1989-2009
20 Years of Research, Partnerships and Progress

Cooperative
Freshwater Ecology Unit
Unité Conjointe
D'écologie D'eau Douce

Cooperative Freshwater Ecology Unit Annual Report 2009

Awards and Recognition

- The CFEU is the winner of the Sudbury Community Builders Award in the Environment Category for 2010. This award recognizes that person or group who has had an important positive impact on our environment, both man-made and natural. The Award was presented to John Gunn, Bill Keller and Tom Johnston on Feb. 18, 2010.

- The Cooperative Freshwater Ecology Unit is pleased to welcome Dr. David Kreutzweiser, a senior scientist with the Canadian Forest Services in Sault Ste. Marie, as its newest member.

- Over 225 delegates attended the Sudbury Restoration Workshop which was held at Laurentian University on Oct. 27-29th, 2009. This year's theme, "Science for a Changing North", brought together experts from across Canada to discuss northern topics ranging from climatic effects on polar bears to wetland restoration at diamond mines. Also featured was a special session on Science and Traditional Knowledge presented by Faculty from the University of Sudbury.

  To kick off the workshop, we celebrated the 20th Anniversary of the Cooperative Freshwater Ecology Unit on October 27th at the "20th Anniversary CFEU Homecoming". For this event, we invited former CFEU alumni to help up celebrate the achievements of the past two decades. This event also marked the end of era, Bill Keller officially retired from the Ministry of the Environment. Bill has moved into a new position with Laurentian University as the Director of Climate Change and Multiple Stressor Aquatic Research.

Community Outreach

- **Biodiversity Challenge**: Charles Ramcharan has served as an environmental advisor.

- **Climate Change Consortium**: Charles Ramcharan has served as an environmental advisor.

- **EarthDay:** The Co-op Unit participated once again in the Sudbury Earth Day Festival organized by the Greater Sudbury Environmental Network.

- **Greater Sudbury Lake Improvement Advisory Panel**: John Gunn, Bill Keller and David Pearson provided technical advice for this program. They also assisted in the review of the lake stewardship grant proposals.

- **Greenspace Advisory Panel:** Peter Beckett serves as a technical resource person assisting in defining conservation areas in Sudbury.

- **Healthy Community Cabinet**: Charles Ramcharan served as an environmental advisor.

- **Junction Creek Stewardship Committee:** John Gunn, Peter Beckett and Karen Oman, among others, provide considerable technical advice and other resources to this committee. This year a thermal study above and below the Maley Reservoir Dam was completed and a biological assessment project by J. Davidson was supported. The Junction Creek Stewardship Committee was the winner of the Community Builders Award for the Environment in 2009.

- **Picture our Lakes Photography Contest:** The Co-op Unit again took a lead role with Artists on Elgin, in a contest to celebrate the more than 330 lakes in the city's boundaries. Other community partners included: Downtown Sudbury, the Chamber of Commerce, and the City of Greater Sudbury. We received media sponsorship from Northern Life and CTV. Vale Inco again provided a major sponsorship for the contest. Over 300 photos were submitted. The Co-op Unit continues to work toward its goal of promoting lake stewardship within the general public through this contest related education.

- **Rainbow Routes:** Peter Beckett is an Environmental Advisor for Rainbow Routes and has led field trips and contributed to the development of curriculum for schools called "Learning with Trails". Development of the Ramsey Lake trail has begun along Ramsey Lake Road.

- **Source Water Protection Program**: Charles Ramcharan has served as an environmental advisor.

- **VETAC:** Peter Beckett chairs this committee and participates in various subcommittees.

- **Education:** Shannon MacPhee, Bill Keller and John Gunn were interviewed on film for use in case study supplementary material for a Grade 10 curriculum science textbook produced by Nelson Education Ltd.

- **Living with Lakes Restoration Trail**: Peter Beckett engaged LU undergraduate students in LWL Restoration Trail development and a science communication project. Throughout the

fall, young legs and active minds explored the Lakes Centre site cataloguing plant and animal life and developing possible trail routes. The students, including CFEU Honours student Michelle Gillespie, created maps and educational materials for the project.

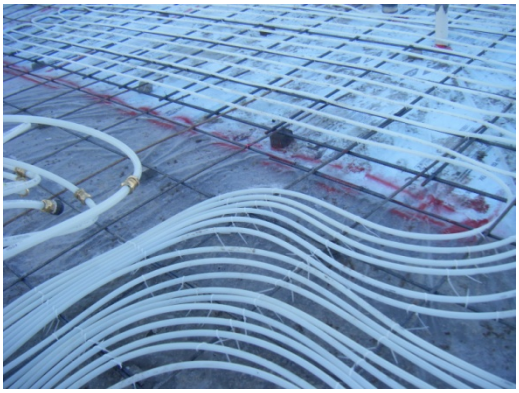
Vale Inco Living with Lakes Centre Project Update

Tenders closed for the Vale Inco Living with Lakes Centre in late February 2009 leaving a funding shortfall of $5.2M. Fortunately, we received confirmation of funding from the Knowledge Infrastructure Program in May 2009. This funding closed the gap on the total needs for the project, and cleared the way for final approval from Laurentian University's Board of Governors. The Board had emphasized that the project would not be approved without full funding in place. A contract with the successful bidder, Tribury Construction Limited, was executed within a month of the funding announcement and construction began June 10, 2010.

The existing structure on the site, the Robertson Cottage, was removed and the reusable materials were sent to Restore – the local outlet for Habitat for Humanity in order to divert this construction waste from landfill thus demonstrating the LEED sustainable principles.

The project incorporates extensive environmental protection measures with which the contractor must comply. These measures are monitored by an independent agent to ensure compliance, and reported to FedNor in our quarterly reports.

The site was cleared, excavation for the foundations began and drilling for the geothermal wells was completed by late summer. The site preparation work progressed well with rough grading, and installation of services (water, natural gas, communication, etc.) has all been completed. By the end of December, the concrete foundations, floor slab and elevator shaft were also all completed. Forty geothermal wells for the building heating and cooling systems were drilled, and associated piping extended to the building foundation.



Vale Inco Living with Lakes Centre Construction Progress: Oct, through Nov - in floor radiant pipes are installed, concrete floors are poured, vapour barriers installed and the buildings' shape is now evident.

By the Christmas holiday break, the engineered structural lumber had been delivered and the erection of the wood framing had begun. The FSC-certified wood is from northern Ontario and Quebec – pine and spruce, native to this region.

Vale Inco Living with Lakes Centre Construction Progress: Nov, through Dec 2010 - wood framing is being installed

The erection of the building is progressing well, and the construction schedule is currently on time. It is projected that the building will be substantially complete by the end of 2010, and that it will be occupied early in 2011.

Far North Science Advisory Panel

In December 2008, the Ministry of Natural Resources established the Far North Science Advisory Panel of experts in a variety of fields to provide scientific and technical advice on how to achieve the government's vision for the Far North as outlined in Bill 191: The Far North Act, an act which is currently under review by the provincial parliament. This strategic initiative concerns conservation of a large area of Boreal Forest at the same time as negotiating and developing economic opportunities and community development plans with First Nations in the Far North. David Pearson and John Gunn were invited to serve as members of this expert panel with David contributing the additional responsibility of serving as the panel chair. The purpose and functions of the Panel include the provision of the best scientific and technical advice to the Minister of Natural Resources on how to achieve the Government's vision for the Far North. This role extends to advice on current and emerging threats to the ecosystems of the Far North, and the availability of scientific knowledge to address those issues. From December 2008 to December 2009, the panel held 10 meetings over 15 days, hosted a two-day workshop in Barrie and attended the two-day Science for a Changing North Workshop held at Laurentian University in late October 2009. The final report and recommendations of the panel are nearing completion with an expected date of submission to the Minister of Natural Resources set for the end of Feb. 2010.

2005-2009 NSERC CRD Program- Barriers to Biological Recovery

Following a more than $1B investment in the industrial emission pollution reduction program in Sudbury, which led to a > 90% reduction in SO_2 and metal particulate emissions since 1960, there were significant water quality improvements in many area lakes but major groups of organisms such as crustacean zooplankton (e.g. Daphnia) or benthic invertebrates (e.g. mayflies, crayfish, snails, amphipods) have remained absent or scarce in many lakes. To address why these invertebrate delays occur and what effect they have on food web function Co-op Unit PIs J. Gunn (LU) , N. Yan, York Univ.), W. Keller(OMOE/LU), and C. Ramcharan (Laurentian Univ.) lead a program entitled " Barriers to Biological Recovery: Lingering effects of Metals or Altered Foodwebs". With support from NSERC CRD and industry our partners at Vale Inco and Xstrata project funding amounted to $760K for this 4 year project.

Completed projects included:

1. A 100 lake zooplankton survey (MSc A. Valois, LU)
2. Temporal (30 yr) analyses of zooplankton changes in 6 key study lakes (MSc N. Webster, LU)
3. Lab toxicity testing of metal and base cation interactions (PhD M. Celis-Salgado, York)
4. Food web study using stable isotopes (PhD A. Luek, LU)
5. Littoral zone habitat and watershed linkage study (MSc B. Wesolek, LU, MSc E. Szkokan-Emilson LU)
6. Mesocosm food web study (MSc Dallas Linley, LU)
7. Genetic diversity study of perch in metal contaminated lakes (MSc A. Tremblay, LU)
8. Analysis of sediment contaminants (PDF K. Vascotto, LU)
9. Fish stocking manipulation in 3 lakes with varying levels of predation (G. Morgan, contract researcher, LU)
10. Extensive reference lakes study in Sudbury and S.C. Ontario to assess regional background changes (PhD M. Palmer, York)

Approximately 8 Honours B.Sc. student projects also contributed. Annual meetings with industrial partners were held and 2 major science workshops were organized to present CRD findings. These included: 1) the Oct. 22-23, 2007 "Mining Water Symposium ", International Mining and the Environment Conference, Sudbury, and 2) Oct. 2-8, 2008 "Barriers to Biological Recovery Symposium", Aquat. Tox. Workshop, Saskatoon.

All the student projects from the 2005-2009 program are now completed and all but the 3 Ph.D. students have defended their theses. A new 5 yr program proposal has now been submitted to NSERC for consideration, again with the offer of support from Vale Inco and Xstrata, to continue this work to better understand terrestrial/aquatic linkages and the role of land reclamation techniques in aquatic ecosystem biodiversity recovery.

Aquatic Restoration Group - Sudbury Environmental Study Lakes

In 2009 the Ministry of the Environment at the Cooperative Freshwater Ecology Unit continued sampling lakes for the Sudbury Environmental Study (SES) under 2 main programs which complement each other: SES Extensive and SES Intensive.

The SES Extensive program is 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. They are sampled once annually during the period late June through early August. The data are intended to provide information on regional patterns in water quality and lake recovery in the lakes near Sudbury. During 2009 all 44 lakes in the SES Extensive lake set were sampled once for a set of standard water chemistry parameters.

The SES Intensive program 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 2009 there were 12 lakes sampled monthly (May - October) and 1 lake sampled twice-monthly (Swan lake) under the SES Intensive program. In 2009 additional weekly sampling was undertaken on Ramsey Lake. This sampling was in support of a regional request to investigate potential causes of blue-green algae blooms.

The zooplankton taxonomy lab continued to process samples collected under the SES program, but also processed samples for several partners and collaborators including the Canadian Wildlife Service (Ontario and Quebec), York University, and the Severn Sound Environmental Association.

Database management during 2009 included updating the several databases that house data produced from our programs. In addition, numerous data requests were addressed from partners and collaborators.

Recent MSc. projects have utilized the Extensive and Intensive data sets to examine the relative roles of metals and fish in the recovery of Sudbury lakes. MSc. theses were completed by Natalie Webster in 2009 (Temporal Changes in Crustacean Zooplankton Communities in Sudbury Lakes Related to Metal Contamination and Fish Predation) and Amanda Valois in 2008 (Spatial Patterns in Zooplankton Recovery: the Role of Regional and Local Factors).

These Sudbury area monitoring programs 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. These results have been widely published and have appeared in some of the world's most prestigious scientific journals including Nature and Science.

Climate Change and Multiple Stressor Research Program

Since Sept. 1, 2009 a position (W. Keller) has been in place to develop the research program and develop and administer protocols for funding assistance for external research projects. Substantial progress has also been made in networking and collaborating with international researchers. A special session on Climate Change and Multiple Stressors was hosted at the Sudbury Restoration Workshop in Oct. 2009.

In July 2009, the Coop Unit coordinated a sampling campaign that focused on the water chemistry and biology of a number of lakes including Hawley Lake, near the Hudson Bay Coast. This study involved scientists and technical staff from Laurentian University and the Ontario Ministries of the Environment and Natural Resources. Collaborators include University of Ottawa and Queens University. All information generated from the studies will be made available to stakeholders involved with managing and protecting water resources in Ontario's far north.

The lakes that were sampled included:
-Aquatuk, Hawley, Kinushseo, North Raft, North Washagami, Opinnagau, Opinnagau East, Raft, Spruce, Sutton, Warchesku

Samples were collected in some or all of the lakes to evaluate the following components:

- Basic biology (zooplankton, phytoplankton, littoral macroinvertebrates) water chemistry (including mercury and methylmercury concentrations in water), and mercury concentrations in fish
- Lake sediment cores, which will allow reconstruction of past environmental conditions in these lakes

A contract researcher (S. MacPhee) has been hired to analyse existing long-term datasets (Cooperative Freshwater Ecology Unit, Dorset Environmental Science Centre) on Boreal Shield lakes to detect climate effects. Results from a recent M.Sc. project (MacPhee 2009) indicate that climate-induced changes in lake thermal regime will decrease crustacean zooplankton body size and increase top-down control from macroinvertebrate predators. This work continues in 2010 with a more rigorous analysis of a 16 year dataset for Swan Lake to examine the role of lake thermal regime in regulating the seasonal dynamics of the crustacean zooplankton community. Additionally, an 18 lake long-term (> 20 yr) dataset from the Sudbury and Dorset regions is being used to examine the role of several limnological and meteorological parameters in explaining variability in spring and summer zooplankton communities. The importance of fall warming to early springtime dynamics will also be explored.

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 northeastern Ontario. The program is led by Tom Johnston (OMNR) and has included a variety of projects examining the biology, ecology, and ecotoxicology of northern fish populations. Work on this program in

2009 was primarily directed at two fields of research: **i) Reproductive ecology of northern fishes.** Research on the reproductive ecology of burbot continued in 2009 with emphasis on further defining spawn timing and reproductive traits in northeastern Ontario populations. This work, in addition to studies of burbot trophic ecology, is part of a collaborative research project with Fisheries and Oceans in Yellowknife, NT (PhD thesis project of Pete Cott, Laurentian University). This research is funded by the OMNR Aquatic Research and Development Section and NSERC. **ii) Mercury bioaccumulation in northern fish populations.** Following an analysis of historic fish mercury data from the OMOE, an intensive fish sampling program was launched in 2009 to acquire contemporary fish mercury data from selected lakes in northern Ontario. Contemporary mercury concentrations will be compared with historic mercury concentrations (1977-1981) across the boreal zone of northern Ontario to determine how mercury bioaccumulation has changed in this region over the past 30 years. This work is part of a graduate student thesis project (Rex Tang, MSc, Laurentian University). In addition, stable isotope analyses are being conducted on selected fish populations from the sampling program to determine how food web structure and fish growth influence mercury bioaccumulation. This work is funded by the OMOE Environmental Monitoring and Reporting Branch, and the OMNR Aquatic Research and Development Section.

The Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN)

Biological indicators such as benthic invertebrates are useful to gauge the degree of impact or recovery from anthropogenic activities using an upstream-downstream study design. Confounding issues and geographical limitations sometimes preclude this traditional design, 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, it is compared to many minimally impacted reference sites with similar habitat characteristics.

The Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN) 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 overall objective of this project is to develop a large network of reference sites to characterize the northern Ontario reference condition and test sites to assess and monitor mining effects on surface waters by detecting any impairment in benthic macroinvertebrate (BMI) community structure.

From its inception in 2003, we have acquired BMI data for 344 sites from 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 Two rounds of cluster modeling led to the latter being used by mining partners as part of their EEM reporting to EC in 2005. Cluster modeling forces discrete grouping on the natural continuum of BMI assemblages. In contrast, the Nearest Neighbor (NN) modeling technique only compares the BMI community of a discharge site to the BMIs at the reference sites that most resemble the discharge site in values for habitat variables (i.e. the discharge site's nearest neighbours). Such a NN model was used by the mining partners in the 2008 EEM reporting.

The core program described above is complemented by work being done to understand the impact of various sources of variability on the assessment of a discharge site. Currently, only a low proportion of the variation among BMI communities is being explained by the physicochemical variables. This may indicate that that other variables not measured in this study were responsible for the variation among communities. With the new addition to our team, Mike White (post-doctoral fellow), we are investigating other possible sources of variation in the BMI community including additional habitat variables, temporal, spatial, replication and methodological factors, confounding anthropogenic effects, as well as various statistical approaches.

Specifically, we are asking the following questions:

1. *Can we streamline the biomonitoring program?*
    a. *Compare the MOE Rapid Bioassessment method against the currently used Environment Canada (EC) CABIN method.*
    We found that streams sampled using the CABIN method are more likely to have lower values for family richness, EPT richness, and the relative abundance of EPT, in comparison to streams sampled using the OBBN ($1m^2$/live pick) method. The CABIN sampled streams are also more likely to have higher values for the relative abundance of Chironomidae and Oligochaeta. The differences in measured biological metrics between the two methods may affect the conclusions of assessment of biological impairment. Stream sampled using the CABIN method are more likely to be classified as stressed, especially if compared to reference sites sampled using the OBBN ($1m^2$/live pick) method.
    b. *Determine the most important habitat variables affecting benthic invertebrate communities.*
    c. *Determine the most appropriate statistical approaches for conducting site assessments against reference condition benchmarks.*
    d. *Determine the key invertebrate taxa or summary metrics important for evaluating discharge sites.*
2. *How do effects such as urbanization and historical impacts confound the assessment?*
    These confounding factors may prove to be important in enabling better interpretation of benthic monitoring results as some discharge sites are in urban areas or in locations that are also impacted by historical mining activity. Multivariate multiple regression (redundancy analysis) was used to partition variation from these sources using data from 93 minimally impacted reference streams, 18 urban streams, 3 historically impacted urban streams and 3 historically impacted streams. One-third of the variance in the 4 EEM metrics was explained by habitat, urban and historical mining factors with 24% of the explained variance as urban and historical mining signals.

3. *What are the effects of yearly temporal changes on the assessment of mining discharge sites.*
    Based on 2003-2006 data, year of sampling was not a significant source of variation in lakes, after accounting for the variance explained by changes in water chemistry. Although some stream communities exhibited low temporal persistence, this pattern

could not be related to change in any measured physicochemical variables. We will continue to track yearly temporal trends with more data as they become available.

The Laurentian University / Science North Graduate Diploma in Science Communication

Interest in the program among students and potential employers grew rapidly in 2009 – 10. Enrolment doubled to 10 plus 2 exchange students from Grenoble in France. Applications for 2010 – 11 are already looking as though we will reach our ceiling of 15 for the first time. For more information see www.sciencecommunication.ca It remains the only program of its kind in North America.

Thirty two students have now graduated from the program since 2006 and have jobs in places such as the Council of Canadian Academies, Jacques Whitford Environmental Consultants, Pollution Probe, the Toronto Regional Conservation Authority, the Royal Ontario Museum, Science North, the Sudbury Neutrino Observatory, several exhibit design companies, and as writers. Students have been interns during their program at Canadian Geographic, the Canadian Polar Commission, the Great Lakes Forest Centre, the "Science Time" in Beijing, and the "Discovery Channel" in Toronto as well as in Provincial Government Ministries, in science centres, and in exhibit design companies.

Climate Change

David Pearson's other hats include Co-Chair of the Ontario Government's Expert Panel on Climate Change Adaptation. The mandate of the Expert Panel is:

- To provide advice to government concerning issues related to climate change impacts and adaptation such as
    - actions, plans and best practices
    - adaptation policies
    - research needs
- To respond to requests for advice on impact and adaptation topics or issues as requested.

The Panel completed its report in November – “Adapting to Climate Change in Ontario”. It includes 59 recommendations ranging from 5 fundamental goals to detailed operational-style recommendations for Ministries across government. It is available on the Ministry of the Environment website.

David also plays a lead role in the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) located at Laurentian. The centre holds workshops, especially for communities,that guide participants through a risk assessment and risk management process to prioritize climate change adaptation strategies and measures in the light of known vulnerabilities and modeled climate change scenarios. The Centre has recently been awarded the task of developing a central hub for a National Adaptation Community of Practice for the Council of the Federation. The Centre will also be a major part of the Ontario Regional Adaptation Collaborative project

jointly funded NRCan and Ontario. The Co-op Unit will work in association with OCCIAR in the RAC.

Lac Croche Lake Mixing Experiment 2009

There is considerable uncertainty about the long-term trend in regional-scale surface wind speeds. However, at a local scale, deforestation through more intensive and larger forest fires or because of insect infestation is likely to increase wind speeds and lake mixing potential. The reverse effect through reforestation is also possible. We have shown that reforestation of the industrial barrens in Sudbury has reduced surface wind speeds by 35% leading to much shallower thermoclines, allowing for reestablishment of cold hypolimnetic waters even during warm years. To experimentally address the effect of wind on thermal conditions and biological responses in lakes, we began experimented with a solar powered lake mixer (Solar Bee Inc.) in Sudbury (Honours B.Sc project N. Webster) and then established a collaboration with colleagues at the Univ. Montreal (M. Amyot) and UQAM (B. Beisner, Y. Prairie), to use the mixer to conduct a long-term study at the Univ. of Montreal field station in the Laurentians. The experimental lake is Lac Croche, a 3 basin lake, with each basin of an area about 5 ha and 12 m deep. The lake supports a small population of lake trout. After a control year (2007), we separated the experimental west basin with a 220 m x 6 m limnological curtain and used the lake mixer to create a 3 level treatment (basin thermoclines at 8 m, 6m, 3m) in the same lake in both 2008 and 2009. One M.Sc. project by UQAM student A. Cantin has been completed to date and the paper has been submitted to CJFAS. In this ongoing project, M. Amyot and his team are looking at Hg changes in water and biota; B. Beisner is dealing with phytoplankton and zooplankton responses, Y. Prairie is focused on CO_2 emissions and John Gunn is working on fish behavioural and population responses, benthic invertebrate changes and food web modeling through stable isotope analysis.

China Symposium - Beijing, Oct. 18-22, 2010

As a member of the International Science Committee for the 8th International Acid Rain Conference in Beijing, J. Gunn is organizing a special symposium entitled Restoration and Recovery from Extreme Damage: The Sudbury Example- to bring the world the Sudbury story. This major conference has been held every five years since 1975, but this is the first time that it is in China. This venue should be an excellent opportunity to showcase our research and to build collaborative networks in parts of the world than will greatly benefit from the knowledge we have gained over the last 30-40 years of research in Sudbury. The invitation to participate in the symposium has been extended to Co-op Unit partners, including the City of Greater Sudbury and our mining industry partners, as well as several researchers from collaborating universities (e.g. York, Trent and Wilfrid Laurier). In addition to the conference proceedings, a block of papers from the symposium will be published in the journal Water, Air and Soil Pollution. For details of the conference see http://naqpms.iap.ac.cn/acidrain2010/index.htm

Specialized Courses Taught

Sarrazin-Delay, C.L., K. Fram and A. Merla. Introduction to Benthic Invertebrate Biomonitoring October 21, 2009. Cambrian College, Sudbury, Ontario

Conference Organizing and Editorial Activities

Arnott, S. Co-chair of organizing committee for joint meeting of American Society of Limnology and Oceanography and the North American Benthological Society, Santa Fe, NM, Jun. 2010

Ramcharan, C. Served as Associate Editor of the Canadian Journal of Fisheries and Aquatic Sciences

Yan, N. Conference program chair for 2009 4th *Bythotrephes* workshop, 30 Sept to 2 Oct., 2009, Leslie Frost Centre Institute, Dorset, ON, Canada.

Yan, N. Conference session chair of the Society of Canadian Limnologists 2009 Conference: chair and organizer of Multiple Stressor Session

Partners and Collaborators

Industry

Vale Inco Ltd. Xstrata Nickel

Government Funding Partners

City of Greater Sudbury
NSERC
CFI/OIT
FedNor/MNDM
Environment Canada
Industry Canada
DFO
Can. Wildlife Service

Scientist Collaborators

Laurentian University
Queen's University
University of Lethbridge
Centre for Ecology and Hydrology, UK
University of New Brunswick
Université du Quebéc à Montréal
University of Winnipeg
Cambrian College
University of Guelph
University of Waterloo
Wilfred Laurier University
University of Turku, FI
University of Alberta
Univ. of British Columbia
York University
University of Toronto
Indiana University
University of Ottawa
University of Montreal
Trent University

Others

Friends of Killarney Park
Ontario Power Generation

Publications

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

Adrian, R, C.M. O'Reilly, H. Zagarese, S.B. Baines, D.O. Hessen, W. Keller, D.M. Livingstone, R. Sommaruga, D. Straile, E. Van Donk, G.A. Weyhenmeyer and M. Winder. 2009. Lakes as sentinels of climate change. Limnol. Oceanogr. 54(6, part 2): 2283-2297

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Holmes S.B., D.P. Kreutzweiser and P.S. Hamilton. 2010. Operational and economic feasibility of logging within forested riparian zones. Forestry Chronicle. Submitted.

Johnston, T.A., M. Power and M. Keir. 2010. Response of native and naturalized fishes to salmonid cage culture farms in northern Lake Huron, Canada. Transactions of the American Fisheries Society. In press.

Johnston, T.A., W. Lysack and W.C. Leggett. 20XX. Comparative abundance, growth and life history characteristics of walleye (*Sander vitreus*) and sauger (*S. canadensis*) in Lake Winnipeg, Manitoba, 1979 - 2003. Submitted to J. Great Lakes Res., Nov. 2009.

Kaufman, S.D., Snucins, E., Gunn, J.M. and Selinger, W. 2009. Impacts of road access on lake trout (*Salvelinus namaycush*) populations: Regional scale effects of overexploitation and the introduction of smallmouth bass (*Micropterus dolomieu*). Can. J. Fish. Aquat. Sci. 66(2): 1-12

Kaufman, S.D., G.E. Morgan and J.M. Gunn. 2009. The Role of Ciscoes as Prey in the Trophy Growth Potential of Walleyes. N. Amer. J. Fish. Man. 29(2): 468-477

Kim, N. and N.D. Yan. 20XX. Culture methods for the invasive spiny water flea, Bythotrephes longimanus. Limnology and Oceanography Methods. In revision.

Keller, W. 2009. Limnology in northeastern Ontario: from acidification to multiple stressors. Can. J. Fish. Aquat. Sci. 55: 1189-1198

Kreutzweiser D.P., S.S. Capell, K.P. Good and S.B. Holmes. 2009. Sediment deposition in streams adjacent to upland clearcuts and partially-harvested riparian buffers in boreal forest catchments. Forest Ecology and Management 258: 1578-1585

Kreutzweiser, D.P., D.G. Thompson and T.A. Scarr. 2009. Imidacloprid in leaves from systemically-treated trees may inhibit litter breakdown by non-target invertebrates. Ecotoxicology and Environmental Safety 72: 1053-1057 ("Highlighted Article" for this issue)

Kreutzweiser, D.P., S.S. Capell and S.B. Holmes. 2009. Stream temperature responses to partial-harvest logging in riparian buffers of boreal mixedwood forest watersheds. Canadian Journal of Forest Research 39: 497-506

Kreutzweiser, D.P., E.A. Muto, S.B. Holmes and J.M. Gunn. 2010. Effects of upland clearcutting and riparian partial-harvesting on leaf pack breakdown and aquatic invertebrates in boreal forest streams. Freshwater Biology. In press.

Luek, A., G. Morgan, B. Wissel, J.M Gunn and C. Ramcharan. 2010. Rapid and unexpected effects of piscivore introduction on trophic position and diet of perch (Perca flavescens) in lakes recovering from acidification and metal contamination. Freshwater Biology. In press.

MacPhee, S., S. Arnott, and W. Keller. 20XX. Thermal structure influences macroinvertebrate predation on crustacean zooplankton: implications of climate warming for shallow lakes. Oecologia. Submitted.

Michat, M. C. and Y. Alarie. 2009. Phylogenetic relationships of *Notaticus Zimmermann* (Coleoptera: Dytiscidae) based on larval morphology. Annals of the Entomological Society of America 102(5): 797-808

Miller, K.B., J.R. Gibson and Y. Alarie. 2009. North American stygobiontic diving beetles (Coleoptera: Dytiscidae: Hydroporinae) with description of *Ereboporus naturaconservatus* Miller, Gibson and Alarie, new genus and species from Texas, USA. The Coleopterists Bulletin 63(2): 191-202

Morgan, G.E., J.M. Gunn, C.W. Ramcharan, A. Luek and B. Wissel. Yellow perch feeding morphology: Adaptive responses to threat from piscivores in food-limited environments. Can J. Fish. Aquat. Sci. Submitted Sept. 2009.

Muto, E.A., D.P. Kreutzweiser and P.K. Sibley. 2009. The influence of riparian vegetation on leaf litter inputs to Boreal Shield streams: implications for partial-harvest logging in riparian reserves. Canadian Journal of Forest Research 39: 917-927

Muto, E.A., D.P. Kreutzweiser and P.K. Sibley. 2010. Over-winter decomposition and associated macroinvertebrate communities of three deciduous leaf species in Boreal Shield forest streams of Ontario, Canada. Hydrobiologia. Submitted.

Pedruski, M. and S. E. Arnott. 20XX. The effects of habitat connectivity and regional heterogeneity on artificial pond metacommunities. Oecologia. Submitted.

Persaud, A.D., P.J. Dillon, D. Lasenby and N.D.Yan. 2009. Stable isotopic variability of meso-zooplankton along a dissolved organic carbon gradient. Freshwater Biology 54: 1705-1719. doi:10.1111/j.1365-2427.2009.02224.x

Petruniak, J., K.M. Somers and N.D. Yan. Predicting the spatial variability of *Bythotrephes longimanus* in Harp Lake, Ontario, Canada. Limnol. Oceangr. In revision.

Polack, R., Y.-W. Chen and N. Belzile. 2009. Behaviour of Sb(V) in the presence of dissolved sulfide under anoxic aqueous conditions. Chemical Geology 262: 179-185

Richardson, J.S. and D.P. Kreutzweiser. 2010. New directions in riparian management. Forestry Chronicle. Submitted.

Sarrazin-Delay, C., M. White and W. Keller. 2009. Benthic Invertebrate Community Survey of Rehabilitated Sites on the Manitou River, Manitoulin Island. Technical Report. Cooperative Freshwater Ecology Unit, Sudbury, Ontario. 47 pp.

Sarrazin-Delay, C., K.M. Somers and W. Keller. 2009. Benthic Invertebrate Community Survey using the Reference Condition Approach for Vale Inco Ltd. Cooperative Freshwater Ecology Unit Report, Sudbury, Ontario. 71 pp.

Schummer, M.L., S.S. Badzinski, S.A. Petrie, Y.-W. Chen and N. Belzile. 2010. Selenium accumulation in sea ducks wintering at Lake Ontario. Archives of Environmental Contamination and Toxicology. On-line.

Shurin, J.B., M. Winder, R. Adrian, W. Keller, B. Matthews, A.M. Paterson, M. Paterson, B. Pinel Alloul, J.A. Rusak and N.D. Yan. 2010. Environmental stability and lake plankton diversity – contrasting effects of chemical and thermal variability. Ecology Letters. In press.

Smith, A.I., D.R. Bazely and N.D. Yan. 2009. Missing the boat on invasive alien species: a review of the post-secondary curricula in Canada. Can. J. Higher Education. Under review.

Somers, K.M., C. Sarrazin-Delay and W. Keller. 2009. Teasing apart the cumulative effects of multiple stressors. Proceedings of the 35th Annual Aquatic Toxicity Workshop: October 5 to 8, 2008, Saskatoon, SK. Can. Tech. Rep. Fish. Aquat. Sci. 2841: 155

Strecker, A.L. , B. E. Beisner, S. E. Arnott, A. M. Paterson, J. G. Winter, O. E. Johannsson and N. D. Yan. Direct and indirect effects of an invasive planktonic predator on pelagic food webs. Limnol. Oceanogr. Under review.

Strecker, A. L. and S. E. Arnott. 2009. Dispersal mediates the effects of the invader, *Bythotrephes*, on crustacean zooplankton community structure and function. Ecology. In press.

Szkokan-Emilson, E., B. Wesolek, J.M. Gunn, C. Sarrazin-Delay, J. Bedore, F. Chan, D. Garreau, A. O'Grady and C. Robinson. 2010. Recovery from acidification of benthic invertebrate communities in Killarney Park lakes. Environmental Monitoring and Assessment. DOI10.1007/s10661-009-1002-x

Wesolek, B. E., E. Szkokan-Emilson and J.M. Gunn. 2010. Assessment of Littoral Benthic Invertebrate Communities at the Land–water Interface in Systems Recovering from Severe Acid and Metal Damage. J. Hum. Ecol. Risk. Assess. In press.

Wesolek, B.E., E.K. Genrich, J.M. Gunn and K.M. Somers. 2010. Use of littoral benthic invertebrates to assess factors affecting biological recovery of acid and metal damaged lakes. Journal of the North American Benthological Society. In press.

Tropea, A.E., A.M. Paterson, W. Keller and J.P. Smol. 2009. Sudbury sediments revisited: evaluating limnological recovery in a multiple stressor environment. Water Air Soil Pollut. In press.

Valois, A., W. Keller and C. Ramcharan. 20XX. Abiotic and biotic processes in recovering lakes: the role of metal toxicity and fish predation as barriers to zooplankton recovery. Freshwat. Biol. Under review.

Valois, M. C.L. Sarrazin-Delay and W. Keller. 2009. A Comparison of Two Rapid Bioassessment Protocols: Can Differences in Sample Collection and Processing Affect the Measurement of Biological Metrics. Best in Science Agreement #7804 Report. Sudbury, Ontario. 33 pp.

Valois, M. C.L. Sarrazin-Delay and W. Keller. 2009. Spatiotemporal patterns in Northern Ontario benthic invertebrate communities. Implications for biomonitoring. Best in Science Agreement #7804 Report. Sudbury, Ontario. 45 pp.

Venturelli, P.A., C.A. Murphy, B.J. Shuter, T.A. Johnston, P.J. van Coeverden de Groot, P.T. Boag, J.M. Casselman, R. Montgomerie, M.D. Wiegand and W.C. Leggett. 2010. Maternal influences on population dynamics: evidence from an exploited freshwater fish. Ecology. In press.

Weisz, E.J. and N.D. Yan. Shifting invertebrate zooplanktivores: watershed-level replacement of the native *Leptodora* by the non-indigenous *Bythotrephes* in Canadian Shield lakes. Biol. Invasions. Under review.

Weisz, E.J. and N.D. Yan. 2009. Relative value of limnological, geographic and human use variables as predictors of the presence of *Bythotrephes longimanus* in Canadian Shield Lakes. Can. J. Fish. Aquat. Sci. In press.

Yang, D.Y., X. Ye, Y.-W. Chen and N. Belzile. 2010. Inverse relationships between selenium on methyl mercury bioaccumulation in tissues of walleye (*Stizosedion vitreum*) in Canadian boreal lakes. Science of the Total Environment. On-line.

Yang, D.Y., Y.-W. Chen, Y.T.H. Truong and N. Belzile. 2009. Improvement of the reliability of methylmercury determination in environmental samples. Analytica Chimica Acta, 633, 157-164

Young, J.D., E.R. Loew and N.D. Yan. 2009. Examination of direct daytime predation by *Coregonus artedi* on *Bythotrephes longimanus*: No evidence for the refuge hypothesis. Can J. Fish. Aquat. Sci. 66 (3): 449-459

Conference Presentations

Arnott, S. E., S. MacPhee, M. McLennan. The influence of climate change on zooplankton communities in Boreal Shield lakes. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists, Jan. 9-11, 2009, Ottawa, ON. Invited.

Arnott, S.E., J. Sweetman, M. Pedruski, C. Symons. Potential climate impacts on lakes in Wapusk National Park. Sudbury Restoration Workshop, Oct. 27-29, 2009, Laurentian University, Sudbury, ON, Canada.

Alarie, Y. 2009. Analyse faunistique des hydradéphages de la Nouvelle-Calédonie: Coleoptera: Dytiscidae, Gyrinidae, Noteridae). ACFAS Sudbury, April 3rd, Sudbury, ON. Canada (with A. Gervais)

Alarie, Y. 2009. Faunistic Analysis of Hydradephaga of New Caledonia (Coleoptera: Dytiscidae, Gyrinidae, Noteridae). March 28, 2009, Biology Day, University of Windsor, Windsor, ON, Canada (with A. Gervais)

Belzile, N., Y.-W. Chen, D.-Y Yang, H.Y.T Truong and Q.-X Zhao. 2009. The selenium-mercury antagonism in freshwater organisms. The 9th International Conference on Mercury as a Global Pollutant. Guiyang, China

Cantin, A., B.E. Beisner, J.M. Gunn and Y.T. Prairie. Artificial deepening of a lake thermocline: Effects on the plankton. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Dirszowsky, R.W., K.A. McLandress and S.B. Foster. 2009. Human Impact, Industrial Pollution and Landscape Change Inferred from Sedimentation Patterns at Kelly Lake, Sudbury, Ontario. Sudbury Restoration Workshop 2009 - Science for a Changing North, Oct 27-29, 2009, Sudbury, ON.

Dirszowsky, R.W. and S.B. Foster. 2009. Evolution of the Kelly Lake Delta: Implications for Landscape Change and Industrial Pollution in the Sudbury Area, Ontario. Canadian Association of Geographers Annual Meeting, May 26-30, 2009, Ottawa (also presented at CAGONT, October 16-17, 2009, Mississauga).

Dirszowsky, R.W. 2009. Environmental Reconstruction using Lake Sediments and other Geomorphological Indicators: Examples from British Columbia and the Sudbury Area. Laurentian University Research Week Symposium, February 9-10, 2009, Sudbury, ON.

Gray, D. and S. E. Arnott. The role of dispersal in the recovery of acid-damaged zooplankton communities: sources of colonists for recovering lakes and the relative importance of regional vs. local variables. Canadian Society for Ecology and Evolution, May 14-17, 2009, Halifax, Nova Scotia

Gunn, J.M., A. Cantin, B.E. Beisner, Y.T. Prairie, J. Chételat and M. Amyot. Artificial deepening of a lake thermocline: A simulation of the impacts of changing surface winds. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Holmes, S.B., K.A. McIlwrick and D.P. Kreutzweiser. Forest bird responses to partial cutting in riparian reserves in Ontario's boreal mixedwood forest. The Wildlife Society 16th Annual Meeting, Monterey, California, Sept. 20-24, 2009

Holmes, S.B. and D.P. Kreutzweiser. A flexible system for logging in riparian AOCs: an Ontario experiment. Riparian Research and Management Network (RIPNet) Workshop on Decision Support Systems for Riparian Management, Sault Ste Marie, Ontario, March 24-25, 2009

Inglis, C., S.E. Arnott and G. Pyle. Comparison of kairomone induced morphological defenses of *Daphnia pulicaria* clones from metal-contaminated and non-metal contaminated lakes in the presence of copper. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Inglis, C., S.E. Arnott and G. Pyle. The effects of copper on kairomone response by Daphnia pulicaria clones from pristine and metal-contaminated lakes. Society of Canadian Zoologists Annual Meeting May 16, 2009, Scarborough, Ontario

Inglis, C., S E. Arnott and G. Pyle. The effect of copper on *Daphnia pulicaria* kairomone response. Sudbury Restoration Workshop, October 27–29, 2009, Laurentian University, Sudbury, ON, Canada (Poster – won best poster award)

James, L.A.H., S.E.A Arnott* and J. Casselman. Effect of the invasive predator, *Bythotrephes longimanus*, on Cisco (Coregonus artedi) in Ontario shield lakes. (*presenter) Bythotrephes Workshop, Sept. 30-Oct. 2, 2009, Dorset, Ontario

Johnston, T.A. 2009. Egg quality variation in wild and hatchery stocks of lake trout. Poster presentation at the Canadian Conference for Fisheries Research, Ottawa, ON, Jan. 9-11, 2009

Jokela, A., S.E. Arnott and B. Beisner. Patterns of *Bythotrephes longimanus* distribution relative to native macroinvertebrates. Bythotrephes Workshop, Sept. 30-Oct. 2, 2009, Dorset, Ontario

Jokela, A., S.E. Arnott and B. Beisner. Patterns of *Bythotrephes longimanus* distribution relative to native macroinvertebrates and zooplankton prey. Canadian Aquatic Invasive Species Network (CAISN) Annual General Meeting, Nov. 10, 2009, Halifax, NS

Keller, W. 2009. Limnology in Ontario's far north: an introduction. p. 45, in Proc. Sudbury Restoration Workshop, October 27–29, 2009, Laurentian University, Sudbury, ON, Canada

Kreutzweiser, D.P., K.P. Good, D. Chartrand, D.G. Thompson and T.A. Scarr. Determining ecological risk of systemic insecticides in trees when standard toxicity testing won't work. Society of Environmental Toxicology and Chemistry Europe 19th Annual Meeting, Gothenburg, Sweden, May 31 –June 4, 2009

Kreutzweiser, D.P. and S.B. Holmes. Informing the riparian DSS: A case study at the White River Riparian Harvesting Impacts Project (WRRHIP). Sustainable Forest Management Network Workshop on Envisioning Tomorrow's Forests: Knowledge Networking for Sustainability, Gatineau, Quebec, April 21-23, 2009. Invited.

Kreutzweiser, D.P. and S.B. Holmes. Intentionally disturbing riparian forests: why? (an example from the WRRHIP). Riparian Research and Management Network (RIPNet) Workshop on Decision Support Systems for Riparian Management, Sault Ste Marie, Ontario, Mar. 24-25, 2009. Invited.

Kreutzweiser, D.P. Ecological implications of emerald ash borer infestations and management. EAB Workshop: Guiding Principles for Managing the Emerald Ash Borer in Urban Environments, Royal Botanical Gardens, Burlington, Ontario, Nov. 18, 2009. Invited.

Kreutzweiser, D.P. Emerald ash borer management: environmental considerations. Emerald Ash Borer Workshop, Great Lakes Forestry Centre, Sault Ste Marie, Nov. 3 2009

Kreutzweiser, D.P. Developing a bioindicator of forest stream health for effectiveness monitoring of forest management guidelines. Forest Ecosystem Science Cooperative Annual Meeting, Sault Ste Marie, Ontario, Sept. 29 –Oct. 1, 2009

Luek, A., G. Morgan and C. Ramcharan. The importance of benthic invertebrates for food web complexity of recovering lakes. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Luek, A., G. Morgan and C. Ramcharan. Limited benthic invertebrate availability hampers the recovery of lakes recovering from acidification and metal contamination. Sudbury Restoration Workshop: Science for a Changing North, Oct. 27-29, 2009, Sudbury, Ontario. Poster.

MacPhee, S. 2009. Lake thermal regime and crustacean zooplankton community structure. Oral presentation. Sudbury Restoration Workshop, Oct. 27–20, 2009, Laurentian University, Sudbury, ON, Canada

McLandress, K.A., R.W. Dirszowsky and B.M. Blackwell. 2009. Human Impact and Landscape Change Inferred from Abrupt Changes in Sedimentation at Kelly Lake, Sudbury, Ontario. Canadian Association of Geographers Annual Meeting, May 26-30, 2009, Ottawa (also presented at CAGONT, Oct. 16-17, 2009, Mississauga)

Morgan, G.E., J.M. Gunn, and B. Wissel. Size doesn't always matter – Yellow Perch (*Perca*

flavescens) growth varies with density and predation risk in Sudbury area lakes. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Pedruski, M. and S.E. Arnott. Effects of dispersal and regional heterogeneity on biodiversity of artificial pond metacommunities. Ecological Society of America, Aug. 2-7, 2009, Albuquerque, New Mexico

Petrie, S., S. Badzinski, N. Belzile, Y.-W. Chen, M. Schummer, L. Ware, C. Brady, A. Hontella and X.-Q. Zhao. 2009. Food-chain transfer and effects of selenium on waterfowl using the Great Lakes. Metals in the Human Environment Research Network 2009 Annual Symposium, Gatineau, Canada

Schummer, M.L., S.S. Badzinski, S.A. Petrie, Y.-W. Chen and N. Belzile. 2009. Selenium accumulation in sea ducks wintering at Lake Ontario. *The 5th North American Duck Symposium and Workshop,* Toronto, Canada

Somers, K.M., C. Sarrazin-Delay and W. Keller. 2010. Using redundancy analysis to quantify the cumulative effects of multiple stressors. Proc. IOC EEM workshop.

Somers, K.M., C. Sarrazin-Delay and W. Keller. Using Redundancy Analysis to Quantify the Cumulative Effects of Multiple Stressors. Environmental Effects Monitoring Meeting, April 29-30, 2009, Gatineau, Québec

Somers, K.M., C. Sarrazin-Delay and W. Keller. 2009. Using Redundancy Analysis to Quantify the Cumulative Effects of Multiple Stressors. Sudbury Restoration Workshop: Science for a Changing North, Oct. 27-29, 2009, Sudbury, Ontario

Szkokan-Emilson, E., B. Wesolek, and J.M. Gunn. The importance of exported catchment products in shaping littoral benthic invertebrate communities. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Szkokan-Emilson and J.M. Gunn. Healthy lands promote healthy waters: Terrigenous organic matter as a subsidy for recovering consumer communities in a Sudbury lake. Sudbury Restoration Workshop: Science for a Changing North, Oct. 27-29, 2009, Sudbury, Ontario. Poster.

Truong, H.Y. T., A. Voros, M. Saleh, Y.-W. Chen and N. Belzile. 2009. Proteomics of *Desulfovibrio desulfuricans* (SRB) response to elevated Hg or Hg - Se levels in cultures. *The 9th International Conference on Mercury as a Global Pollutant.* Guiyang, China.

Wesolek, B., E. Szkokan-Emilson and J.M. Gunn. Use of multiple methods to detect spatial differences in littoral benthic invertebrate communities: A site specific investigation. 2009 joint

conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Yan, N. 2009. The emerging threat of calcium decline for soft-water lakes in Canada. The Society of Canadian Limnologists invited lecture at the opening plenary session of the 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists, Jan. 9-11, 2009, Ottawa, ON.

Yan, N., M.P. Celis-Salgado, B. Keller and J.M. Gunn. Evidence for global, regional, landscape and in-lake influences on the recovery of Sudbury lakes from historical disturbances. 2009 joint conference of the Canadian Conference for Fisheries Research and the Society of Canadian Limnologists. Jan. 9-11, 2009, Ottawa, ON.

Yan, N. 2009. Emerging complexities in the recovery of zooplankton in Canadian lakes from historical acidification. Ecology lecture, Department of Biology, University of Alberta, Edmonton, AB, Jan. 23, 2009

Yan, N. 2009. A prelimlinary examination of changes in crustacean zooplankton at station K42 in Lake Simcoe between 1986 and 2004. Invited lecture at 2009 SIMSYN: Lake Simcoe Synthesis Meeting, Ontario Ministry of the Environment, Toronto, ON, Apr. 21-22, 2009

Yan, N. 2009. The potential loss of Ontario zooplankton populations to the spiny water flea, Bythotrephes: a first risk analysis using Ontario and Norwegian data. Platform presentation at the 2009 Annual General Meeting of the Canadian Aquatic Invading Species Network, May 4-6, 2009, Halifax, NS.

Yan, N. 2009. Are Canadian Shield lakes going to jelly – the impacts of falling Ca and TP levels and the spread of *Bythotrephes* on zooplankton. Invited lecture at the 2009 Gordon Research Conference on Catchment Science: Interactions of Hydrology, Biology and Geochemistry, July 12-17, 2009, Proctor Academy, Andover, NH, USA.

Yan, N. 2009. Are Canadian Shield lakes going to jelly – the impacts of falling Ca and TP levels and the spread of *Bythotrephes* on zooplankton. Lecture at the Laurentian University Co-operative Freshwater Ecology Unit, Sept. 8, 2009, Sudbury, ON.

Yan, N. 2009. Are falling Ca and TP levels driving Canadian Shield lakes to jelly? CCIW invited lecture series, Sept. 10, 2009, Canada Centre for Inland Waters, Burlington, ON

Yan, N. 2009. The rising threat of environmental calcium decline in eastern Canadian lakes. Invited lecture Department of Soil Science, University of Western Australia, Perth Australia, Nov. 18, 2009

Yan, N. 2009. Optimizing scientific communication. Invited lecture to the graduate students in the School of Environmental Systems Engineering, University of Western Australia, Perth

Australia, Nov. 11, 2009

Yan, N. 2009. Local vs. regional control of ecological recovery in historically metal-contaminated lakes. Invited departmental lecture, School of Environmental Systems Engineering, University of Western Australia, Perth Australia, Nov. 12, 2009

Yan, N. 2009. Are Canadian Shield lakes going to jelly? Invited departmental lecture, Biology Department, University of Waikato, Hamilton, New Zealand, Dec. 10, 2009

Yang, D.-Y., Y.-W. Chen and N. Belzile. 2009. Formation of mercuric selenide in *Pseudomonas fluorescens* culture treated with mercuric chloride and sodium selenite. The 9th International Conference on Mercury as a Global Pollutant. Guiyang, China.

Zhao, Q-X., Y.-W. Chen and N. Belzile. 2009. Extraction of organic Se compounds from biological samples followed by separation with HPLC-microsample digestion and HG-AFS. Metals in the Human Environment Research Network 2009 Annual Symposium, Gatineau, Canada.

Research Grants

Alarie, Y

- NSERC operating grant

Arnott, S

- NSERC Network, Canadian Aquatic Invasive Species Network (co-applicant Bea Beisner, UQAM)
- NSERC Discovery, The influence of dispersal on ecosystem response to environmental change
- Great Lakes Fisheries Commission, Toxicokinetic and food web models to quantify the effects of *Hemimysis anomola* on Great Lakes food webs.
- Friends of Killarney Park, The interactive effects of dispersal and pH in the recovery of zooplankton in Killarney Park Lakes
- Chancellor's Research Award, The interaction between dispersal and local conditions in biological recovery of zooplankton communities

Belzile, N.

- NSERC Discovery Grant, Biogeochemistry of toxic trace elements in lake sediments.
- NSERC MITHE-SN Network (with Petrie and Chen) Effect of selenium in waterfowl.

Dirszowsky, R

- 2009 NSERC Research Capacity Development Grant Faculty (with G. Courtin, A. Hawkins and A. Watelet)

- 2008/2009 Canadian Foundation for Innovation, Leaders Opportunity Fund/Ontario Research Fund (CFI/ORF)
- 2008 NSERC Research Capacity Development Grant Faculty Award to Enhance Research Productivity for course release)

Gunn, J

- EJLB Foundation, Thermal ecology of Hudson Bay Lowlands anadromous charr
- NSERC Discovery, Terrestrial/aquatic linkages in the recovery of disturbed ecosystems
- OMOE Research and monitoring grant, Fish Community Ecology Dorset exp. Lakes
- OMOE, Mercury Contamination of Fish in Ontario's Boreal Shield (with T. Johnston)
- City of Greater Sudbury, Urban Lakes Restoration
- NSERC CRC, Stressed Aquatic Systems

Johnston, T

- MNR Operating and Capital Support
- OMOE, Mercury Contamination of Fish in Ontario's Boreal Shield (with J. Gunn)
- NSERC Discovery, Reproductive Ecology of Boreal Fishes

Keller, B

- Vale INCO Ltd., Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN) support (with C. Sarrazin-Delay)
- Environment Canada, NOBIBN support (with C. Sarrazin-Delay)
- Ontario Ministry of the Environment, ARG and NOBIBN support
- Ontario Ministry of the Environment, Climate Change and Multiple Stressor Research Support

Ramcharan, C

- Center for Excellence in Mining Innovation, Establishing an embedded network for weather monitoring across north Baffin Island
- Nickel District Conservation Authority, Cyanobacteria monitoring program on Ramsey Lake

Sarrazin-Delay, C

- Ontario Ministry of the Environment, Best in Science 7804
- Vale INCO Ltd., Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN) support (with B. Keller)
- Environment Canada, NOBIBN support (with B. Keller)

Yan, N

- Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch Research Contract: "Zooplankton recovery in Sudbury lakes".
- Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch Research Contract: "Zooplankton in Lake Simcoe".

- Environment Canada, Canadian Wildlife Service Contract: “Identifying the influence of increasing summer lake temperatures on damaging Ca thresholds for common, Canadian freshwater plankton”
- NSERC Strategic Project Grants Supplemental Competition: “the emerging threat of Ca decline: quantifying current and predicting future Ca levels and their effects on aquatic biota in a 1600 lake watershed (Yan is PI on the application with 3 Co-PI’s)

Theses Completed

Graduate

Fuschino, J. 2009. MSc. Thesis. Rising water temperatures leads to diminished essential fatty acid concentrations in *Scenedesmus obliquus* and *Daphnia magna*: A controlled laboratory study (co-supervised with M. Arts). York University, Toronto, ON. (Yan)

Ingliss, C. MSc. Thesis. 2009. The effect of copper on kairomone-mediated responses by wild D*aphnia pulicaria* clones from lakes along a copper gradient. Queen’s University, Kingston, ON, Canada (Arnott)

Kreutzweiser, D. Ph.D. Thesis. Environmental effects of partial-harvest logging in riparian reserves of Boreal Shield streams.Laurentian University, Sudbury, ON, Canada (Gunn)

MacPhee, S. MSc. Thesis. The effects of thermal habitat and macroinvertebrate predation on the crustacean zooplankton community of a small Boreal Shield lake. Queen’s University, Kingston, ON, Canada, March 2009 (Arnott/Keller)

Petruniak, J. 2009. MSc. Thesis. Analysis of *Bythotrephes longimanus* spatial distribution in Harp Lake, ON (Granted her degree “with distinction”, and nominated for a thesis prize). (Yan)

Szkokan-Emilson, E. MSc. Thesis. The role of land reclamation in promoting the recovery of nearshore macroinvertebrate communities in smelter impacted lakes near Sudbury, Canada. Laurentian University, Sudbury, ON, Canada (Gunn)

Webster, N. MSc. Thesis. Temporal changes in crustacean zooplankton communities in Sudbury lakes related to metal contamination and fish predation. Laurentian University, Sudbury, ON, Canada (Ramcharan/Keller)

Wesolek, B. MSc. Thesis. Spatial patterns in the recovery of littoral benthic invertebrate communities of acid- and metal-damaged lakes. Laurentian University, Sudbury, ON, Canada (Gunn)

Undergraduate

Altschuller, I. 2009. The effects of calcium decline in Canadian Shield lakes on the transcription of several calcium genes of *Daphnia pulex*. Biology Dept. York University (Yan)

Hackett, K. 2009. Effects of predation on the reproductive ecology of yellow perch (Perca flavescens). Biology Dept. Laurentian University (Gunn)

Lahane, M. 2009. Predicting the eventual distribution of the spiny water flea (*Bythotrephes longimanus*) in Canadian lakes using Norwegian native range assessments. Biology Dept. York University (Yan)

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Patenaude, T. 2009. Humans as dispersal vectors for zooplankton, and possible implications for recovery from acidification, in Killarney Provincial Park, Ontario, Canada. Biology Dept. Queen's University (Arnott)

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