NSERC Canadian Network for Aquatic Ecosystem Services

Réseau Canadien du CRSNG sur les Services des Écosystèmes Aquatiques

5th Annual Meeting & Workshop

April 26 – 28, 2017

University of Toronto

Toronto, ON

University of Toronto

Contents

Acknowledgements

Our deepest appreciation is extended to the University of Toronto for the use of their facilities for this year's Annual Meeting and Workshop. Many thanks to our speakers, HQP Committee, and Science Committee for their contributions to the Meeting. Lastly, we extend our appreciation to all of our meeting participants, without whom this event would not be possible. Thank you!

Locations and Directions

All sessions will be held in **Koffler House** and the **Earth Science Centre.**
The Poster Session will be held at the **Faculty Club.**
The Network Dinner will be held at **Hart House**.
Accessible entrances and accessible washrooms are available in each building.

Koffler House, 569 Spadina Crescent, http://map.utoronto.ca/building/145

Earth Science Centre, 5 Bancroft Avenue, Room 4000 and 40001, 4th floor
The entrance is a few steps away from Koffler House.

Hart House, 7 Hart House Circle, http://harthouse.ca/maps-directions/

Faculty Club, 41 Willcocks Street https://www.facultyclub.utoronto.ca/

Getting to Toronto by car, bus, and air:

University of Toronto: https://www.utoronto.ca/university-life/campuses/downtown-toronto
City of Toronto (general): www.toronto.ca/

GO http://www.gotransit.com/publicroot/en/travelling/stations.aspx?station=USTN
Greyhound: https://www.greyhound.ca/
UP Express from Pearson Airport to Downtown Toronto (Union Station): https://www.upexpress.com/

Parking near Koffler House:

The nearest parking lot is: **B.C.I.T. Parking Garage**, **213 Huron Street,** (416)-978-7275
8am-6pm: 20$

One of the cheapest lots in the area is: Precise Parklink Parking, 469 Spadina Crescent, (416) 618 8136
8am-6pm: 14$

To check other parking options: http://toronto.bestparking.com
Other parking spots at UofT: http://www.parking.utoronto.ca/home.htm

Taxi:

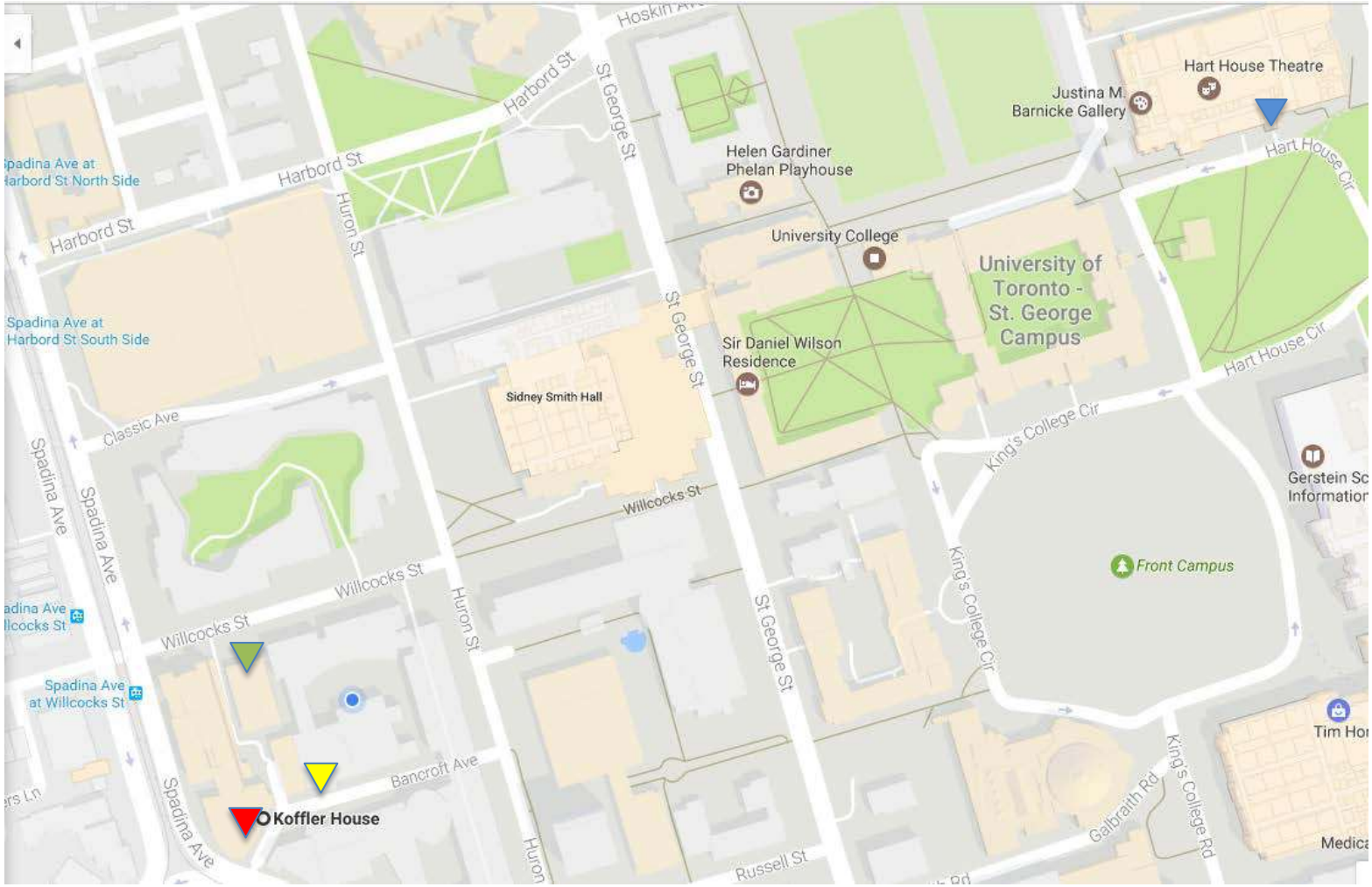
Aeroport Taxi & Limousine Service (Pearson Airport): 1-416-255-2211 http://www.aeroporttaxi.com/

Beck Taxi (Toronto): 1-416-751-5555: http://www.becktaxi.com/

Co-op Taxi (Toronto): 1-416 504 2667: http://www.co-opcabs.com

Map, University of Toronto – St. George Campus

For an interactive map, go to http://map.utoronto.ca/



Koffler House, 569 Spadina Crescent

Hart House, 7 Hart House Circle

Faculty Club, 41 Willcocks St

Earth Science Centre,

Toronto Restaurant Options:

Close to Koffler House/Faculty Club:

American –Harbord House –http://harbordhouse.ca

French-inspired – Bodega –http://www.bodegarestaurant.com/

Vegetarian/Vegan - Fresh on Bloor **–** https://freshrestaurants.ca/

American, locally-sourced – Harvest Kitchen – https://harvestkitchen.ca/

A bit further from Koffler House/Faculty Club:

Vegetarian/Vegan - Grasshopper - http://grasshopperrestaurant.ca/

Chinese - Mother's Dumplings - http://www.mothersdumplings.com/

'Hip' Beer Hall - Trinity Commons - http://trinitycommon.com/

Mexican - La Carnita - http://www.lacarnita.com/

Close by to the Chelsea Hotel:

Thai - Bangkok Garden - https://bangkokgarden.ca/

Japanese - Kenzo - http://www.kenzoramen.ca/index.php

Japanese - Kinka - http://www.kinkaizakaya.com/menu/

Indian - Kothur - http://www.kothurindiancuisine.com/index.php

American - South St. Burger - http://www.southstburger.com/location/bay-temperance/

American - W. Burger Bar - http://wburgerbar.com/WBurgerCollege/

Agenda

Tuesday, April 25, 2017	
Time	**Program**
8:30pm	**HQP Meet & Greet** Duke of Somerset, 655 Bay Street *~5 min walk from the Chelsea Hotel*

Wednesday, April 26, 2017 Annual Meeting Day 1		
Time	**Program**	**Room #**
8:30	**Check-in, name tags, coffee/tea/snacks available**	
9:00	**Welcome, Opening Remarks** **Don Jackson,** Scientific Director, CNAES	**Koffler House 108**
9:10	**The Hard Work of Hope: Sustaining Cooperation on Water Security and Climate Stability in a Post-Truth Trumpocene** **Bob Sandford,** EPCOR Chair for Water and Climate Security, United Nations University Institute for Water, Environment and Health, CNAES Board of Directors	
10:10	**Lighting Talks,** *presented by CNAES Students, Post-docs & Alumni* • **Alex Yeung,** Theme II • **Nicole Balliston,** Theme I • **Liset Cruz Font,** Theme III • **Kelli Charbonneau,** Theme II • **Jason Igras,** Theme II	
10:40	**Networking Break**	**Main Activity Hall, 2nd Floor**
11:05	**Lightning Talks,** *presented by CNAES Students, Post-docs & Alumni* • **Wagner da Costa Moreira,** Theme III • **Amanda Lavalle,** Theme I • **Erika Freeman**, Theme II • **Maitane Erdozain**, Theme II • **Dalal Hanna,** Theme III	**Koffler House 108**
11:35	**Mushkegowuk Climate Summit: Climate change, wetlands and research gap summit for Hudson and James Bay Lowlands** **David Pearson,** Professor, Laurentian University	

<table>
<tr><td>12:00</td><td colspan="3">Lunch</td><td>Main Activity Hall, 2nd Floor</td></tr>
<tr><td>1:30</td><td colspan="3">Lightning Talks, presented by CNAES Students, Post-docs & Alumni
Rachel DeJong, Theme I
Karly Harker, Theme II
Lauren Twible, Theme I
Gillian Fuss, Theme II
Stephanie Tomscha, Theme II</td><td rowspan="2">Koffler House 108</td></tr>
<tr><td>2:00</td><td colspan="3">Boreal 2050, CNAES Strategic Network Enhancement Initiative
Irena Creed, Professor, Western University & the Boreal 2050 Team</td></tr>
<tr><td>3:30</td><td colspan="4">Break
Walk to Faculty Club for Poster Session, Set up Posters</td></tr>
<tr><td>4:00</td><td colspan="3">Poster Session*
Odd-numbered posters will be presented from 4:00 -5:00 and even-numbered posters will be presented from 5:00 – 6:00. Refer to the Abstracts page 25– 45

*Appetizers & Cash Bar (debit/credit accepted)</td><td>Faculty Club, Main Dining Room</td></tr>
<tr><td>Evening</td><td>Dinner with colleagues
Refer to list of recommended restaurants</td><td>HQP Dinner & Social
Organized by the HQP Committee
Dinner 7:15pm,
WVRST
609 King Street West

8:30pm, SPiN
461 King Street West

Dinner and non-alcoholic beverages will provided</td><td>Science Committee Meeting
7:00pm
Her Fathers Cider Bar
119 Harbord Street</td><td></td></tr>
</table>

Thursday April 27, 2017: Annual Meeting Day 2		
Time	**Program**	**Room #**
8:30	**Check-in, name tags, coffee/tea/snacks available**	
9:10	**Opening remarks** **Don Jackson,** Scientific Director, CNAES	**Koffler House 108**
9:15	**Assessing mercury accumulation and concentrations in aquatic biota across the Attawapiskat drainage basin; implications for subsistence fisheries and the Ring of Fire development in the Far North of Ontario.** **Gretchen Lescord,** Laurentian University, CNAES Theme I	
9:30	**Lightning Talks,** *presented by CNAES Students, Post-docs & Alumni* • **Henrique Giacomini,** Theme III • **Matthew Heerschap**, Theme I • **Oscar Senar,** Theme II • **Karl Lamothe,** Theme III • **Camille Ouellet Dallaire,** Theme III	
10:00	**Fish species turnover and functional grouping responses to environmental change among estuaries** **Andrew Chin,** University of Toronto, CNAES Theme III	
10:15	**Networking Break**	**Multi-Purpose Room, 2nd Floor**
10:40	**Relative Influence of landform, hydrology, and stream habitat on benthic macroinvertebrate communities in a managed northern hardwood forest** **Kristin Daoust,** University of Guelph, CNAES Theme II Alumna	**Koffler House 108**
10:55	**Domestic Wastewater Transport and Treatment in Ladder Fen Peatlands: Implications for nutrient and mercury contamination** **Colin McCarter,** University of Waterloo, CNAES Theme I Alumnus	
11:10	**Fish behaving badly: What happens to hydroacoustic data when perch exhibit a novel swimming behaviour** **Abby Daigle**, University of Toronto, CNAES Theme III	
11:25	**Science Communication Video Workshop,** *CNAES Strategic Network Enhancement Initiative* **David Pearson and Colin Stringer, Laurentian University** *Featuring videos created by Abby Daigle and Andrew Chin*	
11:45	**Mentorship Lunch**	**Main Activity Room, 2nd Floor**
1:45	**Understanding the effects of wildfire in the boreal forest on the riparian-stream interface: implications for riparian management strategies** **Jordan Musetta-Lambert**, University of Guelph, CNAES Theme II	**Koffler House 108**

2:00	**Biomonitoring in the Ring of Fire Mining Development Under Changing Climate Conditions: Addressing Seasonal Variability of BMI Communities and Stream Characteristics in Two Ecozones in Northern Ontario, Canada** **Vanessa Bourne,** Laurentian University, CNAES Theme I	**Koffler House 108**
2:15	**Habitat quality and connectivity in urban streams** **Chris Edge,** University of Toronto, CNAES Theme III Alumnus	
2:30	**HQP Committee Update & Networking Survey** **Andrew Chin** and **Stephanie Tomscha**, HQP Committee	
2:45	**Networking Break**	**Main Activity Room, 2nd Floor**
3:10	**Landscape Indicators of Groundwater Nitrate Concentrations: A Tool for Trans-Border Aquifer Monitoring** **Tanya Gallagher,** University of British Columbia, CNAES Theme II	**Koffler House 108**
3:25	**CNAES Overview** **Don Jackson,** Scientific Director, CNAES	
3:45	**Partner Panel Discussion** *Moderated by Don Jackson* **Panelists:** **Rachel Fletcher** **David Kreutzweiser** **Brian Shuter** **Brian Steinback**	
6:30pm	**Network Dinner** **Celebrating 5-years of CNAES!** *Business casual attire* **Reception, 6:30 pm; Dinner served, 7:30pm; Remarks, 8:30pm** *Cash bar, ATM on the premises*	**Hart House, The Great Hall** *7 Hart House Circle*

Friday April 28, 2017: Workshop		
Time	**Program**	**Room#**
8:30	**Breakfast and Theme Meetings** *Hot breakfast buffet provided*	**Main Activity Hall, 2nd Floor**
10:00	**Introduction to the Federal, Provincial, and Territorial Governments of Canada 'Ecosystem Services Toolkit': Completing and Using Ecosystem Service Assessment for Decision-Making** **Ciara Raudsepp-Hearne,** Senior Scientist, McGill University *10:00 – 11:15: Toolkit presentation, plus time for questions* *11:15 – 12:00: Exercises in small groups* *12:00 – 1:00: Debrief and discussion*	**ESC 4000 and 4001, 4th floor** *Enter from Bancroft Avenue*
1:00	**Lunch**	**ESC 4000 and 4001**
	CNAES Board of Directors Meeting **1:45 – 4pm**	**ESC 1014** *enter through 43 Willcocks Ave doors*

Wednesday, April 26th Speaker Titles, Abstracts & Bios

9:10 The Hard Work of Hope: Sustaining Cooperation on Water Security and Climate Stability in a Post-Truth Trumpocene

Bob Sandford, *EPCOR Chair for Water and Climate Security, United Nations University Institute for Water, Environment and Health, CNAES Board of Directors*

During his campaign for President, Donald Trump repeatedly warned that if elected he would eliminate harmful and unnecessary policies such as the Climate Action Plan and the Waters of the U.S. Rule. Thirteen days after the President's inauguration his administration repealed the stream protection rule that restricts coal companies from dumping mining wastes into streams and waterways. What should be of interest to Canadians is that the highly contested Waters of the U.S. Rule was brought into existence specifically to clarify sections of the U.S. Clean Water Act with respect to protection of American water bodies; endangered aquatic ecosystems and species; and the capacity of waters to purify themselves for human use downstream. A few weeks later, Trump went on to effectively gut all previous climate-related legislation and eliminate all funding for federal climate research. This could not have happened at a worse time. Scientists all over the world fear that if we back off on our efforts to stabilize the composition of the Earth's atmosphere now it could cost our civilization the last precious years in which our actions might have made a difference in managing a rapidly accelerating water cycle and its potentially devastating effects on climate stability. This is clearly a time when, for the sake of the future, we need to stand by scientific principles and defend the scientific method in all matters related to water and water-related effects of climate change. Now is the time to support, report, communicate and celebrate scientific research outcomes in Canada.

Bob Sandford holds the EPCOR Chair in Water and Climate Security at the United Nations University Institute for Water Environment and Health. In this capacity Bob was the co-author of the UN *Water in the World We Want* report on post-2015 global sustainable development goals relating to water. Bob is also senior advisor on water issues for the Interaction Council, a global public policy forum composed of more than thirty former Heads of State including Canadian Prime Minister Jean Chretien, U.S. President Bill Clinton and the former Prime Minister of Norway, Gro Brundtland. Bob is also a Fellow of the Centre for Hydrology at the University of Saskatchewan and a Fellow of the Biogeoscience Institute at the University of Calgary. He is a senior policy advisor for the Adaptation to Climate Change team at Simon Fraser University and is also a member of the Forum for Leadership on Water (FLOW), a national water policy research group centred in Toronto. Bob is also the author or co-author of a number of high-profile works on water including *Cold Matters: The State & Fate of Canada's Snow and Ice*; *Saving Lake Winnipeg*; *Flood Forecast: Climate Risk & Resilience in Canada* and most recently *The Columbia Icefield* and *North America in the Anthropocene* all published by Rocky Mountain Books. His latest book *Our Vanishing*

Glaciers: The Snows of Yesteryear and the Future Climate of the Mountain West will be released in the summer of 2017.

10:10 **Lighting Talks,** *presented by CNAES Students, Post-docs & Alumni*

Alex Yeung, Theme II, **Evaluation of stream ecological integrity using litter decomposition: should we consider inter-annual hydrologic variability?**

Nicole Balliston, Theme I, **Capillary Rise of Solute in Partially Saturated Surficial Peat Profiles**

Liset Cruz Font, Theme III**, Lake ecotype influences the metabolic costs by Lake Trout: a telemetry approach using acceleration transmitters**

Kelli Charbonneau, Theme II, **Are there spatially cumulative impacts downstream of forest harvesting operations in northern hardwood catchments?**

Jason Igras, Theme II, **Quantifying Management Uncertainty with the Bowtie Risk Analysis Tool**

11:05 **Lightning Talks,** *presented by CNAES Students, Post-docs & Alumni*

Wagner da Costa Moreira, Theme III, **Unravelling the main productivity drivers of five important sport fish species from Ontario lakes, according to limiting and controlling environmental determinants and anthropogenic impact**

Amanda Lavalle, Theme I, **The effects of simulated treated domestic wastewater on *Sphagnum* productivity, decomposition, and nutrient dynamics in a subarctic ribbed fen**

Erika Freeman, Theme II, **Dolichospermum sp: Pirates of the pelagic?**

Maitane Erdozain, Theme II, **Understanding the effects of high intensity forest management on stream ecosystem integrity to protect aquatic ecosystem services**

Dalal Hanna, Theme III, **Ecosystem service bundles in watersheds located in and outside of protected areas-research design and preliminary findings**

11:35 **Mushkegowuk Climate Summit: Climate change, wetlands and research gap summit for Hudson and James Bay Lowlands**

David Pearson, *Professor, Laurentian University*

A two day Science and Climate Summit attended by 211 people was jointly organized by the Project 1-6 team at Laurentian U. and the Mushkegowuk Tribal Council staff and held on December 7 and 8 in Timmins. Participants included the Mushkegowuk Environmental Stewards from each of their

eight communities, and a delegation of six, including youth, elders and planners from each community. Twenty four PIs and environmental researchers and their graduate students attended, presented, and hosted "table talks" with First Nation participants and others attending. All were either CNAES members or research colleagues involved in work in the Hudson Bay Lowlands. A planning session on the second day resulted in a recommendation that a collaborative environmental research network should be established. Laurentian is intending to continue to contribute, potentially as the post-secondary research hub of the network, helping to connect researchers from several universities and government with the Mushkegowuk Tribal Council and its member First Nations in collaborative projects, such as the climate change impacts and adaptation study already underway.

1:30 **Lightning Talks,** *presented by CNAES Students, Post-docs & Alumni*

Rachel DeJong, Theme I, **Life history characteristics of Lake Whitefish (*Coregonus clupeaformis)*, Cisco (*Coregonus artedi*), and Northern Pike (*Esox lucius*) in rivers of the Hudson Bay Lowlands**

Karly Harker, Theme II, **Measuring Long-Term Cumulative Effects on the Spatial and Temporal Dynamics of Riverine Systems**

Lauren Twible, Theme I, **Evaluating the impact of additions of sulphate on net methylmercury production in pristine sub-arctic peats**

Gillian Fuss, Theme II, **Hydrologic and landscape controls on turbidity within watersheds**

Stephanie Tomscha, Theme II, **Does biophysical and participatory mapping of ecosystem services reveal similar locations for stakeholder conflict and cooperation?**

2:00 **Boreal 2050,** *CNAES Strategic Network Enhancement Initiative*
Irena Creed, Professor, Western University & the **Boreal 2050 Team**

Refer to the related Abstracts #29-35 on pages 41-45

4:00 **Poster Session**

Odd-numbered posters will be presented from 4:00 -5:00 and even-numbered posters will be presented from 5:00 – 6:00. **Refer to the Abstracts page 25– 45**

Thursday, April 27th Speaker Titles, Abstracts & Bios

9:15 **Assessing mercury accumulation and concentrations in aquatic biota across the Attawapiskat drainage basin; implications for subsistence fisheries and the Ring of Fire development in the Far North of Ontario.**

Theme 1, Project 1.5b

Gretchen Lescord*, Brian Branfireun, Tom Johnston*[2], Erik Szkokan-Emilson[3], John Gunn*

**Laurentian University, Sudbury ON Canada; [1]Western University, London ON Canada; [2]Ontario Ministry of Natural Resources and Forestry, Sudbury ON Canada; [3]Cambridge University, Cambridge England.*

Mercury (Hg), a neurotoxic metal, has complex cycling in freshwater systems largely due to interactions with various physio-chemical parameters. To better understand how these interactions change across a watershed, I am studying the vast Attawapiskat Drainage Basin (ADB) in northern Ontario, which transitions from headwater lakes in the Boreal Shield into the Attawapiskat River in the Hudson Bay Lowlands. The goal of my thesis is to utilize the diverse nature of this watershed to better understand how physical and chemical gradients affect Hg concentrations in water, invertebrates, and fish. Specifically, I am considering changes in the quality of dissolved organic matter (DOM), which can have both stimulating and inhibiting effects on Hg bioaccumulation, throughout the ADB. Preliminary results suggest that heavier and more aromatic DOM complexes reduce Hg concentrations in lake water, likely due to sedimentation. Currently, I am analyzing biotic samples for Hg and will relate these concentrations to various measures of DOM quality (e.g. PARFAC). These results will be particularly important given the impending develop of the "Ring of Fire," a mineral-rich area located within the ADB. Such development can greatly alter DOM quality, as well as other water chemistry factors, which in turn can effect Hg cycling.

Originally from Maine in the U.S.A. **Gretchen Lescord** has lived and studied in Canada for over 11 years. In 2013, she completed her M.Sc. degree at the University of New Brunswick, where she worked with an Inuit community to study environmental contaminates in Arctic char from remote lakes in northern Nunavut. Now, using her knowledge on chemical cycling, fish ecology, and environmental effects monitoring practices, she is working on her Ph.D. at Laurentian University under the supervision of Drs. John Gunn and Tom Johnston. Gretchen studies how mercury (Hg) concentrations in water and biota change as the size and chemistry of the lakes/rivers naturally shift across the remote Attawapiskat Drainage Basin in the Far North of Ontario. Her work will provide a thorough understanding of Hg concentrations throughout the Attawapiskat basin and provide valuable baseline data in this pristine region, which is facing extensive mining development within the coming decade. Furthermore, given that many of the fish analyzed for her study are targets of subsistence fisheries, she will also be adding to and updating the Guide to Eating Ontario Fish, a set of fish consumption guidelines based on geographic location and fish species.

9:30 **Lightning Talks,** *presented by CNAES Students, Post-docs & Alumni*

Henrique Giacomini, Theme III, **Expanding biomass size spectra models**

Matthew Heerschap, Theme I, **Concentrations and fatty acid compositions of subsistence fishes in coastal rivers of the Far North of Ontario**

Oscar Senar, Theme II, **Effects of brownification in temperate oligotrophic lakes**

Karl Lamothe, Theme III, **Evaluating Freshwater Ecosystem Condition by Quantifying Resilience**

Camille Ouellet Dallaire, Theme III, **Which rivers do we ask the most work from in Canada?**

10:00 **Fish species turnover and functional grouping responses to environmental change among estuaries**
CNAES, Theme III, Project III.3
Andrew Chin, *University of Toronto*

Estuarine ecosystems are resilient to the dynamic variability of environmental conditions. Yet, it is unknown how the magnitude of environmental change will adversely affect the ability of fish communities to persist in the face of climate change. I assessed how fish community structure varies across estuaries and dynamic environmental conditions based on beta diversity and fish functional traits. I used a Fisheries and Oceans Canada dataset (2004-2012) in 100 sites among 17 estuaries surveying fish abundances and water quality in New Brunswick, Canada. First, I assessed beta diversity as spatial turnover, where four sites were significantly different than across the region. Spatial turnover was mainly driven by water temperature variability at a site. Second, I investigated environmental effects on functional trait composition within sites. Redundancy analysis (R^2_{adj} = 0.259) showed that the abundance of functional trait compositions (pelagic/demersal) responded to salinity and temperature gradients from 2006-2011. These findings of fish community structure can help inform management of estuaries in the face of a rapidly changing environment as changes in biotic resources, such as a fishery, would require mitigation for such an effect.

Andrew Chin's PhD research at the University of Toronto investigates the effects of land use and environmental change on fish communities in estuaries to their headwaters. These changes influence aquatic ecosystems in terms of restricting species movement as well as habitat quality and amount. Results of his findings could help inform policy and management guidelines necessary for species persistence.

10:40 **Relative Influence of landform, hydrology, and stream habitat on benthic macroinvertebrate communities in a managed northern hardwood forest**

Kristin Daoust, *University of Guelph*

Our present understanding of the effects of natural and anthropogenic disturbance in forested landscapes is based on a long history of studies relating watershed physical, chemical, and biological indicators to biotic responses. The predictive relationships resulting from this work has proven informative for forest management, but such evaluations have not been applied to all forest types and management conditions and rarely in the context of the aquatic ecosystem services (AES). In this study, I use a combination of field measurements and modelling based on a comprehensive suite of landscape, hydrological, chemical, and habitat variables (80 in total) to develop predictive relationships between these variables and benthic macroinvertebrate (BMI) community composition of forested headwater streams, which can be used as indicators of AES. I focus on the Lower Batchawana Watershed (LBW), an area of mixed hardwood forests north of Sault Saint Marie, Ontario, which contains a gradient of disturbance, ranging from undisturbed to intensively harvested over the past 25 years. I show that catchment size and stream flow rise rate ('flashiness') has the largest influence on BMI community structure in the LBW, while forest harvest (spatial extent and time since harvest) had no measurable adverse effect. By better defining the relationship between physicochemical and biological indicators of AES, I hope to provide policy makers and managers with the information required to make effective monitoring and management decisions aimed at ensuring sustainability of forest-based AES.

Kristin Daoust completed her BSc, Honours at McMaster University in Integrated Science with a concentration in Biology in 2014. She later moved to the University of Guelph where she completed her MSc in Environmental Sciences earlier this year working with Dr. Paul Sibley to investigate the influence of physical, chemical, and biological indicators on benthic macroinvertebrates in the Lower Batchawana Watershed. She has been a member of the Canadian Network for Aquatic Ecosystems Services since 2014 and has worked for fellow member Dr. Karen Kidd as a field assistant, sampling streams in Northern New Brunswick and Northern Ontario. Kristin has recently returned from a two-month trip to New Zealand.

10:55 **Domestic Wastewater Transport and Treatment in Ladder Fen Peatlands: Implications for nutrient and mercury contamination**

CNAES Theme I, Project I-4

Colin McCarter[1], Brian Branfireun[2], & Jonathan Price[3]

[1]*Department of Earth and Environmental Sciences, University of Waterloo,*
[2]*Department of Biology, University of Western Ontario,*
[3]*Department of Geography and Environmental Management, University of Waterloo*

Safely treating wastewater in remote communities and mining operations in sub-arctic Canada is critical to protecting the surrounding aquatic ecosystems. Undisturbed fen peatlands have been used to

minimize the release of contaminants to the aquatic ecosystems; however, there is a limited understanding of wastewater transport or treatment in undisturbed fen peatlands. To elucidate these processes, a small (9800 m^2, ~250 m long) ladder fen was continuously injected with a wastewater surrogate derived from a custom fertilizer blend and 38 m^3 day^{-1} of water for 51 days. The simulated wastewater included sulphate (27.2 mg L^{-1}), nitrate (7.6 mg L^{-1}), ammonium (9.1 mg L^{-1}), phosphate (7.4 mg L^{-1}), and chloride (47.2 mg L^{-1}). Major ion, total mercury (THg) and methylmercury (MeHg) pore water concentrations were measured throughout the study period. An exponential increase in transmissivity (2.4 to 16.8 m^2 day^{-1}) as the water table rose (~0.16 m) increased the average linear groundwater velocity (0.5 to 3.4 m day^{-1}) and resulted in rapid sulphate (1.3 m day^{-1}) and chloride (1.9 m day^{-1}) transport. Contrary to the rapid transport of sulphate and chloride, the other contaminants were rapidly removed from the pore water (likely through biological uptake or adsorption) and minimal transport was observed (0.2, 0.3 and 0.04 m day^{-1} for phosphate, ammonium, and nitrate, respectively). Within the sulphate plume, MeHg and THg concentrations became highly elevated relative to background (up to 10 ng L^{-1}, ~ five-fold increase) and MeHg comprised 80 – 100 % of dissolved THg in the pore water. No MeHg or THg was exported at the outflow. The large increase in THg cannot be solely accounted for by the increase in MeHg and was likely due to enhanced decomposition of the peat substrate by increased microbial activity due to electron acceptor loading. Since the added nutrients were effectively transformed, sequestered or otherwise removed from pore waters in this experimental system, it appears that fen peatlands have a large capacity to safely treat residential wastewater nutrients; however, the inadvertent increases in THg and MeHg require further investigation and potential management.

Colin McCarter's research focuses on the hydrological and biogeochemical transport of nutrients, contaminants, carbon, and other chemicals in complex organic media, wetlands and watersheds. Additionally, Colin investigate how the physical structure of Sphagnum mosses effects unsaturated water flow and the implications for ecohydrology and peatland restoration.

11:10 Fish behaving badly: What happens to hydroacoustic data when perch exhibit a novel swimming behaviour

CNAES Project III-3

Abby Daigle[1], Brian Shuter[1,2], and Don Jackson[1]

[1]*University of Toronto,* [2]*Ontario Ministry of Natural Resources & Forestry*

An ongoing study at the Experimental Lakes Area has been using mobile hydroacoustic surveys to collect information about the resident fish community in Lake 626. However, the presence of *Chaoborus*, a large zooplankton, complicates data collection. This is because small perch overlap in acoustic reflectivity with the *Chaoborus*. To date, a low-end size threshold has been used to remove this problematic data. However, it is unclear how many individual perch detections are being lost from the dataset. To determine this, we set up two stationary, upward-facing, 120kHz hydroacoustic transducers in Lake 626. These transducers ran 24 hours a day, for seven days straight in August 2016. The goal of this experiment was to capture periods of time where yellow perch were disaggregated

from their schools, but prior to *Chaoborus* rising from the sediment. Such data would allow for the construction of a perch length distribution that would be inclusive of all size classes. This distribution could then quantify the number of individuals lost when our low-end threshold is used to remove noisy data created by the presence of *Chaoborus*. Upon analysis of the stationary data an important and unexpected observation was made; perch are breaking the assumption of horizontal swimming. The novel 'zig-zag' swimming pattern observed presents two large problems for interpreting hydroacoustic data, (1) the data becomes biased toward small sizes and (2) we observe an inflation in detection estimates. Given that the use of hydroacoustics in freshwater systems is relatively novel, such an unexpected finding highlights the importance of testing hydroacoustic assumptions in these environments.

Abby Daigle is an avid aquatic ecologist. She is currently working on her MSc under the supervision of Brian Shuter and Don Jackson at the University of Toronto. Abby has been working on a climate change project that investigates the impact of drier conditions on a boreal freshwater fish community. Abby is an Ontario native, and grew up in the Greater Toronto Area, spending much of her childhood mucking about in streams, ponds, and lakes. She completed her undergraduate at the University of Toronto, but her love of everything water-related brought her to Sweden for a 3rd-year exchange. During this time, Abby participated in a focused aquatic ecology program that was comprised of four core courses: marine ecology, aquatic ecology, fisheries ecology, and water management. Upon returning, she began a 4th-year research project under the supervision of Martin Krkosek. The project aimed to determine the mechanism behind the increase in population variation observed in exploited fish species. Abby finished her undergraduate in 2015, but happily remained at the University of Toronto in the department of Ecology and Evolutionary Biology. When not at her desk, Abby can likely be found either playing inner tube water polo, helping with a friend's field work, or planning a departmental event.

11:25 **Science Communication Video Workshop,** *CNAES Strategic Network Enhancement Initiative*
David Pearson and **Colin Stringer,** Laurentian University
Featuring videos created by Abby Daigle and Andrew Chin

Dave Pearson is an earth scientist and professor in the School of the Environment at Laurentian University. He teaches in the graduate program in Science Communication. In 1975 he worked with TV Ontario to create and host one of Ontario's first television-based distance education courses, "Understanding the Earth". In the 1980s and 1990s he was heavily involved in science communication as "Dr. Dave" on the Monday morning "Radio Lab" on CBC Northern Ontario Radio and as host of a Saturday evening, community-centred environmental series, "Down to Earth", for Mid-Canada TV. David was on leave from Laurentian from 1980 to 1986 as Project Director and then the Founding Director of Science North in Sudbury, Canada's second largest science centre. He is currently leading a small team in the Lake Centre at Laurentian that is working with over thirty remote First Nations in far north Ontario, studying the past and future impacts of climate change and potential ways of adapting to the changes.

Colin Stringer is a filmmaker who holds a Master of Science in Molecular and Cellular Biology from the University of Guelph. Following five years of experience in academic research, Colin completed a Graduate Diploma in Science Communication at Laurentian University with a focus on film and mass media, which earned him several student awards.

In 2014, Colin moved to New York City to work with Brooklyn-based Imagine Science Films (ISF) where he researched, wrote, shot and and edited short "Spotlight" films, including collaborative efforts with TEDMED and the Marina Abramovic Institute. Colin served as ISF's Communications Manager and Volunteer Coordinator for the 8th Annual Imagine Science Film Festival.

Based in Sudbury, Ontario, Colin operates a media production company that works primarily with clients in science and research organizations to effectively communicate the impacts of their research to various stakeholder audiences. Colin has been instructing science video production to graduate students for three years, and is an instructor with the CNAES graduate student science communication training initiative.

1:45 Understanding the effects of wildfire in the boreal forest on the riparian-stream interface: implications for riparian management strategies

Jordan Musetta-Lambert, David Kreutzweiser, Muto E.A., and Paul Sibley.
CNAES Project II-2.2: Experimental manipulations to test the effects of forest management activities on physical, chemical and biological indicators of aquatic ecosystems services from headwaters of forested landscapes.

Managing forested watersheds to maintain stream health through the Emulation of Natural Disturbance (END) paradigm requires understanding how natural disturbances influence riparian-stream structure, function, and cross-boundary energy transfer. We examined riparian condition and stream function across boreal, headwater streams with wildfire, harvested with riparian buffers, and reference catchment histories. We assessed riparian vegetation characteristics, and allochthonous subsidies (terrestrial invertebrate and leaf-litter inputs) to streams. Instream, we assessed leaf-litter decomposition using standardized and disturbed-modelled leaf packs, and their associated macroinvertebrate communities. Riparian juvenile woody-stem and shrub communities had significantly higher taxa richness and were compositionally different at fire than harvested and reference sites. Leaf litter input from riparian forests to streams was compositionally dissimilar and significantly greater at fire than harvested and reference sites. Although *Alnus icana* ssp. *rugosa*, speckled alder, leaf pack decomposition rates were not significantly different among disturbances, the associated invertebrate communities were characterized by significantly higher taxa richness and unique shredder taxa at fire sites. The overall abundance of aquatic macroinvertebrates in drift samples were significantly higher at fire than harvested or reference sites. No differences were detected in terrestrial invertebrate input to streams among disturbances. Using sensitive bio-indicators and setting ecologically relevant targets for managing riparian forests under END could benefit aquatic

ecosystem services (AES). Inducing forest succession, enhancing leaf-litter inputs and instream organic matter processing, and promoting natural complexity in riparian habitats would help sustain AES delivery such as the support of aquatic biodiversity.

Jordan Musetta-Lambert is a PhD. Candidate in the School of Environmental Sciences at the University of Guelph under the supervision of Dr. Paul Sibley and has been a student in the CNAES network since fall 2013. He received his BSc. in biology in 2008 and completed a MSc. working in intertidal ecology in 2013, both at the University of New Brunswick. Throughout his academic career, he has remained interested in the dynamics of boundary ecosystems, but he has shifted his focus from north Atlantic intertidal shorelines studying natural rocky intertidal areas and breakwaters, to mixed-boreal forest watersheds studying riparian forests and headwater streams. Jordan is interested in how forest harvesting and wildfire, two of the main drivers of disturbance in the boreal forest watersheds, influence ecological structure and function in riparian forests and headwater streams, and the connective pathways that link these two habitats. Jordan's research aims to inform forestry management decisions by developing ecologically relevant endpoints to achieve under the Emulation of Natural Disturbance paradigm.

2:00 **Biomonitoring in the Ring of Fire Mining Development Under Changing Climate Conditions: Addressing Seasonal Variability of BMI Communities and Stream Characteristics in Two Ecozones in Northern Ontario, Canada**

CNAES, Theme I, Project I-3

Vanessa Bourne[1], John Bailey[2], John Gunn[1] and Aaron Todd[3]

Laurentian University[1]*, Government of Yukon*[2]*, Ontario Ministry of Environment and Climate Change*[3]

The vast "Ring of Fire" region is considered to be one of the most promising mineral exploration areas to be discovered in Ontario in almost a century. Multiple stresses to the natural ecosystems are anticipated with mining development and climate change, which is predicted to impact hydrological and temperature regimes. Quantifying seasonal variation of habitat characteristics and benthic macroinvertebrate (BMI) communities at proposed biomonitoring reference sites, and determining the influence that the ecozone location may have on that variability, are important components of designing future bioassessments for the region. In this study, we examined seasonal variability in habitat characteristics and BMI communities by sampling 43 stream sites in the post freshet, mid-summer and fall of 2015 that are distributed across the two ecozones in the future mining region. BMI communities varied among sampling seasons, but less variation was observed between the post-freshet/ summer sampling than between comparisons to the fall. Ecozone did not have an impact on the seasonal variability of BMI communities. This is hypothesized to be due to selecting stream sites with similar characteristics (rocky bottoms, flowing water, wadeable), as well as the stream sites having similar riparian vegetation.

Vanessa Bourne is a Master's candidate (soon to defend!) under the supervision of Dr. John Gunn and Dr. John Bailey. She became part of the Living with Lakes Centre family in 2015 after completing a

degree in Environmental Biology at Queen's University. Between finishing up at Queen's and before starting at Laurentian she spent a year working with Aquatic Monitoring Section of the OMNRF. Growing up enjoying the great outdoors has led Vanessa to be curious about the environment she lives in making a careers in aquatic biology a natural path to take. After CNAES she will be starting working for the OMOECC out of the Living with Lakes Centre where she will be a part of the aquatic monitoring of Sudbury's recovering lakes and reference stream sampling in the Ring of Fire region of Northern Ontario.

2:15 **Habitat quality and connectivity in urban streams**
CNAES, Theme III, ProjectIII.7
Chris Edge
Toronto and Region Conservation Authority
Ecology and Evolutionary Biology, University of Toronto

Habitat degradation and fragmentation are two major threats to stream fish communities. Population models show that habitat loss has greater relative impact metapopulation persistence than habitat fragmentation. An effect that is likely due to the scale specific effects of habitat change and fragmentation. Habitat degradation changes the quality of individual stream segments, altering the species that can persist, whereas fragmentation prevents the movement of individuals among stream segments, reducing the amount of available habitat and preventing dispersal. Comparing the structure of stream fish communities to the quality and connectivity of streams demonstrates that habitat change has a greater influence on alpha diversity than fragmentation, and fragmentation has a greater impact on beta diversity than habitat change. Within urban streams restoration activities has focused on restoring habitat quality and mitigating instream barriers. Mitigation has improved the overall connectivity of streams, but these projects have disproportionately been focused on improving connectivity for migratory salmonids rather than resident species.

2:30 **HQP Committee Update & Networking Survey**
Andrew Chin and **Stephanie Tomscha**, HQP Committee

3:10 **Landscape Indicators of Groundwater Nitrate Concentrations: A Tool for Trans-Border Aquifer Monitoring**
CNAES Project II-3
Tanya Gallagher, Sarah Gergel
University of British Columbia

Excess nitrate (NO_3) contamination of groundwater is a growing global health concern, and monitoring the world's 448 transboundary aquifer bodies is challenged by complexities associated with multi-jurisdictional governance. In a region where elevated groundwater NO_3 concentrations are linked to overlying land use and land cover (LULC), we develop landscape indicators (LIs) characterizing likely sources of NO_3 and examine their correspondence with groundwater NO_3 concentrations. We evaluate

their use for trend detection and monitoring in an aquifer spanning the US and Canada, asking two primary questions: Are NO_3 concentrations in the aquifer changing over time? How well do LIs help explain patterns of groundwater NO_3 concentrations?

To answer our first question, a time series (2005-2013) of groundwater NO_3 concentrations was examined for 15 wells using Mann-Kendall trend analysis tests. NO_3 concentrations in 9 monitoring wells decreased while 2 increased over time. To answer our second question, a cross-border land cover mosaic was created. LIs such as crop type (proportion of raspberries, forest, etc.) were measured in terrestrial zones of influence (incorporating varying sized radii and groundwater flow directions) surrounding each well. Backward stepwise regression was used to identify parsimonious models of NO_3 concentrations as a function of LIs with a comparison of US and Canada. Models with proportions of different berry types, bare land, and forage/pasture consistently explained 15-47% of the variance in groundwater NO_3 concentrations, depending on zonal scale, direction, or jurisdiction. Our work provides an important, highly transportable approach for regions facing similar management challenges.

As a PhD candidate at the University of British Columbia, I am interested in studying how human practices impact ecological systems. More specifically, I examine land use and land cover changes and how these changes may be linked to nitrate contamination. Using a landscape mapping perspective, I am working to determine what terrestrial landscape indicators correlate best with and predict groundwater nitrate levels in the Abbotsford – Sumas Aquifer, a region that spans the US-Canada border (between SW British Columbia and Washington). I use high spatial resolution imagery (i.e. LiDAR, RapidEye, historical aerial photos) to quantify fine scale features with suspected mechanistic links to nitrate sources. This work represents an important first step in the development of affordable monitoring approaches for trans-border water resources.

3:25 **CNAES Overview**
Don Jackson, Scientific Director, CNAES

3:45 **Partner Panel Discussion**
Moderated by Don Jackson
Panelists:
Rachel Fletcher
David Kreutzweiser
Brian Shuter
Brian Steinback

Friday, April 28th Workshop Abstract

Introduction to the Federal, Provincial, and Territorial Governments of Canada 'Ecosystem Services Toolkit': Completing and Using Ecosystem Service Assessment for Decision-Making

This workshop will provide a brief introduction to a new interdisciplinary toolkit on ecosystem services for managers and analysts, produced by a joint taskforce of Federal, Provincial, and Territorial Governments of Canada. The toolkit was designed to support the development of policy-relevant, technical information that can feed into processes such as area-based planning, regulatory decision analysis, environmental management and conservation initiatives. The toolkit provides detailed how-to advice for ecosystem service work to be completed by people with different areas of expertise who come to the field of ecosystem services with different perspectives. There is an emphasis on the consideration of the most relevant values associated with ecosystem services within a given context and in relation to specific questions, including biophysical, socio-cultural and economic values. The workshop will begin with a presentation on the resources and tools included in the toolkit. Participants will then work through several exercises designed to focus ecosystem service assessment on policy-relevant questions and metrics. Participants are asked to come with specific projects or policy/management issues that they can apply the toolkit assessment processes to, working in small groups.

Dr. Ciara Raudsepp-Hearne is a researcher and consultant, currently based at McGill University in Montreal. Her research centers on ecosystem service theory and implementation, as well as on sustainability, resilience, and future thinking. Current and recent collaborations include with the UN Convention on Biological Diversity, FutureEarth, the Program on Ecosystem Change and Society (PECS), the Stockholm Resilience Center, and the Sustainable Canada Dialogue. Ciara served as the coordinator of the Subglobal Assessment Working Group of the Millennium Ecosystem Assessment and has co-authored several follow-up methodology documents on ecosystem services for decision-makers, including the recent Canadian governments' Ecosystem Services Toolkit, a World Resources Institute handbook on ecosystem services for the public sector, and a UNEP textbook for ecosystem service assessment. Ciara has worked directly with governments at different scales that are trying to operationalize ecosystem service concepts through policies and programs.

Abstracts (all)

Listed in order of Project ID.

1 Seasonal Variability of BMI Communities and Stream Characteristics in Two Ecozones in Northern Ontario, Canada

CNAES Theme I, Project I-3:

Vanessa Bourne[1], John Bailey[2], John Gunn[1] and Aaron Todd[3]
[1] Laurentian University
[2] Government of Yukon
[3] Ontario Ministry of Environment and Climate Change

The vast "Ring of Fire" region is considered to be one of the most promising mineral exploration areas to be discovered in Ontario in almost a century. Multiple stresses to the natural ecosystems are anticipated with mining development and climate change, which is predicted to impact hydrological and temperature regimes. Quantifying seasonal variation of habitat characteristics and benthic macroinvertebrate (BMI) communities at proposed biomonitoring reference sites, and determining the influence that the ecozone location may have on that variability, are important components of designing future bioassessments for the region. In this study, we examined seasonal variability in habitat characteristics and BMI communities by sampling 43 stream sites in the post freshet, mid-summer and fall of 2015 that are distributed across the two ecozones in the future mining region. BMI communities varied among sampling seasons, but less variation was observed between the post-freshet/ summer sampling than between comparisons to the fall. Ecozone did not have an impact on the seasonal variability of BMI communities. This is hypothesized to be due to selecting stream sites with similar characteristics (rocky bottoms, flowing water, wadeable), as well as the stream sites having similar riparian vegetation.

2 The effects of simulated treated domestic wastewater on *Sphagnum* productivity, decomposition, and nutrient dynamics in a subarctic ribbed fen

CNAES Theme I, Project I-4e

Amanda Lavallee[1,2], Jim McLaughlin[3] and Daniel Campbell[1,4]
[1]Vale Living with Lakes Centre, Laurentian University
[2]Department of Biology, Laurentian University
[3]Ontario Forestry Research Institute
[4]School of the Environment Laurentian University

Peatlands dominate the flat landscape of the Hudson Bay Lowland (HBL). *Sphagnum* mosses are the key peat-generating plants allowing for important ecosystem services such as carbon storage and water polishing. The HBL peatlands may become increasingly used to treat tertiary wastewater from mining camps. We determined how the nutrient additions affected the productivity, decomposition, and nutrient

	ratios, within a ribbed fen wetland. Results show between a four to twelvefold increase in productivity rates of the low-lying *Sphagnum rubellum* species, and a twofold increase in productivity for the higher hummock or ridge dominating species *Sphagnum fuscum* in locations closest to the point source of nutrient effluent. Regions of the experimental ribbed fen greater than 50 m away from the point source showed little difference in productivity rates, nutrient content, or decomposition rate than the reference fen levels. No significant changes to the rate of decomposition of *Sphagnum* were observed with relation to distance away from point source nutrients. *Sphagnum* productivity per year remained greater than mass lost to decomposition. Therefore, this study suggests that in the short-term subarctic peatlands exposed to nutrient levels comparable to that present in treated domestic wastewater will increase their capacity to generate *Sphagnum*-peat and store carbon.
3	**Evaluating the impact of additions of sulphate on net methylmercury production in pristine sub-arctic peats** *CNAES Theme I, Project I.4* **Lauren Twible**[1*] and Brian Branfireun[2] [1]Department of Earth Sciences, Western University [2]Department of Biology and Centre for Environment and Sustainability, Western University Sulphate additions to peatlands are known to increase methylmercury (MeHg) concentrations but little information exists about the effects of different concentrations of sulphate loading on the magnitude of MeHg production. In remote, northern higher latitude peatlands, atmospheric loading of sulphate is extremely low – areas where sulphate is higher are some sites of groundwater-surface water interaction, or where there has been land use change such as extractive mining. Glass chromatography columns were packed with peat, under anaerobic conditions. For the first experiment, continuous additions of three different sulphate concentrations (1, 5, and 30ppm, plus controls) to simulate the addition of sulphate-rich groundwater or wastewater containing sulphate to peat. In the second experiment, sulphate was delivered to the peat column by passing distilled water through a column packed with milled waste rock to simulate the pulse of sulphate delivered from mine tailings. All sulphate additions stimulated net MeHg production in both solid and aqueous phase, however the highest MeHg concentrations were seen in the 5ppm. Results suggest that even very modest additions of sulphate to these pristine peats would result in a significant increase in MeHg in pore waters and potential downstream effects requiring careful consideration of both water and waste rock management for sulphate.
4	**Capillary Rise of Solute in Partially Saturated Surficial Peat Profiles** *CNAES Theme I, Project I.4* **Nicole Balliston**[1] and Jonathan Price[1,] [1]Wetlands Hydrology Lab, University of Waterloo

In Ontario's subarctic, resource extraction operations create an increasing risk of unintentional contaminant release into peatlands. In the event of a release, a thorough understanding of contaminant transport within the unsaturated upper peat layer is necessary to determine plume fate and upwards mobility to surficial mosses. To assess field scale transport, approximately 14 000 L/day of sodium chloride tracer was released into a bog for 45 days in the James Bay Lowlands, and measured using Time Domain Reflectrometry sensors via electrical conductivity (EC). Following the spill, 30 cm cores were extracted and an unsaturated breakthrough experiment was conducted for 60 days in-lab. In-field, elevated EC values were observed in the unsaturated zone, increasing on average from ≈25 to ≈50 µs/cm in the shallowest (5 cm) probes, indicative of capillary rise. In-lab, rates of upward chloride migration were highly variable between cores due to inter core heterogeneity. 50% chloride breakthrough occurred within the 60 day period in the top 5 cm at 2 of 3 cores. Results of this research demonstrate the ability of solute to accumulate within the unsaturated zone, and highlight the importance of selecting reprehensive sample sizes for soil parameterization due to a high degree of heterogeneity.

5 **Domestic Wastewater Transport and Treatment in Ladder Fen Peatlands: Implications for nutrient and mercury contamination**

CNAES Theme I, Project I-4

Colin McCarter[1], Brian Branfireun[2], & Jonathan Price[3]

[1]*Department of Earth and Environmental Sciences, University of Waterloo,*
[2]*Department of Biology, University of Western Ontario,*
[3]*Department of Geography and Environmental Management, University of Waterloo*

Safely treating wastewater in remote communities and mining operations in sub-arctic Canada is critical to protecting the surrounding aquatic ecosystems. Undisturbed fen peatlands have been used to minimize the release of contaminants to the aquatic ecosystems; however, there is a limited understanding of wastewater transport or treatment in undisturbed fen peatlands. To elucidate these processes, a small (9800 m^2, ~250 m long) ladder fen was continuously injected with a wastewater surrogate derived from a custom fertilizer blend and 38 m^3 day^{-1} of water for 51 days. The simulated wastewater included sulphate (27.2 mg L^{-1}), nitrate (7.6 mg L^{-1}), ammonium (9.1 mg L^{-1}), phosphate (7.4 mg L^{-1}), and chloride (47.2 mg L^{-1}). Major ion, total mercury (THg) and methylmercury (MeHg) pore water concentrations were measured throughout the study period. An exponential increase in transmissivity (2.4 to 16.8 m^2 day^{-1}) as the water table rose (~0.16 m) increased the average linear groundwater velocity (0.5 to 3.4 m day^{-1}) and resulted in rapid sulphate (1.3 m day^{-1}) and chloride (1.9 m day^{-1}) transport. Contrary to the rapid transport of sulphate and chloride, the other contaminants were rapidly removed from the pore water (likely through biological uptake or adsorption) and minimal transport was observed (0.2, 0.3 and 0.04 m day^{-1} for phosphate, ammonium, and nitrate, respectively). Within the sulphate plume, MeHg and THg concentrations became highly elevated relative to background (up to 10 ng L^{-1}, ~ five-fold increase) and MeHg comprised 80 – 100 % of dissolved THg in the pore water. No MeHg or THg was exported at the

	outflow. The large increase in THg cannot be solely accounted for by the increase in MeHg and was likely due to enhanced decomposition of the peat substrate by increased microbial activity due to electron acceptor loading. Since the added nutrients were effectively transformed, sequestered or otherwise removed from pore waters in this experimental system, it appears that fen peatlands have a large capacity to safely treat residential wastewater nutrients; however, the inadvertent increases in THg and MeHg require further investigation and potential management.
6	**Variability in the percent methyl mercury (%MeHg) in fish muscle; assessing the effect of fish size and trophic ecology on the ratio of MeHg to THg.** *CNAES Theme I, Project I.5b* **Gretchen Lescord***, Tom Johnston*[1], Brian Branfireun[2] and John Gunn* *Laurentian University [1]Ontario Ministry of Natural Resources and Forestry [2]Western University Mercury (Hg) has a complex biogeochemical cycle and its speciation and toxicity is influenced by a wide range of environmental factors. To better understand how these factors change across a watershed, I am studying the vast Attawapiskat Drainage Basin (ADB) in northern Ontario and utilizing its diverse nature to better understand how physical and chemical gradients affect Hg speciation and concentrations in water, invertebrates and fish. I am measuring the concentration of methyl Hg (MeHg), the organic, toxic, and bioaccumulative form of Hg, in fish from lakes and river sites across the ADB. Generally, it is assumed that >95% of the Hg found in fish muscle is the methylated form and total Hg (THg) measurements are often used as a proxy for MeHg. While it is clear that the majority of Hg accumulated in adult large-bodied fish is MeHg, THg may not be an appropriate measure of MeHg in juvenile or small-bodied forage fish, which have different bioenergetic processes. Data analyses are ongoing but results from this study will provide the first assessment of how the ratio of MeHg-to-total Hg changes based on fish size and feeding ecology and hold major implications for further environmental monitoring and statistical modeling practices.
7	**Concentrations and fatty acid compositions of subsistence fishes in coastal rivers of the Far North of Ontario** *CNAES Theme I, Project I.5c* **Matthew Heerschap**[1], Tom Johnston[2], Wendell (Bill) Keller[1], Michael Arts[3] and John Gunn[1] [1] Department of Biology, Laurentian University, Vale Living with Lakes Centre [2] Ministry of Natural Resources and Forestry, Cooperative Freshwater Ecology Unit [3] Arts Laboratory, Ryerson University

The Far North of Ontario (north of 51˚ N) is home to over 24 000 people (90% First Nations) in 31 communities, and many of these people rely heavily on wild fish as part of their diet. The numerous large and small rivers along the coast are home to a variety of fish species, including some anadromous populations, which support important subsistence fisheries for local communities. We are undertaking a risk-benefit analysis of consuming wild fishes from these northern rivers by inferring risk from mercury and trace metal concentration and inferring nutritional benefit from essential fatty acid composition of the flesh. Lake whitefish, northern pike, brook trout, and several other fish species are being sampled from 11 northern rivers of varying sizes. Fish will be analyzed for basic attributes (size, age), muscle mercury and fatty acid content, and stable isotope composition. We predict that anadromous populations in these rivers will exhibit both lower mercury concentrations and more nutritionally favourable fatty acid profiles than non-anadromous populations. This project will refine fish consumption recommendations for northern fishes and provide important baseline information on the riverine fish communities of Ontario's subarctic.

8 Life history characteristics of Lake Whitefish (*Coregonus clupeaformis)*, Cisco (*Coregonus artedi*), and Northern Pike (*Esox lucius*) in rivers of the Hudson Bay Lowlands

CNAES Theme I, Project I.5c

Rachel DeJong[1], Tom Johnston[2, 3], Bill Keller[3] John Gunn[3] and Heidi Swanson[1]
[1]University of Waterloo
[2]Ontario Ministry of Natural Resources and Forestry
[3]Living with Lakes Centre, Laurentian University

Many northern fishes display plasticity in life history and trophic ecology that can influence fisheries productivity and bioaccumulation of contaminants, such as mercury. I investigated the life history of the important subsistence food fishes Cisco (*Coregonus artedi*), Lake Whitefish (*Coregonus clupeaformis*), and Northern Pike (*Esox lucius*) from three rivers of the Hudson Bay Lowlands. Individuals were classified as non-migratory or migratory using otolith microchemistry; results indicated use of marine habitats by Cisco and Lake Whitefish. Despite well-documented use of brackish-water habitats by Northern Pike in the Baltic Sea, I present the first data indicating their possible use of brackish waters in North America. The majority of Cisco (99%) and Lake Whitefish (92%) classified as migratory, whereas the majority of Northern Pike (70%) classified as non-migratory. A mixing model (MixSIAR) applied to stable isotope ratios of sulphur ($\delta^{34}S$) was used to determine that the majority of the diets of migratory Cisco (74-76%) and Lake Whitefish (51-68%) was comprised of marine-derived nutrients/prey. Both migratory and non-migratory Northern Pike were reliant on marine-derived nutrients/prey, and between 19-46% of diet was from marine sources. In combination with contaminant data, my results can be used to better understand how fish life history influences contaminant bioaccumulation now and in the future.

9 ***Dolichospermum sp*: Pirates of the pelagic?**

CNAES Theme II, Project II.1

Erika Freeman[1] and Irena Creed[1]
[1]Western University, CNAES Project – Boreal 2050

Harmful algal blooms (HABs) are considered to be among the greatest inland water quality threats to public health and aquatic ecosystem services. The most common bloom forming species in Ontario, *Dolichospermum sp*., is capable of not only bloom formation but also toxin production. I present preliminary field-based evidence that in order for *Dolichospermum sp.* to outcompete other phytoplankton they must rely on their adaptive capacity to acquire iron (Fe) from dissolved organic matter (DOM). Even though DOM keeps Fe in solution, the Fe is not readily accessible to phytoplankton. Several *Dolichospermum sp.* species have been observed to rely on a Fe-uptake strategy involving the release of specialized low molecular weight compounds called siderophores. These siderophores scavenge Fe from the environment (including DOM), bind it, and then diffuse back into the cell. In a series of lab experiments I will answer the question: How do DOM properties influence the effectiveness of *Dolichospermum sp.* Fe acquisition?

10 **Landscape Indicators of Groundwater Nitrate Concentrations: A Tool for Trans-Border Aquifer Monitoring**

CNAES Theme II, Project II.1

Tanya Gallagher[1] and Sarah Gergel[1]
[1]University of British Columbia

Globally, groundwater is the primary source of nearly half the freshwater used in drinking and cooking. Excess nitrate contamination of groundwater is a growing health concern, particularly in regions of intensive agriculture. Monitoring the world's 448 transboundary aquifer bodies is challenged by the complexities associated with multi-jurisdictional governance, disparities in data collection, and inconsistencies in geospatial data among countries. In a region where elevated nitrate concentrations may be linked to overlying land use practices and land cover, we develop landscape indicators characterizing likely sources of nitrate and examine their correspondence with groundwater nitrate concentrations. We evaluate their use for trend detection and monitoring in an aquifer spanning the US and Canada (the Abbotsford-Sumas Aquifer), asking two primary questions: Are nitrate concentrations in the aquifer changing over time? How well do landscape indicators help explain patterns of groundwater nitrate concentrations?

To answer our first question, long-term (2005-2013) groundwater nitrate concentrations were examined

for 15 shallow wells using Mann-Kendall trend analysis tests. Nitrate concentrations in nine of the fifteen monitoring wells decreased while two increased over time. To answer our second question, a seamless harmonized cross-border land cover mosaic was created using available US and Canadian land use and land cover datasets. Landscape indicators such as crop type (proportion of raspberries, forage and pasture, etc.) were measured in terrestrial zones of influence (incorporating varying sized radii and groundwater flow directions) surrounding each well. Backward stepwise regression was used to identify parsimonious models of nitrate concentrations as a function of landscape indicators with a comparison of US and Canada. Models with proportions of different berry types (e.g. blueberries and raspberries, and mixed berries), bare land, and forage/pasture consistently explained 15-47% of groundwater nitrate concentrations, regardless of the scale of zone radii, zonal direction, or jurisdiction. As very few studies have quantitatively linked nitrate concentrations to changing land use, land cover, and/or land use practices, our work provides an important new approach that is highly transportable to other regions facing similar management challenges.

11 **Ecological resilience in lake trophic status**

CNAES Theme II, Project II.1

Aleksey Palstsev Irena Creed
Western University, Department of Biology

Temperate lakes in the Great Lakes Basin are vulnerable to regime shifts from nutrient poor oligotrophic states to nutrient rich eutrophic states due to climate change. To explore the potential of regime shifts, we examined peak algal biomass using a time series of chlorophyll-*a* (a proxy of algal biomass). We developed a regression model that relates Landsat TM and ETM+ optical reflectance to chlorophyll-*a*. Landsat band 3 showed the strongest correlation with in situ data from 24 lakes explaining 85% of variance in chlorophyll a ($p<0.001$). The regression model was used to build a continuous time series of chlorophyll-*a* in 12,664 lakes for 28 years (1984 – 2011) in the Ontario portion of the Great Lakes Basin. From the time series, trends (detected by Mann-Kendall trend analysis) and cycles (detected by Morlet wavelet analysis) were removed, and standard deviation (SD) of the residuals was used as an indicator of lake stability. Four classes of lake stability were identified: stable (SD is consistently low); destabilizing (SD increases over time); unstable (SD is consistently high); and stabilizing lakes (SD decreases over time). We found that stable lakes were oligotrophic, destabilizing lakes were shifting from oligotrophic to lakes with a higher trophic status (indicating eutrophication), unstable lakes were switching between oligotrophic and eutrophic, and stabilizing lakes were shifting from eutrophic to the lakes with lower trophic status (indicating oligotrophication). This indicates that both eutrophication and oligotrophication are occurring simultaneously within the region.

12 **Evaluation of stream ecological integrity using litter decomposition: should we consider inter-annual hydrologic variability?**

CNAES Theme II, Project II.2

Alex Yeung[1], David Kreutzweiser[2], John Richardson[1]
[1] Department of Forest and Conservation Sciences, University of British Columbia
[2] Great Lakes Forestry Centre, Canadian Forest Service

Hydrology influences litter decomposition in low-order streams through physical abrasion and by affecting detritivorous invertebrates. The degree to which the hydrological regime – mediated by precipitation changes – may contribute to the temporal variability of litter decomposition is not well studied. Such variability need to be quantified to better characterize reference conditions for stream bioassessment. We determined shredder- (10-mm mesh) and microbial-mediated (500 µm) litter decomposition, and litterbag-associated shredder abundance in forested streams during three consecutive and hydrologically different autumns in British Columbia and Ontario, Canada. Overall, the ratio of shredder- and microbial-mediated decomposition rate at any given year to the three-year mean ranged from 0.78-1.39 and 0.75-1.30, respectively. This variation of decomposition was explained by differences in hydrological regime. In the low-flow years, decomposition was similar to or faster than the higher-flow year, as under reduced flow, the increase in shredder abundance and hence decomposition likely approximated or surpassed the reduction in the physical fragmentation of litter. Using litter decomposition rate to monitor changes in aquatic ecosystem services should deserve caution when covering hydrologically distinct years, as the range of inter-annual variability in reference streams slightly exceeded the range (0.75-1.33) reflecting 'no impact' on stream integrity in a recommended bioassessment framework.

13 **Hydrologic and landscape controls on turbidity within watersheds**

CNAES Theme II, Project II.2

Gillian Fuss[1], John Richardson[1], and Patrick Lucey[2]
[1]University of British Columbia
[2]Aquatex Scientific Consulting Ltd.

Turbidity, the amount of light scattering off of particles in the water column, is often used as a water quality indicator, as it is correlated with suspended particles and dissolved colored substances in the waterbody which can carry heavy metals, host illness-causing viruses and bacteria. However, studies have shown that relationships between turbidity and organic/inorganic particles may be more complex than previously thought. That is, that turbidity may also be affected by smaller particles, landscape forms, and exhibit localized responses. Therefore, a better understanding of the linkages between turbidity sources, measurement techniques, and particle size and composition in the water column can improve quality

assessments. We examined turbidity responses to land use and particle types using data collected from the field and laboratory analyses. Preliminary results show varying turbidity responses to hydrological events of the same magnitude due to land use and stream characteristics that alter the availability of organic and inorganic particles to streams. Results also suggest localized turbidity peaks that may not scale upwards to landscape level monitoring. Higher turbidities have also been more highly correlated with the percentage of suspended particles that are organic matter than particle size. Together, these results suggest that the use of turbidity as a simple water quality indicator may need to be rethought in the current way it is applied in British Columbia, due to the interactions between natural stream features and land use.

14 **Understanding the effects of wildfire in the boreal forest on the riparian-stream interface: implications for riparian management strategies**

CNAES Theme II, Project II.2

Jordan Musetta-Lambert[1], David Kreutzweiser[2], Elisa Muto[3] and Paul Sibley[1]
[1]University of Guelph

[2] Canadian Forest Service
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Managing forested watersheds based on the emulation of natural disturbance (END) paradigm to sustain riparian forest and stream health requires understanding how natural forest disturbances influence riparian-aquatic linkages. We conducted a comparison of riparian condition and stream function across boreal, headwater streams within fire-disturbed, harvested with riparian buffers, and reference forested catchments. We assessed riparian vegetation characteristics, including leaf-litter inputs to streams, instream leaf-litter decomposition, and associated macroinvertebrate communities. Additionally, terrestrial invertebrate input to streams and aquatic invertebrate drift were sampled repeatedly throughout the summer season. Riparian juvenile woody-stem and shrub communities had significantly higher taxa richness and were compositionally different at fire than harvested and reference sites. Although *Alnus icana* ssp. *rugosa*, speckled alder, leaf pack decomposition rates were not significantly different among catchment disturbances, the associated invertebrate communities were characterized by significantly higher taxa richness and unique shredder taxa at fire sites. The overall abundance of aquatic macroinvertebrates in drift samples were significantly higher at fire than harvested or reference sites throughout two summer months. These results suggest that managing riparian forests under the END paradigm could sustain ecosystem services by promoting habitat complexity through inducing forest succession and enhancing leaf-litter inputs and processing in streams.

15 **Understanding the effects of high intensity forest management on stream ecosystem integrity to protect aquatic ecosystem services**

CNAES Theme II, Project II.2

Maitane Erdozain[1,2], Karen Kidd[1,2], David Kreutzweiser[3], Paul Sibley[4]
[1]University of New Brunswick
[2]Canadian Rivers Institute
[3]Canadian Forest Service,
[4]University of Guelph.

Forests are key suppliers of aquatic ecosystem services (AES); however, forestry may alter forest condition and thus compromise the integrity of stream ecosystems underpinning AES. This study examines a suite of in-stream abiotic and biotic indicators sensitive to disturbance and related to AES in 12 headwater streams with managed catchments ranging in harvesting (18-100 % of the catchment harvested in last 10 years), road density (21-89 road m/ha), stream crossings (0-4) and forest composition (deciduous/mixed/coniferous dominated) and 3 reference streams in New Brunswick (Canada). Most indicators reflect the gradient in forest management intensity, with fine inorganic sediment deposition and entrainment, water chemistry PC1 (related to conductivity, TIC…), DOC aromaticity and humification, temperature and total biofilm biomass increasing, leaf decomposition decreasing, and the benthic macroinvertebrate community shifting as management intensity increased. However, our results do not suggest site impairment due to forestry, since biotic endpoints in streams with managed catchments were comparable to those in reference streams. Therefore, it seems that intensive forest management under best management practices in these catchments does not adversely affect stream ecosystem structure and function, and the delivery of AES.

16 **Measuring Long-Term Cumulative Effects on the Spatial and Temporal Dynamics of Riverine Systems**

CNAES Theme II, Project II.3

Karly Harker[1] and Sarah Gergel[1]
[1]University of British Columbia

Environmental assessment procedures lack approaches for long-term evaluation of ecosystems. Management of riparian zones, in particular, has changed greatly over the past 90 years. This work aims to characterize long-term spatio-temporal changes in heterogeneity of stream reaches and riparian zones. Using historical aerial photography spanning eight decades, we examined the Skeena river system in northwestern British Columbia, Canada, an important spawning route for *Oncorhynchus tshawytscha* (Chinook salmon). We conducted manual air photo interpretation to quantify changes in stream reach type and riparian zone disturbances at multiple years from 1937 to 2015. We characterized changes in reaches

	with contrasting levels of disturbance over multiple time periods and compared disturbance patterns using spatial pattern metrics, including measures of spatial autocorrelation. We also correlated long-term changes in fish habitat with historical Chinook salmon spawner abundance data. Due to ever-increasing development pressures in Northern Canada and the changing milleu of environmental assessment globally, such approaches can form a key component of rigorous quantification of cumulative effects.
17	**Are there spatially cumulative impacts downstream of forest harvesting operations in northern hardwood catchments?** *CNAES Theme II, Project II.3* **Kelli Charbonneau**[1], Karen Kidd[1], Dave Kreutzweiser[2], Paul Sibley[3], Nelson O'Driscoll[4] [1]University of New Brunswick (Saint John) & Canadian Rivers Insititute [2]Canadian Forest Service [3]University of Guelph [4]Acadia University Despite a suite of guidelines for environmental protection surrounding forest harvesting in Canada, legacies of ecosystem degradation persist, many of which are specific to aquatic environments. While impacts to small headwater streams are well-studied and reasonably predictable, it is not well-known whether effects occurring upstream may be spatially cumulative in larger downstream areas. In response, this project examines the potential for cumulative impacts to forest streams from selection-based harvesting of northern hardwood stands on the northeastern shore of Lake Superior. The study area consists of four catchments that have been subject to either very little (<15% area) or substantial (>60% area) harvest in the last 10 years. Metrics used to quantify impact from harvesting include water quality, stream temperature, sediment deposition, leaf-litter decomposition and associated invertebrate community structure, bioaccumulation of methylmercury, and analysis of stream consumer diet. The objectives of this research are firstly to use metrics of impact to assess changes to streams in catchments with recent harvesting, and secondly to determine if effects are spatially cumulative at sites downstream of the forest disturbance. A comprehensive and predictive understanding of the spatially cumulative effects associated with forest management is critical to maintaining healthy future forests and their provisioning of aquatic ecosystem services.
18	**Effects of brownification in temperate oligotrophic lakes** *CNAES Theme II, Project II.3* **Oscar Senar,** Western University The increase in organic matter loads from catchments to lakes has been reported in boreal and temperate areas. This process, known as brownification, is a consequence of changes in atmospheric temperature and hydrological connectivity. We investigate the drivers of soil carbon export into the aquatic network in

a subcatchment of the Turkey lakes Watershed, in north-western Ontario. We observe how, for the 5-year period from 2005 to 2010, stream dissolved carbon concentrations have been increasing as a consequence of changes in hydrological connectivity. In addition, we argue that brownification can influence competition among primary producers in lakes by modulating nutrient and light availability. Changes in the physical and chemical conditions of lakes could give a competitive advantage to nitrogen-fixing and iron-scavenging cyanobacteria, leading to the formation of harmful algal blooms. Our survey of oligotrophic Ontario lakes, presenting a range of dissolved organic matter quantity and quality, set out to define the conditions that promote cyanobacterial growth.

19 **Does biophysical and participatory mapping of ecosystem services reveal similar locations for stakeholder conflict and cooperation?**

CNAES Theme II, Project II.3

Stephanie Tomscha[1], Sarah Gergel[1] and Elena Bennett[2]
[1]University of British Columbia
[2]McGill University

Interactions among ecosystem services, such as trade-offs, are influenced by both the biophysical and social components of the landscapes that provide them. While most research on ecosystem service interactions has focused on their biophysical locations, the spatial interactions of people and their ecosystem services use has rarely been explored in tandem with biophysical interactions. Focusing on aquatic ecosystem services in a Northern Ontario watershed, we ask three main questions to explore the multiple facets of ecosystem service interactions: (1) Where are important locations of biophysical interactions among ecosystem services? (2) Where do activities of different user groups overlap across the landscape? and (3) How do user-reported conflict and cooperation differ from those derived from trade-offs found using biophysical mapping approaches? Using freely available geospatial data, including high-resolution aerial photography, we map biophysical locations important for ecosystem services and overlay these locations with maps of ecosystem service use identified by 28 stakeholders. We also asked stakeholders about their attitudes towards other user groups. Our paired understanding of biophysical and social components allows for a richer examination of ecosystem service interactions and their consequences, including potential conflict or cooperation among different stakeholders.

20 **Estimating Management Uncertainty for Achieving Phosphorus Reduction Policy Objectives**

CNAES Theme II, Project II.4-II.5

Jason Igras
Western University

21 **Development of a pan-Canadian hydrological framework for modelling aquatic ecosystem services**
Which rivers do we ask the most work from in Canada? A hydrological approach to aspect of hydrological services for Canadian rivers.

CNAES Theme III, Project III.1

Camille Ouellet Dallaire[1], Elena Benett[1] and Bernhard Lehner[1]
[1]McGill University

Canadians rely on rivers and watersheds that span areas far away from urbanized landscapes and away from monitoring stations. Without a clear spatial understanding of the riverscapes providing services to Canadians, sustainable management of these resources will be challenging, especially in the face of future, spatially uneven climate and environmental changes. This study aim to identify these critical rivers and watersheds using a hydrological approach combined with a spatial analysis of different aspects of ecosystem services.
Ecosystem services are often conceptualized using three main aspects, namely capacity, demand and pressures. In river systems, these aspects of services can be separated by long distances and, yet, be connected by river networks. Using four hydrological services (provision of water for municipalities, agriculture, industries and hydroelectricity), a map of critical watersheds in Canada was created using a hydrological approach. Because of the directional nature of river flow, a cumulative approach was used to map out the hotspots of interactions among services and aspects of these services aiming to identify regions and river types potentially at risk. The results portrayed a polarized use of water in Canada. Identifying these key areas is beneficial for long-term and large-scale sustainable management of water resources.

22 **Unravelling the main productivity drivers of five important sport fish species from Ontario lakes, according to limiting and controlling environmental determinants and anthropogenic impact**

CNAES Theme III, Project III.2

Wagner Moreira[1], Nigel Lester[2]and Pedro Peres-Neto[1]
[1]Université du Québec à Montréal
[2]Ontario Ministry of Natural Resources & Forestry

The ecological and economical importance of freshwater fish populations is unquestionable, providing aquatic ecosystem services such as: they regulate ecosystem structure and function through the processes of selective (non-random) predation; nutrient cycling; bioturbation; play a major ecological role in structuring the benthic and zooplanktonic invertebrate communities; they are key indicators of ecosystem health and environmental disturbance, and possess a central spiritual value to many native cultures. However, high aquatic habitat degradation from overexploitation, water pollution, flow modification, destruction or degradation of habitat and invasion of exotic species are causing freshwater fish to become

	one of the most threatened groups of vertebrates worldwide. It is therefore vital that fisheries managers, governments and outdoor recreation industry prioritize their actions on ensuring the sustainability of the actual fish stocks under exploitation and habitat loss. The general objective of this work is to develop biomass models via boosted regression trees for 5 important sport fish species from Ontario lakes, using as predictors environmental parameters known to control and limit fish productivity, including fishing pressure to evaluate its influence. Preliminary results show surface area of the lake, mean depth and mean air temperature to be main influents on the biomass of these different species.
23	**Expanding biomass size spectra models** *CNAES Theme III, Project III.3* **Henrique Giacomini**[1] and Brian Shuter[1,2] [1] Ontario Ministry of Natural Resources and Forestry [2] University of Toronto Size-spectrum models provide a simple framework for understanding the dynamics of interacting fish communities and have been increasingly used as strategic tools for ecosystem-based fisheries management. In this project, we developed an analytical approach to incorporate phenotypic plasticity in size-spectrum models, which can be used to model the short-term changes in life history traits that are both common and influential in fish. In particular, this approach is able to account for life-history responses to changes in (i) prey species composition and (ii) climate. The predicted effects of prey composition were consistent with empirical observations of Lake Trout (*Salvelinus namaycush*), which tend to grow faster, mature older and at larger sizes when relatively bigger prey is available. The effect of climate was tested with a data compilation of six fish species from North America and Europe, with mixed results. As predicted, growth rate increased overall with the duration of the growing season, after controlling for temperature. However, there was no trend across species with different temperature tolerances (e.g., cold- versus warm-water species), which is contrary to model expectations. Ongoing research will broaden the range of fish populations and evaluate model assumptions, particularly those underlying the effects of climate.
24	**Detecting the impact of climate change on a boreal freshwater fish community** *CNAES Theme III, Project III.3* **Abby Daigle**[1], Brian Shuter[1,2] and Don Jackson[1] [1]University of Toronto [2]Ontario Ministry of Natural Resources & Forestry A large-scale watershed experiment was initiated in 2008 to investigate how the structure of a Canadian boreal fish community would respond to a drier climate. The experiment turned a fourth-order lake into a

	headwater lake, which is expected to reduce the input of dissolved organic carbon (DOC). This manipulation mimics the effects of a drier climate scenario, where the increase in temperature would increase evapotranspiration rates, reducing terrestrial runoff, and thus reducing DOC input into surrounding lakes. Logically, the reduction of DOC is expected to affect lake characteristics (eg. water clarity, thermal structure, and productivity), and ultimately the resident fish community. Hydroacoustic surveys have been conducted each summer from 2010-2016 and fish length data have been determined. Fish community structure is being defined through the lens of size-spectrum theory, which represents how energy flows through a community as a function of organism size rather than species identity. Size-spectra are often represented as negative linear relationships where the intercepts and slopes are the parameters of interest. These parameters can indicate when ecosystem services are being threatened due to environmental stressors. To date, within-lake comparisons revealed that the reference lake has a shifting baseline. Future plans are aimed at accounting for this background variation in order to determine the real effect of the lake manipulation.
25	**Lake ecotype influences the metabolic costs by Lake Trout: a telemetry approach using acceleration transmitters.** *Theme III, Project III.3* **Liset Cruz-Font**[1], Brian Shuter[1], P. Blanchfield[2], C. Minns[1] [1] Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Canada [2] Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Canada The energy budget theory is built on the premise that growing and reproductive organisms need to consume energy in excess of that required by basic metabolic processes. The quantity and quality of prey available to organisms therefore influence their metabolic demands and subsequently their adult size. Field-based bioenergetic studies are challenging given the difficulty of measuring metabolic rates in free-ranging animals. However, biotelemetry techniques offer the possibility of performing these kinds of studies. We used acoustic telemetry and acceleration transmitters to study the metabolic costs by Lake Trout (*Salvelinus namaycush*) in four lakes. These lakes represented a range of ecotypes, where the typical prey available to Lake Trout differed among lakes along a size gradient from small invertebrates to large planktivorous fish. The estimated metabolic rates across the four lakes revealed higher costs of activity in lakes with lower prey quality, indicating a greater energy requirement in these lakes. The time of the day (night, dawn, dusk or daytime) was important in describing the metabolic rates. The illuminated periods of the day showed higher activity rates, complying with the expected behaviour of a visual top predator. Similarly, the proportions of detections where Lake Trout showed a resting state were higher during the night hours and were more frequent in lakes were Lake Trout had access to the largest and more energetically rewarding prey. Across all four lakes, we found an association between foraging costs, prey quality, and adult sizes for Lake Trout. In lakes with low quality prey, Lake Trout invested more in foraging activity, and showed smaller size at maturity. We conclude that prey quality is important in shaping the foraging costs by Lake Trout.

26 Evaluating Freshwater Ecosystem Condition by Quantifying Resilience

CNAES Theme III, Project III.4

Karl Lamothe[1], Donald Jackson[1] and Keith Somers[1]
[1]University of Toronto

As many as 2 million lakes are estimated to be in Canada and they provide important ecosystem services such as clean drinking water and freshwater fisheries. Despite their inherent societal value, cumulative effects of anthropogenic disturbances on the landscape pose questions regarding the maintenance of these systems to future change. As such, understanding and quantifying the resilience of lake communities, or their ability to withstand disturbance and remain relatively unchanged, is a management priority. The primary objective for my PhD research is to address a question that inhibits our understanding of resilience, specifically, how do we measure it? Using a novel simulation approach, we address this challenge of measuring resilience using a multivariate distance-based framework. We then applied these techniques to long-term monitoring data of freshwater crustacean zooplankton communities impacted by anthropogenic acidification. Finally, we approach resilience from a functional diversity lens, demonstrating the variable levels of redundancy among freshwater fish communities in Ontario. Overall, by tracking changes in freshwater communities over time, or through the use of functional diversity metrics, we highlight the valuable information that existing biomonitoring programs hold that can inform lake management decisions.

27 Determining potential functional connectivity of fish species with various life history traits

CNAES Theme III, Project III.5

Andrew Chin[1], Marie-Josée Fortin[1], Roland Cormier[2] and Carole Godin[3]
[1] Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Canada
[2] Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
[3] Fisheries and Oceans Canada, Moncton, Canada

The effect of stream fragmentation due to culverts on the functional connectivity of various fish species may be determined by their life history traits. Depending on the location of the spawning habitat, certain species encounter more obstacles to swim upstream from the estuaries to the headwaters, such as diadromous species which require both freshwater and marine habitat. By contrast, non-diadromous species will encounter obstacles at any point in the stream network. However, the ability of many species to pass through the culverts due to the swimming strength is unknown. We used the total length of species as a morphometric approach to infer the swimming strength of four focal species with different life histories (diadromous versus non-diadromous). We analyzed the amount of habitat available for these species by calculating the Dendritic Connectivity Index (DCI) to assess the overall potential functional

	connectivity of stream networks of three watersheds of New Brunswick (Canada) for each species to pass through culverts located by Fisheries and Oceans Canada. We also determined the probability of reaching each stream segment based on the swimming strength. Overall, our findings emphasize that a species-based approach is necessary to inform policy and management in the development of fish passage standards.
28	**Ecosystem service bundles in watersheds located in and outside of protected areas-research design and preliminary findings** *CNAES Theme III, Project III.6* **Dalal Hanna**[1] and Elena Bennett[1] [1]Department of Natural Resource Sciences, McGill University While the ecosystem services provided by protected areas are undoubtedly different than those provided by non-protected areas, research is only beginning to quantify how the provision of multiple services differs between protected and unprotected areas. Quantifying the variation between ecosystem services bundles found inside and outside of protected areas, as well as the trade-offs and synergies between these services, is an important step toward improving our understanding of the distinct roles of protected areas and their surrounding landscapes in the provision of ecosystem services. This information has the potential to help inform new and improved multifunctional landscape management strategies that account for the unique functions of different types of protected areas and other land-uses in ecosystem service provisioning. In this project, I plan on comparing ecosystem services bundles in a series of paired watersheds found inside and outside of Provincial and National parks in the province of Quebec, Canada. I will assess the capacity of these watersheds to provide ten different ecosystem services. During this symposium, I will present the research design for this project and preliminary results showing water quality measurements from two protected areas, and six watersheds.
29	**Demographics and societal values as drivers of change in the Canadian Boreal Zone** Alistair Chan[1], Andrew T.M. Chin[2], Sophie Nitoslawski[3], Irena F. Creed[4], Jim Fyles[1], John Parkins[5], Marian L. Weber[5] *[1]Department of Natural Resource Sciences, McGill University; [2]Department of Ecology and Evolutionary Biology, University of Toronto; [3]School for Resource and Environmental Studies, Dalhousie University; [4]Department of Biology, Western University; [5]Environmental Planning and Economics, Alberta Innovates* The Boreal Zone has both provisioning and non-provisioning services that attract some people to its communities, while repelling others. It is an area that arguably affects many Canadians in different ways, and represents a wide range of values. Demographic patterns shed light on the development of the social-ecological landscape of the Boreal, and can help us understand potential changes in the future of the region. Using demographic data, we examined population size, immigration, emigration, and birth and death rates; within and outside the Boreal. We also explored links between social values and

demographics as important drivers of change in the Boreal, presenting three future scenarios in the region for 2050. We paid particular attention to the indigenous population, generational differences, international immigration, and the urban-rural divide. Fertility rates and immigration are crucial drivers of population demographics within and outside the Boreal, respectively. The region is currently comprised of many smaller towns and communities scattered across the landscape, yet it remains important to consider the influences of larger cities located outside the Boreal, particularly in terms of governance and political power. Together, these factors provide insight on social cohesion and connectedness, demand for goods and services, and changes in Boreal-centric activities.

30 Governance and geopolitics as a driver of change in the Boreal Zone, Canada

Gillian Fuss[1], James Steenberg[2], Irena Creed[3], M.A. (Peggy) Smith[4], Marian Weber[5]
[1]Department of Forest and Conservation Sciences, University of British Columbia; [2]School for Resource and Environmental Studies, Dalhousie University; [3]Department of Biology, Western University; [4]Natural Resources Management, Lakehead University; [5]Environmental Planning and Economics, Alberta Innovates

This paper examines governance and geopolitics as a driver of change in the Canadian Boreal Zone. Governance of the Boreal addresses the various actors involved including Indigenous Peoples, non-governmental organizations, the private sector, and all three levels of Canadian government in jurisdictions across the country. We explored the major pieces of legislation and policy that affect Boreal management decisions including the authorities and responsibilities at different levels of the policy process. Boreal governance considerations include the scope and authority for decision making and influence of different actors; the property rights that determine rights to Boreal resources; and the processes and approaches that are used to implement management objectives (e.g., engagement, planning, and markets). We considered broader geopolitical trends and how Canada's relationships with foreign government and non-government actors have affected Canadian Boreal governance. The influence of foreign governments, policies, societies, and economies on Boreal forest governance, as well as the role of the Boreal zone in global geopolitical concerns was considered in addressing the following questions: Will access to the Boreal zone, or Boreal-related issues/concerns become increasingly important to the global community in the future? What geopolitical affect the Canadian Boreal zone? Finally, extrapolating from past trends, we present three contrasting scenarios predicting the state of the Boreal in 2050.

31 Industry, Innovation and Infrastructure as a driver of change in Canada's Boreal zone

Eric Enanga[1], Jordan Musetta-Lambert[2], Sonja Teichert[1], Irena Creed[1], Karen Kidd[4], David Kreutzweiser[5], Paul Sibley[2]
[1]Department of Biology, Western University; [2]School of Environmental Sciences, University of Guelph; [4]Department of Biology and Canadian Rivers Institute, University of New Brunswick; [5]Canadian Forest Service, Natural Resources Canada

Canada's industrial sector relies heavily on natural resources supplied by the Boreal zone. Varied and often intensive processes used by resource-based industries and associated infrastructure have inextricably

altered the region, creating concern over the future health of the region. Industries need to innovate in their processes, management, and infrastructure to better contribute to societal goals related to sustainability, including pollution abatement, while also improving extraction efficiency. We explore historical trends and current state of industrial innovation and infrastructure in the Boreal zone for forestry, mining, pulp and paper, oil and gas, and renewable energy generation. To assess the role of innovation on the future state of the Boreal zone, we summarized potential interactions between innovation in industry and infrastructure and other key drivers of change in the boreal. We present three divergent future scenarios highlighting trajectories of change in the Boreal ecosystems based on past and current states of innovation in industry and infrastructure. Minimizing environmental impacts associated with industrial sectors will only be possible through innovation focussed on reducing emissions, energy, water consumption, and infrastructural footprint. Innovations in Information Technology will be key, and should cover industrial processes, management techniques and end products, while emphasising collaboration among industrial sectors.

32 **Turning on the Tap: Demand for resources as a driver of change in the Boreal Zone, Canada**

Camille Dallaire[1], Maitane Erdozain[2], Erika Freeman[3], Sonja Teichert[4], Irena Creed[4], Harry Nelsen[5]
[1]Department of Geography, McGill University; [2]Department of Biology and Canadian Rivers Institute, University of New Brunswick; [3] Department of Geography, Western University; [4]Department of Biology, Western University; [5]Department of Forest Resources Management, The University of British Columbia

The Canadian Boreal Zone has often been described as the "Amazon of the North". As part of the global circumboreal zone, it is distinct in that both direct and indirect anthropogenic disturbances have remained small compared to other ecosystems. Particularly notable components of its natural capital that are extracted from the Boreal are wood products, renewable (predominantly hydropower) and hydrocarbon energy resources (oil, gas, coal), and minerals. These provisioning ecosystem services (PrES) from the Boreal are critical to Canada's resource-based economy and their production involves either extraction at a large scale, or alteration of existing ecosystem services to satisfy demands outside of the Boreal. Since the demand for PrES can affect both the capacity of the Boreal ecosystem to produce as well as the flow or delivery of these commodities, the demand for PrES is a key determinant of the potential for the sustainable management of natural resources within the Boreal. We examined past trends in demand for PrES, the ways in which these extractive activities interact, and interactions between the demand for PrES and other drivers of change to construct three divergent future scenarios to assess the potential risks of demand for PrES to the Boreal Zone.

33 **Demand for non-provisioning ecosystem services as a driver of change in the Boreal Zone, Canada**

Karl Lamothe[1], Rick Dong[3], Oscar Senar[3], Sonja Teichert[2], Irena Creed[2], David Kreutzweiser[4], Fiona Schmiegelow[5], Lisa Venier[4]
[1]Department of Ecology and Evolutionary Biology, University of Toronto; [2]Deparment of Biology, Western University; [3]Department of Geography, Western University; [4]Canadian Forest Service, Natural Resources Canada; [5]Department of Renewable Resources, University of Alberta

The Canadian Boreal Zone provides ecosystem services at both local and global scales. Demand for these services is an important driver of change in the region. We present evidence for past, present, and potential future demand of maintaining non-provisioning ecosystem services (NPES), or the indirect and non-marketable services obtained from ecosystems. Our evidence of demand stems from federal and provincial policy, efforts by Indigenous peoples, and non-governmental initiatives (Forest Certification, ENGOs, and primary forests, intact forest landscapes and protected areas) that aim to improve the sustainability of natural resource extraction and maintain a healthy ecosystem condition of the Boreal. Presently, the demand for NPES influences decisions related to natural resource development (e.g., forestry) that in turn impacts the condition of the Boreal Zone. Informed by the present conditions and past trends, three future scenarios to the year 2050 were constructed that contrast in their trajectory – status quo, increased demand for NPES, and decreased demand for NPES. As well, we summarized the interactions among the drivers of change in the Boreal and the synergies and trade-offs among the different types of demand for NPES. Ultimately, sustainability of the Boreal zone and the ecosystem services it provides will result from a complex suite of interacting drivers of change, where the balance of demands for provisioning and NPES will continue to influence regional conditions.

34 **Designing the future of Boreal waters**

Irena F. Creed[1] and the **Boreal 2050 Team**
[1]Western University

Boreal 2050 is a transdisciplinary project conducted to improve understanding of the risks of natural resource extraction activities to the Boreal Zone as Canada transitions from a high to low carbon economy. Major drivers of change – demographics and societal values, governance and geopolitics, industrial infrastructure and innovation, demand for provisioning ecosystem services (i.e., oil and gas, mining, forestry, renewable resources), demand for non-provisioning ecosystem services (e.g., regulating, supporting, cultural), and of course climate change – were identified and used to frame four plausible futures of the Boreal Zone in 2050. Current policies were considered in our determination that Canada is heading towards an undesirable future, and that changes in policies are needed for Canada to change its course towards a desirable future. To "design" this course correction, the International Standards Organization (ISO) Risk Management Framework (ISO 31000) and its Bowtie Analysis Tool (ISO 31010) are being used to characterize and evaluate the performance of the system of management measures in place to protect the freshwater ecosystem integrity of the Boreal Zone. Through Boreal 2050, we will be able to present to decision makers policy and management options to improve the performance

	of the system of management measures and reduce the risk of changes in natural resource extraction activities on freshwater ecosystems, both now and into the future.
35	**Atmospheric change as a driver of change in the Canadian Boreal Zone** **Alex Yeung**[1], Aleksey Paltsev[2], Abby Daigle[3], Peter Duinker[4], Irena Creed[2] [1]Department of Forest and Conservation Sciences, University of British Columbia; [2]Department of Biology, Western University; [3]Department of Ecology and Evolutionary Biology, University of Toronto; [4]School for Resource and Environmental Studies, Faculty of Management, Dalhousie University Global emissions of greenhouse gases (GHGs) and hazardous air pollutants have produced broad yet regionally disparate changes in climatic conditions and pollutant deposition in the Canadian Boreal Zone. We described historical and present trends (~1980-2015) of the subdrivers of atmospheric change (i.e., temperature, precipitation, and deposition of hazardous air pollutants) and atmospheric-mediated natural disturbance regimes in this region. We examined their associations with key components of Boreal terrestrial and freshwater ecosystems, including ecosystem condition and productivity, biological diversity, soil and water, and carbon budget, with an emphasis on the variability of these associations across ecozones. Considering plausible future global emission trajectories of GHGs and hazardous air pollutants, and the mitigation and adaptation measures reflecting different societal attitudes towards atmospheric change, we constructed three divergent future scenarios of Boreal ecosystems in 2050. Achieving environmental and socio-economic sustainability will be an enormous challenge, in light of more variable atmospheric conditions and frequent land disturbances, and growing global demand for Boreal natural resources. Without proactive actions and improved foresight of all levels of government and all sectors of society in Canada to collaborate, innovate, and invest in response to atmospheric change, we portend a dim future for the Boreal.

List of Attendees

Last Name	First Name	Organization/Institution
Balliston	Nicole	University of Waterloo
Benoit	David	University of Toronto
Bourne	Vanessa	Laurentian University
Branfireun	Brian	Western University
Chalmers	Ben	Mining Association of Canada, CNAES Board of Directors
Charbonneau	Kelli	University of New Brunswick (Saint John)
Chetkiewicz	Cheryl	Wildlife Conservation Society Canada
Chin	Andrew	University of Toronto
Creed	Irena	Western University
Cruz Font	Liset	University of Toronto
da Costa Moreira	Wagner	Universite du Quebec a Montreal (UQAM)
Daigle	Abby	University of Toronto
Dallaire	Camille	McGill University
Daoust	Kristin	University of Guelph
DeJong	Rachel	University of Waterloo
Dong	Rick	Western University
Edge	Chris	Toronto and Region Conservation authority
Edwards	Brie	Wildlife Conservation Society Canada
Erdozain	Maitane	University of New Brunswick
Fletcher	Rachel	Ontario Ministry of Environment and Climate Change
Fournier	Bertrand	Concordia University
Freeman	Erika	Western University
Fuss	Gillian	University of British Columbia
Gallagher	Tanya	University of British Columbia
Gergel	Sarah	University of British Columbia
Giacomini	Henrique	Ontario Ministry of Natural Resources and Forestry
Granados	Monica	Wildlife Conservation Society
Gunn	John	Laurentian University
Hanna	Dalal	McGill University
Harker	Karly	University of British Columbia
Heerschap	Matthew	Laurentian University
Igras	Jason	Western University
Jackson	Don	University of Toronto
Johnson	Lucinda	University of Minnesota Duluth
Kidd	Karen	University of New Brunswick
Kreutzweiser	Dave	Natural Resources Canada

Last Name	First Name	Organization/Institution
Lamothe	Karl	University of Toronto
Laurent	Katrina	Western University
Lavallee	Amanda	Laurentian University
Lescord	Gretchen	Laurentian University
Lester	Nigel	Ontario Ministry of Natural Resources and Forestry
Louste-Fillion	Jasmine	Laurentian University
MacLean	Jim	CNAES Board of Directors
McCarter	Colin	University of Waterloo
Minns	Ken	Adjunct Prof EEB Toronto/DFO Emeritus
Moiana	Dana	University of Toronto
Musetta-Lambert	Jordan	University of Guelph
Paltsev	Aleksey	Western University
Pearson	David	Laurentian University
Peres-Neto	Pedro	Concordia University
Raudsepp-Hearne	Ciara	McGill University
Robinson	Jenn	University of Toronto
Sandford	Bob	CNAS Board of Directors
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Somers	Keith	University of Toronto
Steenberg	James	Dalhousie University
Steinback	Brian	De Beers Canada
Stringer	Colin	Laurentian University
Teichert	Sonja	Western University
Tomscha	Stephanie	University of British Columbia
Twible	Lauren	Western University
Wood	Christina	Board of Directors
Yeung	Alex	University of British Columbia
Young	Alan	CNAES Board of Directors

Project Interview Training, April 26 – 28

Training opportunity for students and Post-docs
CNAES Strategic Network Enhancement Initiative

Being hired for a job or coming second can depend on how well you can talk about the research you've done in everyday, jargon-free language. In what seems to be emerging as a post-truth world of alternative facts, there are also other important and far reaching reasons for clear communication about the value as well as content of research.

CNAES and NSERC are pleased to provide an opportunity to learn and practice in a very friendly, relaxed but realistic setting during both days of the meeting. The product will be a professionally video-recorded and edited interview about your work. A studio with good lights, microphones and cameras will be set up in a room close to the main presentation and poster locations. Dr. David Pearson from Laurentian will ask the questions. Colin Stringer, a professional free-lance video producer and photographer, and a graduate of Laurentian's science communication program, will be behind the camera.

We would like to post the videos on the CNAES website but will not do that unless we have your permission after you have seen the final video. You will, of course, be free to use it and post it wherever you wish. It will be your intellectual property. We expect each interview, after editing out any glitches, will be about 6 or 7 minutes long. Given a chance for warming up and practice, each interview "appointment" will last about 15 to 20 minutes.

The only preparation that makes sense would be to think through your project in everyday language; and imagine an audience that has never taken a science class but holds purse strings and writes policy. Be ready to talk more about why your research is important than how you did it. Think of analogies. Tell stories. If I were just going into High School, why would I want to work toward doing what you do ?

A sign-up sheet will be posted at a strategic location.