11th Annual Earth Day Colloquium Alphabetized Abstracts

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Environmental Decision-Making, Deep Values and the Potential for Consensus Building in Environmental Assessments in Canada

Canada's environmental legislation is rapidly diminishing due to a focus on economic expediency. In particular, public consultation and participation is minimized in the environmental assessments and policies in order to speed up the process. In the proposed presentation, I will attempt to affirm the importance of public participation in Canadian environmental decision-making and analyze its theoretical basis and potential for implementation through the utilization of conflict resolution theory. I will also consider the concept of "deep value" differences in environmental conflict. I will focus my theoretical analysis in particular on the environmental assessment process as it has significant ethical and legal underpinnings towards public participation in Canada's environmental decision-making.

Environmental decision-making is rooted in deep value conflict, and as a result, has been pursued using an adversarial approach. Non-adversarial approaches to conflict resolution are often marginalized by corporate interests, government and the public since they are perceived as ineffective in generating solutions. Deep value differences, in combination with power imbalances between parties, can make consensus-building a daunting process. I argue in the following paper that parties with environmentally based, deep value differences can still achieve a collaborative resolution and that current legislation in the form of public participation acknowledges this goal.

Public participation legislation acknowledges the need to include the interests of public stakeholders in environmental decision-making. However, this process has not been successful in practice, and deep value differences and power imbalances continue to limit public participation. Despite its failings in practical application, public participation is considered a crucial aspect of environmental decision-making in Canada and is illustrative of a desire for more collaboration on environmental decision-making. In the proposed presentation, I will examine deep value differences and related barriers in environmental decision-making, power imbalances in environmental decision-making and consider a successful case of consensus-building in environmental decision-making in Canada. I will examine the concept of public participation in particular, as public participants are the proponents with the most to lose. They often feel coerced to accept suboptimal results and walk away from the process due to power imbalances. In my analysis, I will focus particularly upon projects that require environmental assessments and I will use the environmental assessment of Voisey's Bay as an example of a successful interest based resolution.

Hamed Avari, Shady Ali, Karin Blackman, Chowdhury Jubayer, Lauren Cuthbertson, Mitchell Dooreleyers, Charles Guo, Rajeev Kumar, William Lin, Christopher Oreskovic, Matthew Roberto, Eric Savory & Katelin Spiler

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Advanced Fluid Mechanics Research Group: Environment and Human Health

We will present a large poster (approx 4' high by 6' wide) showing our group's research in fluid mechanics as it relates to the environment and sustainability. We are mechanical and civil engineers, atmospheric scientists, cell biologists and public health scientists tackling multi-disciplinary problems affecting the natural and built environment and human health.

Environmental projects examine issues related to damaging storm winds, urban and indoor air quality, "green" engines and buildings. Sustainable human healthcare topics include healthy buildings, prevention of airborne virus transmission and understanding the factors leading to arterial disease.

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Cleaning Surfaces with Green Coatings

While temporarily disinfection of a surface is possible with the help of strong cleaners, tremendous interest exists for the control of microorganisms on surfaces by effective, durable antimicrobial coatings to prevent multidrug resistant pathogens. There is a wide spectrum of potential applications for antibacterial coatings, spanning from industrial surface coatings to biomedical applications, where sterile conditions are crucial. This work examined the synthesis of nanotitanium dioxide/polyurethane (nTiO2/PU) composite coatings prepared by using various bifunctional monomers. The antibacterial behavior of virgin PU, nTiO2/PU and silver doped nTiO2/PU composites were investigated qualitatively and quantitatively against both gram-negative and gram-positive bacteria. The effect of exposure time was investigated using a solar simulator by monitoring the growth of bacterial populations in the presence and absence of the above-mentioned nanocomposites. The distribution of nTiO2 in the polymer matrix was enhanced by monomer functionalization in which nTiO2 was chemically attached to the backbone of the polyurethane polymer matrix with a bifunctional monomer (DMPA). Silver was also examined in this study as a TiO2 dopant. The quantitative examination of bacterial activity was determined by the bacterial survival ratio. Good inhibition results were observed and demonstrated visually with close to 97% of bacteria killed after 2 hours of irradiation. In summary the functionalized nTiO2/PU, and silver doped nTiO2/PU composite coatings displayed considerable antibacterial activity against both gram-positive and gram-negative bacteria under solar irradiation while silver doped nTiO2/PU coatings displayed considerable antibacterial activity even under irradiation of visible light.

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Long-term effects of inclement weather on white-throated sparrows' (Zonotrichia albicollis) stress and behavioural response systems

Climate change has been linked to increasing the frequency and severity of violent, unpredictable winter storms and other extreme weather events at nearly all latitudes. As climate change becomes a more prominent issue in the present, it is important to study and understand the effects that climate change, particularly inclement winter storms, will have on species in future years. There has been prior research regarding how birds cope with winter weather and their ability to predict oncoming inclement weather, but very limited research surrounding how birds respond, both physiologically and behaviourally, to recurrent inclement winter storms over a long-term period. The primary objective of this study is to determine the long-term effects that inclement winter weather has on white-throated sparrows' (Zonotrichia albicollis) stress response system and behaviour. I will be using a hypobaric climatic wind tunnel to simulate storms approaching, residing, and subsiding in the area by altering pressure and temperature accordingly over a 10 week period. This novel research is important for determining the effects of futuristic environmental conditions with respect to physiology and behaviour in a migrating songbird. It will be the first long-term study to manipulate environmental conditions in a controlled setting, and additionally to look at stress and behavioural responses over a long-term period on a songbird species. Understanding how species will respond to expected environmental changes

will give an insight into future conservation and management strategies surrounding climate change.

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Micronutrients may be the key to the recent expansion of cyanobacteria blooms in freshwater systems

For decades, cyanobacterial algal blooms (cyanoblooms) have been observed frequently in eutrophic, nutrient-rich lake systems. Surprisingly, cyanoblooms have been reported in nutrient poor, oligotrophic waters in recent years, specifically in the Laurentian Great Lakes- St. Lawrence River Basin. Despite nitrogen (N) and phosphorous (P) as important components in the production of cyanobacterial blooms, another way cyanobacteria can assimilate nutrients is by utilizing siderophores to competitively bind iron (Fe). A laboratory grow-out experiment will be conducted using filtered lake water and phytoplankton communities from ten study lakes in the Algoma Highland region to investigate the effect of P- and N (either in limitation or surplus) on hydroxamate and catecholate siderophores. In this grow-out experiment, it is hypothesized that cyanobacterial hydroxamate and catecholate siderophore production will be heightened when P and N are low in induced Fe-limited conditions. Nutrient manipulations used in this experiment will improve our mechanistic understanding of which lakes are controlled by macro and micronutrients. In addition, this research can assist in narrowing the gap between terrestrial ecosystems and their impact on freshwater lakes.

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Fluorescence fingerprinting of dissolved organic matter in the Attawapiskat River Watershed – Towards the development of in situ proxies for mercury in northern waters

The Hudson Bay Lowlands (HBL) is the second largest contiguous peatland in the world, located in Ontario and Manitoba. Drainage from this landscape regulates freshwater and solute fluxes (including organic matter) to the James/Hudson Bay. Climate and land-use changes are stimulating increased interest in water quality in the region, however the remoteness and areal extent of the HBL makes it a challenge to execute traditional sampling programs. We assessed the effectiveness of in situ high-resolution measurements of chromophoric dissolved organic matter fluorescence (FDOM) as a proxy for dissolved organic carbon (DOC), total mercury and methylmercury and their viability for widespread application in surface water quality monitoring programs in the HBL. Laboratory-based fluorescence measurements and parallel factor (PARAFAC) analysis were used to characterize properties of dissolved organic matter in surface waters from a first and a fourth order river, and watershed contributors to elucidate the temporal variability of water and chemical sources throughout the ice-free season. Of the in situ and PARAFAC-determined fluorescence indices, in situ FDOM yielded a very strong correlation with DOC in the higher order river only, while SUVA and fluorescence index served as suitable proxies for total mercury in both streams. Seasonal trends were observed in fluorescence characteristics of surface waters, notably demonstrating a greater influence of deep groundwater in the higher order river during low flow in the summer. The consistently low fluorescence index values (<1.35) are also suggestive of dominantly allochthonous (terrestrial) sources of organic matter contributing to both surface waters in this study.

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Don't Buy Your Clothes at the Mall

The textile industry is one of the most impactful on the environment in terms of water usage and waste generation. Our obsession with cleanliness and lack of attachment to our possessions is fuelling a constant cycle of consumption, specifically, clothing purchases. I propose a new model of consumption known as "Experiential Consumption", which focuses on a reduction in consumption of new garments and attaching a challenging search or experience for newly purchased possessions. We are emotionally and psychologically more tied to experiences than possessions, so my new model advocates a combination of the two to reduce waste generation and increase consumer happiness.

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Wetting the Sponge: Storage, rainfall and runoff relationships in a Mexican tropical dry forest

Catchment water storage and rainfall thresholds that are required for the generation of runoff are the subjects of intense study in catchment hydrology in the recent literature. Yet, to our knowledge, these threshold relationships remain undescribed in tropical dry forest catchments. Tropical dry forests comprise more than 40% of all tropical forests and more than 20% of forests worldwide. The extent of these systems, the sensitivity of their associated intermittent streams to strongly seasonal precipitation inputs, and forecasted climate change in these regions make the application of a threshold analysis of streamflow generation essential for predicting future water availability in these water-limited catchments.

This hydrological investigation examined the water storage and hydrometeorological controls of streamflow activation and event-scale runoff response in a tropical dry forest catchment in Mexico. Our results show that over a 30 day transition phase from the dry to wet season, soil water movement was dominated by vertical percolation until a threshold volumetric soil moisture of 22% was measured 100 cm below the surface, satisfying a 103 mm storage deficit and activating streamflow. High antecedent soil water conditions were maintained through the wet season but had a very weak influence on stormflow. We identified a threshold value of 185 mm of summed event rainfall and antecedent soil water needed to generate runoff >6 mm. Above this threshold, runoff response and magnitude is almost entirely governed by rainfall event characteristics, and not antecedent soil moisture conditions. Understanding these thresholds and runoff responses will allow for more informed decision-making under the warmer and drier climate forecasts that are anticipated for this region due to climate change.

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What do people mean by going green? Understanding lay perceptions of pro-environmental action

Science provides a wealth of evidence regarding the causal role of human behavior in environmental problems. Nevertheless, many individuals fail to modify their behavior to mitigate the outcomes of environmental problems. It is important for social scientists to understand how individuals in the community perceive environmentally sustainable behaviours, and how this relates to their willingness to engage in these behaviours. In our research program, we employed qualitative and quantitative research methods to examine perceptions of pro-environmental behaviours. Specifically, we asked North American adults open-ended questions about

environmentally-sustainable behaviours that they would likely engage in, and examined the types of behaviours they identified. Additionally, we designed and validated a new scale for assessing pro-environmental intentions and behaviour. The scale included 22 items that ranged from simple low involvement behaviours (e.g., reading an article about the environment, sharing pro-environmental information on social media) to more substantial high involvement ones (e.g., pressuring political representatives to take a stand on climate issues). Importantly, we also examined participants' perceptions of the effectiveness of each of the behaviours in mitigating environmental problems. The scale demonstrated good validity and reliability. Further analyses revealed that there were three main categories of pro-environmental behaviours (i.e., emerging factors): (1) knowledge acquisition and sharing, (2) environmentally-responsible consumption, and (3) environmental activism/ group affiliation. Responses on this new scale were significantly related to beliefs about environmental issues, as well as existing measures of environmental attitudes. Furthermore, willingness to engage in any given pro-environmental behaviour was related to people's perceptions of how effective this behaviour is.

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The adaptive capacity of thermal tolerance: Reintroduction of Atlantic salmon into Lake Ontario

Climate change is projected to have widespread effects that could threaten the viability of natural populations. The ability of a species to adjust to climate change is modulated by its adaptive capacity, some of which involves an evolutionary response. We focus on aquatic ectotherms due the variety of physiological processes dependent on their thermal environment. In the face of impending climate change, conservation managers must consider using individuals that have high thermal tolerance or populations that have high adaptive capacity to the projected elevated water temperatures. Efforts to restore a self-sustaining Atlantic salmon (Salmo salar) population into Lake Ontario currently focus on three candidate source populations (LaHave, Sebago, and Lac Saint-Jean). In this study, we evaluated the underlying genetic architecture and thereby adaptive capacity of thermal tolerance for juveniles in these populations. We determined optima for performance using maximum heart rate measurements (thermal optimum Topt, and critical temperature Tcrit) as a proxy for aerobic scope. Furthermore, this study investigated underlying cellular and molecular factors which may facilitate tissue oxygen supply and thereby whole-organism thermal tolerance at individual and family levels. The results of this study will be used to further our understanding of the thermal adaptive capacity of freshwater fishes and provide insight into relative long-term survival for ongoing restoration efforts of Atlantic salmon.

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The Humanitarian Award-Winning Lake Naivasha Sustainability Project

Dire ecosystem health concerns and the risk of pesticide exposure in Naivasha, Kenya has international and local advocates and researchers pointing fingers at the booming floriculture industry. Residents are very concerned about the effects chemicals are having on their health. Many groups have studied this community-at-risk, however none have established an accurate diagnosis or an effective treatment to improve the health and well-being of the residents of Naivasha. Our Ecosystem Health team has adopted a comprehensive, innovative and transdisciplinary approach in order to establish links between the socio-ecological system and the health of this community-at-risk – the first of its kind in the region. Contrary to popular belief, we found no evidence of increased occupational exposure to pesticides. Awareness and/or fear of exposure to the pesticides actually served as a deterrent to exposure. Due to ineffective

regulations and a lack of appropriate information, these pesticides appear to have become pervasive in the communities and in the basin leading to exposure of those most vulnerable. This includes women who we also found to be the most stressed. This is likely due to the cultural and socioeconomic conditions that prevail in much of sub-Saharan Africa. An ecosystem cannot be truly sustainable until its most vulnerable members are healthy.

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Environmental stressors on ancient Lake Ontario water levels inferred from stable isotopes

The modern Great Lakes are being studied extensively in order to ascertain anthropogenic effects on lake levels. Only limited amounts of research, however, have focused on natural variability and how environmental changes affected ancient Great Lakes water levels. Understanding the connection between changing natural environmental parameters and historic lake levels is needed as a benchmark for anticipating the impacts of future climate change on these freshwater lakes. Sediment cores obtained from these lakes contains such historical information on ancient lake levels. In this study, we have used the oxygen-isotope composition of ostracodes valves and clam shells (obtained from Lake Ontario sediment cores) to show how environmental stressors affected lake levels and lakewater isotopic compositions over the last 16,000 cal year BP. During glacial periods, glacial meltwater from the Laurentide Ice Sheet (LIS) ponded in the Lake Ontario basin. This resulted in higher lake levels and lakewater O-isotope compositions of <–18‰, reflecting LIS input. Post-glacial Lake Ontario underwent hydraulic closure. Under these conditions, Lake Ontario water levels to fell to the lowest levels in history. The cessation of glacial meltwater input followed by prolonged evaporative stress under closed-basin conditions forced the lakewater O-isotope composition to –6‰. The eventual return of Upper Great Lakes water to Lake Ontario at ~5,200 cal year BP established the modern hydraulic regime. The O-isotope composition of Lake Ontario, as measured before the disappearance of the biogenic carbonate record, is not significantly different than today (–6.6‰).

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Nitrate sources in alpine lakes: new insights from Δ17O, δ18O and δ15N

Paleolimnological evidence indicates that atmospheric nutrient deposition may be leading to changes in primary productivity at some high elevation lakes, but so far scientists have been unable to pinpoint the relative contributions of different nitrate sources to these aquatic ecosystems. The modern sources of nitrate inputs to six lakes in the Uinta Mountains, Utah, were determined from the analysis of Δ17O, δ18O, and δ15N of nitrates to these alpine aquatic environments. The proportional contribution of four potential nitrate sources, (atmospherically oxidized nitrate; manure; soil nitrate; and nitrate and ammonium-based fertilizers + ammonium in rain) were identified using SIAR, a Bayesian isotope mixing model. Our results show that the dominant source of nitrate input to these high elevation sites is the atmospheric transport of nitrate- and ammonium-based fertilizers. Atmospherically oxidized nitrate and soil nitrate sources are of secondary importance. As 45 % (lakes) and 72 % (inflows) of nitrates at these sites originate from anthropogenic sources (fertilizers + fossil fuels), these results provide a modern context for paleoenvironmental studies that implicate atmospheric deposition of nutrients in recent ecological changes. Comparisons of Uinta Mountain nitrate isotope compositions with those in the U.S. Rocky Mountains suggest that anthropogenic nitrogen deposition is common in other regions of the western United States. This study also reveals the potential for the triple isotope analysis method to be used to quantify the contribution of different sources in atmospheric nitrogen deposition.

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Adsorption of naphthenic acids on activated carbon

The global demand for energy has more than doubled since the 1980s as the human population has grown and economic activity has expanded. Currently, fossil fuels such as hydrocarbons are used to generate the bulk of human energy demand. As demand has increased the price of oil has risen to an extent where nonconventional sources have become economically viable for exploitation. These sources include the Athabasca “oil”, or “tar” sands, found in Alberta, Canada. The bituminous oil is first separated from the sand using a caustic wash, a water intensive process, resulting in tailing water that is both toxic and alkaline. The source of the toxicity has been attributed to a class of acids known as naphthenic acids. The present work aims to determine the adsorptive capacity of both commercial and proprietary activated carbon to remove these acids from water. A synthetic solution of several naphthenic acids has been made that would serve as a representative model for the tailing pond water. The adsorptive capacity of the activated carbon is being determined by varying different process parameters such as the loading of the activated carbon, initial concentration of the acids, and solution pH. The concentration of model contaminants is determined using high performance liquid chromatography (HPLC). Adsorption isotherms and kinetic models are being developed for scaling up of the process.

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Responding to Change and Threat of Collapse

Modernity has resulted in a number of positive and negative social-ecological outcomes. Many negative outcomes challenge the well-being and resilience of civilization. There are a number of "resilience", or transition, groups and communities who attempt to respond to these issues. These groups can be categorized via a new typology of transition. This quadrant typology situates groups who respond to issues such as over consumption, peak oil, economic growth and individualization on two scales. The first scale is collapse versus continuity of social order. Some groups, such as governmental and academic organizations, attempt to create transition goals that allow for the continuation of the status quo, while others attempt to dismantle it with an ontology of collapse; that the status quo will no longer suffice. The second scale is political versus apolitical. Some groups, such as “preppers”, attempt their goals without political motivation; rather they are concerned about individual well-being, not societal. This scale helps to illuminate motivations of different transition groups. It can be contended that groups falling within the quadrant of "political collapse" may hold the best hope for our future.

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Pharmaceuticals change abundance of microorganisms in agricultural soils

Pharmaceuticals used to lower incidence of disease and mortality in livestock can be transferred from the treated animals to the agricultural fields through spread of manure (animal waste used as fertilizer).The main purpose of using manure on the fields is to provide nitrogen, often a limiting nutrient for plant growth. However manure contains organic nitrogen that needs to be converted to plant-usable forms, such as ammonia and nitrates. Conversion from organic compounds to ammonia (mineralization) and from ammonia to nitrite and nitrate (nitrification) is achieved by microorganismal activity in the soil. Ammonia oxidizing bacteria (AOB) and archaea (AOA)

both contain amoA gene (used for detection of those microorganism) allowing for conversion from ammonia to nitrite. Pharmaceuticals are used to fight microbes harmful to the animals, but their effects on species in agricultural fields, especially useful microbes like ammonia oxidizers, are not clear. A series of plots, treated annually for the past 3 years with pharmaceuticals (ivermectin, monensin, zinc bacitracin) at two concentrations were used to test the rate of mineralization, nitrification, and the abundance of AOA and AOB microorganisms. There were no changes in mineralization and nitrification, but the abundance of AOA and AOB increased and decreased, respectively, after addition of the pharmaceuticals. Addition of manure containing the studied pharmaceuticals is not detrimental to the investigated soil processes, despite the changes they cause in abundance of AOA and AOB microorganisms.

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The daytime evaporative cooling performance of green roofs in London and Calgary

Green roofs have become increasingly prevalent with increasing policy drivers such as Toronto's green roof by-law which requires green roofs on new developments. An important function of green roofs is their ability to reduce urban temperatures through evaporative cooling. The energy balance of a green roof surface provides the forcing for its influence on urban climate and can be used as a metric to assess its ability to cool urban areas. The energy balance of a surface is given by $Q^* = QG + QE + QH$, where Q^* is the net total of all incoming and outgoing radiation of all wavelengths, QG is the flux of sensible heat to storage through conduction, QE is the flux of latent heat through convection, and QH is the flux of sensible heat through convection. A higher QE indicates higher evaporative cooling. The daytime energy balance of green roofs were assessed in two distinct climate regions, Calgary, Alberta and London, Ontario. When normalized for to allow comparison between the two sites, London showed a higher Q E and a lower QH than Calgary for both the 2012 and 2013 study periods. In the 2013 study period, with Calgary receiving high than average precipitation, QE was similar to that of London. During typical climate conditions the London green roof had greater evaporative cooling than a green roof in Calgary. During higher than normal precipitation periods however the Calgary green roof performed similarly to that of London's green roof.

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Is the imagination stronger than knowledge? How stories can inform and support natural resource management for the Great Lakes-St. Lawrence River basin.

The Great Lakes-St. Lawrence River basin is an ecosystem whose future sustainability is at threat. The socio-economic and environmental policy needs of the Great Lakes-St. Lawrence River basin has and continues to be a challenge – the goals of a sustainable basin are not being met. Although mechanisms exist in science, social science, policy and law to develop policies for a sustained Great Lakes-St. Lawrence River basin, these policies often do not meet their full potential. We propose scenario analysis as an effective tool to support natural management for the Great Lakes-St. Lawrence River. Scenario analysis is an approach that transcends disciplines and embraces uncertainty. It facilitates dialogue among stakeholders and adds depth and diversity to the science-policy interface. We provide evidence for why scenario analysis is effective, why it was used in the Great Lakes Futures Project, and how its results can be used to complement and strengthen interdisciplinary scholarship and current management within the basin.

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Can intercropping help ensure crop productivity and agricultural sustainability?

Intense agriculture tends to use chemical fertilizers and pesticides on continuous basis to maintain production. However, with greater health and environmental concerns, some farmers are increasingly relying on organic or more environmentally friendly systems, such as diversification through intercropping or polyculture, to reduce the use of agrochemicals. To make this work, the main challenge is to understand the biological mechanisms underlying intercropping. For example, understanding the interactions between crop species to ensure facilitation rather than competition between them makes it possible to increase crop yield. Additionally, it is important to understand if, through intercropping, the resilience of the crop system to undesirable organisms is restored. The objective of our study was to examine onion and wax bean intercropping because of their potential capacity to gain higher productivity and deal with competition by weeds compared to their growth in monoculture systems. To do so, onion and wax bean monocrop microcosms were compared to their intercrops with or without two species of weeds, Chenopodium album and Amaranthus hybridus. We found that growth of onion under intercropping is significant higher than when it was grown in monoculture and two weeds have significantly lower biomass and height under onion and wax bean intercropping. Land equivalent ratio (LER) was calculated to be 2.1 and this indicated yield advantages of onion and wax bean intercropping compared to monocultures. In another words, this type of intercropping increased crop productivity and supressed weed growth. In light of these results, increasing crop diversity in the field is a potential way to make positive interaction among crops to increase crop yield and reduce the infestation of undesirable organisms.

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Background and Benthic Mercury in Lake Erie: Toward Identifying the Cause of Recent Increases in Fish Mercury

Long-term monitoring has revealed that despite a decline in regional atmospheric Hg emissions since the early 1970s, there is a recent increasing trend in mercury (Hg) concentrations in the top predatory fish of Lake Erie. Although body burdens of Hg in biota are expected to decrease concurrently with declining deposition, the availability of Hg in aquatic ecosystems is complicated by other factors. Some of these factors, such as water temperature, oxygen levels, and pH, vary among and even within lakes. They influence the conversion of inorganic Hg to the more biologically harmful and bioaccumulaing methylated form (MeHg). A current, comprehensive study of total Hg (THg) and MeHg over both space and time is needed to establish the background environmental profile of Lake Erie, which is required to accurately analyze Hg trends seen in biota. THg and MeHg concentrations were measured in Lake Erie water, sediment and seston collected from spring to fall, 2012. Mean THg from the lake basins ranged from 0.21-1.13 ng/L, with nearly 80% of MeHg concentrations falling below quantification limits. THg and MeHg in water and sediment follow the same spatial gradient, with concentrations decreasing from West to East, however modern sediment concentrations have not decreased significantly from historical ones. Mean seasonal THg concentrations in the West and Central basins are somewhat comparable, however, the Central basin mean MeHg concentration is nearly twice that of the West. These data will be used to analyze Hg patterns in prey species, as well as further interpret trends in fish concentrations.

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Effect of Pesticides on Honey Bee Survivorship, Foraging and Immunocompetence

The honey bee, Apis mellifera, is a highly social insect that has been domesticated into a key pollinator of agricultural crops. In southern Ontario, honey bees are vital to the agro-food industry yet honey bee populations continue to decline. Here I test the impact of a locally deployed pesticide on forager performance and health. I exposed foragers to conventional and new nicotine-like pesticides (neonicotinoids), and measured the effects on worker survivorship, foraging behaviour and immune response. Topical exposure to an agriculturally relevant dose of a neonicotinoid had an immediate and chronic effect that differed significantly from untreated controls. This study demonstrates how pesticides impact the behaviour and immunity of Ontario bees. The results suggest a differential effect of neonicotinoids on bees that should inform current discussion on pesticide use and regulation

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Toxic Tides: Examining the effects of ocean acidification and coastal eutrophication on the growth and toxicity of the marine raphidophyte Heterosigma akashiwo.

Harmful algal blooms (HABs) are a global issue that have been garnering the attention of scientific studies, industries, and coastal communities in the past 20-30 years. Negative impacts of these blooms on coastal waters include: toxin production, disruptions to marine food chains, and altered ecological relationships. Despite an increasing frequency of HABs, these harmful relationships are generally poorly defined and not fully understood. This is especially true in the case of the marine raphidophyte Heterosigma akashiwo, whose fish-killing toxic mechanism remains a mystery. My project addresses the variable toxin production of H. akashiwo and its relation to environmental changes. Specifically, this project examined whether anthropogenic eutrophication and acidification (driven by high CO2) of coastal waters will stimulate growth and/or toxicity in H. akashiwo. It was found that Heterosigma akashiwo are likely to persist in the future ocean, with the potential to express high levels of ichthyotoxicity. By closely examining the connection between nutrients, pH and the variable toxicity in H.akashiwo, this project provides insight on this species' toxic mechanism and enhances the current understanding of HAB dynamics as a whole. Results underline that efforts to curb anthropogenic carbon dioxide emissions and nutrient loadings are the key to sustained coastal ecosystems and industries.

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The Importance of Native Trees in London, Ontario

For a city who's nickname is The Forest City, it appears as if the value of trees and natural areas in London has been valued less than that of corporate developments. With a greater frequency, natural areas are being destroyed to erect shopping malls and medical complexes. As it turns out, this seems to be part of the natural cycle of London, since this has happened before. I will present a brief overview of the history of trees in London, Ontario, and a case study from human history (Easter Island) to illustrate the importance of trees and natural areas. I will then discuss the value of some key natural areas in this city, why their preservation is important, and why tree plantings of native species should be considered an important investment in London's future.

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Healthy, Resilient and Multicultural Water-centered Communities: A Sustainability-based planning framework

Communities over the waterline such waterfronts and river side face disruptions of varying magnitudes in addition to a long list of challenges, such as: obsolete industrial sites, demographic shifts, degrading infrastructures, and loss of natural lands. While generic sustainability requirements are the foundation for building community resilience in water-centered communities, context-specific factors make the difference to achieve sustainability goals through cross-disciplinary research.

The research aims to detect untapped/missed opportunities for recognizing and enhancing multiculturlism and social diversity in building sustainable water-centered communities by using a sustainability-based analytical planning framework to address the complexity of urban renewal. The framework is based on three pillars: (1) urban sustainability, (2) planning for multiculturalism and social diversity, and (3) ecosystem approach to urban management (Marcotullio & Boyle, 2003). As the research focuses on Toronto water communities, supporting cases are used, such as the retrofit program implemented in Black Creek neighborhood and other national and international cases. This project comes under the umbrella of the collaborative partnership between the University of Waterloo and the Toronto and Region Conservation Authority (TRCA).

A new paradigm that addresses non-linearity, heterogeneity, spatial complexity and vagueness, and build the ultimate measuring system that link indicators to both society and economy as social and economic forces as well as the biophysical factors, is needed. The study will draw from qualitative and quantitative methods, such as: policy and other document qualitative content analysis and Multi-Criteria Decision Analysis (MCDA), building an illustrative system depiction and perform a simulation exercise using Insights Maker, a policy simulation application, to demonstrate how the proposed analytical planning framework could be applied in interactive facilitated workshops and other scenario planning sessions attended by key stakeholders. International water communities' revitalization projects will be taken into consideration in designing the analytical framework.

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Bridging the "Town and Gown" Gap in Avian Science

The bird watching community cares about birds and avian science because it is important for conservation and it's interesting. The academic avian science community depends on the birding community's citizen science initiatives such as the Christmas Bird Count and breeding bird surveys for raw data. In spite of these important links, there is often a real or imagined silo-ing that occurs. It's easy to neglect the "town and gown" relationship. Nurturing it however will result in long term win-win outcomes such as greater engagement in eBird and more active support of bird science. The same principle applies of course across other science disciplines.

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Transport pathways and accumulation rates of plastic debris near Humber Bay, Lake Ontario

Accumulation and persistence of plastic debris in waterways pose a serious threat to aquatic ecosystems. Many studies have investigated the accumulation and effects of plastic debris in marine environments, but few have examined the accumulation of plastics in fresh water environments. A section of beach along the shoreline of Humber Bay, Lake Ontario was surveyed for industrial plastic pellets, plastic fragments, and intact plastic debris. The accumulation rate of plastics was calculated by sampling from a quadrat measuring 25m x 4m over 3 week intervals. An average of 1500 pellets, 405 plastic fragments, and 91 intact plastic items accumulated per 3 week interval. A site along the Humber River, which drains into Humber Bay, was surveyed in order to assess the river's potential as a transport pathway for plastic pellets into Lake Ontario. The shoreline and riverbank sampling areas contained comparable pellet compositions and colours. Using Raman Spectroscopy on random pellets, polymer compositions included high density polyethylene, low density polyethylene and polypropylene, which are all considered floating plastic polymers. Understanding the relationship between sources, transport pathways and sinks for plastics will help locate key areas for investigations concerning the effects of plastic debris on aquatic organisms.

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Life Cycle Analysis of LDPE Reusable Bags

LDPE reusable plastic bags are available at retail stores in place of traditional disposable plastic bags. In order for these bags to be viable, they must have a lower environmental impact than disposable bags throughout the life cycle. We have completed an analysis of the life cycle of LDPE reusable plastic bags from cradle to grave. Stages of raw materials, processing, manufacturing, transportation, and retail/use were considered for environmental. social, and economic impacts both as inputs and outputs. Additionally, we have identified recommendations for each stage in order to decrease the environmental impacts.

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Allelopathic potential of a common weed in Canada, Amaranthus hybridus

Allelopathic interactions between crops and weeds can result in reduced crop yield and quality and ultimately to economic loss. Amaranthus hybridus is one of the dominant weeds in Ontario, however few have examined the possibility of its allelopathy. The effects of aqueous extracts from A. hybridus obtained from an organic farm and a conventional farm were examined. Aqueous solutions at concentrations of 0% (control), 20%, 40%, 60%, 80% and 100% were used for germination test on seeds of lettuce, spinach, yellow beans, and green beans. The results showed that both solutions significantly reduced the germination of spinach, yellow beans and green bean, but only the conventional solution had any significant impact on the germination of lettuce seeds. The inhibition of germination was significantly different between the organic and conventional treatment for spinach and lettuce but not significant for the beans. The same crops were also grown with aqueous solutions of 0%, 10%, 40%, 70% or 100% to measure their growth responses. The results showed that lettuce exhibited a fertilization effect under the conventional treatment of 100% concentration while spinach was not significantly affected by any of the solutions. Yellow beans and green bean showed allelopathic effects from both solutions however,

the effect of the organic solution on green beans was greater. The dry root weight of both beans was reduced by the organic tea. The variation in responses of the test species to the two solutions indicates the importance to test various crops and the potential allelopathic effects of pigweed.

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How individuals with high versus low feelings of environmental importance differ in their responses to environmental messages

The evidence for climate change as an urgent global issue has become increasingly evident in recent years, yet despite widespread recognition of this concern, inaction is still common. The current research began with an observation about the disconnect between environmental activists, who are highly motivated both to act and to persuade others, and people who may not deny climate change but who are not highly identified. Research suggests that if people face very threatening information over which they feel little control, they may react defensively by trivializing or denying the threat. We hypothesized that people who were not highly engaged in environmental concerns would show this defensive tendency when presented with threatening climate change information, but that highly identified environmentalists would manage to mobilize against the threat. We presented participants who reported being high or low in environmental engagement with a future climate change scenario that was highly severe and focused on local effects expected to occur in this region. We manipulated the degree to which participants felt either high control or low personal control, and expected that low-engagement participants who felt low personal control would be most likely to defend against the threat by minimizing climate change severity, expressing skepticism and relegating consequences to the distant future, whereas high-engagement people would mobilize under these conditions. Results demonstrated the predicted differences in reaction to climate change threat among those who were induced to feel low personal control, while groups did not differ when they were led to feel high personal control.

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Rapid Adaptation of Early Life History Traits in Great Lakes Chinook Salmon

Ecological disturbances such as those wrought by directional climate change can impact the rearing habitats of salmonids and alter selection regimes. The early life history (ELH: embryo-smolt) stages of salmonid development often experience the highest mortality and are particularly vulnerable to environmental change. In the Morbey lab at Western University, we are using recently introduced Great Lakes Chinook salmon (Oncorhynchus tshawytscha) populations to study the rapid adaptation of ELH traits in response to current and projected changes. We use field and common garden hatchery studies to: 1) investigate the adaptive potential of ELH traits, and 2) understand how environmental variation and parentage influence ELH traits. We found that egg size differs among populations independent of female length and that egg size explains much of the variation in ELH traits. However, there were differences in almost all ELH traits among populations after controlling for egg size and these differences varied by temperature and developmental stage. We are now investigating how maternal effects (i.e. egg size) can mediate the adaptive response of salmon populations. We are also looking at how individuals can respond to seasonal cues to ensure the proper timing of smoltification, whereby juvenile Pacific salmon undergo a transformation in their freshwater habitats in order to survive the migration to and residency at sea. The timing of this transformation is crucial, especially if river conditions experience faster seasonal deterioration as expected under climate change scenarios.

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Food preference of diamondback moth (Plutella xylostella) exposed to leaves of radish of different ages.

The diamondback moth (DBM), Plutella xylostella, is a specialist insect feeding exclusively on Brassicaceae plant. DBM is considered one of the most destructive insect pest attacking cruciferous vegetable crops with estimated cost associated with damage and management of US$ 4-5 billion per year. DBM is hard to control due to its unique ability to develop resistance to all classes of pesticides used against it (including DDT and even Bt). Field observations suggest that the species is more attracted to old plants than younger ones. Therefore, the ecology and food preference of DBM need to be investigated to develop a safe, environmentally friendly bio-control management strategy. The main objective of this study was to determine the preference of DBM exposed to radish leaves of different ages. Four populations of DBM (from Alberta, Ontario, Quebec and Saskatchewan) were exposed to radish of 5 different ages (leaves aged 2 to 10 weeks old). Populations from Quebec, Ontario and Saskatchewan preferred 6 and 10 weeks old while Alberta evidently preferred the oldest leaves. This suggests that there is some differential preference among populations due to their origin or genetic variability. However, it was observed that selection of the leaves did not significantly affect the relative insect weight gain during the one hour feeding time. The results were consistent for all four populations. Further research will attempt to link preferences to the chemical contents of the leaves and gradually determine the possibility to use natural chemicals as attractant out of the crop fields.

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Effects of fragmentation on swallowtail butterflies

Landscape changes such as habitat fragmentation and habitat loss are contributing to a global decline in biodiversity. Research is mainly focused on species that show negative edge responses. Based on a proposed resource distribution model, some species that require complementary resources in different habitat types are reliant on the edge, and are therefore edge species. I use the Eastern Tiger (Papilio glaucus) and the Spicebush (Papilio troilus) swallowtail butterflies to test for this positive edge response. Both species require deciduous forests for larval resources and meadows for nectar resources. I examine their relative abundance, flight behaviour, and flight orientation in relation to the edge to evaluate their edge response. Overall, I found that their distribution and flight behaviour is consistent with the positive edge response model, however differences do exist between species and sexes. My results suggest that some degree of fragmentation in southern Ontario can benefit native species.

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Sustainability of agriculture through the growth and collapse of the ancient Maya settlement of Kante't'u'ul in the polity of Motul de San José

The combination of repeated drought and the management and intensification of agriculture in ancient Maya settlements may have contributed to the Classic Maya collapse in heavily populated centers. Using a soil geochemical approach, the spatial and temporal distribution of human-cultivated lands will be investigated at the Classic Maya site of Kante't'u'ul. Residues of maize (Zea mays) will be identified in soils via the δ13C values of extracted humic substances and bulk organic carbon. This should allow us to delineate areas that supported ancient maize agriculture and, with careful sampling, determine the relative timing of maize cultivation surrounding Motul de San José. In addition, high-performance liquid chromatography will be used to identify traces of theobromine, an alkaloid of the cacao plant (Theobroma cacao) that resists biodegradation in soils. The presence of theobromine will be indicative of the location of former cacao orchards or the processing and use of cacao. Finally, the oxygen isotope composition of char extracted from the soils will be related to fire characteristics to assess burn strategies for land clearance associated with milpa agriculture. Maya agricultural practices may not have been sustainable in light of drastic changes in politics, climate change and landscape modifications. Identifying the locations of ancient maize fields, cacao orchards and intensified land clearance via deforestation will provide insight on resource use and possible growth of agricultural systems throughout the Classic Period.

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Daytime and night time surface temperatures of green and standard roof

Previous green roof research shows reductions in summer daytime surface temperature of about 25°C and night time temperature increases of about 5°C, in comparison to a standard roof. The lower night time surface temperature of a standard roof is attributed to radiative cooling and the higher surface temperature of the vegetated roof to soil storage capacity. This opposite behavior during the night has not been closely studied, however increased night time surface temperatures can contribute to larger urban heat islands (UHI). Taking into consideration that green roofs are

currently one strategy to mitigate the UHI effect it is important to understand the possible temperature reduction/increase under specific climate conditions both during the day and night.

This research investigates the daytime and night time behaviour of green roofs, and specifically the extent to which they are cooler than standard roofs during the day and warmer at night. As the reduction of surface temperature on a green roof in comparison to a standard roof is closely associated with meteorological conditions (air temperature, relative humidity, wind speed, etc.), soil moisture and surface type (type of plants, color and density) we investigate how they affect the daytime and night time energy fluxes and surface temperatures, based on data from field sites in London and Calgary. We find that under specific meteorological conditions it is possible for the green roof to remain cooler than a standard roof during both the day and night. The lower the soil moisture the smaller the temperature difference between the two roofs.

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How does photosynthetic capacity vary with temperature and photoperiod in white spruce (Picea glauca)?

Global surface temperatures are projected to increase at a greater rate at high latitudes and during winter, which could disrupt seasonal environmental cues used by evergreen boreal conifers to enter winter dormancy, such as declines in temperature and photoperiod during late summer and autumn. Elevated temperatures associated with global climate change may extend the growing season in conifers; however, photoperiod might constrain total growing season length. I hypothesized that photoperiod is more important than temperature in regulating photosynthetic capacity in white spruce (Picea glauca) due to changes in photoperiod being a more reliable cue than changes in temperature during autumn. White spruce were grown from seed and treated with declining or constant temperature and/or photoperiod to simulate late growing season environmental cues. Photosynthetic capacity was measured weekly. The preliminary data suggest that temperature is more important than photoperiod in regulating photosynthetic capacity in white spruce, as warming disrupts down-regulation of photosynthetic capacity while photoperiod does not. Future work with this system includes characterizing the pigment changes, and incorporating the photosynthetic capacity data into a model of ecosystem responses to global change.

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Bats and Wind-Power: An Issue on the Great Lakes

Bats in North America are threatened by the increasing number of wind-power generation facilities, with large numbers of bat deaths caused by wind-turbines. The highest bat mortality around turbines has been recorded between July and October when many species show migratory behaviour, and may be further predictable based on various climatic factors. However, our limited knowledge of bat migration presents a significant difficulty to determining the impact of turbines. Therefore it is a priority to increase our understanding of migrating bats, in particular the routes and timing of their movements, as well as the species undertaking migratory behaviours.

I will present a summary of current knowledge about interactions between bats and wind turbines, including methods to track large-scale movement of bats. This is partially addressed in my own research on bats migrating across the Great lakes, and the use of islands as stopover

sites. I am investigating this using acoustic monitoring of bats to track their activity throughout the season. This topic is highly relevant in the Great Lakes area, which has been identified as having a high potential for wind-power generation and also appears to experience a high occurrence of migratory bats.

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Motivation for Small and Medium Sized Businesses to Engage in Energy Reduction

There is increasing interest in how to effectively engage people in behavioural changes that are necessary to reduce energy use. There has been a focus on interventions that encourage individual households and large corporations to reduce energy, however, there has been very little research investigating the motivational factors that might induce small and medium sized enterprises (SMEs) to engage in energy reduction strategies. This program of research fills in this very important gap. Using a sequential mixed-method design: qualitative interviews (n = 18) and a comprehensive quantitative survey (n = 331), an SME Motivational Model was developed to capture the key motivational factors expected to influence energy reduction motivation for SMEs. Using multiple regression modeling (Study 2), five motivating factors emerged: (1) expectation for improved efficiency, (2) existing environmental values, (3) desires to save money on utility bills, (4) perceived social norms, and (5) increasing customers via positive reputation. The results of the present research provide important evidence in understanding the motivation for small and medium sized enterprises to engage in energy reduction. The motives for reducing energy all seem to point towards an overall desire to make decisions that 'make good businesses sense'. We discuss the broad theme of SME business decision-making and how future research could elaborate on the SME Motivational Model.

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Mercury-Dissolved Organic Carbon-Marine Silt Adsorption Kinetics: Implications for Open Pit Mine Dewatering, Hudson Bay Lowland, Canada

Open pit mining in the Hudson Bay Lowlands (HBL) has unknown implications on the geochemical cycling of mercury (Hg) and dissolved organic carbon (DOC) in peat pore water. In particular, when vertical hydraulic gradients are imposed due to pit dewatering and peatland pore waters are mobilized vertically through silts and underlying bedrock, the mobility of DOC-bound Hg is unknown. Batch laboratory experiments were used to study the adsorption kinetics of mercury (Hg) and investigate interaction of Hg and DOC to marine silt underlying peat soils. The influence of DOC on the adsorption kinetics was investigated by comparing Hg adsorption to marine silt suspended in deionized (DI) water to Hg adsorption to marine silt suspended in peat-derived DOC solution over 24 hours. Hg adsorption was predicted to be rapid, and enhanced in the presence of DOC. Differences between initial and final concentrations of total mercury (THg) and DOC were analyzed after samples interacted for time intervals of; 5,10,30,60, 360 and 1440 minutes. Adsorption of Hg in DI showed rapid initial adsorption and 96% adsorption over 24 hours. All concentrations of Hg in peat-derived DOC also showed rapid initial adsorption, but had decreased overall adsorption. Peat-derived DOC solutions had incomplete adsorption over 24 hours. Peat-derived DOC solutions in undiluted, diluted by a factor of 2, and diluted by a factor of 10 solutions had 66%, 72%, 52% adsorption, respectively, over 24 hours.

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Thermal Behaviour of an Experimental Green Roof in London, Ontario, Canada

Green roofs have been used to aid in the moderation of high urban temperatures leading to improved environmental conditions. The surface temperature of vegetated and standard grey membrane roof surfaces was analyzed for the growing season on an experimental green roof located on Talbot College at the University of Western Ontario. The difference observed between green and standard roofs was assessed. In addition, the difference between vegetation type and soil depth treatments used in the experimental design which included four and six inch soil depth, and sedum, aquilegia, and grass plants, was tested. Surface temperature data was collected under varying meteorological conditions using both fixed infrared thermometers as well as fixed and handheld thermal scanners. Direct measurements of all radiation balance components, module mass, air temperature, relative humidity, and rainfall data were made for all tests. The green roof displayed consistently lower surface temperatures during daytime conditions and had warmer overnight surface temperatures than the standard roof surface, associated with surface heat capacity. The green roof also displayed a lower degree of temperature variability associated with daily changes in meteorological conditions and overall roof wetness. Vegetation treatments with six inch soil depth displayed lower average surface temperatures than four inch soil depth modules with the same vegetation in almost all tests. Across the growing season under varying moisture conditions, Sedum modules with six inch soil depth displayed lower diurnal surface temperatures. This can be attributed to their dense plant canopy throughout the growing season and their ability to store water.

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Growth and maturation: are reproductive tactics in female kokanee salmon growth dependent?

Female kokanee salmon (Oncorhynchus nerka) from the Meadow Creek Spawning Channel (British Columbia) express two distinct reproductive tactics related to parental care. Females either arrive sexually mature with a red nuptial colouration, or less commonly, sexually immature with a silver colouration. Silver fish arrive earlier, delay spawning, and are generally younger and smaller than red fish. Given that maturation at younger ages can be a consequence of rapid growth, we tested the hypothesis that reproductive tactics in female kokanee are related to growth history. To estimate annual growth, we back calculated size-at-age from otolith growth bands. Otoliths grow continuously throughout the life of a fish and are highly associated with fish body size. However, the relationship between otolith and body size varies by species, and even differ between populations of one species. Preliminary results showed a strong positive relationship between otolith size and body size of the kokanee in Meadow Creek population. Reduced age at maturity may reflect the individual resource allocation in unstable environments. By maturing at a younger age, silver-arriving females have a shorter generation time, reduce exposure to lake predators, but may pay costs associated with spawning at a less reproductive condition.