2016
Annual Report
Cooperative Freshwater Ecology Unit
Awards and Recognition

- Dr. David Pearson was appointed to the Order of Ontario in 2016. The Order of Ontario is the province’s highest honour.

- Dr. Peter Beckett was the recipient of the Pioneer in Reclamation award from the American Society of Mining and Reclamation in Spokane, WA on June 2, 2016. On Sept. 9, 2016, Dr. Beckett was officially recognized for his outstanding contributions and leadership in environmental restoration through the establishment of the “Peter Beckett Doctoral Bursary” at Laurentian University endowed by the Sudbury Mining and the Environment International Conference Series. Dr. Beckett was also awarded the Dr. Edward M. Watkins Award by the Canadian Land Reclamation Association in 2016. In addition, the Mayor of the City of Greater Sudbury presented Dr. Beckett with an Award of Distinction for his 40+ years of reclamation activity in the community. Dr. Beckett’s work over the years has included engagement and leadership with local community groups, city, industry, and public education and outreach. Congratulations!

- Dr. Nadia Mykytczuk was selected to be the new NOHFC Industrial Research Chair in Biomining, Bioremediation and Science Communication on April 1, 2016. Dr. Mykytczuk was also awarded an MRI Early Researcher Award for 2017 (-2021)! Congratulations!

- In June of 2016 an oak tree on the Lakes Centre property was dedicated to Bill Keller, one of the founders of our Cooperative Freshwater Ecology Unit in 1989. Bill has been a strong and steady pillar (like an oak) of the CFEU and will soon be transitioning into the role of Senior Research Fellow of Northern Studies. This is the first Senior Research Fellow position at the Lake Centre.
Dr. John Gunn received a royal request from his majesty King Carl XVI Gustaf of Sweden to attend the 12th Royal Colloquium at Rosersberg Palace near Stockholm on May 22-26, 2016.

Under the leadership of Dr. Chantal Barriault, the Science Communication Program became a Master’s Program in 2016 and will accept its first round of Master’s students in the Fall of 2017. It is the first program of its kind in Canada and one of just a handful in the world.

Dr. Pascale Roy-Levéillée, an assistant professor in the School of Northern and Community Studies, and a specialist in permafrost and climate interactions, joined the Co-op Unit in 2016 and moved into an office at the Lake Centre in early 2017. Welcome!

Dr. Shaun Watmough was appointed the Director of the Trent School of the Environment in June. Dr. Watmough was also named outstanding reviewer for The Science of the Total Environment.

Dr. John Bailey was selected for the position of Assistant Deputy Minister with the Dept. of Energy, Mines and Resources with the Yukon Government in Whitehorse. He was the MOECC scientist at the Co-op Unit for the past 5 years.

**Student Scholarships, Fellowships, Bursaries**

- Vanessa Bourne was a NSERC One Minute Thesis Video competition finalist with her research video [https://www.youtube.com/watch?v=7iQgopTvDuA](https://www.youtube.com/watch?v=7iQgopTvDuA)

- Samantha Burke, PhD Candidate (CGS-D award 2015-present), was awarded a prestigious W. Garfield Weston Award for Northern Research. Samantha was also awarded an ‘Extended Stay’ grant from the Canadian Northern Studies Trust, and a Northern Scientific Training Program Grant for her field research in the Yukon. In addition, she received a grant to attend an international GLEON (Global Lakes Ecological Observatory Network) workshop. University of Waterloo (Swanson)

- Michael Carson, PhD Candidate, received a Trillium Foundation Fellowship for International Students (2014-2017). Laurentian (Basiliko)

- Stéphanie Guernon received an NSERC CREATE ÉcoLac scholarship. UQAM/Waterloo (Swanson)

- Rachel de Jong, MSc. Candidate, continued to be supported by a QEII Scholarship and a prestigious W. Garfield Weston Award for Northern Research. She also received the
Golder Poster award at the Laurentian SETAC (Society for Environmental Toxicology and Chemistry) Annual General Meeting and Conference in June 2016. University of Waterloo (Swanson)

- Amelia Fitch, MPhil Candidate, was the recipient of a Gates Cambridge Scholarship. University of Cambridge (Tanentzap)

- Varun Gupta, PhD Candidate, received a NSERC CGS (2015-2018), a Goodman School of Mines Scholarship (2014-2018) and a NSERC Create Mine of Knowledge (2014-2018). Laurentian (Mykytczuk/Gunn)

- Matthew Heerschap, MSc Candidate, received a W. Garfield Weston Foundation 2016 Fellowship for Northern Conservation, a Department of Fisheries and Oceans (DFO) Scholarship for habitat protection research and Northern Student Training Program Support. He was also the recipient of the first R.W. Drysdale Memorial Scholarship in Aquatic Biology. Laurentian (Gunn/Johnston).

- Brent Lewis, MSc Candidate, was one of only a few students invited to speak to the W. Garfield Weston Foundation annual meeting in January 2016. Brent spoke to philanthropists regarding his research and the valuable experiences he gained as a recipient of the Weston Foundation-Wildlife Conservation Society Northern Research Award (in 2015). University of Waterloo (Swanson)

- Genevieve Noyce, PhD Candidate, received an OGS International Student Fellowship (Sept 2015- Aug 2016). University of Toronto (Basiliko)

- Chloé Orland, PhD Candidate, received a University of Cambridge Frank Smart Bursary. University of Cambridge (Tanentzap)

- Ashley Stasko, PhD Candidate (CGS-D award 2013-2016), was awarded an Ontario Graduate Scholarship, and spent January – June 2016 on exchange at the University of Tromso in Norway (supported by an NSERC Michael Smith Foreign Study Supplement). A primary publication that resulted from this exchange (with University of Tromso faculty member Dr. Bodil Bluhm) was submitted in November 2016. University of Waterloo (Swanson)

- Nelson Zabel, MSc Candidate, was awarded the Graduate Seminar Award for the best MSc seminar at the Biology Graduate Symposium. He was also awarded a Northern Scientific Training Program Grant, and an Arctic Institute of North America Grant-in-Aid for his field and laboratory research in the Yukon. University of Waterloo (Swanson).
Community Outreach

- Cyndy Desjardins made a presentation on the Cambridge project to the Clearwater Lake Stewardship group in December 2016

- Dr. John Bailey participated in the following outreach activities in 2016:
  ~ Met with Marten Falls Chief and Council re: Ring of Fire surface water sampling. May 2016
  ~ Met with Webequie Chief and Council re: Ring of fire surface water sampling
  ~ Conducted CABIN Stream Sampling Training Session in Sudbury for the MOECC, EC and Sagamok FN with Nicole Novodvorsky, May 2016

- Dr. Peter Beckett is the Outreach Coordinator with the VLWLC. He served in the following Capacities in 2016:
  ~ VETAC: Chair
  ~ Canadian Land Reclamation Association (Ontario Chapter): Director
  ~ Junction Creek Stewardship Committee: Technical Advisor
  ~ Rainbow Routes: Environmental Advisor and Board Member
  ~ Sudbury Naturalists: Co-chair
  ~ Dr. Beckett also gave the following talks and tours
    o Regreening of Sudbury lectures for multiple courses at Laurentian including the OUPFB field course with Dr. Graeme Spiers
    o Regreening presentation and tour to Government and Industrial Representatives from South Korea with Dr. Graeme Spiers Nov 2016
    o Sandford Fleming/Trent University’s Restoration Ecology Program with Dr. Graeme Spiers Oct 2016
    o Sault College’s Natural Resources and Outdoor Studies Program with Dr. Graeme Spiers Sept 2016
    o Regreening tour based on the Jane Goodall Reclamation trail for the Canadian Ecology Centre, Mattawa. July 2016
    o Regreening talk and tour to Third Age Learning Group (Retirees) from Guelph, ON with Dr. Graeme Spiers May 2016
    o Cambrian College Environmental Technology and Impact Assessment Program/Environmental Monitors Program Feb 2016

- Dr. Nathan Basiliko contributed to ongoing content development and promotion of the award-winning Soil-4-Youth educational portal bringing exciting soil science educational resources to high school teachers and students to promote the important discipline of Soil Science: http://soilweb.landfood.ubc.ca/promo/raising-awareness/soil-4-youth

- Dr. John Gunn participated in the following public outreach initiatives in 2016:
  ~ Presented a research overview to the Rotary Club Feb. 8, 2016
  ~ Served as an expert member for the City Watershed Advisory Panel
~ Participated in “Nature of Things” filming Aug. 16-18, 2016
~ Assisted with the organization and presented at the Sudbury Protocol Conference May 9-11, 2016
~ Served as the Wallace McCain visiting professor at UNB St. John Campus Sept. 19 - Nov. 4, 2016. During this time, Dr. Gunn also gave a public presentation at the Fredericton campus.
~ Conducted tours with Greg Fergus, Parliamentary Secretary to the Minister of Innovation, Science and Economic Development on Feb. 29, 2016 and the Federal Minister of Science, Kristy Duncan on Aug. 20, 2016

- Dr. Charles Ramcharan served as a member of the Long Lake and Ramsey Lake Stewardship Committees, the City of Greater Sudbury’s Food Policy Council and the City of Sudbury’s Watershed Advisory Panel.

- Dr. Pascale Roy-Léveillé participated in the following radio interviews in 2016:

- Dr. Bjorn Rosseland participated in the following public outreach initiatives in 2016:
  ~ Served as an expert in Ecotoxicology for the City of Oslo. This resulted in the implementation of the ICP Waters Protocol for ecotoxicology/pollutant studies in fish for all the major rivers within the city.
  ~ Served as a member of an expert panel for the Norwegian Research Council on Innovation Project Applications in Aquaculture
  ~ Gave a presentation entitled “Fisk og vin (og «nogo attåt» (miljøgifter)). (Fish and wine (and something in addition (environmental pollutants))” at a meeting of the Oppegård Wine club, 13 Apr 2016

- Dr. Graeme Spiers served as a member of VETAC and gave the following talks and tours in 2016:
  ~ Regreening of Sudbury lectures for multiple courses at Laurentian including the OUPFB field course with Dr. Peter Beckett
~ Regreening presentation and tour to Government and Industrial Representatives from South Korea with Dr. Peter Beckett Nov 2016
~ Sandford Fleming/Trent University’s Restoration Ecology Program with Dr. Peter Beckett Oct 2016
~ Sault College’s Natural Resources and Outdoor Studies Program with Dr. Peter Beckett Sept 2016
~ Regreening talk and tour to Third Age Learning Group (Retirees) from Guelph, ON with Dr. Peter Beckett May 2016

• Dr. Heidi Swanson participated in the following outreach activities in 2016:
  ~ In collaboration with Kluane First Nation and the Arctic Institute of Community-Based Research, she participated in the documentary ‘Remembering our Past, Nourishing our Future.’
  ~ Worked with 2 First Nations researchers in the Dehcho region, NT
  ~ Hosted 3 youth, 1 youth councillor, an Aboriginal filmmaker, and the Indigenous coordinator from the Arctic Institute of Community-Based research at the University of Waterloo and Western University as part of a First Nations-University exchange
  ~ Presented at 3 community meetings in Dehcho region, NT in November 2016
  ~ Participated in the following media interviews in 2016:
    o ‘First Nations students to help UW test Yukon fish’ (Waterloo Record)
    o ‘Good news from Kluane Lake’ (Yukon News)
    o ‘Research and Innovation’ (Globe and Mail)

• Dr. Andrew Tanentzap participated in “Nature of Things” filming Aug. 16-18, 2016

• Dr. Shaun Watmough helped organize the North American Envirothon in July 2016 and was a VIP Judge. He was also interviewed for the Chemical and Engineering News in February 2016

• Lynne Witty provided external taxonomic confirmation for D. Karsten Liber, Director of the Toxicology Centre at the University of Saskatchewan as well as serving as a Staff Biologist with Chantal Sarrazin-Delay for A Fon de Train television production.

• Dr. Norm Yan gave the following invited lectures to the general public:
  ~ “Working together to support tourism, science, education, jobs and our waters”, invited 45 minute presentation to the board of the Muskoka Steamship and Discovery Centre, Gravenhurst, ON, 29 April 2016.
  ~ “Practicing environmental science: reflections on a 50 year lesson”, invited presentation to the Canadian Federation of University Women, Muskoka, United Church, Bracebridge, ON, 6 Jan 2016.
2016 Watershed Lecture with Dr. Gene Likens, “Mr. Watershed”
We were honoured to have Dr. Gene Likens give the annual Watershed Lecture for 2016 on Friday, September 9th. Dr. Gene Likens, is the co-founder of the internationally renowned Hubbard Brook Ecosystem Study and one of the world’s most recognized environmental scientists.

Recipient of 10 honorary doctorates, the 1993 Tyler Prize, the 2001 USA National Medal of Science, co-recipient of the 2003 Blue Planet Prize (considered the Nobel Prize of Ecology) and many other prestigious awards, Dr. Likens is an educator and advisor at state, national and international levels. He currently holds faculty positions at Yale, Cornell, Rutgers Universities, SUNY Albany, the University of Connecticut, and was awarded a Chair as Albert Einstein Professor from the Chinese Academy of Science.

End of an Era
The original home of our Cooperative Freshwater Ecology Unit, the former MNR bush plane air base on the edge of Ramsey Lake, was demolished in 2016. Although it hasn’t been our home for years, we have great memories of the people, the hard work and the fun we had on this historic site.

We are happy to confirm that the property is now City owned and our hope is that it will remain a green strip and inspirational property on the edge of our drinking water lake, available for public use for decades to come.
Cambridge University Project: RELATED 2014-2017

This three year $900K NERC funded project called RELATED (Restoring Ecosystems by Linking Aquatic and Terrestrial Ecosystem Dynamics) is a collaborative project between the VLWLC and Cambridge University. The principal investigator is Dr. Andrew Tanentzap, our former Banting Fellow and now a faculty and Chair of the Ecosystems and Global Change Group at Cambridge University. Drs. Nadia Mykytczuk, Nathan Basiliko and John Gunn are the Laurentian collaborators on this project. Cambridge Postdoctoral Fellow Erik Szkokan-Emilson splits his time between the Vale Living with Lakes Centre and the University of Cambridge. The goal of the project is to assess how changing terrestrial landscapes affect productivity (zooplankton, microbes, benthic invertebrates) of nearshore waters and their release of greenhouse gases (CH₄, CO₂, H₂S).

The Cambridge project supports a full time research technician here at the Lake Centre (Cyndy Desjardins) and 5-6 Cambridge staff/students have been coming to the Lake Centre each year. Laurentian student (Kurt Yakimovich) also spent 4 weeks in Cambridge conducting his sediment genetics study and John Gunn visited Cambridge to participate in a RELATED workshop.
Swedish Royal Colloquium
Dr. John Gunn attended the 2016 Royal Colloquium, hosted and chaired by the King of Sweden at his Rosersberg Palace on May 22-25th. John presented a summary of the Sudbury environmental recovery story and discussed Laurentian's plans for global exchange of information through the proposed Sudbury Protocol and the upcoming on-line course on Environmental Remediation. During the event John presented his Majesty with a copy of Sudbury's "Healing the Landscape" photography book.
OUPFB Students Engage in Sudbury Discoveries
The VLWLC hosted the Ontario University Field Biology Course entitled “Restoration Ecology: From Fish to Microbes” on August 22–September 4, 2016 with 10 students from 6 universities (Queen’s, Toronto, Trent, Waterloo, York, Western). Drs. Gunn, Beckett, Mykytczuk and Spiers were the instructors and TA support was provided by Renate Vanderhorst and Amanda Wittmann. In addition to intensive research projects, students were certified in the regreening module of the new signature course “Environmental Remediation: Global Lessons from the Sudbury Story” produced by Dr. Mykytczuk and supported by the Goodman School of Mines.

We also held the ICP Waters Dissection course again this year with the help of our visiting scientist in residence, Dr. Bjorn Rosseland from the Norwegian University of Life Sciences, who joined us by video. Emily Smenderovac led the dissection course from our lab and provided overall leadership for the course.

MNDM Day at the Lake Centre
Deputy Ministry David de Launay playing jazz piano might have had something to with it, but we were delighted with the large crowd that came to our MNDM open house January 8, 2016. It was a great opportunity to showcase our innovative mining related research in the areas of bioremediation, regreening, bioassessment in the Ring of Fire area and First Nations partnership activities.
MNDM Day activities at the Lake Centre included a concert, demonstrations and short research lectures.

**NSERC CRD Program TÄLER 2010-2016**

“Terrestrial Aquatic Linkages for Ecosystem Recovery”

The TÄLER project funded by NSERC, Vale Ltd. and Glencore Ltd. (total $1M) addressed the concerns (erosion, elevated metals, low organic matter in soil) identified through the Sudbury Ecological Risk Assessment. The research team for this project consisted of J. Gunn, N. Mykytczuk, W. Keller (Laurentian), D. Kreutzweiser (Can. For. Serv.) S. Watmough (Trent), N. Yan (York), J. McGeer (Wilfrid Laurier), S. Arnott (Queen’s), A. Yates (Western), J. Bailey (MOECC) and A. Tanentzap (University of Cambridge).

TÄLER addressed the following questions:

1) How does disturbance type (fire, logging, mining) affect benthic invertebrate recovery? (D. Kreutzweiser, J. Gunn, S. Arnott, N. Mykytczuk, A. Tanentzap)

2) What controls the quantity and quality of organic matter entering lakes? (S. Watmough, J. Gunn)

3) How do organic matter and base cations interact to influence the toxicity of residual metals? (J. McGeer, N. Yan, M. Celis-Salgado)

4) What habitat characteristics are associated with healthy invertebrate communities? (A. Yates, J. Bailey, W. Keller)

Scientists and community stakeholders participating in the Nov. 27, 2014 TALER workshop. A total of 8 TALER workshops were held.
Aquatic Restoration Group - Sudbury Environmental Study Lakes

In 2016, the Ministry of the Environment and Climate Change at the Cooperative Freshwater Ecology Unit continued sampling lakes for the Sudbury Environmental Study (SES) under 2 main programmes which complement each other: SES Extensive and SES Intensive. The SES Extensive programme includes a set of 44 lakes, located within a 100 km zone around Sudbury. These lakes were all acidified to below pH 5.5 in the early 80s, but are now in various stages of recovery. The lakes are sampled once annually during the period late June through July. The data are intended to provide information on regional patterns in water quality and lake recovery in the lakes near Sudbury. During 2016, all 44 lakes in the SES Extensive lake set were sampled once for a set of standard water chemistry parameters. Additionally, twelve lakes were selected for zooplankton sampling, chosen to reflect both current acidification status and lake size. This subset will continue to be sampled annually moving forward, in an effort to have a more continuous record of zooplankton data for this broader range of lakes. In addition to the 44 lake Extensive set, a set of 24 reference lakes also exists, that were all non-acidic during the original lake surveys in the 1980s. These lakes are only visited periodically, and in 2016 all 24 of these lakes were sampled for both chemistry and zooplankton. The SES Intensive programme is a set of lakes sampled monthly or twice-monthly through the ice-free season for a wide range of physical, biological and chemical parameters (water chemistry, Secchi disc transparency, oxygen/temperature profiles, zooplankton, phytoplankton), therefore giving a larger and more varied amount of data on a smaller group of lakes. In 2016 there were 10 lakes sampled monthly (May - October) and 1 lake sampled twice-monthly (Swan lake) under the SES Intensive programme.

In addition to the routine samples collected under the SES programme, sampling for additional smaller projects was also conducted. A preliminary study was undertaken on Ramsey Lake, investigating the feasibility of using a blue-green algae probe as part of a routine monitoring programme, to detect changes in the lake related to these blooms. Samples from six stations on Ramsey Lake were sampled monthly through the ice-free season. As well, in support of a long-term perspective paper planned for Whitepine McLeod and Clearwater lakes, benthic invertebrate samples were collected from both soft and rocky substrates, in collaboration with the Gunn lab.

The zooplankton taxonomy lab continued to process samples collected under the SES programme, but also processed samples for various partners and collaborators including the Severn Sound Environmental Association, the Ministry of Natural Resources and Forestry, and the Climate Change and Multiple Stressor Research Programme. Samples from Lake Simcoe were processed specifically for spiny water flea screening as has been done in the past. In addition, a set of Lake Simcoe samples was processed as part of a method development project, examining the possible use of hydroacoustic techniques to characterize the zooplankton community. In total 367 zooplankton samples were processed in 2016. Work also continued on testing potential replacement software for the current zooplankton enumeration system (Zebra2), in collaboration with the MOECC office in Dorset, Ontario.
Database management during 2016 included updating the several databases that house data produced from our programmes. In addition, 20 data requests were addressed from partners and collaborators. Support for other projects, including graduate student projects was also provided (data, expertise and logistics). There is a current ongoing focus on generating updated lake reports summarising data collected through 2016.

The MOECC crew at the Vale Living with Lakes Centre 2016.

These Sudbury area monitoring programmes continue to be a very important component of Canadian and international efforts to assess the effects of acid deposition and the responses of lakes to sulphur emission controls. In recent years these studies have also figured prominently in large-scale collaborations investigating the effects of other major environmental stressors including climate change, UV-B irradiation, changes in DOC concentrations and declines in calcium. Results from these sampling programmes have been presented and interpreted by ARG partners and numerous collaborators. Publication highlights for 2016 included a zooplankton recovery paper published by Norm Yan et al., in the *Journal of Limnology* that used historical ARG lake chemistry and zooplankton data. As well, following on the 2015 papers on changes in surface temperature published in *Nature-Scientific Data* and *Geophysical Research Letters*, preliminary findings on trends in the associated full temperature profile data were presented at the Society for Freshwater Science Conference. Initial findings from the eDNA project started in 2015 have now been presented. Further details of recent publications arising from this programme can be found within the publication section of this report. These products underscore the value of continuing to collect long-term lake data.

**Climate Change and Multiple Stressor Aquatic Research Program**

An extensive network of collaboration has been established with international researchers. These collaborations are resulting in many journal papers examining climate change/multiple stressor effects on northern aquatic systems. Many more papers are in preparation.

Good working relationships have been developed and are being maintained with First Nation communities at Fort Hope, Fort Severn, and Peawanuck. Results from our scientific studies in
their traditional lands have been provided to the communities on an ongoing basis. Discussions are underway to develop sampling plans in the far north of Ontario for summer 2017.

W. Keller participated in the NSERC CRD Project entitled “Role of Terrestrial Carbon and Base Cations in the Recovery of Damaged Aquatic Systems” with the mining companies Glencore and Vale and a number of universities. This project was completed. W. Keller is also part of a multi-University NSERC network program – the Canadian Network for Aquatic Ecosystem Services (CNAES). A key element of this programme is the assessment of aquatic ecosystems in the Attawapiskat River watershed of northern Ontario.

W. Keller, with John Smol (Queen’s University) received funding from the Best in Science Program of the Ontario Ministry of the Environment and Climate Change for a project “Assessment of contaminants and ecosystem change in aquatic systems within the ‘Ring of Fire’ prior to resource extraction: have contaminant levels been affected by recent warming”? The final project report was completed and submitted to MOECC.

During the summer of 2016, field studies focused on three areas of the far north of Ontario.
1) Six rivers draining to Hudson Bay between Fort Severn (Wasaho First Nation) and the Manitoba border were sampled for water chemistry (Black Duck, Pipowatin, Tamuna, Majikan, Black Currant, Mintiagan). Three of these rivers were also sampled for fish (Pipowatin, Tamuna, Mintiagan). These waters are important fishery resources for the community of Fort Severn. In the Pipowatin River recording thermisters were also used to track temperature conditions during the sea trout spawning run.
2) Sampling was continued in the Hawley Lake/Sutton River area, east of the community of Peawanuck (Weenusk First Nation). Studies of the limnology of Hawley Lake, including sampling for water chemistry, zooplankton, phytoplankton, and thermal conditions were continued. Water chemistry samples were collected from the Sutton River and recording thermisters were again used to track thermal conditions in this world class sea trout fishery.
3) Repeat sampling was conducted on 12 lakes in the Ring of Fire area of northwestern Ontario that were sampled previously. This study seeks to document the current status of lakes in this region prior to any resource extraction developments. Sampling was conducted for lake physico-chemical conditions and plankton.

Science transfer activities focused on the preparation of scientific manuscripts to disseminate the knowledge gained so far from our northern studies. Work has continued on creating a useful, accessible database of far north lake and river data from the studies completed or coordinated to date by the Climate Change and Multiple Stressors Aquatic Research Program Laurentian University (2009-2016). Datasets on various aspects of lake chemistry and biology have been transferred to the Ministry of the Environment and Climate Change for inclusion in their broad northern Ontario database.
Northern Fisheries Research Program
This program improves our understanding and aids the management of the fish populations that support the recreational, commercial and subsistence fisheries of northern Ontario. The program is led by Tom Johnston (MNRF) and has included a variety of projects examining the biology, ecology, and ecotoxicology of northern fish populations. Work on this program in 2016 was primarily directed at two fields of research:
1) Food web structure and contaminant bioaccumulation and in northern fish populations. This work is supported by MNRF Far North Branch, MNRF Regional Operations, MNRF Aquatic Research and Monitoring Section, MOECC Environmental Monitoring and Reporting Branch, NSERC CNAES, NSERC Discovery Grants Program, and Wildlife Conservation Society Canada. The geographic focus of this work was split between the Near North and Far North of Ontario in 2016. Fish sampling was carried out on 7 coastal rivers of the Far North as part of a study of food quality of wild fish (Heerschap, MSc), and 19 shield lakes of the Near North and Far North to support research on ecosystems with multiple apex predators (Savage, MSc). In addition, a new graduate study was initiated to model the food web structure of the Lake Nipissing ecosystem (Montgomery, MSc).
2) Reproductive ecology of northern fishes. This research is funded by the MNRF Aquatic Research and Monitoring Section, and NE Regional Operations. Research on Lake Nipissing continues to explore the effects of multiple stressors (spawning stock decline, food web disruption) on energy allocation and reproductive ecology of its walleye and white sucker populations.

The Freshwater Invertebrate Research Network of Northern Ontario (FIRNNO)
Biological indicators such as benthic macroinvertebrates (BMI) are useful in gauging the degree of impact due to human activities. The simplest approach involves the collection of BMI data prior to the activity at paired control and impact areas and the comparison to BMI data after the activity. The traditional before-after/ upstream-downstream (BACI) study design is not always feasible due to confounding issues and geographical limitations, hence alternative designs have been proposed. The Reference Condition Approach (RCA) to bioassessment is based on the premise that when a site is to be assessed, its BMI community is compared to that of many minimally impacted reference sites with similar habitat characteristics. The implementation of the RCA design generally requires a large network of reference sites encompassing many habitat types from which to best match a site of interest. Such a network is currently maintained by the Co-op Unit.

The Freshwater Invertebrate Research Network of Northern Ontario (FIRNNO) was designed to assist the metal mining industry in locating suitable reference sites to meet the Environmental Effects Monitoring (EEM) requirements of the Fisheries Act. The objectives of this project are:
- to develop and maintain a large network of reference sites to define the normal range of Northern Ontario benthic macroinvertebrate (BMI) communities
- to maintain an accessible database of BMI abundance and chemical/physical habitat characteristics for Northern Ontario lakes and streams
to assess and monitor mining and other anthropogenic effects on surface waters by detecting any change in BMI community structure.

Since FIRNNO’s establishment in 2003, BMI data for over 400 sites have been collected in the vicinity of 4 mining centers including Red Lake, Hemlo, Sudbury and Timmins along with accompanying water chemistry as well as site, channel and watershed level habitat data. This was expanded in 2013 with 72 sites sampled in the Attawapiskat River basin as part of MOECC’s Ring of Fire Baseline Environmental Data Collection Programme. Thirty-one more sites were sampled in this area in 2014 using a crew from the Co-op Unit and Marten Falls First Nation. In order to expand coverage of the reference site network, the Co-op Unit fall 2014 sampling focused on the upper Albany River Basin, where 35 sites were sampled. These sites expand coverage of the Network and also provide information on the type of environment a transportation corridor from the Ring of Fire is expected to pass through. Sampling in 2015 was focused on the Ring of Fire Region. Forty-six sites were sampled, split between the Hudson Plains and Boreal Shield Ecozones. Sampling occurred three times for each site: post-breakup, mid-summer and fall. These data will contribute to the MOECC baseline data collection and also serve to support Vanessa Bourne’s MSc research project examining seasonal variability of biota and water chemistry across the two Ecozones.

FIRNNO sampling in 2016 was again carried out in the Ring of Fire region to maintain and expand data collection for reference streams. Thirty-two sites and 11 lakes were sampled in the summer, split between the Hudson Plains and Boreal Shield Ecozones. In addition to CABIN sampling, stream fish communities were also sampled in collaboration with the Ministry of Natural Resources and Forestry. Live invertebrates (zooplankton and amphipods) and fish (slimy sculpin) were also collected and transported to Wilfred Laurier University for future ecotoxicology studies.

Fall 2016 FIRNNO sampling was carried out in the Pickle Lake region to expand the reference site data base into an area that may be developed into an important Far North transportation corridor. Finally, the FIRNNO reference site data base was expanded by the addition of 11 sites sampled in the North Bay region.

The FIRNNO data were used for a number of research and management initiatives in 2015. A manuscript is in preparation investigating the concordance of benthic communities across watersheds and the spatial application of reference sites. These data were also used for a study of Junction Creek as well as for the Wildlife Conservation Society Canada’s Far North Study.

The FIRNNO data are managed through the Canadian Aquatic Biomonitoring Network (CABIN) online database. In 2016 assessment tools for the Near North Ontario were designed at the Co-op Unit and uploaded to the CABIN site following review by a national panel of aquatic bioassessment science experts. These tools allow users to carry out assessments of stream sites of interest, to calculate a wide range of commonly-used benthos community metrics and to prepare publication-ready reports. An update of the existing Attawapiskat Basin model is in
development and the improved online tools for that region should be available in the spring of 2017.

**Mine of Knowledge Program: Finding Microbial Solutions to Ecosystems Problems**

The Mine of Knowledge program is 5 year $1.65 NSERC funded CREATE program designed to train students in a multi-disciplinary research to provide the mining industry with highly qualified personnel in environmental management and restoration of ecosystem services at mining locations around the world. Laurentian University joins with the University of Montréal, INRS, McMaster, and Ottawa universities in this bilingual Quebec/Ontario program. Bacterial metabolism represents the root cause of deleterious mine drainage, but is also a significant untapped opportunity to enhance mine sustainability through strategic characterization of its roles in these ecosystems. In addition to providing students with hands-on experience, the SMART-MINE initiative will provide them with training in analytical and environmental chemistry, mine waste mineralogy, biogeochemistry, ecotoxicology, environmental genomics and molecular microbiology using state-of-the-art instrumentation and modeling approaches. Graduate projects will range from fundamental laboratory-based projects on membrane protein transport to large-scale field studies on the bioremediation of mine drainage. This bilingual Quebec/Ontario training program will form a new generation of environmental scientists who understand the needs of mining industries and are prepared to propose innovative solutions to improve the environmental sustainability of this key Canadian economic sector. With the increasing overlap associated with expansion of mining activities into the Canadian north between Canadian mining activities and First Nations communities, this Mine of Knowledge will emphasize First Nations representation and involvement.

**Canadian Network for Aquatic Ecosystems Services (CNAES)**

**Network Lead Scientist**
Dr. Don Jackson, University of Toronto

**Theme I Co-Leaders:**
Dr. John Gunn, Laurentian University
Dr. Brian Branfireun, Western University
LU/CFEU participants:
J. Bailey, D. Campbell, J. Gunn, T. Johnston, B. Keller, D. Pearson, H. Swanson

NSERC funding: Total of $4,416,625.00 over 5 years (2012-16)

Participating Universities: Toronto, Laurentian, UBC, UQAM, Western, Guelph, Trent, UNB, Waterloo, McGill, Nipissing

CNAES Graduate Students at LU (to date):
Project 1.3 Characterize the structure and function of aquatic ecosystems
1.3(a) RCA invertebrate surveys – MSc Nicole Novodvorsky (PI John Bailey/John Gunn)
1.3(b) Zooplankton and Phytoplankton – MSc Josef MacLeod (PI Bill Keller/ John Gunn)

1.4 Impact of nutrient additions on wetlands – MSc Amanda Lavallee (PI Daniel Campbell)

Project 1.5 Characterize the distribution of Hg and MeHg in surface water and freshwater biota
1.5(a.1) Headwater to Coast Hg Survey – PhD Gretchen Lescord (PI Tom Johnston/John Gunn)
1.5(a.2) Stable Isotopes and Hg – MSc Alexandra Sumner (PI John Gunn/Tom Johnston)
1.5(c) Anadromy and Hg – MSc Rachel DeLong (PI Heidi Swanson, Waterloo)
1.5(d) Anadromy and Fatty Acids – MSc Matt Heerschap (PI Tom Johnston/John Gunn)

1.6 Science Communication and First Nation Engagement – (PI Chantal Sarrazin-Delay/David Pearson)

Partnering agencies: Ontario Ministry of the Environment and Climate Change, Ontario Ministry of Natural Resources and Forestry, Canadian Forest Service, Natural Resources Canada, Parks Canada, Fisheries and Oceans Canada, Central & Arctic Region, Le Ministère des Ressources naturelles et de la Faune du Québec

Partnering Industries and Foundations: DeBeers Canada, Alberta Innovation Technology, Kongsberg Maritime, David Suzuki Foundation

In 2016, the annual CNAES meeting was held at the University of Guelph, Guelph, ON. May 3-5.
A New Model for Upper Level Student Engagement and E-learning through Social Online Course Environments with a Global Reach: the Laurentian University SOLE Model

A team led by Nadia Mykytczuk, in collaboration with several LU departments, faculty, staff, and external city and industry collaborators have been working to develop, test, and deliver an innovative new learning model for e-learning courses. The model and first production will lead to the establishment of a signature course for Laurentian on “Bioremediation; Global Lessons from the Sudbury Restoration Story.” Such a course will be key to Laurentian’s provincial, national and international student recruitment efforts. The interactive experimental model that we will develop and test will guide future developments of not only our own distance education programs, but is also designed to lead to major improvements in on-line courses at other institutions in Ontario. The first of six course modules (Module 4: Terrestrial and Aquatic Linkages for Ecosystem Recovery) was completed and “beta-tested” at a stakeholders workshop in November 2014. The second module was presented as a workshop during the Mining and Environment International Conference in June 2015. The full course was launched as a 3 credit course in January 2017.

Science Communication at the Vale Living with Lakes Centre

www.sciencecommunication.ca

A new Master’s in Science Communication (MSCom)

Our proposal for a new 12 month Master’s in Science Communication was approved in November 2016! We are excited to finally be accepting students into the first and only Master’s degree program of this kind in North America starting in September 2017. The nine month Graduate Diploma we currently offer will still be offered for those who already have a graduate degree and do not want to write up another major research project. The Master’s degree has increased the number of applications to the program, ensuring that we will fill all 15 of graduate spaces!

The new Masters program confirms our profile as experts in the field in this country. The obvious direct benefit of the program for the Lake Centre is that every year about a dozen science communication students join forces with their peers in the Biology Graduate Seminar.
course to create YouTube style video stories and animations about the biology students’ research projects. This synergy is reinforcing our Lake Centre culture of high quality communication, as well as providing excellent videos for our annual Eagle Awards Student Film Gala.

As the program grows, we can anticipate the direct benefits to the Lakes Centre to increase. For example, researchers and their work will become the focus of Science Communication student assignments and research, providing Lake Centre researchers with effective communication products that showcase their work for various audiences, through social and traditional media. Internal and external requests for professional development training in science communication have begun as more scientists from Laurentian and from government ministries seek guidance on effectively communicating with stakeholders and the public.

We are pleased to be able to continue to offer bursaries to our students from the interest on a dedicated endowment fund totaling $560,000. The largest contributors have been the F. Jean MacLeod Trust and the TD Financial Group, as well as the Grace Rumball Bursary.

We are looking forward to welcoming the new cohort of Master’s students this coming fall.

**Communicating Climate Change and Building Science Capacity in the Far North of Ontario**

In the first three months of 2016 the Science Communication outreach group continued to offer hands-on science activities in remote First Nation schools in the far north of Ontario, supported by the privately funded Far North Ontario Youth in Science Opportunity Program and the NSERC Aquatic Ecosystem Services Network (CNAES). Chantal Sarrazin-Delay was the Outreach Coordinator for these activities. Visits to schools in Fort Severn and Fort Hope occurred alongside discussion about adapting to climate change through David Pearson’s participation in the Ontario Centre for Climate Change Adaptation Resources (OCCIAR) on the Laurentian campus.

On April 1, a shift occurred as climate change became the focus of our work when OCCIAR received funding for 2 years from Ontario’s Green Investment Fund through the Ministry of Indigenous Relations and Reconciliation to engage First Nations across the province on issues related to climate change. The purpose of the funding is to work with First Nations to build understanding of climate change, to develop climate change adaption plans, to reduce greenhouse gases through energy planning and renewable energy generation, as well as to participate in discussion of economic opportunities through Ontario’s cap and trade program. OCCIAR has partnered with the Ontario First Nations Technical Services Corporation to deliver the energy related parts of the mandate. Because of our experience in the far north, the Science Communication Outreach Group in the Lake Centre took on the responsibility of working with northern and remote First Nations focused on a Climate Change Impact Study and Adaptation Planning for the North. We continue to include hands-on school activities in some of our visits to communities.
For school visits, as well as for community open houses, we take wifi microscope and iPads along with a wide variety of specimens, including aquatic invertebrates, (although we usually collect fresh material – even through the ice), for students and community members to examine. We also have desk top demonstrations of lake stratification and the use of water monitoring equipment; fossils and minerals; animal bones; otoliths and other fish structures for aging; lichens, and whatever local material is available at the time.

To further connect with community members and environmental staff from far north First Nation communities, we attended the Northern Ontario First Nation Environment Conference (NOFNEC) in Thunder Bay, delivering a talk and a workshop about climate change impacts in the north and manning a table during the trade show where we demonstrated science activities for young people.

While in Fort Severn FN, we collaborated with Frontier College, a not-for-profit organization and national leader in literacy programming, to offer one-day science workshops for children enrolled in their literacy and numeracy camp. Children had an opportunity to learn about aquatic ecosystems by dip netting for benthic invertebrates and sampling for fish.

**Mercury and the Guide to Eating Ontario Fish**
In communicating science related to CNAES research, we have given attention to mercury issues, especially to developing graphic ways of communicating the information in the Guide to Eating Ontario Fish. Several designs have been tested in communities and at NOFNEC. We are collaborating with Gretchen Lescord who is also interested in this topic and are continuing to assess the effectiveness of mercury graphics.

**Climate Change Impact Study and Adaptation Planning for the North**
The first nine months of the “Climate Change Impact Study and Adaptation Planning for the North” in 2016 were spent on building relationships with northern Tribal Councils and their member First Nations. Letters of Agreement were drafted for the Matawa, Keewaytinook Okimakanak, Nokiiwin, and Mushkegowuk Tribal Councils and NAN (Nishnawbe Aski Nation). Over 40 First Nations have been engaged through their tribal council and NAN.

The model we have adopted involves employing a part-time First Nation Climate Change Leader in each Tribal Council and a part time Climate Change Specialist in each First Nation community. Before the project ends on 31 March, 2018, we intend that they will have formed a Far North Climate Change Network of informed and interacting participants. Interaction among network participants will occur through occasional collective workshops, especially at meetings such as NOFNEC (Northern Ontario FN Environment Conference), and in parallel with Tribal Council events. A trilingual website is being developed and will be introduced in mid-2017 to facilitate interaction among communities with adequate internet access. Teleconferences, now being used for the Mushkegowuk Environmental Stewards, will be an important means of keeping participants connected and informed.
The first task for the CC Specialists in the communities is to audiorecord interviews with 10 Elders and community members about their observations and knowledge of changes in weather patterns and the impacts, using a standard list of questions. They will then follow up indications of important impacts to assist in determining the climate change vulnerabilities of their communities and their community members. They will collaborate with project team members from Laurentian U. to prepare risk statements for consideration by community leaders and community members. Training sessions for this work during 2016 were done with nine Mushkegowuk and eleven NAN communities.

A very successful two-day Climate Summit attended by 211 people was jointly organized with Mushkegowuk Tribal Council staff and held on Dec 7 and 8. Participants included the Mushkegowuk Environmental Stewards in communities and a delegation of six, including youth, Elders, and planners from each community. Twenty-four science researchers from universities and government along with graduate students attended, hosting “table talks”. A planning session on the second day resulted in a recommendation that a collaborative environmental research network should be established. Laurentian U. is intending to continue to contribute as the post-secondary research hub of the network, connecting researchers active in the north with the Mushkegowuk TC and its member First Nations in collaborative projects.

Special projects were developed in 2016 for field work in summer 2017. One will look at the consequences of permafrost melting along the west bank of the Severn River in the community of Fort Severn. There appears to be a risk that slumping of the bank is being enhanced by melting.

Another project is using bird song meters (recorders) to catalogue song-bird species and frog species in Fort Hope and Fort Severn. This will add to the observations of community members about impacts on biodiversity in the north.

Building on earlier work, climate change impact and adaptation action reports were prepared for presentation to the leaders of Eabametoong FN, Constance Lake FN, Webequie FN, and Fort Severn FN. (The first was presented in Fort Hope in early February, 2017.)

Future work in the communities will see the CC Specialist involved in community-based climate change impact monitoring, the details of which are currently under discussion. Two training sessions in identifying aquatic invertebrate species that indicate water quality have been held in preparation for that being one of the important skills for climate change impact monitors. This training will be offered by the project team from Laurentian and integrated into community visits.

Engaging youth in the work in communities and in understanding climate change is an ongoing part of the project. The project team has visited schools for day long, hands-on outdoor and classroom sessions in four schools during community visits. We intend to extend that into all communities engaged in the project.
Encouraging adaptation to a longer growing season by encouraging people in outdoor vegetable gardening is a community and family oriented component of the project. In Fort Hope this is already involving students from the school as interns participating in the project. Interviews and field footage to illustrate the impacts of climate change in Fort Hope was shot in July 2016 and will be used in the upcoming web site. It will emphasize how a combination of traditional knowledge and science leads to the most complete and useful understanding of past and likely future changes with an eye to enabling First Nations to be as prepared as possible for weather patterns that are now inevitable.

**Conference Organizing, Program Coordination and Editorial Activities**

Arnott, S.
- Associate Editor for Ecology and Ecological Monographs, 2016-present
- Associate Editor of Journal of Applied Ecology, 2010-2016
- Member of Organizing Committee, ASLO Sante Fe meeting, 2016
- Member of the Consortium of Aquatic Science Societies (representing ASLO)
- NSERC RTI Committee Panel 2017
- Chair of Physical Sciences, Mathematics and Statistics, and Computing/Information Sciences Subcommittee of Senate Advisory Committee, Queen’s University, 2016/17

Bailey, J.
- Appointed to Canadian Aquatic Biomonitoring Network Science Committee

Basiliko, N.
- Served on the Council of the Canadian Society of Soil Science (Jan 2015-Dec 2016)
- Served as Associate Editor, Canadian Journal of Soil Science (2013-present)
- Served as Review Editor, Frontiers in Microbiology (2011-present)
- Served as Associate Editor, FEMS Microbiology Letters
- Ad-hoc reviewer of >20 journal manuscripts and grant applications

Beckett, P.
- Organized and lead the Regreening field trip for the Sudbury Protocol Conference delegates May 2016

Belzile, N.
- Served as Associate Editor for the Journal of Geochemical Exploration
- Served on the Editorial Board of Geochemistry: Exploration, Environment, Analysis
- Served on the Editorial Board of ISRN Environmental Chemistry
- Served on the Editorial Board of Green and Sustainable Chemistry
Gunn, J.
• Served as Coordinator for the Boreal Ecology PhD Program
• Science Committee Member and Theme 1 Co-leader for NSERC CNAES program
• Organizing Committee Member and proponent of the development of the Sudbury Protocol as an International Standard and the Sudbury Protocol Conference in Sudbury, Ontario May 9-11, 2016

Kreutzweiser, D.
• Program Committee Chair, NSERC CREATE Program for Great Lakes Multiple Stressors and Cumulative Effects
• Forest Research Advisory Committee member, JD Irving Ltd, Forestry Division
• Science Committee member, NSERC Canadian Network for Aquatic Ecosystem Services
• International Union for the Conservation of Nature (IUCN) Advisory Task Force on Systemic Insecticides
• Invited reviewer ~ 15 international journals

McGeer, J.
• Editor of the Bulletin of the Canadian Society of Zoologists (2013-present)

Mykytczuk, N.
• Associate Editor, Canadian Journal of Microbiology (2017-present)
• Associate Editor, Water, Air, and Soil Pollution (2016-present)
• Served on the Editorial Board for the Journal of Microbiological Methods (2014-present)
• NSERC DG program external reviewer (2013-present)

Pearson, D.
• Organized participation of CNAES and government researchers, and graduate students in the Mushkegowuk Climate Summit, December 7-8, 2016

Ramcharan, C.
• Associate Editor, Canadian Journal of Fisheries and Aquatic Sciences.

Swanson, H.
• Associate Editor, Canadian Journal of Fisheries and Aquatic Sciences

Tanentzap, A.J.
• Served as Associate Editor at the Journal Nature Scientific Reports
• Served as Associate Editor at Journal of Vegetation Science

Watmough, S.A.
• Member of the editorial board of Science of the Total Environment
Yan, N.D.
• Served as Guest Editor for special issues of Journal of Limnology

Partners and Collaborators

Industry
Vale Ltd.  Glencore Ltd.  DeBeers Canada

Partners and Collaborators
• Appalachian State University
• City of Greater Sudbury
• Cornell University
• Dept. of Fisheries and Oceans Canada
• Environment and Climate Change Canada
• Goodman School of Mines
• Government of Northwest Territories
• Great Lakes Forestry Centre, NRCAN-CFS
• Inst. Nat. de la recherche scientifique – Eau Terre Environnement
• Lakehead University
• Laurentian University
• Michigan Tech U
• Natural Resources Canada
• Nipissing University
• OMOECC
• OMNRF
• Ontario Forest Research Institute (MNRF)
• Queen’s University
• Ryerson University
• Skidmore College
• South West U. of Science &Technology
• Tianjin Univ. of Science &Technology
• Trent University
• Universidad de Santiago de Chile
• University of British Columbia
• University of Cambridge
• University of Geneva, Switzerland
• University of Guelph
• University of New Brunswick
• University of Sherbrooke
• University of Toronto
• University of Waterloo
• University of Windsor
• University of Winnipeg
• Western University
• Wilfrid Laurier University
• York University

Others
• Aboriginal Aquatic Resources and Oceans Management Program
• Astina Forest AG
• Arctic Institute of Community Based Research
• Canada-Ontario Invasive Species Centre
• Dehcho First Nations
• Domtar
• DMI- Peace River
• Great Lakes Fishery Commission
• Haliburton Forest and Wildlife Reserve
• Institute of Ecosystem Study, Italy
- J.D. Irving Ltd.
- Keewaytinook Okimakanak (Northern Chiefs) Tribal Council and member First Nations
- Kluane First Nation
- Long Point Waterfowl and Wetlands Res. Fund
- Manitoulin Streams
- Marten Falls First Nation
- Matawa Tribal Council (Four Rivers Inc.) and member First Nations
- Moose Creek First Nation
- Mushkegowuk Tribal Council and member First Nations
- National Research Council, Italy
- Nishnawbe Aski Nation (Environmental Group)
- Nokiiwin Tribal Council and member First Nations
- Ontario Centre for Climate Impacts and Adaptation Resources (OCCiAR), LU
- Ontario First Nations Technical Services Corporation (with OCCiAR)
- Severn Sound Environmental Association
- Tembec
- Tolko
- United States Forest Service
- United States Fish and Wildlife Service
- United States Geological Survey
- Wasaho First Nation
- Webbequie First Nation
- Weenusk First Nation
- Wildlife Conservation Society Canada

**Book Chapters**


Publications

Co-op Unit Members authored or co-authored numerous publications in 2016:


Azan SSE and SE Arnott. 201X. The impact of calcium decline on population growth rates of crustacean zooplankton in Canadian Shield lakes. Limnology and Oceanography. Under Review.


Celis-Salgado MP, W Keller, MT Arts and ND Yan. 201X. Digestive tract variations as indicators of metal induced stress in four species of Daphnia. Hydrobiology. Under review.


Cott PA, AM Muir, CC Krueger, TA Johnston and JM Gunn. 201X. Buoyancy control mechanisms in deepwater fish assemblages of Nearctic lakes. Fish and Fisheries. Under review.


Emilson C, D Kreutzweiser, J Gunn and N Mykytczuk. 2017. Leaf-litter microbial communities in boreal streams linked to forest and wetland sources of dissolved organic carbon. Ecosphere 8(2) e01678.10.1002/ecs2.1678.


Haring M, TA Johnston, MD Wiegand and TE Pitcher. 2016. Differences in egg quantity and quality among hatchery and wild-origin Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 73:737-746.


Kielstra BW, SW Arnott and JM Gunn. 201X. Biological recovery at multiple scales: the importance of land-water linkages in mining impacted landscapes. Ecological Applications. Submitted.


Rosseland BO, TO Haugen, SS Hartman, K Våge, H Myreng and LS Heier. 2016. Mercury in fish in a TOC-changing world: A model to improve the general dietary regulations and focus on individual lakes versus large scale catchment advice. I: Proceedings of the 31st Task Force meeting of the ICP Waters Programme in Monte Verità, Switzerland, October 6-8, 2015. ICP


Volta P, ND Yan and JM Gunn. 2016. Past, present and future of the fish communities of Lake Orta (Italy), one of the world’s largest acidified lakes. Journal of Limnology 75 (s2):131-141.


Reports


Conference Presentations


Belzile N and Y-W Chen. The use of low-cost adsorbents to remove arsenic from contaminated waters: the case of a closed mine site. School of Environmental Resources and Engineering, Southwest University of Science and Technology, Mianyang, China. 2016.


Branfireun B and JM Gunn. From microbes to migratory fishes: a synthesis of Far North research from the NSERC Canadian Network for Aquatic Ecosystem Services. CCFFR/CCRP/SCL. Montreal, QC. 5-8 Jan 2017.


DeJong R, TA Johnston, J Gunn, BA Branfireun and HK Swanson. The influence of life history on tissue mercury concentration in fish from coastal rivers of the Hudson Bay Lowlands. NSERC Canadian Network for Aquatic Ecosystem Services 4th Annual Meeting and Workshop, Guelph, ON, 3-5 May 2016.


Dutkiewicz D, D Kreutzweiser, P Hazlett, P Sibley and T Scarr. Riparian forest canopy and soil nutrient responses to the loss of ash from EAB. SERG-International Annual General Meeting, Saskatoon, SK. 2-4 February 2016.


Kreutzweiser D. The budworm’s back in eastern Canada: should we use insecticides this time around? University of Guelph, School of Environmental Sciences Departmental Seminar, Guelph, ON, 25 Nov 2016.


Lescord G, B Branfireun, T Johnston, E Szkokan-Emilson and J Gunn. Assessing dissolved organic matter (DOM) quality and its effects on mercury (Hg) bioaccumulation across a freshwater watershed in the Canadian Boreal Ecozone. Canadian Network for Aquatic Ecosystem Services AGM, Guelph, ON. 3-5 May 2016.

Lescord GL, B Branfireun, TA Johnston, E Szkokan-Emilson, and JM Gunn. Assessing dissolved organic matter (DOM) quality and its effects on mercury (Hg) bioaccumulation across a large freshwater watershed in the Canadian boreal zone prior to mining development. CCFFR/CCRP/SCL. Montreal, QC. 5-8 Jan 2017. Poster.

Mariussen E, LS Heier, H-C Teien, MN Pettersen; TF Holth, B Salbu and BO Rosseland. High concentrations of lead (Pb) accumulated in brown trout (Salmo trutta) from a lake downstream
a former shooting range. 6th Norwegian Environmental Toxicology Symposium (NETS 2016); Assessing and solving environmental challenges in a multiple stressor world. 25-27 Oct 2016.


Pearson D. Climate Change Impact Study. MNRF Land use planning Sudbury, Ontario 27 Sept 2016.


Rosseland BO. How to develop good scientific papers. 6th Norwegian Environmental Toxicology Symposium (NETS 2016); Assessing and solving environmental challenges in a multiple stressor world. 25-27 Oct 2016.


Rosseland BO. I en verden full av kostholdsråd, hva bør en spise?. (In a world filled with food advisories, what should we eat?). TEFA seminar (Tverrflaglig Etatsgruppe For Forsuringsspørsomål i Agderfylkene). 10 Mar 2016.

Rosseland BO. Fisk: Gjennomføring, oppfølging, overvåking og kalking. Da Norge ble rammet av den sure nedbøren. Hva kan vi lære av SNSF-prosjektet? (Fish: Implementation, follow up, monitoring and liming. When Norway became affected by acid rain. What have we learnt from the SNSF-Project (“Acid precipitation – Effects on forest and fish”) 26 Jan 2016.


Swanson H, G Low, B Branfireun, M Low and M Evans. Drivers of spatial variability in fish mercury levels in the Dehcho region, NT, Canada. Society of Toxicology and Chemistry World Congress, Orlando, FL. 6-10 Nov 2016.


Tanentzap A. What does a greener boreal mean for the world’s freshwater ecosystems? Welcome to the Anthropocene Symposium. Cambridge Centre for Climate Science 16-20 Aug 2016.


Wiegand MD, KA Muise and TA Johnston. 2016. Atypical fatty acid profiles in the ova of two invertebrate-eating freshwater fish species, white sucker and cisco. Association for the Sciences
of Limnology and Oceanography, Aquatic Sciences Meeting, Santa Fe, NM, USA. 5-10 Jun 2016. Poster.


Yan ND. Differing dynamics and regulators of recovery of crustacean zooplankton from acid and metal pollution in Lake Orta (Italy) and 2 urban lakes in Sudbury (Canada): inferred roles of colonization, toxicity and planktivory. SCL conference, St John’s NL & LR. 8 Jan 2016. Invited.

Yan ND. Practising environmental science: reflections on a 50 year lesson. Special seminar, School of Biosciences, University of Birmingham Birmingham, UK. 16 Jun 2016. Invited.


Yu X, E Appiah-Hagan, Y-W Chen and N Belzile. Adsorption efficiency of coal fly ash and drinking water sludge for removal of As(V), Se(IV), Mo(VI) & Cr (VI) from tailing pond waters. 1st International Conference on Sustainable Water Processing, Sitges, Spain. 11-14 Sept 2016

Zabel N, R Hall, B Branfireun and H Swanson. Paleoecological history and contemporary controls of mercury accumulation in Kluane Lake, Yukon. Annual Eastern Student Meeting of the Canadian Geophysical Union –Biogeosciences and Hydrology sections, Waterloo, ON. 5-7 Feb 2016.

**Patents**


**Research Grants**

**Alarie, Y**
- NSERC Discovery 2016

**Arnott, S**
- NSERC Strategic Network NSERC Network on Aquatic Invasive Species (29 PIs, Lead: Hugh Macrae) (2011-2016)
- NSERC Discovery Grant: Community response to environmental change: the role of dispersal, local adaptation, and species interactions (2013-2018)
- OMOECC, Best in Science, Linking road salt application, lake chloride concentration, and biotic thresholds in Canadian Shield lakes (2017-2020)
- OMOECC, Drivers of food web change in Lake Simcoe (2017-2019)
- OMOECC, Development of zooplankton counting and measuring software (2016)
- OMOECC, Development of phytoplankton counting and measuring software (2017-2020)
- Friends of Killarney Park, Calcium decline, a potential through to biological recovery in Killarney Park lakes (2016)
- OMNRF, Testing the efficacy of decontamination methods for preventing the spread of invasive species (2017-2019)

**Bailey, J**
- NSERC Canadian Network for Aquatic Ecosystem Services (2011-2016)
- Vale Ltd., Aquatic Restoration Group
• Glencore Ltd., Aquatic Restoration Group
• Ministry of the Environment and Climate Change, Aquatic Restoration Group
• Ministry of the Environment and Climate Change, Ring of Fire Baseline Data Collection Programme

Basiliko, N
• Environment Canada, Environmental Damages Fund. Microbial consortia in mining waste rock: understanding microbial dynamics to optimize metal recovery, minimize metal migration and facilitate revegetation in cold environments Susan Glasaur (PI, Guelph), S Watmough (Trent), N Mykytczuk, T Merritt, and Basiliko (LU) (2016-2020)
• NSERC Discovery Grant: The functional role of microbial diversity in terrestrial ecosystems.
• Canada Research Chair (CRC): Environmental Microbiology (2013-2018)
• Canada Foundation for Innovation and Ontario Research Fund infrastructure funding for an advanced laboratory in microbial ecology and biogeochemistry.
• NSERC Strategic Project Grant: Northern Peatland Ecosystem Responses to Climate change. B Branfireun PI (Western), N Basiliko and 3 others
• NSERC Collaborative Research and Development Grant (CRD) Fundamental studies of drying, combustion and ash properties of biomass, and impacts on boiler and pulp and paper mill operations. Honghi Tran (University of Toronto Chemical Engineering and Applied Chemistry) PI, Basiliko (1 of 4 project leaders), and 8 others.
• US Department of Energy, Joint Genome Initiative. Fungal, bacterial, and archaeal communities mediating C cycling and trace gas flux in peatland ecosystems subject to climate change. E Lilleskov (USFS) PI, Basiliko, and 3 others

Belzile, N
• VALE Canada, Investigation on nanoparticles to remove metals from mine waters (with Chen and Mercier)
• SWUST (Southwest University of Science and Technology) Travel Grant
• NSERC CRD, Preparation of an adsorbent matrix modified with nanomaterials for the removal and recovery of metals and selected anions from mine waters (with Mercier and Chen)

Gunn, J
• NSERC CRC Tier 1 for Stressed Aquatic Systems
• NSERC Discovery, Terrestrial ecosystem services and recovery of damaged aquatic systems (2016-2020)
• NSERC Industrial CRD with Vale Ltd. and Glencore Ltd. Terrestrial aquatic linkages for ecosystem recovery (2010-2016)
• NSERC Canadian Network for Aquatic Ecosystem Services (2011-2016)
• NSERC CREATE Training Program (Mine of Knowledge) Applied research and training for sustainable mining. Collaborator (2013-2018)
• NSERC CREATE Training Program (ÉcoLac) for the study of lake and river ecology (2014-2019-, 11 co-PIs)
• SSHRC Connect, Sudbury Protocol Workshop (with Wang and Buchanan)
• Wildlife Conservation Society Canada, Food web structure and mercury bioaccumulation in fish communities of large rivers of the Far North of Ontario (with Keller and Johnston)

Johnston, T
• NSERC Discovery Program. Individual specialization and the trophic niche of aquatic consumers.
• NSERC Canadian Network for Aquatic Ecosystem Services (2011-2016 Jackson et al.)
• Ontario Ministry of Natural Resources and Forestry, Aquatic Research and Monitoring Section. Northern fisheries research.
• Ontario Ministry of Natural Resources and Forestry, Far North Information and Knowledge Management Program. Mercury in fish communities of Ontario’s Far North.
• Wildlife Conservation Society Canada, Food web structure and mercury bioaccumulation in fish communities of large rivers of the Far North of Ontario (with Gunn and Keller)
• Ontario Ministry of Natural Resources and Forestry, NE Regional Operations Division. Status of Lake Nipissing ecosystem.

Keller, B
• NSERC Canadian Network for Aquatic Ecosystem Services (2011-2016)
• NSERC Industrial CRD with Vale Ltd. and Glencore Ltd. Terrestrial Aquatic Linkages for Ecosystem Recovery (2010-2016)
• Wildlife Conservation Society Canada, Food web structure and mercury bioaccumulation in fish communities of large rivers of the Far North of Ontario (with Gunn and Johnston)
• Ontario Ministry of the Environment and Climate Change, Best in Science Program for project entitled “Assessment of contaminants and ecosystem change in aquatic systems within the ‘Ring of Fire’ prior to resource extraction: have contaminant levels been affected by recent warming”? (with J. Smol)
• Ontario Ministry of the Environment and Climate Change, Climate Change and Multiple Stressor Research Support

Kreutzweiser, D
• NSERC CRD - Landscape level effects of intensive forest management on biodiversity: integrating monitoring with retrospective and projective landscape analysis (co-PI, project co-lead)
• NSERC SNG - Canadian Network for Aquatic Ecosystem Services, Theme II Healthy forests and healthy aquatic ecosystems (partner; project co-lead)
• Genomics Research and Development Initiative, Shared-priority Interdepartmental Program: EcoBiomics - Developing molecular and environmental genomic approaches to assess ecosystem integrity in forest management (co-PI; project lead)
McGeer, J
- Environment Canada: Aquatic toxicity of rare earth elements to aquatic invertebrates. (McGeer and Smith)
- Dept. of Fisheries and Oceans and National Contaminants Advisory Group, Development of water quality assessment methods and toxicity reference values for northern biota in northern environments (McGeer, Smith and MacLatchy)
- NSERC Strategic Program, Tools for risk identification and validation of the effects of elements in northern Canadian environments (McGeer, Smith, Wilkinson, Amyot, Fortin and Campbell)
- NSERC CRD, Development of a marine biotic ligand model for nickel (Smith (PI), McGeer, Santore and Wood).

Mykytczuk, N
- NOHFC IRC in Bioming, Bioremediation and Science Communication
- MRI Early Researcher Award. Principal Investigator (2017-2021)
- Ontario Research Fund, Research Excellence Round 8: Elements of Bio-Mining (EBM): Genomics-Driven Improvements in Bioleaching, Sulfur and Selenium Stabilization in Mine Operations. $4,000,000 (2016-2020) Role: Co-lead
- Environment Canada Environmental Damages Fund (Guelph U, Laurentian): Microbial consortia in mining waste rock: understanding microbial dynamics to optimize remining and metal recovery, minimize AMD, and facilitate re-vegetation in cold environments. Co-Investigator (2016-2020)
- Natural Resources Canada, Canadian Forestry Service Genomic R&D Initiative: Developing molecular and environmental genomic approaches on microbial and invertebrate communities to assess forest ecosystem integrity in forest management (2015-2019)
- NSERC Discovery- Ecology and molecular biology of the effects of cold temperatures on acid mine drainage microbial communities. (2013-2018)

Pearson, D
- Ontario Ministry of Indigenous Relations and Rehabilitation, MOECC Green Investment Fund, in partnership with Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR)
- NSERC Canadian Network for Aquatic Ecosystem Services, (CNAES) Project 1-6, Outreach
- NSERC Strategic Network Enhancement Initiative – video workshops (SNEI / CNAES)
Spiers, G

- Ontario Ministry of the Environment and Climate Change: Weathering of rocks from the ring of fire: Understanding the release and mobilization of Cr and V. Co-Investigator (2014-2016)

Swanson, H

- NSERC Discovery Program, Aquatic ecology and contaminant accumulation in northern lakes: understanding and predicting change
- NSERC Northern Research Supplement, Aquatic ecology and contaminant accumulation in northern lakes: understanding and predicting change
- NSERC Collaborative Research and Development Grant, Investigating occupancy, habitat use, and migrations of Arctic Grayling (Thymallus arcticus) in northern barrenland streams
- DeBeers Canada Inc., Movement and habitat use of Arctic grayling (Thymallus arcticus) near a diamond mine development
- US Fish and Wildlife Service: Biological responses to warming lake temperatures in the Barrow/Atqasuk focus watershed
- Great Lakes Fishery Commission: Ecology of humper Lake Trout in Lake Superior, Canada
- Cumulative Impacts Monitoring Program: Bioaccumulation and biomagnification of mercury in Dehcho lakes

Tanentzap, A.J.

- Long-Term Ecosystem Research in Europe project (funded by the European Commission Horizon 2020), Disentangling long-term drivers of change in a flagship European lake
- NERC Biomolecular Analysis Facility, Temporal colonization of lake sediment by microbial communities along environmental gradients

Watmough, S.A.

- NSERC Discovery, Calcium in the environment: the highs and the lows (2016-2021)
- Environment Canada, Microbial consortia in mining waste rock: understanding microbial dynamics to optimize metal recovery, minimize metal migration and facilitate revegetation in cold environments (with 4 others) (2016-2019)
- OMNRF, Modelling Ca patterns in low Ca Boreal Lakes (2016-2017)

**Theses Completed**

**Graduate**

Azan, Shakira, PhD. The effects of non-native invertebrate predator *Bythotrephes longimanus* and declining aqueous calcium on crustacean zooplankton communities in Canadian Shield lakes. Queen’s University (Arnott/Yan)

Noyce, Genevieve, PhD. Biochar and wood ash impacts on soil microbial community structure and biogeochemical functioning in forests. University of Toronto (Basiliko/Fulthorpe)

Shabaga, Jason, PhD. The influence of section siviculture biomass harvesting on soil carbon, nutrients and respiraton in a northern mixed-deciduous forest. University of Toronto (Basiliko)

Hoffman, Justin, MSc. Investigating trophic ecology and dietary niche overlap among morphs of lake trout in Lake Superior. University of Waterloo (Swanson)

Jamieson, Tyler, MSc. The direct and indirect effects of woody debris influx resulting from selective timber harvest on in-stream nutrient pools in streams located in the Canadian Shield region of south-central Ontario. Trent University (Watmough Co-sup)

Loveridge, Alexandria, MSc. Do toxicity modifying factors influence acute or chronic toxicity of thulium to *Hyalella azteca*? Wilfrid Laurier (McGeer)

Souter, Laura, MSc. Geochemistry and toxicity of a large slag pile and its drainage complex in Sudbury, Ontario. Trent University (Watmough)

Sumner, Alexandra, MSc. The effects of climate on the bioaccumulation of mercury in two large-bodied fish species in northern Ontario lakes. Laurentian University (Gunn/Johnston)

Williams-Johnson, Shanay, MSc. Peatland microbial community structure and function along a metal contamination gradient in Sudbury, Ontario. Laurentian University (Basiliko/Mykytczuk)

Yu, Xiao, MSc. Chemical Sciences. Utilization of drinking water sludge and modified coal fly ash as adsorbents of metals and metalloids. Laurentian University (Belzile)
Undergraduate

Clancy, Eric, BSc Honours. Embryonic development of lake whitefish eggs. Laurentian University (Gunn)

Ford, Jonathan, BSc Honours. Rare earth metals – how toxic are they? Wilfrid Laurier (McGeer)

Mitchell, Katie, BSc Honours. An analysis of the spatial variability of atmospheric ammonia in the Alberta oil sands region. Trent University (Watmough)

Robinson, Bryce, BSc Honours. Influence of nickel additions on methane production in Sphagnum dominated northern peatlands. Laurentian University (Basiliko)

Seed, Marian, BSc Honours. Food web positions and trophic niches of co-habiting walleye and sauger in boreal lakes. Laurentian University (Johnston)

Wilson, Emilie, BSc Honours. A comparison of the effects of preservation techniques on analysis of total mercury concentrations in fish. Waterloo (Swanson)

HQP Supervised

Brougham, Kaitlyn, BSc Honours in progress. Queen’s University (Arnott)
Calabrese, Deanna, BSc Honours in progress. Trent University (Watmough)
Ciric, Emma, BSc Honours in progress. Laurentian University (Roy-Léveillé)
Courtemanche, Josée, NSERC CREATE Mine of Knowledge (Mykytczuk)
Hang, Shyann, Co-op Student. University of Waterloo (Swanson)
Humphries, Zoe, BSc Honours in progress. University of Waterloo (Swanson)
Michel, Cassia, NSERC USRA, Laurentian/Cambridge (Gunn/Tanentzap)
Mohammadi, Aram, BSc Honours in progress. Wilfrid Laurier University (McGeer)
Packull-McCormick, Sara, BSc Honours in progress. University of Waterloo (Swanson)
Rossberg, Timo, Undergraduate. University of Cambridge (Tanentzap)
Watterson, Claire, BSc Honours in progress. Wilfrid Laurier University (McGeer)

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Emilson, Caroline, Research Assistant (Mykytczuk)
Lehman, Sara, Summer student, MNRF (Johnston)
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Moonias, Jack, Far North Field Technician, MOECC (Bailey/Charron)
Palmer, Erin, Co-op Student Placement (Gunn)
Reid, Michelle, Science Communication Internship (Mykytczuk)
Remillard-Scott, Candice, Workstudy Research Assistant (Pearson)
Robinson, Bryce, Lab Technician (Basiliko)
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