Environmental Science
2021 Projects

Applicants: *Remember your top two project preferences, as you will be required to select them during your application.*

Micro and Nanoplastics in the environment

Supervisor: Greg Goss ggoss@ualberta.ca
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Description: The global annual production of plastic in 2016 was 330 million metric tonnes; a staggering number is expected to double over the next 20 years as consumption increases. Plastics breakdown over time via weathering and degradation to eventually produce micro or nanoplastics that litter the terrestrial, aquatic, and marine environments. These nanoplastics are known to be small enough to transfer across gill cell membranes and into fish. However, the uptake of plastics by fish intestine has not been thoroughly investigated.

This research project will examine the uptake of various plastics across the intestinal epithelia of freshwater and marine fish. The project will involve both laboratory and field research in Edmonton and at Bamfield Marine Sciences Centre on Vancouver Island. The student will determine the extent of plastic pollution in both freshwater and “pristine” seawater environments through both water sampling and examination of fish for evidence of plastics pollution. A second objective is to examine the uptake of both plastics and co-contaminants across model fish intestinal epithelia. Overall, this program, funded by Environment and Climate Change Canada’s Increasing Knowledge of Plastic Pollution initiative, will allow us to characterize the risk of nanoplastics to fishes better. In the event of further COVID restrictions, it is possible that fieldwork away from Edmonton city may be restricted, but the project will continue regardless.

I-STEAM pathways
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Wiretapping the wilderness

Supervisor: Erin Bayne bayne@ualberta.ca
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Description: The Bayne lab uses autonomous recording units to capture the sounds of our environment. We use these data to understand how humans are influencing wilderness areas by evaluating how changes to habitat influence the abundance and behavior of species including birds, bats, and amphibians. The human disturbances we study range from forestry, oil and gas, agriculture, recreation, hunting, and other human activities. In 2021, we are emphasizing how to use sounds and artificial intelligence with computers to understand the effects of light pollution.

I-Steam interns will aid in research on how artificial light affects bird habitat selection and distribution in Alberta. Artificial light is one of the fastest-growing pollutants on earth, and has well-documented effects on birds at the individual level, but its impact on bird abundance and distribution are rarely studied. This project will provide the undergraduate with experience in the field and with computers and machine learning. During the May/June field season, the undergraduate student will work to place acoustic recording units in artificially lit and in dark study sites throughout Alberta. The student will develop their skills in driving through rugged terrain, navigating on foot in wetlands and forests, and camping for extended periods. After returning from the field, the student will use computer software programs to identify bird vocalizations in the recordings, calculate several metrics of habitat use, and compare habitat use to artificial light levels. The ideal student does not need prior field or data analysis experience but should be enthusiastic about physically exerting themselves in the field and learning new skills on the computer.

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A cross-habitat comparison of nutrient availability and levels of invasion in Central Alberta

Supervisor: Viktoria Wagner vwagner1@ualberta.ca
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Description: Globalization has accelerated the biotic exchange across our planet by an unprecedented rate. In Alberta, 16% of vascular plant species in the wild are not native. While most non-native plants occur only infrequently, some have become invasive by spreading quickly and altering native species composition and ecosystem services, which necessitates elaborate eradication measures. While there is an increasing body of knowledge on the invasiveness of non-native plants, we know little about the intrinsic properties of habitats that make them susceptible to invasions. The fluctuating resource hypothesis proposes that plant communities with high soil nutrient availability provide a competitive advantage for non-native plants. However, this prediction has been rarely tested across multiple habitats. The project will inspect the relationship between levels of invasions and soil nutrient availability among eight habitat types in Central Alberta. This region is the most densely populated and the most fragmented area of our province and features a remaining native landscape threatened by the invasion of non-native plants.

The I-Steam student will be integrated in an ongoing MSc project, funded by an NSERC Discovery Grant. Together with a graduate student, the I-Steam intern will conduct vegetation surveys in the field, learn how to identify plants with taxonomic keys, analyze soil samples in the lab, and process data for preliminary analyses. In case of COVID-related restrictions, all field and lab activities will be adjusted to meet safety requirements. By being part of our research team, the I-Steam student will help scientists and land managers to understand how soil nutrient availability influences a habitat's susceptibility to non-native species. As a large part of the Treaty 6 territory has been developed, it is important to conserve the remaining native habitats and the ecosystem services that they provide. When protected, native habitats can provide social and economic benefits for generations to come.

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Impacts of glaciers on aquatic microbial diversity and carbon cycling in the Canadian Rocky Mountains

Co-Supervisors:

1.Suzanne Tank stank@ualberta.ca; Faculty of Science, Department of Biological Sciences https://www.suzannetank.net

2.Maya Bhatia mbhatia@ualberta.ca; Faculty of Science, Earth and Atmospheric Sciences https://bhatia-lab-ualberta.squarespace.com

Description: It is predicted that there will be little to no glacial coverage in the Canadian Rockies by 2100 due to anthropogenic climate change. As glaciers can store ancient organic carbon, deglaciation will increase organic carbon delivery to downstream ecosystems. These increases in glacial organic carbon release could increase regional carbon dioxide levels through microbial decomposition processes. Additionally, downstream microbial communities adapted to glacial organic carbon sources may change as glaciers disappear. Since microbial communities form the basis of aquatic food webs, changes in their structure may affect broader ecosystem functioning.

This research project aims to better understand the impact of glacial loss and organic carbon export from glaciers to streams, and how these carbon additions are contributing to downstream microbial community composition and function in the Canadian Rockies. This will be accomplished through seasonal measurements of organic carbon and microbial composition along a downstream transect in glacially fed streams, coupled with incubation experiments to determine how downstream microbes are utilizing glacial meltwater. The I-STEAM funded student will have the opportunity to develop: (1) field skills through participation in six field trips to Banff and Jasper National Parks where the student will aid in the collection of hydrochemical and microbiological samples in glacially fed rivers; (2) laboratory skills though the analysis of microbial samples using flow cytometry to assess microbial abundance, and the analysis of organic material through ultra-violet visible techniques to assess carbon type. Ultimately, this research will yield insight into how microbial communities are utilizing glacially derived organic carbon stores. This will help predict how glacial loss will influence regional carbon cycles and downstream ecosystems, and by extension how indigenous communities and local municipalities that depend on glacially sourced watersheds may be impacted.

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Does body size play a role in behaviour and lifespan of honey bees?

Supervisor: Olav Rueppell olav@ualberta.ca
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Description: Honey bees are the most important pollinator of agricultural crops in addition to producing honey. They live in complex societies that are characterized by cooperation and division of labor. Similar to other pollinators, honey bee health is threatened by a number of factors and studies of their behavior and life history are not only interesting but also of practical importance to find sustainable solutions for improving honey bee health. In a functioning colony, one large reproductive queen cooperates with thousands of workers that are all of an invariantly smaller size. In our research, we can generate honey bees of different sizes, making use of 3D-printed comb with different cell sizes. Such variation of body size has not been explored and we will try to understand the influence of the artificially induced body size on the behavior of individuals and their role in the colony. Worker bees normally go through an age-based progression from nursing and cleaning to food-storing and guarding to foraging behavior but this might be different for workers of different sizes. We will also evaluate whether body size has any consequences for how long honey bees can live.

The I-Steam student will be working with live honey bees in our research apiary to set up experiments and will become familiar with advanced apicultural techniques, such as grafting brood, individual marking of bees, and standardizing observation hives. In addition, they will assist a graduate student with laboratory experiments to monitor survival of individuals, behavioral observations via video-recording inside observation hives, and molecular assays to assess the level of oxidative stress in differently-sized workers. As a team, we will evaluate the data and prepare the findings of our experiments for presentations at scientific conferences or to the public.

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Effect of tree host and population phase on dispersal of mountain pine beetle

Supervisor: Maya Evenden mevenden@ualberta.ca
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Description: Mountain pine beetle is an eruptive bark beetle species that is native to western North America, and has expanded its range into Alberta following the most recent population outbreak that that has killed millions of pine trees since the early 2000s. Mountain pine beetles exhibit different population phases that result in different beetle densities on the landscape. During the epidemic phase, beetles attack and kill healthy pine trees. Range expansion has resulted in a host switch from lodgepole to jack pine, which is the major pine species in the boreal forest that extends across Canada. Understanding mountain pine beetle dispersal in its expanded range is necessary to predict further range expansion into the boreal forest. The current project tests the effect of beetle population state (endemic vs. epidemic) and host tree (lodgepole vs jack pine) on beetle dispersal by flight. The objectives are to measure beetle flight capacity using computer-linked flight mills to determine the effect of: 1) population state; 2) tree host; and 3) the interaction between population state and tree host on dispersal by flight. This project will generate data to predict movement and aid in management of mountain pine beetle as it becomes established in the jack pine forest. The research will benefit Indigenous communities that are directly impacted by the ecosystem-level disruption caused by mountain pine beetle damage to both their livelihoods and way of life, and contribute data toward sustainable forest management and monitoring of the beetle. The recruited I-Steam student would work closely within a diverse lab group to 1) identify beetle-infested stands; 2) collect environmental data at sampled stands; 3) collect and transport beetle-infested wood to the laboratory; 4) rear beetles in the laboratory; 5) conduct flight bioassays; 6) conduct fat extractions.

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Ground beetle abundance and biodiversity in pulse fields in Alberta

Supervisor: Maya Evenden mevenden@ualberta.ca
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Description: Ground beetles (Coleoptera: Carabidae) are typically polyphagous predators that are crucial for preventing insect pest outbreaks in agricultural systems. Ground beetles are sensitive to changes in habitat quality caused by anthropogenic activity, but assemblages are enhanced by crop diversification. The ground beetle assemblage in pulse crops (Fabaceae) in Alberta is not known and there could be important predators that impact population levels of pea and faba bean pests (i.e. pea leaf weevil, pea aphid, lygus bugs). Identification of beetle assemblages is the first step in the development of conservation biological control of pulse crops. Agriculture is a crucial industry in Alberta that contributes to food security and can benefit from Indegenous knowledge to maintain sustainable systems. By development of conservation-based biological control, we will promote biodiversity while providing non-insecticidal population suppression of harmful pests in pulse agroecosystems. The ecologically based philosophy behind Integrated Pest Management can be adapted to other managed ecosystems in agriculture, forestry and horticulture. The objectives of this project are to: 1) survey the diversity and abundance of ground beetles in pea and faba bean fields across Alberta ; 2) determine if the most common ground beetles are predators of the invasive pest, the pea leaf weevil. The recruited student will sort and identify specimens that have been collected from pulse fields in 2019. In collaboration with other lab personnel, the student will collect live beetles from pulse agro-ecosystems, using pitfall traps, and conduct predation bioassays in the laboratory. The student will gain lab skills (microscope use, insect identification, insect rearing) and field skills.

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Translocation of Columbian Ground Squirrels in Jasper National Park

Supervisor: Colleen St Clair cstclair@ualberta.ca

Faculty of Science, Department of Biological Sciences

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Description: This project will refine methods for translocating Columbian ground squirrels (Urocitellus columbianus) that are displaced by infrastructure development in Jasper National Park. Because squirrels provide ecosystem functions and a prey base for many other species in the mountain parks, current management requires that they be translocated when they interfere with infrastructure development. However, there are no standardized procedures for doing so and no measures of past success.

We will evaluate soft-release methods and characteristics of ground squirrels that lead to successful translocations. We will also determine if ground squirrels can be displaced using deterrence at squirrel burrows. Field work began in 2020 on the north end of the Jasper townsite where several new buildings and parking lots will be constructed. In 2021, we will translocate approximately 30 squirrels, deter another 10-20 squirrels, and measure the survival of both groups.

We seek a senior undergraduate student in biology or a related field. The student will live in Jasper from early April to mid August and participate in trapping and handling ground squirrels, fitting ground squirrels with tags and radio collars, preparing release sites, and conducting burrow blocking experiments. Additionally, they will assist with data input, management, and analysis. In addition to assisting with all aspects of the project, the student will manage the implementation and preliminary analysis of burrow blocking experiments to determine effects of squirrels, blocking materials, and deterring scents. Accommodation will be provided in Jasper National Park, but the student will be responsible for purchasing and preparing their own food. All work will contribute to the M.Sc. thesis of the supervising graduate student and will support wildlife management that promotes ecological integrity in Jasper National Park. More generally, the project addresses management of ground dwelling rodents and Indigenous traditions of coexisting with, rather than displacing or dominating, other species.

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Maintaining ecological resilience through ecosystem-based forest management

Supervisor: Charles Nock nock@ualberta.ca
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Description: A key objective of ecosystem-based forest management in the maintenance of biodiversity in managed forests to ensure that forest resilience is maintained in the future. To this end, adjustments to harvesting methods following the clear-cut area have been made so that more structure, or biological legacies, are retained when harvesting stands. In a large part, this practice has been inspired by observations that after natural disturbances such as forest fires, one can find many living and dead trees that enrich the post-fire structure and community. However, to date, studies on how this method, "structural retention harvesting", influences biodiversity have predominantly compared harvested with retention vs. an un-disturbed stand, or a stand with no retention. There is now an opportunity to now study effects of structural retention in harvested stands after ~20 years to address the knowledge gap: how do communities of post-fire island remnants compare to those of post-harvest island remnants? Furthermore, it is an exciting time to be studying forests, with many innovative methods and technologies (drones, terrestrial laser scanning and microclimate monitoring) and researchers have only just begun to integrate them. In this project, we will compare island remnants of fire and harvest origin, and examine how these differ compared to reference stands.

The I-Steam student will work closely with a MSc student to study vascular plant communities. We are excited about the opportunity for the I-Steam student to address First Nations perspectives on the changes in plant abundance we are likely to observe in fire-disturbed and harvest-disturbed stands, and differences between them. Thus, in addition to learning to sample plant communities and to compare them, the student will help to interpret what these potential differences mean from a First Nations perspective. This will involve exploring appropriate collaborative research methods and teaching us about these!

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Development and Application of Low-Cost Sensors for Indoor Air Quality

Supervisor: Ran Zhao rz@ualberta.ca
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Description: Humans spend more than 90% of their time indoors, and clean indoor air is a determining factor for our health and wellbeing. Indoor air quality represents a unique and pressing environmental challenge for Canadian indigenous communities. Poor housing conditions, growth of molds, and elevated smoking rate have been suggested as potential causes by a few previous studies. The cost of research-grade air pollutant sensors is commonly over $10,000 CAD and has been a limiting factor to conduct long-term monitoring at remote communities. Over the past few years, advancement in technology has enabled low-cost air quality sensors, which opened new avenues for indoor air quality research. A previous summer student in my group built a prototype air quality sensor utilizing Arduino, an open-source, miniaturized platform for hardware and software development. The overall objective of this summer project is refinement, validation, and application of this sensor. First, the student will add more components to the prototype, enabling a wider spectrum of pollutant detection. Second, an inter-comparison between the sensor and research-grade instruments will be performed in collaboration with Environment Canada and Climate Change. Finally, in the latter half of the project, the student will deploy sensors in real indoor environments (e.g., residence and offices) to tests its performance. The developed sensors will be employed in future long-term household monitoring proposed by myself and collaborators at the Faculty of Medicine and Dentistry.

Through this project, the participating student will be able to gain hands-on experience on instrumentation and programming, which is essential for a career in environmental sciences and engineering. The student will be supervised directly by myself and a PhD student. The student will also be invited to participate and present at Prairie Environmental Chemistry Colloquium, a local conference which I am organizing.

I-STEAM pathways
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Assessing the decline of Alberta's freshwater fishes

Supervisor: Mark Poesch poesch@ualberta.ca
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Description: Freshwater fishes are in global decline and are thought to be higher than terrestrial mammals and marine fishes. In Alberta, many once widespread species, are now facing decline, and this has impacts on people and communities who rely on them for food, or other stakeholders. Species in decline include those listed under the Species at Risk Act, such as: Bull Trout, Lake Sturgeon, Athabasca Rainbow Trout and many others (e.g. Brassy Minnow, Plains Sucker). The student (or students) selected from ISteam will contribute towards improved understanding of the decline of freshwater fishes in Alberta. Some of the projects include: sampling Brassy Minnow in and around Fort McMurray to determine their distribution and abundance, sampling Bull Trout near Sundre to understand how competition from non-native species are impacting them, sampling of Plains Sucker in southern Alberta to understand how flow regime is effecting them. All projects will include field-base sampling where the student will get a chance to go into the field, sample fish, identify fish and measure habitat (including water quality). Each project will help understand limiting factors for a species in decline, with the hope that it will provide improved management and conservation for these species.

High Latitude Ocean Studies

Supervisor: Paul Myers pmyers@ualberta.ca
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Description: The high latitude oceans are evolving, relating to changes in temperature, freshwater (including from river runoff and glacial), winds and sea-ice. This evolution will have important consequences for their functioning, as well as the role they play in the climate system. Thus, it is important to understand the key physical processes that explain how these oceans work and evolve. Any intern working on this project will work with historical observed ocean data from the Canadian Arctic and/or the output from eddy-permitting numerical ocean/sea-ice models to analyze key processes and their variability. Work will generally be carried out using computational scripts written in either fortran or matlab for analysis and visualization purposes.

River Chemistry and Oilsand Outcrops

Supervisor: Murray Gingrass mgingras@ualberta.ca
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Description: The research is focussed in the area of Fort McMurray, Alberta. The aim of the work will be to compare whether or not the composition of river water changes where rivers run over or cut into oilsand deposits. This would be done by comparing chemical analyses of the oil in the outcrop to water and clay compositions upstream and downstream of outcrops. Although access is limited for many rivers in the Fort McMurray area, there are two rivers that provide upstream and downstream access (the Hangingstone and McKay rivers). The workflow for this project would be sampling in the field, which would take a week. Chemical analyses would be conducted at the University of Alberta and will include assessment of metal ion content. Characterization of Polycyclic Aromatic Hydrocarbons (PAHs), which can be associated with hydrocarbons, will also be measured.

Environmental monitoring via Wireless Sensor Networks (WSN) and Terrestrial Laser Scanning (TLS)

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Description: This project aims to introduce the student to the theoretical and practical applications of Wireless Sensor Networks (WSNs) and Terrestrial Laser Scanning (TLS) in tropical environments. The student will have the opportunity to work at the Alberta Centre for Earth Observation Sciences (CEOS) and at the Santa Rosa National Park Environmental Monitoring SuperSite (SRNP-EMSS) located in Guanacaste, Costa Rica. Guanacaste (Nahual for "Ear Pod tree") is one of the country's richest ecological and cultural regions. It is also the former home of the Chorotega Tribe, of which many inhabitants are decedents. WSN are non-intrusive sensing technologies that allow for remote monitoring of environmental variables such as temperature, relative humidity, Photosynthetic Active Radiation (PAR), and soil moisture. This state-of-the-art technology permits an assessment of ecosystem health in real-time. TLS is also a state-of-the-art technology that enables three-dimensional (3D) rendering of trees and lianas (large parasites growing on trees) with high spatial resolution. The integration of WSN and TLS will allow the student, at the end of this project, to have enough skills to conduct an MSc or Ph.D. on environmental monitoring.

This project will provide the student with technical skills and a cultural experience associated with indigenous communities outside of Canada. My NSERC Discover grant will cover the airfare and ground transportation in Costa Rica, while the student stipend will cover his/her stay at the SNRP_EMSS (approx. US$25 a day (food and lodging). It is expected that the student will be available to conduct fieldwork in a tropical environment (high temperature and relative humidity). While in Costa Rica, the student will also be part of a crew made of UofA graduate students, myself, and costarrican field assistants, which may help the student learn a little Spanish.

I-STEAM pathways
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Aquatic stream health in the North Saskatchewan watershed

Supervisor: Maya Bhatia mbhatia@ualberta.ca
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Description: The North Saskatchewan watershed is of crucial importance to Edmonton residents, as it is the city's source of drinking water. River systems are tightly linked to landscape features such as agriculture or percent forest cover, therefore in order to understand stream health, we must understand how these landscape features interact with the river system. Understanding this interaction will become more important as we experience climate change and both natural and anthropogenic land use and land cover change.

This research project aims to assess the linkages between landscape and aquatic ecosystem health in the North Saskatchewan watershed. The goal is to create a model that can predict stream ecosystem health through an understanding of its surrounding landscapes. To create this model we must first complete seasonal sampling of the stream ecosystems, in order to generate accurate, robust datasets. This project takes a whole ecosystem approach by assessing water chemistry, microorganisms, periphyton, benthic invertebrates, and fish. The I-STEAM funded student will assist a graduate student responsible for the water chemistry and microbial component of the project, and will therefore gain: 1) Field skills over the summer of 2021, sampling sites on day trips across Alberta and 2) laboratory skills at the University of Alberta, involving processing and analysis of microbial DNA and various water chemistry parameters. Overall, the role of the I-STEAM funded student will join an inter-disciplinary team, assisting in a project essential to sustainable water quality for all local and Indigenous communities that rely on the North Saskatchewan Watershed for resources, education, and recreation.

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