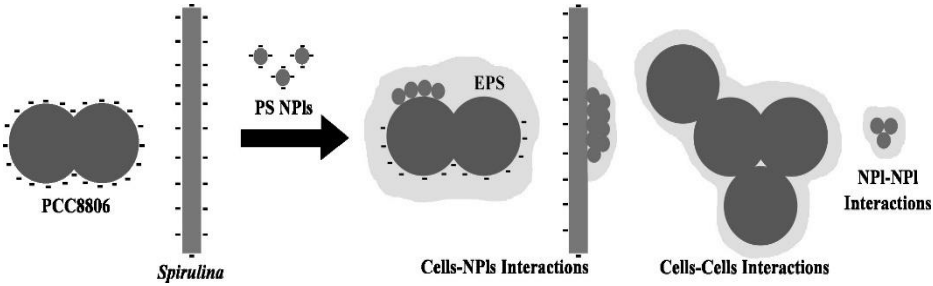


Figure Caption: Schematic illustration of the surface interactions between (pico)cyanobacteria and PS NPls.

Plastic debris can be degraded in aquatic environments to form nano-sized plastic particles or nanoplastics (NPls). NPls are defined as plastic particles less than 1 ¬µm in size. Within aquatic environments, degradation processes and environmental factors determine the size, surface charge, and reactivity of NPls. As the outer cell surfaces of most freshwater and marine cyanobacteria are negatively charged, there is the potential for electrostatic interactions between NPls and cell surfaces to occur. Picocyanobacteria and cyanobacteria are among the most prominent primary producers in freshwater and marine environments; picocyanobacteria genus Synechococcus contributes to ~20% of total primary production in marine systems. The cyanobacterium genus Spirulina is an essential source of algal biomass for industrial and commercial applications. Despite their importance, the impacts of NPls on (pico)cyanobacterial physiology and cell surface properties remain understudied. We investigated the effects of polystyrene (PS) NPls at environmentally relevant concentrations on cell growth, morphology, and surface properties of marine and freshwater strains of Synechococcus and Spirulina. When exposed to PS NPls, cell growth, morphology, and ultrastructure were not altered significantly despite observations of cell-NPl interactions and changes in (pico)cyanobacterial surface

charges. These observations were attributed to the aggregation of NPls and secretion of extracellular polymeric substances (EPS); under NPl exposure, EPS was observed at higher concentrations. Studying the impacts of NPls on cell surface properties can provide insights into the physiological and ecological functions that Synechococcus and Spirulina contribute to aquatic environments.

Tracking Host-Parasite Dynamics across Environmental and Human Use Gradients in a National Urban Park

Joe Kawalec and Peter Molnar

Year: PhD 3rd

Research Category: Experimental and Theoretical Science

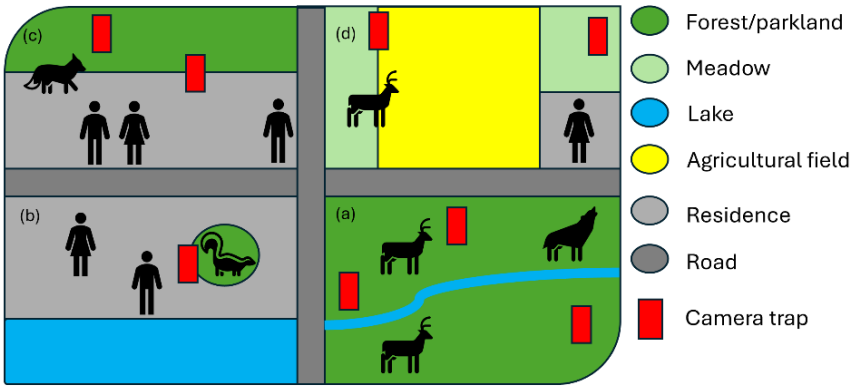


Figure Caption: Due to encroaching development, landscapes that once supported large, natural populations are now mosaics of remnant forests (a), urbanized areas with small parklands (b), residential areas with larger parklands (c), and agricultural fields (d), for example. Wildlife species that inhabit these landscapes contend with habitat fragmentation, barriers to movement, novel sources of mortality, and anthropogenic noise. While the overall carrying capacity of the ecosystem is reduced due to these factors of human use areas, patches of green space and near-urban habitats can still be suitable to a variety of generalist species. Distributing camera traps across these habitats can help elucidate wildlife distribution and habitat use on modified landscapes.

Humanity has been transforming natural habitats into complex, modified landscapes for thousands of years. Urbanization is associated with human fragmentation, but patches of urban green spaces can still be used as suitable habitat by many species. Environmental "mosaics" of developed and natural features display environmental and human use gradients as one moves from heavily disturbed urban centers to surrounding, near-urban areas. I am particularly interested in these transitional zones, as studying them can reveal how the distribution and habitat use of wildlife changes accordingly. For instance, the influence of landscape structure on disease transmission is generally poorly understood, both empirically and theoretically. To unravel the environmental, landscape and human use characteristics that shape wildlife-parasite

dynamics in near-urban landscapes, Rouge National Urban Park (NUP) with its complex mosaic of forests, meadows, and agricultural and human use areas - is ideally suited as a study area. Focusing on mammals that inhabit near-urban environments, the objectives of my research are to assess (i) their spatial distribution and habitat use, (ii) their activity patterns and temporal overlap, and (iii) the distribution and prevalence of their parasites. To do this, I have worked with Parks Canada to obtain a sampling permit for a 3-year study that distributes 100 camera traps across the southern portion of Rouge NUP, and I will collect scat samples near these camera traps to identify their parasites. Together, these studies will fill knowledge gaps regarding the use of Rouge NUP varying landscapes by the mammalian community and resulting wildlife health dynamics.

High-throughput affinity selection-mass spectrometry reveals binding spectrum of ToxCast chemicals to FABPs

Diwen Yang and Hui Peng
Year: PhD 2nd
Research Category: Experimental and Theoretical Science

Advancements in high-resolution mass spectrometry-based nontargeted analysis have led to the identification of a diverse array of environmental chemicals with potential adverse effects on human health and ecosystems. Toxicology in the 21st Century (Tox21), a U.S. federal research collaboration program, applies high-throughput screening (HTS) assays to detect potential toxicants from environmental pollutants. However, these methods lack robustness for proteome-wide screening due to unavailable bioassays for many proteins and the absence of individual chemical standards, as most chemicals are detected in mixtures. Therefore, we developed an affinity selection-mass spectrometry (ASMS) method to find environmental ligands binding to human proteins. Eight purified His-tagged proteins and their positive control compounds were used to benchmark the ASMS assay. All positive control compounds were mixed with 500 compounds to create compound pools and incubated with the individual proteins. The protein-ligand complex was isolated from the chemical mixture by affinity selection, and the isolated ligands were further analyzed using an LC-Orbitrap mass spectrometer. The compounds with significantly higher peak intensities in the protein target group compared to negative controls were considered detected ligands. The robustness, selectivity, and sensitivity of this new assay were validated based on the results. Human fatty acid-binding proteins (FABPs) are essential proteins distributed in different tissues at high concentrations, e.g., liver, intestine, and brain. These proteins have been studied to be targeted by many environmental toxicants, such as per- and polyfluoroalkyl substances (PFAS). The US EPA's Toxicity Forecaster (ToxCast) program has compiled different categories of environmental pollutants. We aimed to determine new ligands binding to FABPs from the ToxCast chemical library using our newly developed ASMS assay. Nine new ligands

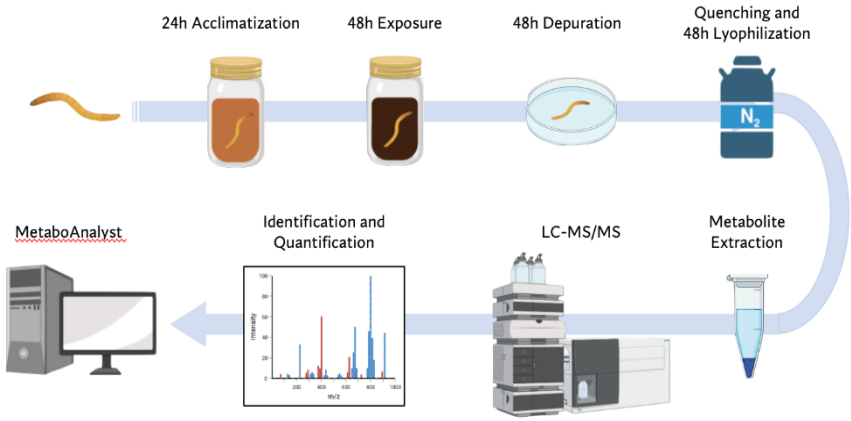
of liver-FABP were discovered, and their interactions were further validated using a fluorescence displacement bioassay. These new compounds are structurally different from previously known ligands, which suggests they may cause different adverse health effects. Further study is needed to elucidate the contribution of the protein-ligand interaction to the potential accumulation of these pollutants in the liver and their toxicities. Therefore, our ASMS platform presents an opportunity for comprehensive proteome-wide screening of potential ligands binding to human proteins, offering preliminary insights for further in vivo environmental toxicity studies.

Assessment of the metabolic perturbations with exposure to N-(1,3-dimethylbutyl)-N-phenyl-p-phenylenediamine (6PPD) in *Eisenia fetida* earthworms

Gloria H.Y. Gao, Suzie Reichman, and Myrna Simpson

Year: PhD 2nd

Research Category: Experimental and Theoretical Science



Tire wear particles are a pervasive form of microplastics in the environment, produced from the abrasion between vehicle tires and road surfaces. Leachates from tire wear particles can introduce pollutants into the environment. One compound that has been detected in multiple environmental matrices is N-(1,3-dimethylbutyl)-N-phenyl-p-phenylenediamine (6PPD), an additive that is ubiquitously used in tire to increase product lifetime. Since most tire wear particle emissions are deposited in soil, 6PPD may leach out and pose a potential risk to soil organisms. We studied the acute toxicity of 6PPD on earthworms (*Eisenia fetida)* by investigating both traditional toxicity and molecular-level endpoints. The acute median lethal concentration (LC50) was 693 Œºg/g, following a 14-day exposure period. Targeted mass spectrometry-based metabolomics was employed to measure the metabolic responses of earthworms

exposed for 48h to five 6PPD concentrations (0.12, 1.2, 12, 120, and 1,200 Œºg/g). At the highest concentration, multivariate analysis showed that changes to the metabolic profile of earthworms were statistically significant (p = 0.006) compared to the unexposed group. Furthermore, normalized concentrations of alanine, which has been reported as universal bioindicator of oxidative stress, were significantly upregulated with high concentrations of 6PPD exposure. Biochemical pathway analyses revealed disruptions to protein synthesis, amino acid metabolism, and energy metabolism. No metabolites were significantly perturbed after exposure to 6PPD concentrations 0.12-120 Œºg/g, compared to the control (p > 0.05). Given the high octanol-water partition coefficient of 6PPD (log KOW = 4.47), soil sorption may have reduced the bioavailability and impact of 6PPD on earthworms. This study demonstrates that acute metabolomics yield results that are concurrent with LC50 findings and is valuable to elucidate molecular-level perturbations of pollutants in soil organisms.

Water Chemistry and Mercury Profiles of Canadian High Arctic Sea and Lake Ice Cores

Sarah Gigi and Carl Mitchell

Year: Master 1st

Research Category: Experimental and Theoretical Science

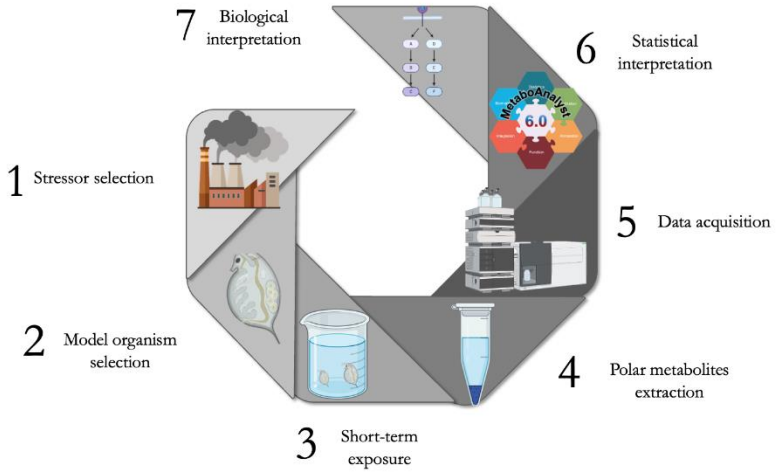
The Canadian High Arctic is being disproportionately affected by climate change, with for example, enormous contemporary losses of multi-year sea ice. These dramatic changes affect arctic marine, aquatic and terrestrial ecosystems as well as people and wildlife living in or around these areas. Before coastal, multi-year sea ice is entirely lost, it is important to better understand whether the biogeochemistry varies significantly between multi-year (MYI) and first-year sea ice (FYI). This study therefore examined major ion concentrations, water stable isotope measurements, and dissolved organic matter in two sea ice cores (FYI and MYI) and one freshwater lake ice (FWI) core from the northernmost place in Canada Alert, on the northern tip of Ellesmere Island. Water isotope measurements tell us about the different years in the ice cores and they better our understanding of melting patterns in the ice. The ion concentrations were as expected for the sea ice - with sodium and chloride levels being quite high and in similar ratios. Total mercury depth profiles were created for MYI, FYI, and FWI. These profiles showed highest concentrations in MYI, middling concentrations in FYI and lowest concentrations in FWI. These differences are relatively small and may be related to small-scale spatial variability with sampling. Overall, the results from this study will discuss how the effects of the climate driven shift from multi-year to first-year sea ice will impact net methylmercury production and bioaccumulation in local marine food webs.

Metabolomics identified early molecular responses after exposure to phenanthrene and its oxygen and nitrogen containing analogues on *Daphnia magna*

Salwa Hajir and Myrna Simpson

Year: PhD 3rd

Research Category: Experimental and Theoretical Science



The prevalence of polycyclic aromatic hydrocarbons and their oxygenated and nitrogen containing analogues in freshwater ecosystems are of concern due to their reported toxicity to several aquatic species including *Daphnia magna*. The aim of this study was to explore the mode of action of phenanthrene (PHEN), 9,10-phenanthrene quinone (PHQ), and phenanthridine (PN) as little is known about the molecular-level impairments, especially at low levels. For this purpose, *D. magna* was exposed to three sub-lethal levels of pollutants for 24 h. To assess biochemical responses, 52 polar metabolites were extracted from individual adult daphnids, and analyzed using a mass spectrometry-based targeted metabolomics approach. Changes in the normalized metabolite concentrations revealed up and down regulation with respect to the control group for all pollutants. PN exposure resulted in the most statistically significant changes to metabolite concentrations across all applied sub-lethal levels. Moreover, PN exposure responses where non-monotonic across exposure concentrations, whereas monotonic responses were observed for PHEN and PHQ. Biochemical pathway analysis for PN showed that all exposure concentrations had the same perturbed metabolic pathways. However, the number of perturbed pathways increased with increasing exposure concentrations for PHEN and PHQ. The results suggest that PN, and PHQ are more disruptive due to the presence of reactive functional groups when compared to PHEN. The findings of this study indicate that the

sub-lethal mode of action of PN was equally disruptive across all applied levels; however, for PHEN and PHQ, the mode of action was concentration dependent. Although the reported median effective concentration for PN is higher than PHEN and PHQ, our data shows that metabolomics captures molecular-level changes that may not be detected by traditional toxicity metrics.

The impact of phosphorus level on vivianite precipitation during microbial reduction of ferrihydrite

Xiaoqing Shao and Maria Dittrich
Year: PhD 4th
Research Category: Experimental and Theoretical Science

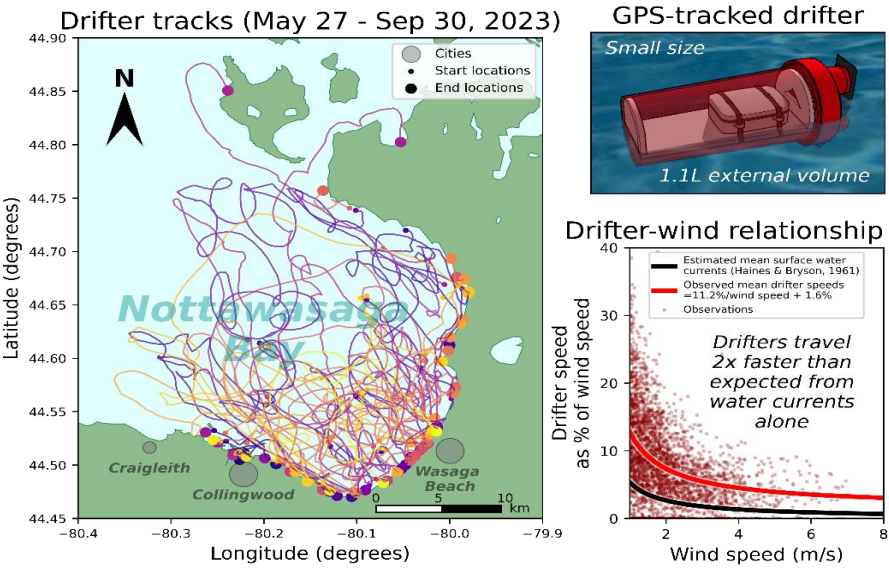
Iron minerals play a pervasive role in the cycling of phosphorus (P) within both terrestrial and aquatic environments. The behavior of P, especially in oxygen-depleted environments, is frequently regulated by changing redox conditions and the associated phase transformations of iron (Fe) oxyhydroxides. Although the research on the stability of Fe oxyhydroxides under changing redox conditions is well established, the relationship between specific iron mineral geochemistry, its microbial transformation to Fe-P minerals, and the resulting impact on P sequestration remains unclear. To better understand the biogeochemical mechanisms behind these interactions, we examined the effects of P concentrations on the reduction of ferrihydrite ($Fe_2O_3 \cdot 0.5H_2O$) by *Shewanella putrefaciens CN32* and the resulting vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$) formation. In this study, bio-reduction experiments were conducted under sterile conditions in serum bottles. Dissolved Fe (II), P concentrations, pH, and optical density (OD) values throughout the experiments were also measured. Our results showed that during incubation, ferrihydrite become crystalline and vivianite principate in the treatment involving Fe, phosphate and bacteria. Scanning electron microscopy analyses of precipitates showed well-formed and highly crystalline vivianite particles under high P level conditions. Some crystalline precipitates were confirmed as vivianite through X-ray diffractometry and Raman microscopy matching the vivianite standard reference. Dead bacterial cells can also facilitate iron reduction and induce vivianite formation. However, high phosphate concentrations can cover minerals, significantly reducing the possibility of electron transfer required for these processes. Based on our results, P concentrations and microbial conditions do indeed have a pronounced effect on the transformation of ferrihydrite to vivianite.

GPS-tracking of buoyant plastic bottles in Nottawasaga Bay, Lake Huron

Patricia Semcesen and Mathew Wells

Year: PhD 6th+

Research Category: Experimental and Theoretical Science



To safeguard the near-pristine waters of Lake Huron Georgian Bay from plastic pollution, Georgian Bay Forever began the Tagging Trash Trips project which utilized GPS-tracked bottle-drifters to understand where and how water currents transport floating plastic pollution in Nottawasaga Bay (dimensions 27 km x 40 km), part of Georgian Bay in Lake Huron. Nottawasaga Bay, provides drinking water to local municipalities, and is a travel destination for over 1.5 million visitors annually who inevitably produce plastic pollution that enters Georgian Bay. To understand how water currents transport plastic pollution, and to inform the prioritization of limited plastic pollution remediation resources, GPS-trackers were fitted in plastic bottles and released throughout Nottawasaga Bay. A total of 71 drifter datasets were collected in 8 rounds of deployments from May through September 2023. We learned that most drifters entering Nottawasaga Bay were retained and had travelled tens of kilometers before reaching shore within several days. An apparent near-shore water current transported 2 drifters out of northern Nottawasaga Bay this demonstrated that plastic pollution can be quickly transported into rocky areas of Georgian bay, facilitating plastic fragmentation, and reducing cleanup feasibility. An animation of observed drifter tracks can be viewed via: https://youtu.be/HVGTaywbXU8. Due to drifters being half-submerged in the water, drifters directly interacted with winds and

demonstrated wind-dependent transport which contributed to drifters travelling on average twice as fast as would be expected from water currents alone. The use of drifters allowed us to identify spatial patterns of transport and accumulation to inform conservation efforts.

Nanoplastic resistant bacterial biofertilizers for sustainable agriculture
Franklin Perez and Ruby Sullan
Year: PhD 4th
Research Category: Experimental and Theoretical Science

In a shift towards more sustainable agriculture, the use of pesticides and fertilizers are increasingly being phased out for more eco-friendly alternatives such as bacterial biofertilizers. However, large-scale application requires a need to understand the fertility of bacteria in soils tainted with hazardous contaminants such as nanoplastic. In this context, the goal of my research is to understand the implications of nanoplastic-bacteria interactions to improve the use of bacteria as biofertilizers. Atomic force microscopy is used for nanoscale characterizations on bacterial membranes and electron microscopy is used to discover protective mechanisms against nanoplastic toxicity. Nanoplastics have differential impacts towards bacterial biofilm formation on plant roots depending on nanoplastic functional groups and bacterial species. For Gram-positive bacteria, vesicle-like corona formation is a protective response towards positively charged nanoplastic whereas for Gram-negative bacteria, vesiculation and tubulation are prominent. These results could potentially be used to design bacteria which are more resistant to nanoplastics in agricultural soils.

Approaches to Equity in the 100 Resilient Cities Initiative
Ichha Kaur Kohli and Laura Tozer
Year: PhD 4th
Research Category: Environmental Social Science

The Rockefeller Foundation launched the 100 Resilient Cities initiative to support cities globally to address environmental and socio-economic challenges and create more sustainable cities. As part of this initiative, member cities were supported in creating Resilience Strategies that prioritized local resilience and its intersection with equity. This study will draw on a coding scheme that was developed to evaluate cities,
Resilience Strategies, from which twelve key action areas were identified and used to categorize policy actions in plans. An analysis of all strategies will be completed to understand how equity indicators were approached by member cities to identify common or important action areas and may draw on an analysis of how cities are approaching equity based on factors such as geographic location, size, or capital. This

analysis will be translated into a practical framework to guide cities on how to undertake and evaluate local resilience planning. By drawing on the analysis of equity indicators, key areas of action and approaches will be synthesized to provide an assessment of how-to best approach equity initiatives in resilience planning, also drawing on best examples of cities doing this work well and filling in gaps where equity planning may be falling short. A case study on the City of Toronto will follow to illustrate how this framework can be usefully applied to both analyze and inform local resilience planning, identifying indicators that would also be needed to further assess these equity action areas.

On the contested compliance of CBDRRC and the erosion of trust
Raul Salas Reyes, Nicole Klenk, and William Gough
Year: PhD 6th+
Research Category: Environmental Social Science

Trust is necessary to ensure international cooperation between nation-states who negotiate responses to address the causes and effects of climate change. Signs of an erosion of trust have been perceived during the Paris Agreement negotiations. Yet, it is unclear how and why trust started to erode. Interviews with twenty-two climate negotiators indicate that a contested compliance with CBDRRC is resulting in an erosion of trust in line with issues of reliance, responsibility, reciprocity, and recognition. Such issues include a perceived lack of compliance for the provisions of finance and other forms of support, lack of progress in reflecting highest possible ambition in the implementation of NDCs, and challenges in increasing resilience and addressing loss and damage. An erosion of trust from a contested compliance with organising principles has significant implications for climate negotiations, including those on the transition away from fossil fuels.

Building Community Food Strategies: supporting food insecure communities while engaging in environmental stewardship through community food strategy development in the communities of Melvern and Scarborough Ontario Canada
Siobhan Courtney Bonisteel and Daniel Bender
Year: PhD 3rd
Research Category: Environmental Social Science

Siobhan Bonisteel research explores community food strategies used to address food insecurity and environmental stewardship in the non-profit sector. The focus is on the community of Melvern and Scarborough Ontario. Conventional agriculture contributes significantly to climate change including agriculture emitting more than 24% of global emissions, while simultaneously climate change exacerbates food insecurity. Localized sustainable food systems are an antidote to this negative loop. Non-profit

organizations such as food banks and community garden are on the frontlines of community responses to food insecurity and climate change adaptation while using food as an eco-social transformational tool. The Canadian government has highlighted the non-profit sector as crucial for realizing the government's aims for a national food strategy, but while the non-profit sector overall plays a critical role in Canada's transition towards sustainability, they face significant challenges. This research explores the elements required for non-profits to create impactful local food strategies which focus on their capacity to produce fresh, sustainable food in meaningful ways mainly for those in need. This work analyses a completed food strategy from the Centre for Immigrant & Community Services (CICS) in Scarborough. Literature review, interviews, surveys and data gathered from a community symposium is used to identify the short and long-term needs of these organizations. The goal is to create a roadmap that will help organizations vision, develop, and implement their food strategies to enhance food security and environmental sustainability. On a broader scale this research will contribute to the national food strategy of Canada and align with the UN Sustainable Development Goals.

Day 1 (June 20): Lightning Round Presentations

Addressing Limitations of Using Index of Area of Occupancy to Improve the Outcomes of Species at Risk in Canada
Dale Moskoff and Nicholas E. Mandrak
Year: PhD 1st
Research Category: Applied Science and Technology (Lightning Round)

Index of Area of Occupancy (IAO) is an index of occupied habitat applicable to Canadian federal extinction risk assessments as both a measure of spatial distribution and as a proxy for population size. IAO is calculated as the sum of the area of 2 km x 2 km grids overlayed on occurrence points for a species. The standard 2 km x 2 km grid unit may not reflect the actual area occupied by species with diverse home range sizes and shapes and can result in inaccurate IAO measurements that are poor predictors of population size. Therefore, extinction risk assessments based on IAO measures can be inaccurate and reduce the efficacy of conservation priority setting. My research suggests alternative units for measuring IAO that may more accurately reflect the area occupied by species compared to standard 2 km x 2 km grid. I present a method of unit selection using taxon-specific allometric predictions of home range size. These biologically relevant units placed around occurrence points for a species may represent a precise IAO index effective for estimating abundance. The effect of unit size on IAO outcomes will be accounted for by scaling IAO extinction risk thresholds so that thresholds group species by comparable extinction risk. This strategy will be

immediately applicable to improve the accuracy of species extinction risk assessments in Canada.

Investigating Community Energy Justice in Toronto
Emmanuel Taiwo and Laura Tozer
Year: PhD 1st
Research Category: Environmental Social Science (Lightning Round)

This talk will explore energy justice, a critical part of broader climate justice debates, and also propose a community-based approach for applying and operationalizing energy justice in the City of Toronto, Ontario. It will highlight the need for low-carbon, climate-positive innovations in energy transitions, but also the inequity and injustice outcomes that result from these transitions, while outlining some key conceptual frameworks in scientific literature underpinning justice and equity in energy transitions. It will explore existing literature on energy injustices in Ontario, highlight major findings and limitations of such studies, and ultimately propose a uniquely community-oriented approach to investigating energy injustices in Toronto. In doing so, it will underscore key rationale for why community-centred approaches matter and are critical for generating insights that traditional energy justice approaches may not uncover. Thereafter, it will outline a proposed four-part approach to investigating energy injustices in Toronto's marginalized, disadvantaged and underserved communities, in four chapters. These include, namely: a systematic review; the barriers driving energy inequities in Toronto's marginalized communities; the role of intermediary actor-advocates; and the effect of multi-level governance in shaping energy justice outcomes in these Torontonian communities.

Investigating Eutrophication and Regime Shifts Across Canadian Lakes
Shabnam Majnooni, George B. Arhonditsis, and Irena Creed
Year: PhD 1st
Research Category: Applied Science and Technology (Lightning Round)

Lakes and reservoirs play a crucial role in providing numerous benefits and ecosystem services to humans (Sterner et al., 2020). Despite their crucial value, freshwater ecosystems face numerous challenges, putting them among highly threatened ecosystems (Vari et al., 2022; Green et al., 2015). The global increase in phytoplankton biomass and lake algal blooms poses a significant threat to aquatic ecosystems (Hou et al., 2022; Smith, 2016; Ansari et al., 2011). Especially, Certain bloom-forming algal species known as harmful algal blooms (HABs) can produce toxins harmful to humans and animals (Grattan et al., 2016). Recent research indicates that the problem is expected to worsen under global warming and intensification of hydrological cycles due to climate change (Favot et al., 2023; Havens and Jeppesen, 2018; Paerl and

Huisman, 2009; Persaud et al., 2015). Canada, boasting over a million lakes, faces escalating algal blooms (Pick, 2016; Rashidi et al., 2021). Due to its location, Canada's warming rate is double the global average (Cohen et al., 2020). Additionally, the rising bloom frequency signals potential regime shifts, warranting further study (Zhang et al., 2018). As my PhD research, I am aiming to explore the change in magnitude and frequency of algal blooms, among other characteristics, using satellite-derived time series of chlorophyll-a as a proxy of phytoplankton biomass. Further, I am aiming to investigate potential drivers of changes using prior machine learning models and to develop a new AI-based model for predicting regime shifts in lakes.

Effects of land management practices and multi-species interactions on wild bee communities in rare alvar habitat on Pelee Island, Ontario, Canada

Janean Sharkey, Marc Cadotte, and Scott MacIvor

Year: PhD 2nd

Research Category: Experimental and Theoretical Science (Lightning Round)

Located in southwestern Ontario, Pelee Island is the most southern populated point in Canada. Its warm microclimate and unique biogeography make it a desired location for tourism, and agricultural land use, but it is also an important area for biodiversity, containing globally rare grassland alvar habitat. Alvars are disturbance mediated ecosystems, requiring disturbance such as fire, drought, or flooding to prevent encroachment of woody, and invasive species for native plant communities to persist. The alvar habitat on Pelee Island is home to many provincially and nationally rare species of plants and animals. and it is likely an important area for wild bees. Wild bees contribute millions of dollars to Canada economy annually by providing pollination services to agricultural crops, as well as to flowering plants that are essential to maintaining healthy ecosystems. The bee community of Pelee Island has never been sampled before and bee communities in alvar habitats are poorly known, therefore even in areas like southern Ontario there is potential to find new species occurrence records or even undescribed species. As well, some groups such as bumble bees, (*Bombus* spp.), are experiencing clear trends of decline both globally and in North America. Approximately 20% of Ontario bumble bee species are now considered species at risk. The reasons for this are complex but may be due to a combination of environmental stressors such as habitat loss, agrochemical use, disease, competition from non-native species, and climate change. Therefore, there is a lack of knowledge about the impacts of land management on bees in these habitats. Pelee Island presents a unique opportunity to study multi-species interactions and land management impacts on wild bee communities. The overall aim of this research is to inform management and conservation efforts of imperiled alvar habitat as well as contribute to information about the effects of urbanization on multi-species interactions in North America.

Characterizing Carbon Dynamics of Wetlands in Lake Erie Basin

Nayyer Mirnasl, George B. Arhonditsis, and Irena Creed

Year: PhD 1st

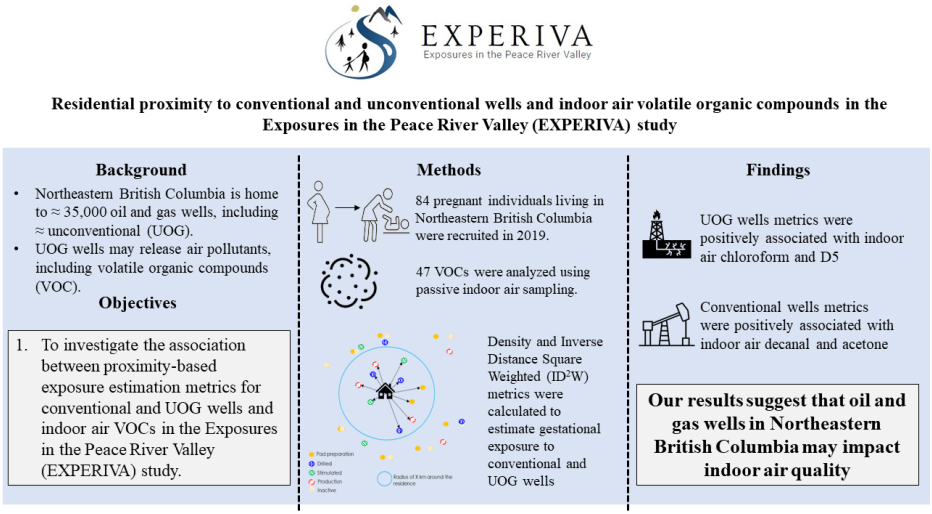
Research Category: Applied Science and Technology (Lightning Round)

Wetlands, ecosystems characterized by saturated soils and specialized biota, are distributed across diverse climates and continents, excluding Antarctica. Occupying less than 8% of the terrestrial land surface, they are globally recognized for their crucial role in regulating biogeochemical cycles. Due to their high productivity and slow decomposition rates, wetlands possess the highest soil carbon density among terrestrial ecosystems while also serving as the primary source of methane emissions into the atmosphere. When interconnected with surface water flow, wetlands transport carbon in both dissolved and particulate organic forms to adjacent water bodies. A considerable portion of the organic material discharged from wetlands eventually reaches the oceans, with estimates indicating that around 15% of terrestrial organic matter flux to marine environments originates from wetlands. Since the lateral transfer of carbon through the aquatic system plays a significant role in the overall dynamics of terrestrial ecosystems, my research focuses on studying the lateral flow of organic carbon from wetlands. The main objectives of my research are: (i) to develop models for estimating the rates of dissolved organic and inorganic carbon accumulation and transport to and from wetlands to downstream waters, and (ii) to formulate models for predicting the potential of wetlands for organic carbon sequestration.

Day 2 (June 21): Oral Presentations

Residential proximity to conventional and unconventional wells and indoor air volatile organic compounds in the Exposures in the Peace River Valley (EXPERIVA) study

Coreen Daley and Elyse Caron-Beaudoin
Year: PhD 3rd
Research Category: Applied Science and Technology



<u>Background:</u> Northeastern British Columbia represents one of Canada, key regions that produce natural gas using techniques such as hydraulic fracturing.
<u>Objective:</u> To investigate the associations between proximity-based metrics for conventional and unconventional wells and measured indoor air VOC concentrations in the Exposures in the Peace River Valley (EXPERIVA) study samples.
<u>Methods:</u> Passive indoor air samplers were analyzed for 47 measured VOCs. Oil and gas well legacy data were sourced from the British Columbia Energy Regulator. For each participants home, 5 km, 10 km and no buffer distances were delineated, then density and Inverse Distance Square Weighted (ID2W) metrics were calculated to estimate exposure to conventional and unconventional wells during pregnancy and the VOC measurement period. Multiple linear regression models were used to test for associations between the well exposure metrics and indoor air VOCs. For exposure metrics with >30% participants having a value of 0, we dichotomized exposure (0 vs. >0) and performed ANOVAs to assess differences in mean VOCs concentrations.

Results: Analyses indicated that: 1) conventional well density and ID2W metrics were positively associated with indoor air acetone and decanal; 2) unconventional well density and ID2W metrics were positively associated with indoor air chloroform and decamethylcyclopentasiloxane, and negatively associated with decanal; 3) drilling specific ID2W metrics for unconventional wells were positively associated with indoor air chloroform.
Conclusion: Our analysis revealed that the association between the exposure metrics and indoor air acetone could be attributed to conventional wells and indoor air chloroform and decamethylcyclopentasiloxane could be attributed to unconventional wells.

The prospectors' ice stream landsystem model: a case example from Finland Central Lake District

Syed Bukhari, Nick Eyles, Roger C. Paulen, and Niko Putkinen
Year: PhD 2nd
Research Category: Applied Science and Technology

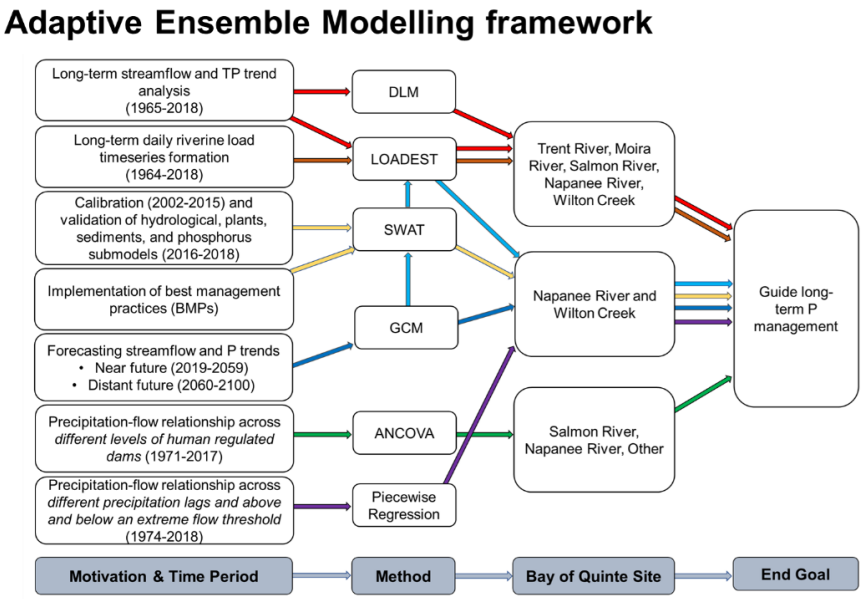
Rapidly evolving digital mapping technologies have resulted in a renewed understanding of ancient and modern ice-sheet beds and their glaciological structure, in particular the presence of fast-flowing ice streams where ice-flow velocities may have been as high as 10 km/yr within the Laurentide and Scandinavian ice sheets. New work using LiDAR to map the beds of former ice streams reveals a distinct internal structure consisting of multiple sub-ice flow units based on the identification of multiple en echelon flow sets of mega-scale glacial lineations (MSGLs). LiDAR data is also used to determine crucial information regarding the presence and origins of hybrid palimpsest beds resulting from phases of fast flow that were superimposed on the Last Glacial Maximum or older surfaces that hitherto have been poorly documented. Till sampling surveys conducted without this contextual information about the nature of former ice-flow dynamics and, in crucially, the presence or absence of fast-flowing ice are of limited value. This study integrates high-resolution LiDAR digital topographic data from various parts of central Finland to develop a composite 'Prospectors' ice stream' landsystem model to contextualize and guide mineral exploration programs. This process is akin to facies modelling that relates surface forms to underlying genetically related sediment types, which has been particularly useful in understanding complex depositional systems left behind by former ice sheets in a range of settings. This approach is already being applied to determine the mineral potential of lithium-bearing pegmatites in Finland, a glaciated bed very similar to that of the Canadian Shield.

Evaluating the effectiveness of best management practices in mitigating phosphorus export

Aisha Javed and George B. Arhonditsis

Year: PhD 6th +

Research Category: Applied Science and Technology



Empirical evidence and modelling predictions suggest that the interplay between inflowing nutrient loads and circulation patterns of the Napanee River and Wilton Creek shapes the local biogeochemical processes, thereby modulating the severity of eutrophication in the picturesque Bay of Quinte (BoQ) receiving waterbody. In attempt to assist in guiding the long-term phosphorus management strategy in the BoQ and other similar agriculturally dominated areas, the objective of our research has been to apply Soil and Water Assessment Tool (SWAT) and evaluate the effectiveness of popular Best Management Practices (BMPs) in the case study watersheds. Our analysis shows that while the implementation of rotations and cover crops results in the greatest reduction in particulate phosphorus export (>30%), the implementation of vegetative filter strips result in the most reduction (>15%) for the soluble form of phosphorus. Nonetheless, our BMP assessment suggests that the greatest reduction for both low and high flow conditions and for both soluble reactive and particulate phosphorus occur when the BMPs scenarios are combined. Future projections suggest that the effectiveness of these combination of BMPs decreases relative to the assessed

present period, thereby highlighting the need for an adaptive modelling framework that can be used to assess alternative BMP scenarios in light of more current state of knowledge.

The impact of agroecological transition on soil quality: Evidence from natural farming systems in central India.

Adarshana Thapa and Marney Isaac

Year: PhD 3rd

Research Category: Applied Science and Technology

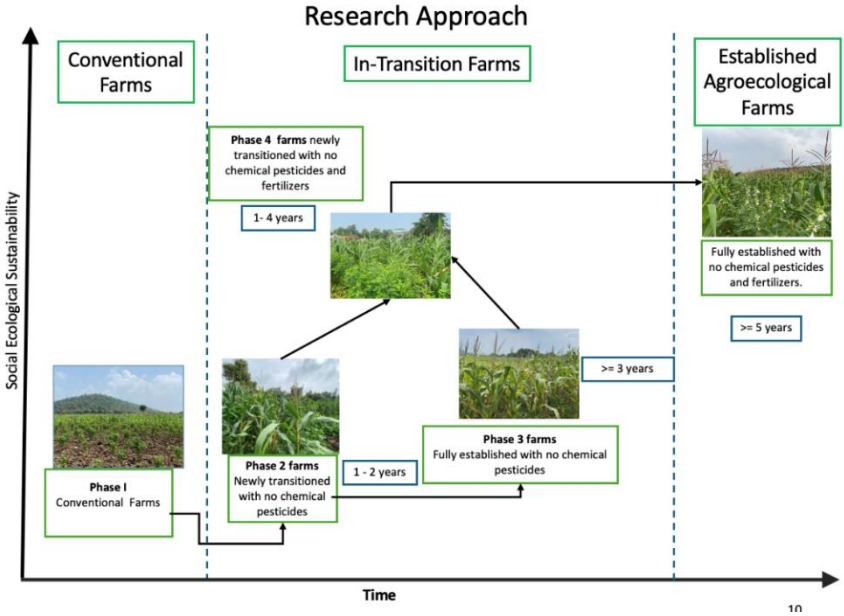


Figure 1. The thesis study design categorizes farmers across a transition gradient into different phases: Phase 1 represents conventional/chemical farmers using all types of chemical pesticides. Phase 2 includes farmers who stopped using chemical pesticides but have been using fertilizers with bio-inputs for up to two years. Phase 3 includes farmers who have stopped using chemical pesticides but have been using chemical fertilizers together with bio-inputs for three years or more. Phase 4 includes farmers who have stopped using chemical pesticides and fertilizers but have been using bio-inputs for up to four years. Phase 5 includes farmers who have not used chemical pesticides and fertilisers but have been using bio-inputs for five years or more.

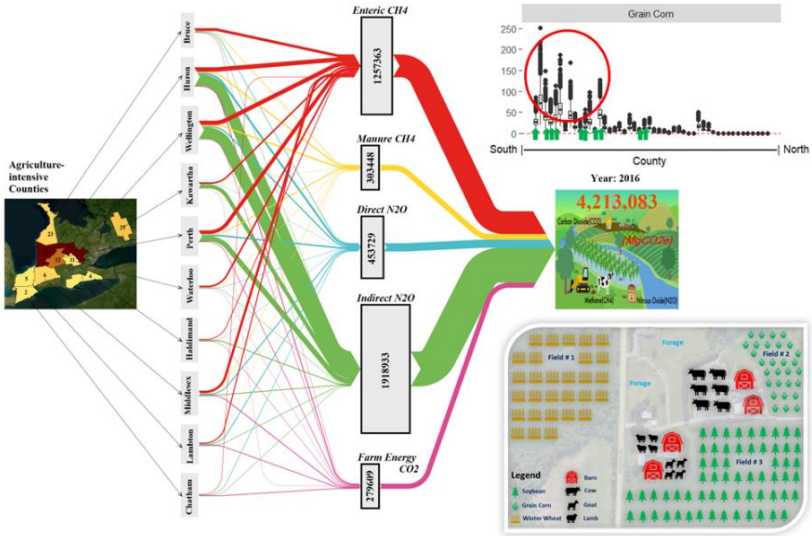
The scale and intensity of current agricultural practices have severe implications on ecological processes. When combined with external factors such as climate change, global pandemics, and the growing demand for sustainable diets, there arises a need for transformative sustainable agricultural methods. Agroecology and natural farming apply ecological principles to manage agroecosystems, improving social-ecological outcomes and meeting these requirements. Transforming conventional farm systems into more sustainable ones necessitates an agroecological transitional with multiple potential pathways, including replacing chemical inputs with bio-inputs or biological processes. To bridge the knowledge gap regarding the effects of transitioning to agroecological systems on soil quality, we measured multi-year soil quality parameters on farms at various phases of transitioning to natural farming in central India. These phases include conventional, newly transitioned with no chemical pesticides, fully established with no chemical pesticides, newly transitioned with no chemical pesticides and fertilizers, and fully established with no chemical pesticides and fertilizers. Results indicate that fully established natural farms exhibit improved soil quality outcomes. Specifically, these farms have higher soil organic matter, total soil nitrogen, total soil carbon, and active carbon compared to conventional farms. Soil microbial abundance and composition differ significantly among the transitional phases, highlighting strong management effects on soil functioning. Understanding soil quality changes along various pathways is essential for farmers shifting to agroecological practices and provides actionable soil health assessments that are crucial for policymaking and farm management, underlining the practical implications of our research. It also motivates even the most risk-averse farmers to undertake agroecological transitions.

Land use changes and agricultural impacts on GHG emissions in a changing climate in Ontario, Canada

Ratnajit Saha and George B. Arhonditsis

Year: PhD 4th

Research Category: Applied Science and Technology



Agricultural practice is a significant contributor to greenhouse gas (GHG) emissions, and knowledge of spatial and temporal agriculture trends in Ontario is essential to extending these practices to ensure food security. Canada has committed to the Paris Agreement to reduce GHG emissions by 30% below 2005 levels by 2030 and achieve net zero by 2050. The study aims to investigate the change in agricultural land use and its impact on GHG emissions in a changing climate in Ontario, Canada. Bayesian statistical models were used to detect significant changes in cropland and livestock. HOLOS (version 4.0), an empirical farm-scale model, was used to calculate GHG emissions in a virtual farm. Over the last seven decades, cropland areas have been extended mostly in southern and western Ontario. We found a temporal increasing trend for major crops (like soybeans) and a decreasing trend for hay per county, along with significant variability in livestock trends across Ontario. Large live-weight animals emitted the highest amount of GHG, and considering the number of livestock on the farm, the order of animals contributing GHG was Sheep > Cow-Calf > Crop > Hog > Poultry. Agriculture-intensive counties emitted 110,472 to 1,060,425 $MgCO_2e$ (42 to 383 $MgCO_2e.km^{-2}$) in 2016. County-specific total and emissions.Km^{-2} increased by 5.3% to 34.6% $MgCO_2e$ and 5.0% to 25.7% $MgCO_2e.km^{-2}$, respectively, from 2001 to 2016.

The study findings will contribute to provincial and national agricultural strategies to achieve net zero carbon emissions and help develop nature-based solutions for a carbon-smart ecosystem.

Next Generation Data Interactions: Reimagining Academic Workflows in Environmental Science with Virtual Reality

Phillip Ruscica, Heidi Daxberger, and George B. Arhonditsis

Year: PhD 2nd

Research Category: Applied Science and Technology

Virtual Reality (VR) is a technology which allows for the immersive exploration of three-dimensional digital worlds. Environmental sciences prevalence of three-dimensional phenomena provides a prime opportunity to visualize or analyze information, communicate research results, and facilitate educational experiences. These digital worlds can be constructed to dynamically illustrate datasets in their original context, while simultaneously traversing through space or time. VR flexibility in setting, natural interactions, and the ability to display simulated systems produces great deal of potential for science communication. However, this potential has been touted for more than fifty years, but VR has not changed our daily interactions with data. The language around VR is chaotic, there is a lack of structure for reporting results, and computing power has limited the complexity of applications. So, what has changed now? Advances in computing power, supportive development tools, and affordable mainstream hardware have made VR more accessible and powerful than

ever before. Yet, how do we as environmental scientists integrate it into our research, teaching, and outreach? My thesis investigates the effective utilization of VR for environmental science applications within the following three stages of academia: (i) data exploration and hypothesis creation, (ii) result analysis and communication, and (iii) summarizing knowledge into educational content. Each stage will serve as an example for VR integration while also being used to communicate overlooked and challenging topics such as uncertainty, risk, changes over time or scale, and multi-dimensional analysis to a wide audience of researchers, students, stakeholders, policymakers, and the public.

The importance of the volatile carbon fraction in estimating deadwood carbon stocks in temperate forests

Mahendra Doraisami, G.M. Domke, S.C.Thomas, and A.R. Martin

Year: PhD 4th

Research Category: Applied Science and Technology

Coarse woody debris (CWD) is an important component of forest carbon (C) cycling, accounting for ~8% of total forest biomass C globally. However, CWD quantities are projected to increase in coming decades due to increased tree mortality. Consequently, accurate estimates of C stocks and fluxes in CWD are becoming more essential in refining global C budgets. My research aims to quantify variation in two wood chemical traits, wood carbon fractions and wood volatile C fractions, by integrating intensive field sampling of CWD stocks in a large (13.5 ha) forest dynamics plot in central Ontario, with novel characterization of wood chemical traits. In 2021-23, I measured size-, decay- and spatial-related attributes of 3,821 CWD pieces from 3,210 trees, across 15 tree species. Additionally, wood samples were extracted from ~400 CWD pieces across two tissues, for wood chemical trait quantification. Based on a preliminary analysis of 192 CWD samples, my results show that 1) wood C fractions across CWD average 53.8% and vary widely across species; 2) mean volatile C fractions are highest in early stages of wood decay; and 3) mean C fractions are higher in bark compared to stems, though 4) stem tissue maintains a higher volatile C fraction. Both total wood C and the volatile C fraction in CWD vary across species, indicating that wood chemical trait variation within and among trees is a critical determinant of ecosystem functioning, even after tree death.

Understanding the Interactions between Cladophora, Dreissenid Mussels, and Phytoplankton in Lake Ontario: A 0-D (Box-Model) Approach

Yasasi Fernando, Alexey Neumann, and George B. Arhonditsis

Year: PhD 3rd

Research Category: Applied Science and Technology

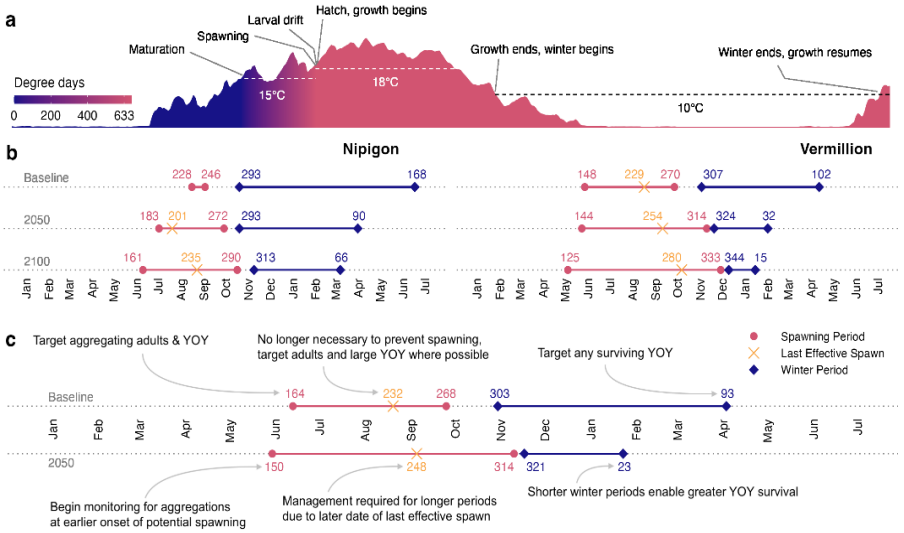
Cladophora glomerata is a filamentous green alga that has proliferated in the rocky nearshore zone of eastern Lake Erie and several locations in Lake Ontario since the mid-1990s, leading to extensive fouling of local beaches with decaying organic material. Cladophora blooms are influenced by several factors, including nutrient loading, light availability, and the presence of dreissenid mussels, thus requiring a more granular approach to modelling its growth and impacts. Our analysis presents the preliminary findings from a comprehensive sensitivity and uncertainty analysis focused on the interplay among bioavailable phosphorus, and three interacting modules for plankton, dreissenids, and Cladophora, within the nearshore zones of Lake Ontario. While these sub models have been studied individually, evaluation of the range of dynamics they can collectively produce has been limited. Based on our results, we revisited the existing parameterization and input specifications to accurately reflect the nearshore, small-scale processes within the Lake Ontario ecosystem. Our study clearly identifies and addresses several knowledge gaps and outstanding questions to improve our understanding of the system. We identify areas where data collection efforts are needed and ways to maximize the value of information from monitoring in the nearshore of Lake Ontario, ultimately contributing to the effective management of Cladophora proliferation in Lake Ontario.

Overwintering under climate change how juvenile survival could allow Bighead Carp to invade

Erik K. Dean, Nicholas E. Mandrak, and Andrew R. Drake

Year: PhD 6th +

Research Category: Applied Science and Technology

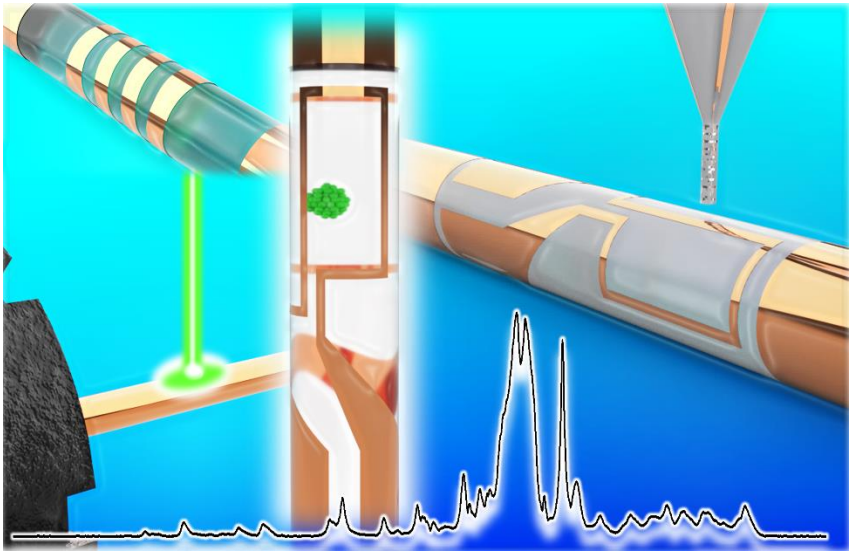


Young-of-year fish (age-0) need to store enough energy to endure starvation over winter, but have limited capacity to do so because of their small size. As a result, colder climates at northern latitudes can impose population bottlenecks by inducing mortality for this critical life stage. Such conditions can also influence the northern range limits of invasive species; however, warming temperatures anticipated under climate change could eliminate such bottlenecks and increase the potential for invasion. Bighead Carp threatens to expand northward and invade the Laurentian Great Lakes, but it is unclear how its young-of-year might contend with northern winter conditions, or how they may be affected by climate change over time. We explored how overwinter survival of young-of-year Bighead Carp could be affected by climate change by modelling the onset and duration of potential spawning activity, periods of growth, and overwinter starvation for young-of-year fish. Our results indicate that warming could enable young-of-year to acquire more energy while also reducing the amount they need to survive over winter, by creating opportunities for greater growth before the onset of winter and reducing the duration of overwinter starvation. Climate change could also increase both the performance of Bighead Carp and the management effort necessary to curb invasion overall, primarily by widening the window for spawning activity, and enabling overwinter survival at latitudes where previously impossible. Because young-of-year Bighead Carp and their subsequent life

stage (age-1) are highly influential to population performance, warming conditions facilitating overwinter survival could significantly influence the potential for invasion.

CNC Laser Etching vs. CNC Micro-milling: A Comparison of Methods for 3D Volume Microcoil Production

Vincent Moxley-Paquette and Andre Simpson
Year: PhD 6th+
Research Category: Applied Science and Technology



The enhanced filling factor and mass sensitivity provided by NMR microcoil technology allows for the analysis of small mass-limited biological samples, including *Daphnia magna* eggs and some types of cells. Recently, 5-axis CNC micromilling was demonstrated to be an excellent tool for prototyping custom NMR microcoil technology that can be tailored to various mass-limited samples. However, this technique lacks the precision required for machining complex 3D volume microcoils (i.e. solenoids and saddle coils). To counter this, a high-precision Elara 4-axis CNC milling machine was developed alongside a MiRA7L 5-axis CNC machine (outfitted with a Passat UV picosecond Laser). Here, the performance of three complex 3D volume microcoil designs (machined from copper-coated Acrylic rods using the ELARA 4-axis CNC milling machine) will be evaluated using a series of standards (150mM Sodium Acetate and 208mM 13C-labelled D-glucose). In addition, the performance of a micro-solenoid and a micro-saddle coil (etched from Cu-coated Glass capillaries using the

gentler MiRA7L) will be evaluated using a mass-limited biological sample in addition to an extract of a biological sample.

Modelling vegetation in managed systems in southern Ontario with the ecosys model

Lamees Shah and George B. Arhonditsis

Year: PhD 2nd

Research Category: Applied Science and Technology

Eutrophication is an ongoing problem in waterbodies all around the world. In Ontario, management practices that increase vegetative presence on agricultural fields such as cover crops have been recommended as a strategy to control non-point source pollution to the receiving water. Mechanistic models are proposed as useful ways to test the practices in a site, given the wide range of factors to consider for implementation, complementary management, and context-specific characteristics. Cover crops as any plant may change the physical, chemical, and biological environment for the next crop, or also for the current crop if seeded before harvest of that crop. These changes can shift nutrient fate and transport if they impact nutrient release and water dynamics, as well as plant growth and litter turnover. Therefore, it is crucial not to forsake the biological component of the cycles. Using available climate, topography, soil, and management data of a range of fields in southern Ontario, we implement a field-scale mechanistic model called ecosys and explore the model capability to represent common crop rotations and thus the ability to test the diversified practice in the area.

Beyond Phosphorus: Integrating Nitrogen Dynamics into Watershed Modeling for Mitigating Algal Blooms in the Bay of Quinte

Rosen Chang and George B. Arhonditsis

Year: Master 2nd

Research Category: Applied Science and Technology

The Bay of Quinte is a long narrow bay located on the northeastern shore of Lake Ontario, Canada. However, this popular tourist destination has been subjected to a long history of eutrophication characterized by the presence of algal blooms due to high nutrient export from upstream watersheds. Past modelling work has attempted to investigate the mechanisms and drivers of long-term phosphorus export in the area. By focusing on phosphorus export, past work has completely overlooked the role of nitrogen, which may play an important role in the proliferation and production of harmful algal blooms. This study aims to bridge this knowledge gap by characterizing the nitrogen cycle using a pre-existing hydrological, sediment and phosphorus model for the Soil and Water Assessment Tool (SWAT), of the Napanee River and Wilton

Creek watersheds of the Bay of Quinte. SWAT was calibrated for 2002-2015 and validated for 2016-2018 using observed daily streamflow and Load ESTimator (LOADEST) regression model outputs for the observed daily nitrogen (TN, NO2, NO3, NH4) loads. Results illustrate how SWAT can be applied to identify areas of high nitrogen export and to compare these exports with phosphorus to understand its impact on the N:P stoichiometry of the Bay. Further, the effectiveness of different cover crops and riparian buffers as best management practices will be assessed in mitigating nitrogen export for improved water quality conditions of the Bay.

Parameterizing quantitative climate-match analyses for screening-level risk assessment of non-native freshwater fishes

Justin Hubbard, Andrew R. Drake, and Nicholas E. Mandrak

Year: PhD 4th

Research Category: Applied Science and Technology

Climate match measures the similarity of the climates between where a species occurs in nature and a non-native region where the species may become introduced, providing an estimate of species survival in the area of introduction. Climate matching is an important component of biological risk assessments, which are used to inform the risk management of species and pathways. Climate change will affect invasive species' survival in introduced regions and should be incorporated into screening risk assessments. Survival estimates from climate matching are impacted by the climate variables, spatial scale (i.e., the size and delineation of the source and recipient regions), and the species occurrence data used in the assessments. I present the software package Euclimatch, published in the R programming language with the Comprehensive R Archive Network (CRAN). The package provides data-agnostic tools for climate matching with any climate or species occurrence records, and spatial data, and can incorporate climate change projections. Several case studies of invasive freshwater fishes are used to demonstrate climate matching with the Euclimatch package. Further, I conducted a structured assessment of the climate variables and spatial scale used in climate matching using a dataset of species introductions with known outcomes using classification tree analysis. This research will inform a screening-level assessment of freshwater species in the aquarium, water garden, and live-food trades in Canada and other risk assessments of aquatic invasive species.

Towards Long-term Nutrient Management: Spatiotemporal Dynamics of Total Phosphorus in the Canadian Side of Lake Erie Basin

Akunne Okoli , Odai Al Balasmeh, Alex Neumann, and George B. Arhonditsis

Year: PhD 4th

Research Category: Applied Science and Technology

Managing nutrient load in Lake Erie is central to the ongoing binational agreement between the United States and Canada to mitigate the negative effects of eutrophication and enhance the overall water quality and ecosystem health. In line with this, a comprehensive understanding of spatiotemporal patterns of tributary phosphorus (P) is crucial to track the effectiveness of current nutrient reduction programs, monitor progress, and inform future watershed management policy. In this study, we present a quantitative assessment of the nonpoint source tributary phosphorus load and its associated uncertainties in the Canadian side of the Lake Erie basin. Utilizing daily phosphorus and flow datasets from the existing network of tributary water quality monitoring stations and stream gauges, spanning 22 water years (2000-2021), we apply different load estimation methods to subbasins of gauged and ungagged locations. We then using self-organizing map analysis – a novel artificial neural network algorithm – to classify monitored watersheds based on their physiographic characteristics into several clusters and investigate the main factors driving variability in total P concentration within each cluster. The anticipated findings from this study are expected to offer valuable insights to help guide actions toward developing long-term watershed management plans.

The effects initial planting diversity and management on urban forests and wetland restoration outcomes

Menilek Sisay Beyene and Marc Cadotte

Year: PhD 4th

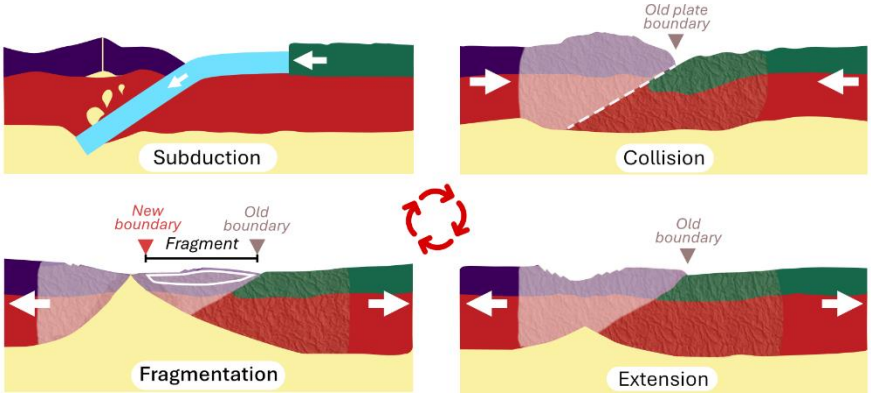
Research Category: Applied Science and Technology

Restoration of human-degraded environments is critical to returning the beneficial functions of ecosystems. A primary effort to counteract anthropogenic disturbances of natural systems is the reintroduction of species assemblages and assisted reestablishment of vegetation. However, a greater understanding of the role of biodiversity of the plantings and their relative importance to outcomes is critical to informing restoration practitioners. We aimed to determine planting diversity's and composition's effect on survival and health in planted trees and shrubs. Observed biodiversity-ecosystem functioning relationships suggest that increases in diversity will correspond with increases in community productivity. This is due to either selection for species suitable to environmental conditions or a complimentary usage of space and resources due to differences in fitness-relevant traits. Additionally, the role of herbivory, invasive species, human disturbance, and surrounding urban land use was

investigated for their influence on species suitability, and whether management by practitioners (i.e., fencing, invasive species removal, signage) reduces their impacts. Restoration outcomes were assessed using visual ordered scoring of planted vegetation, natural regeneration, invasive species presence, browsing presence, and human disturbance components. Initial results demonstrate that urban land uses negatively influence restoration outcomes, while diversity shows limited influence on restoration outcomes compared to planting composition. This may be due to the time frame of restoration assessments, which range from 1 ‚Äì 5 years after planting. Interestingly, diversity influences browsing pressure and invasive species presence scores, suggesting an important indirect impact on restoration outcomes and informing restoration planting practices.

Days 1 & 2 (June 20-21): Poster Presentations

A recipe for continental fragment formation: big data analysis of rift models
Alan Yu and Phil Heron
Year: Master 1st
Research Category: Applied Science and Technology (Poster Presentation)



Ancient plate boundaries (sutures) are often considered the locations for future plate breakup, but exceptions exist. For example, plate extension in passive margins can create a continental fragment microplate displaced from its principal tectonic plate and stranded on another plate as a terrane. Notable examples include the Nain Province of Eastern Canada, the Lewisian Complex of Northwestern Scotland, and the São Luís and São Francisco cratons of Eastern South America, among others. Despite

the prevalence of dispersed fragments and stranded terranes in the geological record, the underlying processes leading to their formation remain poorly understood. Previous geodynamic models have indicated that strength heterogeneities inherited from old tectonic events play a major role in driving the initiation of continental breakup. However, most of these studies have primarily focused on the styles of rifted margins, with limited attention given to fragment formation. In this study, we conducted 148 numerical 2-D models of rifting, featuring various inherited structures with the potential to create new continental fragments. Our models demonstrate the first-order impact of structural inheritance on rifting and fragment formation. Here, the size of the isolated fragment is controlled by the extent and geometry of the inherited structures and deformation. Using automated processing of rift models and detection of fragments, our models provide a range of physical constraints for the formation mechanisms. Most importantly, they highlight the potential role of different forms of inheritance in controlling deformation within complex tectonic plate margins.

Soil carbon dynamics in urban and peri-urban agriculture

Umma Farhana Khushi and Marney Isaac

Year: PhD 1st

Research Category: Experimental and Theoretical Science (Poster Presentation)

With a rising interest in local food, urban and peri-urban agriculture (UPA), which refers to the production of food and other products in and around cities, is becoming popular. In addition to strengthening food security, UPA has also been suggested to reduce GHGs through direct (e.g., soil management, urban agroforestry) and indirect (e.g., reduced food miles, avoided land conversion) pathways. Although several studies have been made in recent years, Canadian UPA systems lack data on GHG emissions and their controlling factors. In my PhD research, I will determine the impact of various factors such as soil organic C (SOC), soil N, and amendments on soil CO_2 efflux in a suite of urban and peri-urban farms (classified using surrounding plant cover parameters) of different ages of establishment in the Greater Toronto Area (GTA). To quantify soil C dynamics, soil CO_2 emissions in-situ will be measured using LI-6800-09 closed chamber system, and sources of soil CO_2 will be measured with a Picarro G2131-I isotope and gas concentration analyzer. The SOC and N will be measured in laboratory using a muffle furnace (through , loss on ignition) and an elemental analyzer (LECO, St. Joseph, MI, USA), respectively. From this, I will describe various sources of variation (urban versus peri-urban and age of establishment) on C storage and GHG emissions. The findings of my research will contribute advances in quantifying urban and peri-urban agriculture's potential to mitigate GHG emissions across Canada.

Investigating the interplay between soil history and plant type diversity on plant growth

Haider Alsafar and Terrence Bell

Year: PhD 1st

Research Category: Applied Science and Technology (Poster Presentation)

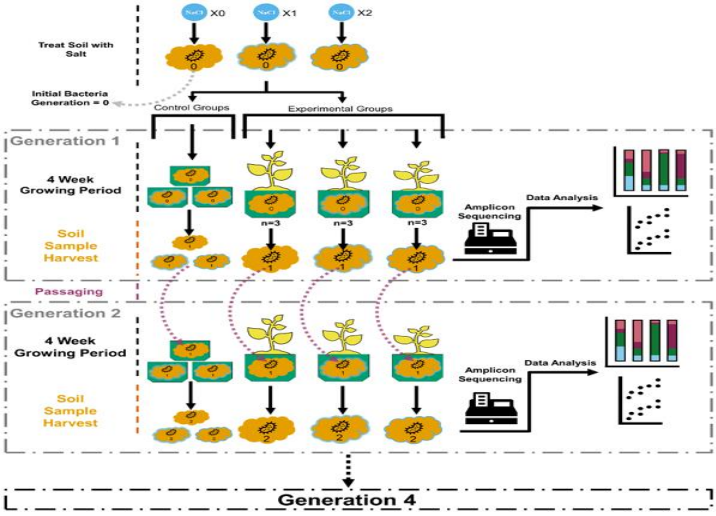


Figure: Main Diagram detailing project flow. Where n=3 represents replicates and will be conducted on multiple plant types over several 4-week growing generations.

Historical soil conditions can shape the current phenotypes of plants. Many plant-influencing soil features are shaped by the environment through time, including soil nutrient content, pH, and biotic composition. One key feature is soil microbial composition, which is shaped jointly by plants (e.g. through root exudation and litter deposits) and other environmental pressures. Insomuch as soil microbes can influence plant productivity. A previous study of native grassland plants from near Toronto, ON, showed that each plant type recruited a specific microbial assemblage. Other studies have shown that microbial selection by environmental regimes also influence downstream plant success. In this study, we seek to understand the relative impact of microbial conditioning under different environmental regimes and plant types, to determine which matters most in shaping plant growth and competition. We hypothesized that microbial conditioning under an environmental stressor (Salt vs. No Salt) would have a larger impact on plant growth than conditioning under particular plant species. We are selecting microbial assemblages over four passaging generations, with or without the addition of NaCl, and in the presence of a variety of native Ontario grassland plants. After passaging, selected microbiomes will be transplanted across different environmental regimes used in conditioning to assess

plant responses, in terms of both growth and plant-plant interactions. We will also be collecting microbial compositional data to assess the extent of divergence of microbiomes under each environmental regime. The data generated by this study will highlight the importance of short-term microbiome conditioning on plant success in natural ecosystems.

Spatial distribution of earthquakes at different depth in Western Quebec Seismic Zone

Janvi Patel and Phil Heron

Year: Master 1st

Research Category: Applied Science and Technology (Poster Presentation)

Western Quebec experiences many earthquakes each year in an area known as the Western Quebec Seismic Zone (WQSZ). As the region is located in the Grenville Province far from current plate tectonic boundaries, the earthquakes are known as intraplate events. WQSZ experiences earthquakes of mostly low to medium size magnitude and is close to the large cities of Ottawa and Montreal. Previous studies have found that these earthquakes are linked to different tectonic layers of the crust (Ma & Atkinson, 2006). Specifically, the earthquakes were shown to demonstrate different spatial patterns at shallow, middle, and deep crustal depths (Ma and Eaton,

2007). Given the high urban area of the WQSZ, it is important to see if such theories on earthquake stratification with crustal depth are still valid with recent earthquake datasets. Here, I explore the spatial distribution of the earthquakes in three depth layers shallow (depth < 8 km), midcrustal (8 km depth, 17 km), and deep (depth > 17 km) with recent data to better understand the complex seismic environment of intraplate earthquakes far from active plate boundaries.

Assessing the composition and function of soil microbial colonizers after long-term nitrogen deposition

Kara Reardon and Terrence Bell

Year: PhD 1st

Research Category: Applied Science and Technology (Poster Presentation)

Humans have massively altered nitrogen inputs to terrestrial landscapes through atmospheric deposition and fertilizers. This perpetual input pressure may lead to local conditioning of soil microorganisms, with unknown impacts on microbial function regulation of ecosystem services (e.g. promoting plant health; cycling nutrients). In this study, we leverage microbial traps to assess the impact of long-term nitrogen deposition on dispersing pools of soil microorganisms. The Jasper Ridge Biological Preserve contains plots that were treated with combinations of nitrogen, raised temperature, watering, or increased CO2 from 1998-2016. To test the legacy of these treatments on potentially active microorganisms, I have deployed microbial traps in the topsoil of each of these plots, which consist of nylon bags filled with sterile soil. Half of these were treated with nitrogen to determine whether long-term nitrogen addition leads to local enrichment of microbial types that can colonize high nitrogen soils. After three months in the field, I will extract DNA from traps, and perform 16S rRNA gene and fungal ITS sequencing. In previous work, we have shown traps to be more sensitive to treatment and spatial differences than bulk soil, owing to the much lower proportion of relic DNA and dormant microbes. I expect traps to have more sensitivity in detecting legacy effects of nitrogen-treated traps to contain higher microbial diversity incubated within sites under long-term nitrogen enrichment. This analysis will help to determine whether long-term nitrogen deposition alters the composition of potentially active microbes, and if it is detectable after an 8-year recovery period.

Modeling Aquatic Ecosystems: Dynamics of the Laurentian Great Lakes over a Century of Ecosystem Modification and Governance

Alfred Achieng, George B. Arhonditsis, and Nicholas E. Mandrak

Year: PhD 1st

Research Category: Applied Science and Technology (Poster Presentation)

The complexity of modeling ecosystems that have transformed over a century, such as the Laurentian Great Lakes, necessitates a comprehensive approach that integrates historical data and information, accounts for various anthropogenic impacts, and incorporates intricate ecological interactions. This is further complicated by the governance dimension, which involves navigating the transboundary nature of resource management, and incorporates; the binational agreements and treaties in managing their jurisdictional boundaries, transformation of these agreements and treaties over time, the shared purpose of Federal, Provincial or State and tribal/indigenous agencies responsible for their management, and the mandate of research and academic institutions grappling with modelling objectives that focus on ecosystem approach to conservation and remedial actions. We review this complexity in ecosystem modification and governance by focusing on the main objectives for developing ecosystem models as; i) to improve our understanding of ecosystem function through description and disentangle of ecosystem components, ii) to communicate knowledge about the ecosystems, including making predictions about future ecosystem state and, iii) to support ecosystem management through informed decision making, comparing alternative strategies, and identifying important uncertainties. The approach to achieve these objectives varies immensely based on the differences in models composition. If the purpose of the models is to understand ecosystem functioning, it may narrow to the specific parameters and aspects of the studied ecosystem function (objective i), otherwise, communicating knowledge about an ecosystem and supporting ecosystem management (objective ii & iii) extends beyond simplified functioning or specific-threat frame. For the latter, ecosystem approach to modelling which focuses on model ensemble is the most appropriate approach to understand the modifications over time and proper governance.

Functional Traits of Carrots in Response to Environmental Conditions

Samantha Macklin and Adam Martin

Year: Master 2nd

Research Category: Experimental and Theoretical Science (Poster Presentation)

Food security is among the most pressing socio-environmental concerns of our time, with many scientists believing that this problem stems from mismanagement and a fundamental misunderstanding of sustainable agriculture. In order to adapt to a shifting climate, new agricultural practices will be necessary, particularly innovations that allow agriculture to simultaneously produce food while enhancing ecosystem

services. Limitations within food transportation systems pose a threat to food security especially amid a changing climate. Gaining an understanding of regional adaptations allows for a more sustainable local food system that is less vulnerable to problems linked to climate change. Variation in plant functional traits i.e., the measurable attributes that impact and correlate with the survival and performance of an organism is a critical determinant of ecosystem processes under environmental change, especially in agroecosystems. Yet, there are few studies that evaluate the extent, causes, and consequences of within-species variation in the Leaf Economic Spectrum (LES) and related crop traits, and particularly how this trait variation relates to regional seed adaptation and breeding. My study quantifies variations in LES traits namely, leaf mass per area (LMA), maximum photosynthetic rates (Amax), and leaf carbon (C) and nitrogen (N) concentrations along with leaf carbon isotopes (as a measure of drought tolerance) and root carbohydrate content (as a measure of nutritional quality) in carrots (Daucus carota). Carrots are used in cuisines across the globe and provide essential nutrients such as beta-carotene, vitamin K1, and antioxidants. Therefore, they possess a great social and economic importance. According to the Golden Horseshoe Food and Farming Alliance, carrots generated just under $130 million in Canada in 2018. Most of Canada carrots are produced in Ontario and Quebec, accounting for 42% and 36% respectively. Our study, which has examined locations across those provinces, suggests that the functional trait values listed above differ by carrot variety and farm location. My research will identify the functional traits that affect how crop varieties respond to environmental conditions; in doing so, it will guide crop breeding programs designed to support sustainable agriculture under a changing climate.

Differential Impacts of Desiccation on Bacterial Growback Across Varying Taxa and Dry Period Lengths

Hooman Ahmadpanah, Andrew Blakney, and Terrence H Bell

Year: Undergraduate 4th

Research Category: Experimental and Theoretical Science (Poster Presentation)

Soil bacteria frequently encounter fluctuations in moisture availability, both seasonally and in response to short-term precipitation events. The ability of soil bacteria to persist following a dry period also has implications for the development of agricultural probiotics, particularly for bacteria targeted for application on-seed or as dry powders. Such dry powders can be conveniently applied in agricultural settings, but there is a need to understand the growth dynamics of these bacteria, and how they might behave differently following industrial processing and storage. We assessed the impact of desiccation on the growth dynamics of eight non-model soil bacterial strains, isolated from a common soil. Some of the selected strains were shown to perform phosphate solubilization, a targeted function in agricultural probiotics. The strains were grown in liquid Tryptic Soy Broth (TSB)

for 48 hours, then a 500 µl subsample of each culture was pelleted. The supernatants were removed, and the pellets were left dry for 24 hours, 48 hours, or 8 days. To assess growth dynamics after desiccation, the pellets were rehydrated in TSB, and their growth was monitored at OD 600 nm. Our results suggest the strains are differentially affected by desiccation and time of dry-down. All strains had longer lag phases post-desiccation, with greater lag phase extension after longer dry periods. Overall, these results will help in identifying bacteria that are likely to be more resistant to industrial dry-down, while also providing a benchmark for the selection of strains with enhanced dry-down tolerance.

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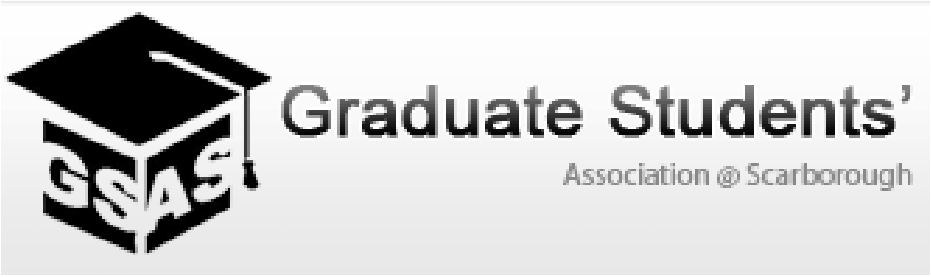
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