



Cooperative Freshwater Ecology Unit Annual Report 2006

Staff Changes

Peter Beckett joined the Co-op Unit as the education and outreach coordinator for the Lake Centre. The formal announcement of this appointment occurred at the Laurentian University Community meeting on Feb. 14, 2007. Peter will be enriching the Co-op Unit with his extensive experience in wetland and watershed restoration and will continue to promote public involvement and science communication throughout the community.

In 2006 George Morgan assumed the new role of Aquatic Ecosystem Analyst at the Co-op as part of the Canada Research Chair program. This year George has been providing support to many of the students in the NSERC CRD program as well as initiating a new bio-manipulation project to test the effects of invading fish species on the biotic recovery in the MOE intensive monitoring lakes.

Living with Lakes Centre Project Update

A major milestone was reached in 2006 – completion of the Design Development phase for the Living with Lakes Centre. The June 9th announcement about the funding for the Detailed Design from FedNor and Inco (\$300,000 each) was attended by over 75 people.

We issued an RFP for architectural consulting services for the Detailed Design in late winter 2006. Seven excellent firms responded. The contract was awarded to a joint venture between J.L. Richards and Busby, Perkins and Will.

The Busby Perkins + Will firm has received six Governor General Awards for Architecture and Canada's first LEED Gold building completed in 2003. Mr. Busby is a founding member of the Canada Green Building Council and was instrumental in bringing the LEED green building rating system to Canada. In 2005, Peter Busby received the Order of Canada in recognition of his leadership role in sustainable design in the country. Founded in 1955, J.L. Richards & Associates Limited is an integrated Architectural/Engineering firm offering multidisciplinary services in architecture, all major engineering disciplines and planning. Their Sudbury office has considerable experience working on university projects. Its full-service capability provides excellent coverage for all facets of the design and construction phase.

Another related decision in 2006 was the selection of the site for the LLC on a magnificent eight acre property at the entrance to the university on the shores of Lake Ramsey. Luke Norton, SGA President was among many to applaud this decision saying “ *a ‘green’ building at the entrance to our campus will make a powerful statement to prospective students and can be an important recruiting tool for Laurentian University*”

Work on the **Detailed Design** began shortly after the June 9 funding announcement. A number of meetings with the architects and the Core Review Team were held to confirm design goals and approaches. The reaffirmed goals for the Centre are based on core values embodied by the 3 “R’”: Restore, Reduce and Renew.

- Construct facilities to sustain and grow the world class aquatic restoration research and monitoring programs of the Cooperative Freshwater Ecology Unit (Co-op Unit).
- Achieve the prestigious LEED (Leadership in Energy and Environmental Design) Platinum certification, the first institutional building in Canada to accomplish this.
- Provide a high quality work environment with low-cost operating expenses (demonstrate long-term sustainability).
- Measure and monitor the performance of the building and site to ensure that we minimize our ecological footprint and assist in the restoration of Sudbury’s ecosystems. (Shorelines will be protected and stormwater managed on site with minimal or no air and water pollutants coming from the site.)
- The high quality, state-of-the art research facility will lead to retention and recruitment of the best future staff and to expansion of research streams to include health and watershed management. The operating savings will be invested to support new research and graduate student bursaries.

The addition of the **Aquatics Experimental Lab** to support MNR scientist Tom Johnston’s research for egg incubation and hatching was a significant change over the earlier design. Located in the Field Compound building it will consist of a living stream system with water pumped directly from Ramsey Lake

The design for the Living with Lakes Centre was unveiled by Peter Busby to City of Greater Sudbury’s council on Oct 25. The following day we held an Open House at Tom Davies Square. The architects highlighted some of the key features:

- The chosen materials, all non-toxic, will reflect the region’s natural resources with, outside, the use of glass, limestone and white washed pine planks, and inside, the use of exposed wood beams, timber (some likely recycled from older demolished buildings) and natural stone.
- Two constructed wetlands (one outdoor and one indoor), inhabited by a variety of plants, will help to treat and purify storm water, as well as naturally control the level of humidity and contribute to the passive heating and cooling of the building. The great number of windows and the two-storey open foyer, situated at the centre of the building, will maximize solar heating and natural daylight. The Centre will also be equipped with a multimedia teaching room, with access to outdoor terrace and meeting areas. In addition,

the building will be light-colored to minimize excessive summer heat retention and the need for air conditioning.

- Other sustainable design features include a limestone building envelope to treat acidic rain water, green roof to reduce storm water runoff, high-performance thermal envelope, ground source heat pump, biomass powered heat, radiant floor hydronic heating system, wind turbines with net metering, solar domestic water heating, composting toilets, flow through aquatic lab using natural lake water, permeable paving for driveways and parking lots, energy efficient lighting and appliances and smart building systems.

Two significant and exciting sub-projects have grown out of the Living with Lakes project – a Living with Lakes Centre Watershed and Ecological Footprint mapping project to assist with monitoring the ecological impact the centre will have and a film to help explain and promote the Centre.

The Watershed/Ecological Footprint project involves scientists from the Biology, Geology and Geography Departments. The “watershed” draining into Ramsey Lake has been mapped and an inventory of flora and fauna has been prepared. Student projects are being developed to measure ecological parameters within the watershed to determine our success at achieving one of our goals to minimize our ecological footprint and influence the sustainable “practices” at the rest of the university. Through this project we also hope to preserve and develop the existing extensive network of trails within the university campus in order to minimize vehicular traffic and to connect to the Trans Canada trail currently being developed close by.

At Water’s Edge, a 7.5 minute film about the project, was premiered at the Oct 25th presentation to city council and has been extensively used as a promotional tool since that time. Developed by Dr. Hoi Cheu, documentary filmmaker and director of Humanities Research Centre at Laurentian University, with assistance from students enrolled in the Science Communication Graduate Diploma program, it has received widespread acclaim. Some minor modifications are underway to better describe the project’s “green” features with the view to using it as a fundraising tool. A longer, 22 min. documentary –style film will also be produced to tell the “Sudbury Story” of recovery from environmental damage with an emphasis on the damage and recovery of aquatic ecosystems and to convey the principles of sustainability by explaining the science programs of the Co-op Unit and the sustainable design features of the Living with Lakes Centre.

The Design Development Report was completed at the end of December 2006. The next steps include refining the project budget and securing necessary funding to continue to the next phase – construction documents, tender documents and construction.

Science Communication Graduate Program

David Pearson, Laurentian Co-Director

Enrolment began with 8 students in 2005-6 and rose to 12 in 2006-7. Only students with 4 year Honours science or technology degrees are normally admissible. The range, both geographically and in experience, is expanding. This year (2006-7) we have a Chinese student from the Chinese Academy of Sciences in Beijing; a Mexican student from the organic chemistry graduate program at UBC; and a consultant from Golder Associates in Calgary, as well as recent science graduates from Canada.

Two students from the first class spent their internships at the EMR Branch of the MOE and one is now employed there permanently in the Director's (Ed Piché's) office. Internships this year will include the Canadian Polar Commission, the Tri-University Meson Facility in Vancouver, the Experimentarium in Denmark, Pollution Probe, exhibit production companies in Montreal and Toronto, and the IMAX Production Unit at Science North.

Applications have already been received for 2007-8. Enrolment is limited to 15. For more information see www.sciencecommunication.ca

Aquatic Restoration Group

Sudbury Environmental Study Lakes

In 2006 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. These lakes are sampled once annually in the period of late June through early August. These data are intended to provide information on regional patterns in water quality and lake recovery in the lakes near Sudbury. During 2006 all 44 lakes in the SES Extensive lake set were sampled once for a set of standard water quality parameters. A data report covering the last twenty-five years of this program (1981-2005) has just been published.

The SES Intensive program is a set of lakes sampled monthly or bimonthly through the ice-free season for a wide range of physical, biological and chemical parameters (water quality, 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 2006 there were 16 lakes sampled monthly (May – October) and 1 lake sampled bimonthly (Swan lake) under the SES Intensive program. Four of these SES Intensive lakes (Joe, Nelson, Laundrie and Wavy) were also part of the sampling program for MSc. Student Natalie Webster. She is co-supervised by Charles Ramcharan and Bill Keller.

These Sudbury area monitoring programs are 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 programs have also become very important

in the study of the interactive effects of acidification and other large-scale stressors like climate change, base cation depletion, and UV radiation on aquatic systems.

Northern Ontario Benthic Invertebrate Reference Condition Approach (RCA) Biomonitoring Network

The Northern Ontario Benthic Invertebrate Reference Condition Approach Biomonitoring Network (Northern Ontario RCA Network) is the first large-scale, multi-partner RCA project designed to assist the metal mining industry in locating suitable reference sites to meet the Environmental Effects Monitoring (EEM) requirements of the Federal Metal Mining Effluent Regulations (MMER) of the Fisheries Act. The objective of this project is to develop a large network of reference and test sites to assess and monitor mining effects on surface waters by detecting any impairment in benthic invertebrate community structure.

The RCA Network began in 2003, with a large field effort generating data for 214 reference and test sites from 4 northern Ontario mining centers. Over 150 of the reference sites and 76 Moose River sites from another study were used to generate Phase One models. Following the 2004 fall sampling season, two refined models were created using 92 reference stream sites and 117 reference lake sites respectively. The refined models were used as part of Environment Canada's EEM reporting by all our mining partners in June 2006. The RCA Network focus shifted in 2005 to unanswered science questions, specifically temporal, methodological, replicate and spatial variability in the data. This variability was analysed using 2001-2004 data. A draft report is now being reviewed. Similar analyses will soon be conducted including the 2005 data.

In 2006, the RCA Network continued to focus on science questions. The sampling of sites previously sampled continued to document temporal variation. Approximately 10% of sites in the database were resampled. Nearly all sites sampled in 2006 (61) were sampled using both the MOE method and the CABIN method concurrently to document methodological variation. If previous year's sampling is included, approximately 80 stream sites will be available for method comparison. A second goal in 2006 was database diversification and growth with a push to increase the number of urban and historically impacted sites in the reference database. Thirteen new urban sites were sampled in northern Ontario. The receiving environment of slag or tailings areas of 13 historically impacted sites was also sampled. Fifteen new reference sites were sampled in 2006 with the intention of filling habitat gaps and increasing geographic coverage. Also new for 2006 is a pilot project to find suitable reference sites for the Porcupine River in Timmins in collaboration with the regional MOE (collaborator: Ed Snucins). We sampled five test sites on the Porcupine River and its tributaries in order to document habitat.

NSERC CRD Program- Barriers to Biological Recovery

This is a 4 year partnership program between the Co-op Unit (J.Gunn, W. Keller, C. Ramcharan, G. Morgan), York University (N. Yan), and our industrial partners CVRD Inco. (G. Watson, L. Lantaigne, C. Breerton) and Xstrata (M. Butler) designed to determine the factors that affect recovery of urban industrial lakes. Much of the field work in 2006 (year

2) focused on completion of the extensive survey work: benthic invertebrates, fish, zooplankton, water, and lake sediments contaminants. There were primarily 3 sampling projects: 1) the 38 lakes and industrial ponds within the high metal deposition zone (< 20 km from the smelters) 2) the regular 44 SES MOE lakes and 3) the 8 Dorset A lakes used for contaminant analysis (sediments, water, zooplankton). New in 2006 was the initiation of the biomanipulation project led by G. Morgan to test the effects of altered predator/prey communities on recovery dynamics. The annual CRD meeting was held Nov. 21, 2006 at the Italian Club in Copper Cliff with full attendance of students and PPs, industrial partners and several guests. In addition, several CRD students (N. Webster, E. Genrich, A. Valois, D. Linley, K. Lippert and M. Palmer) presented results of their studies at the Jan. 4-7, 2007 national meeting of SCL and CCFFR.

Note: CVRD Inco staff (L. Lanteigne) provided additional support for this CRD project in 2006 by providing support for contaminant analysis of water sediments and zooplankton at the Testmark Laboratory.

NSERC Strategic Research Project - An exploration of inter-individual variability in reproductive potential in iteroparous fish populations

This is a 4-year, \$ 620 K project that was initiated in 2002. The principal investigators include researchers from Queen's University (P. Boag, W. Leggett, R. Montgomerie), and the Ontario Ministry of Natural Resources (J. Casselman, T. Johnston, B. Shuter), and non-academic participants include the Department of Fisheries and Oceans, and natural resources agencies from five Canadian provinces. The major objectives of this research have been: 1) to quantify inter-individual variability in reproductive potential with respect to adult characteristics in iteroparous (i.e., spawning more than once in a lifetime), age- and size-structured fish populations, and 2) to improve the predictive power of stock-recruitment models for these populations by incorporating individual-based estimates of reproductive potential. Walleye and lake whitefish have been our model species and we have examined populations across Canada over wide gradients of climate and exploitation. Our research approach has involved traditional spawning stock surveys to examine reproductive effort, as well as manipulative breeding experiments to quantify the contributions of individual spawners to year-class formation. Two MSc students, one PhD student, four PDFs, and numerous undergraduates have received training through the course of this work. This project concluded in 2006. A final workshop was held in June and a final report was submitted to NSERC in July.

Climate Change Community Case Study

The Co-op Unit is a partner in a case study led by Laurentian University to examine the vulnerability of the City of Greater Sudbury to the potential impacts of climate change. A number of workshops and focus groups have been held to determine how well Sudbury's socioeconomic sectors are likely to be able to adapt to the impacts of a changing climate and what the barriers to adaptation might be.

The principal investigator, Dr. Liette Vasseur, Associate Vice President Research is leading a multi-disciplinary team that includes Bill Keller, David Pearson and Liz Bamberger from the

Co-op Unit. Funded by Natural Resources Canada, other partners include the City of Greater Sudbury, the Nickel District Conservation Authority, the Ontario Ministry of the Environment, MIRARCo, Environment Canada, Science North, the colleges, consulting firms, business, industry and community organizations. The total project budget is \$437,850. The report is expected to be completed by the end of March 2007. It is anticipated that future research will be funded to address knowledge gaps identified in the report.

New Field Course

Methods in Aquatic Biodiversity Assessment Course :

This year Laurentian became an official member of OUPFB and our students now have access to 41 new field courses offered by 16 universities. The field course program covers a broad range of topics, from behavioural energetics, to methods in ecotoxicology, to arctic, marine, desert, alpine and tropical reef biology.

The Co-op Unit will be offering our new aquatic methods course on Aug. 26-Sept. 8, 2007. Students will be introduced to a wide variety of field methods for use in assessing the effects of multiple stressors (e.g. climate change, excessive exploitation, acidification, shoreline development) on the biodiversity of Boreal Shield lakes. The emphasis will be on sampling fish, benthic invertebrates and zooplankton using standard methods currently employed by many government agencies in Canada and Scandinavia. All participants will first be trained in boat safety and will obtain an official pleasure boat operators card. They will then receive extensive class, lab and field training in proper sampling design, sampling equipment and procedures, species identification, sample processing, and data management. Teams of participants will perform actual whole ecosystem surveys as well as special projects tailored to student interests. Special projects will generally be designed to allow students to access extensive comparable data within the instructors data base. Included in the course is a 4 day camping trip to Killarney Park to sample some of the clearest and most beautiful lakes in the country. Lectures from the instructors and several additional experts will be interspersed throughout the course.

International Outreach and Students

This year the Co-op Unit was pleased to host two students through the Canada World Youth Program. James Manhyara Kamau of Kenya and Sylvester Shija of Tanzania joined our team at the end of August and actively participated in a number of projects until Oct.31, 2006. Their energy, enthusiasm and life experiences were enlightening and served to remind us of the importance of our partnership and research on a much greater scale. Participation in the Canada World Youth Program was a success, a great experience for all involved.

Mining and the Environment Conference IV

The Co-op Unit is co-hosting this conference (with the Centre for Environmental Monitoring) to be held from Oct 20 – 27, 2007 at Laurentian University. Planning began in fall 2006 and it was decided to incorporate the “Sudbury Restoration Workshop” into the conference.

The theme for the conference is **sustainability** (inclusive of the workforce and the communities). The conference will include papers dealing with the following topics:

- Sustainable Workforce
- Globalization
- Climate Change
- Reducing Fossil Fuel Use
- Mining and the Community
- Air Quality Issues in Mining
- Environmental Management Systems
- Mining of Ancient Groundwater
- Mining Studies: Fertile Ground for both Applied and Basic Research
- Tar Sands Developments
- Metals/Climate/Acidity: Interactions
- Mining in Extreme Environments
- Bioleaching and Genetic Engineering

The Co-op Unit is leading a **Mining Waters Symposium** that will cover a variety of topics related to the sustainability of mining-affected aquatic ecosystems. The Co-op Unit is also offering the Ontario Benthos Biomonitoring Network Certification Course (2 ½ days) lead by Chris Jones and Chantal Sarrazin-Delay as well as organizing tours of the Killarney study lakes.

Dr. David Schindler from the University of Alberta will present the Keynote plenary address, opening both the conference and our Mining Waters Symposium. In addition Elizabeth May, leader of Canada’s Green Party is the banquet speaker.

Publications

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

Alarie, Y. 2006. Amphizoidae, Aspidytidae, Haliplidae, Noteridae and Paelobiidae (Coleoptera, Adephaga). World Catalogue of Insects, Volume 7. The Coleopterists Bulletin 60: 305-306

Alarie, Y. and Challet, G. L. 2006. Larval description and phylogenetic placement of the South African endemic genus *Andex* Sharp (Coleoptera: Adephaga: Dytiscidae). Annals of the Entomological Society of America 99: 743-754.

Alarie, Y. and Challet, G. L. 2006. Study of the larvae of *Prismopes suturalis* Sharp (Coleoptera: Dytiscidae, Hydroporinae) with implications for the phylogeny of the Hyphydrini. Aquatic Insects 28: 31-46

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- Derry, A. M. and Arnott, S. E. 2006. Adaptive reversals in acid tolerance in copepods from lakes recovering from historical stress. *Ecological Applications*. (in press).
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- Shurin, J. B., Arnott, S. E., Hillebrand, H. Longmuir, A., Pinel-Alloul, B. Winder, M. and Yan, N. D. 2007. Diversity-stability relationship varies with latitude in zooplankton. *Ecology Letters* (in press).
- Strecker, A.L., Arnott, S.E., Yan, N.D., and Girard, R. 2006. Variation in the response of crustacean zooplankton species richness and composition to the invasive predator *Bythotrephes*. *Can. J. Fish. Aquat. Sci.* 63: 2126-2136.
- Swanson, H.K., Johnston, T.A., Schindler, D.W., Cunjak, R.A., and Whittle, D.M. 2005. Are the trophic ecologies of boreal forage fishes related to ecosystem size? *Oikos* (under review).
- Swanson, H.K., Johnston, T.A., Schindler, D.W., Bodaly, R.A. and Whittle, D.M. 2006. Mercury bioaccumulation in forage fish communities invaded by rainbow smelt (*Osmerus mordax*). *Environmental Science and Technology* 40: 1439-1446.
- Tanentzap, A.J., Yan, N.D., Keller, W., Girard, R., Heneberry, J., Gunn, J.M., Hamilton, D.P., and Taylor, P.A.. 2006. Cooling lakes while the world warms: effects of forest re-growth and increased dissolved organic matter on the thermal regime of a temperate urban lake. *Limnol. Oceanography* (under review).
- Vascotto, S. 2006 Variability in Benthic Invertebrate Community Data and Methodological Implications on Test Site Assessments DRAFT Cooperative Freshwater Ecology Unit Report, Sudbury, Ontario. 44 pp.
- Wiegand, M.D., Johnston, T.A., Leggett, W.C., Watchorn, K.E., Ballevena, A.J., Porteous, L.R. and Casselman, J.M. 2007. Contrasting strategies of ova lipid provisioning in relation to maternal characteristics in three walleye populations. *Canadian Journal of Fisheries and Aquatic Sciences* (in press).
- Witty, L. and Sarrazin-Delay, C. 2006. Illustrated Guide to Northern Ontario Invertebrate Benthos. Cooperative Freshwater Ecology Unit Report.

Invited Presentations

- Alarie, Y. 2006. Recognizing Discontinuity in the Continuum: the core of scientific activity. Immature beetles meeting; informal meeting on taxonomy, morphology and ecology of Immature beetles. Department of Zoology, Faculty of Science, Charles University, Prague, The Czech Republic, November 2nd– 4th.
- Alarie, Y. 2006. Continu et Discontinu, Essence de l'activité scientifique. Département de Sciences biologiques, Université de Montréal. Montréal, Qc. September 11-12.
- Arnott, S. 2006. Local and Regional Determinants of Community Structure, Cornell Biological Field Station, June 2006.
- Arnott, S. 2006. Factors Controlling Biological Recovery from Acidification, INCO Acid Rain Meeting, Feb. 24, 2006
- Gunn, J.M and W. Keller. 2006. Recovery of Acid and Metal Damaged Lakes Near Sudbury. Ontario Laurentian Chapter of SETAC Annual Meeting, Laurentian University, Sudbury, ON, May 18 – 19.
- Gunn, J.M. 2006. Watershed Rehabilitation, International Outreach, and Sustainable Energy Use. INCO Acid Rain Meeting, Feb. 24, 2006
- Keller, W., Yan, N.D., Gunn, J.M. and Heneberry, J. 2006. Recovery of acidified lakes: lessons from Sudbury, Ontario, Canada. INCO Acid Rain Meeting, Feb. 24, 2006

Conference and Workshop Presentations

- Alarie, Y. 2006. Phylogenetic relationships of world Colymbetini (Coleoptera: Dytiscidae). Annual meeting of the Entomological Society of America. Indianapolis, IN, USA, December 10th – 13th (with Michat, M.).
- Alarie, Y. 2006. Allometry and sexual selection in the whirligig beetle *Dineutus nigrior*. Annual meeting of the Entomological Society of America. Indianapolis, IN, USA, December 10th – 13th (with Fairn, E. and Schulte-Hostedde, A.).
- Alarie, Y. 2006. Selenium-mercury interactions in aquatic organisms. 8th International Conference on Mercury as a Global Pollutant, Madison, USA (with Belzile, N., Chen., Gunn, J.M., Ye, X. and Yang, D.-Y.)
- Alarie, Y. 2006. Regional climate change and the size and shape of a stream invertebrate: microevolution meets macroecology? Peter Yodzis Colloquium in Fundamental Ecology, May 17th – 18th, Guelph Ontario (with J. Babin-Fenske and M. Anand).

- Alarie, Y. 2006. Selenium and mercury in aquatic organisms. 11th Annual General Meeting of the Laurentian Chapter of Society of Environmental Toxicology and Chemistry, Sudbury, Canada, May 11th (with Belzile N., Chen Y.W., Gunn J.M., Ye W. and Yang D. -Y.)
- Alarie, Y. 2006. Allometry and sexual selection in the whirligig beetle *Dineutus nigrior*. Ontario Ecology and Ethology Colloquium, Brock University, St. Catharines, Ontario, May 5th (with Fairn,E. and Schulte-Hostedde, A.).
- Alarie, Y. 2006. Selenium-mercury interactions in fish organs COMERN, Sixth General Congress, UQAM, Montréal, Qc, February 6th-10th (with Belzile N., Chen Y.W., Gunn J., Ye W. and Yang D.-Y)
- Arnott, S. E. and Hasek, D. 2006. Community closure following acidification: biological resistance to recovery. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7, 2006. Oral
- Arnott, S. E. and Hasek, D. 2006. Biological Resistance to Recovery Following Chemical Recovery from Acidification Advancing the Science of Limnology and Oceanography (ASLO). June
- Belzile, N., Chen, Y.W., Gunn, J.M., Alarie, Y., Ye, X. and Yang, D.-Y. 2006. Selenium-mercury interactions in aquatic organisms. 8th International Conference on Mercury as a Global Pollutant, Madison, USA.
- Belzile, N., Chen, Y.W., Gunn, J.M., Alarie, Y., Ye, X. and Yang, D.-Y. 2006. Selenium and mercury in aquatic organisms. 11th Annual General Meeting of the Laurentian Chapter of Society of Environmental Toxicology and Chemistry, Sudbury, Canada.
- Belzile, N., Chen, Y.W., Gunn, J.M., Alarie, Y., Ye, X. and Yang, D.-Y. 2006. An overview on the interactions between selenium and mercury in aquatic organisms. 6th Annual Congress of the Collaborative Mercury Research Network, Montreal, Canada.
- Bowman, M.F., Somers, K.M., Keller, W., Sarrazin-Delay, C.L, and Brereton, C.I. 2006. Developing reference benchmarks: A comparison of ecoregion, clustering - discriminant analysis, and nearest neighbor classifications, North American Benthological Society Annual meeting, June 8, Anchorage, Alaska
- Bowman, M.F., Brereton, C.I., Sarrazin-Delay, C.L., Keller, W., and Somers, K.M. 2005. Developing reference benchmarks for the Northern Ontario biomonitoring network, 32nd Aquatic Toxicity Workshop, Oct. 2-5, Waterloo, Ontario.
- Couture, P., Gunn, J.M., Pyle, G.G. Kraemer, L.D. and Campbell, P.G.C. 2006. Additional stressors in metal-contaminated yellow perch: Ecological and seasonal influences on morphometric and physiological condition indicators. SETAC Europe 2006. The Hague May 7-11

- Derry, A.M., and Arnott, S.E. 2006. Resurrected zooplankton resting eggs reveal rapid ecological shifts in response to historical lake acidification. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7, 2006. Oral
- Derry, A.M., Arnott, S.E., and Boag, P.T. 2006. Rapid landscape-level evolution of acid tolerance following historical lake acidification. Canada Society for Ecology and Evolution, Montreal, QC
- Genrich, E. and Gunn, J.M. 2006. Testing the use of benthic macroinvertebrates as an indicator of recovery for acid and metal damaged aquatic ecosystems in Sudbury, Ontario. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7, 2006.
- Hatton, E.C., Campbell, L.M., and Arnott, S.E. 2006. The role of invasive *Bythotrephes* in inland lake food webs and mercury trophic transfer to fish. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7
- Hatton, L., Arnott, S. E., Campbell, L., and Mierle, G. 2006. The role of invasive *Bythotrephes* in inland lake food webs and mercury trophic transfer to fish. Gananoque Metals in the Environment, Gananoque, February
- Johnston, T.A., Whittle, D.M., and Power, M. 2006. Response of native fishes to salmonid cage aquaculture in Northern Lake Huron. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7
- Kaufman, S.D, Morgan, G.E., Malette, M.D., Lowman, D., and Selinger, W. 2006. Comparing lake trout (*Salvelinus namaycush*) and walleye (*Sander vitreus*) angling effort in Northeastern Ontario: When, Who, and How? Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7
- Kaufman, S., Selinger, W., Snucins, E., and Gunn, J.M. 2007. Road access as the vector for two invasives in lake trout lakes of northeastern Ontario: anglers and bass. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Montreal, QC. Jan 4-6
- Linley, R.D., and Ramcharan, C.W. 2006. A mesocosm study on the effects of fish and macroinvertebrate predators on zooplankton communities in relation to biological recovery from acidification. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7

- Moles, M.D., Johnston, T.A., Robinson, B.W., Leggett, W.C., Cunjak, R.A., Lysack, W., Wiegand, M.D. and Wilson, C.C. 2006. Ecological divergence of normal and dwarf morphotypes of walleye (*Sander vitreus*) in Lake Winnipeg. Oral presentation at Canadian Conference for Fisheries Research, Calgary, AB, Canada, January 5-7
- Petrie, S.A., Badzinski, S.S., Belzile, N. and Chen, Y.W. 2007. Food-chain transfer and effects of selenium in waterfowl. 2007 Annual Research Symposium of the MITHE Research Network, Gatineau, Canada.
- Ramcharan, C.W., Keller, W., and Yan, N.D. 2006. Effects of herbivore composition on community clearance rates. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7
- Ramcharan C.W., Keller W., and Yan N.D. 2006. Stability of ecosystem function in acid-stressed lakes. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7
- Shead J.A. and Arnott, S.E. 2006. Continued recovery from acidification in Killarney Park, Ontario: 1971-2005. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7, 2006.
- Shead, J.A., and Arnott, S.E. 2006. Assessing the recovery of lakes in Killarney Park, Ontario, from the effects of historical acid deposition: 1971-2005. Advancing the Science of Limnology and Oceanography (ASLO), June Oral.
- Strecker, A.L., and Arnott, S.E. 2006. Disruption of energy flow in boreal shield lakes: implications of the invasion of an invertebrate predator, *Bythotrephes*. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7. Oral
- Truong, Y., Chen, Y.W and Belzile, N. 2006. Reduction of selenium under control conditions. Sudbury Restoration Workshop, Sudbury, Canada. Feb. 22-23
- Venturelli, P.A., Shuter, B.J., Johnston, T.A., Lester, N.P., and Murphy, C.A.. 2006. Is bigger better for walleye (*Sander vitreus*) recruitment?: a modeling approach. Oral presentation at Canadian Conference for Fisheries Research, Calgary, AB, Canada, January 5-7
- Wiegand M.D., Johnston, T.A., Watchorn, K.E., Ballevena, A.J. and Leggett, W.C. 2006. Relationships between egg characteristics and maternal traits in two populations of walleye (*Sander vitreus*). Oral presentation at International Congress on the Biology of Fish, St. John's, NF, Canada, July 18-22
- Yang, D.-Y., Ye, X. Chen, Y.W. and Belzile, N. 2006. Methylmercury in aquatic systems – Antagonistic effect of selenium on its accumulation in fish. 8th International Conference on Mercury as a Global Pollutant, Madison, USA.

Sudbury Restoration Workshop Feb. 22-23, 2006

- Bowman, M., Somers, K., Keller, B., Sarrazin-Delay, C. and Brereton, C. 2006. Developing reference condition benchmarks. p.20, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Gunn, J., Butler, M., Keller, B., Ramcharan, C., Watson, G. and Yan, N. 2006. Barriers to biological recovery in historically disturbed Sudbury lakes: A collaborative research program. p.12, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Hatton, L., Arnott, S. E., Campbell, L., and Mierle, G.. The role of invasive *Bythotrephes* in inland lake food webs and mercury trophic transfer to fish
- Keller, B., Ford, A. and Gallie, A. 2006. Testing an ice-out model for Ramsey Lake. p.70, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Linley, R.D., Ramcharan, C. and Keller, B. 2006. Predation and biological recovery of zooplankton communities from acidification: a mesocosm study. p.14, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- MacPhee, S., Heneberry, J., Keller, B. and Gunn, J. 2006. Studies on the native lakes of the endangered aurora trout. p.72, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Ramcharan, C., Keller, B. and Yan, N. 2006. Stability of ecosystem function in acid-stressed lakes. p.77, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Sarrazin-Delay, S., and Keller, B. 2006. Development and growth of the northern Ontario RCA network for benthic invertebrate monitoring. p.79, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Valois, A., Ramcharan, C., Keller, B. and Heneberry, J. 2006. Spatial patterns in zooplankton recovery in Sudbury lakes. p.61, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Vascotto, S., Sarrazin-Delay, C. and Keller, B. 2006. RCA method comparison: a preliminary approach using summary metrics. p.81, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Webster, N., Gunn, J., Ramcharan, C. and Keller, B. 2006. Use of a lake mixer to simulate climate change effects on the limnology of a small shield lake. p.83, in Proc. Sudbury Restoration Wkshp., Laurentian Univ., Sudbury.
- Yang, D.-Y., Chen, Y.W., Gunn, J.M. and Belzile, N. 2006. Methylmercury in aquatic systems. Sudbury Restoration Workshop, Sudbury, Canada.

Theses Completed

Graduate

Lippert, K. 2006. Yellow perch (*Perca flavescens*) phenotypic plasticity: Rapid changes following the arrival of a predator. MSc. Thesis. Department of Biology, Laurentian University, Sudbury, ON. 156 p.

Moles, M.D. 2006. Life history variation and divergence of walleye (*Sander vitreus*). MSc. Thesis, Department of Integrative Biology, University of Guelph, Guelph, ON. 113 p.

Undergraduate:

Adriana Hoogenboom. 2006. Fish community assessment for Kelly Lake: a contaminant trap for metal and nutrient-rich water flowing from the City of Greater Sudbury

Dave Hasek. 2006, Biotic resistance in acidified zooplankton communities: the effects of predation and competition on zooplankton colonists.

Rebecca Milne. 2006. Dispersal limitation and climate-related environmental gradients structure crustacean zooplankton composition in freshwater lakes, Ellesmere Island, Canada.

Bonnie Matthews. 2006. Rapid change in yellow perch (*Perca flavescens*) gill morphology caused by piscivore introductions.

Research Grants

Y. Alarie

- NSERC Research Networks, for COMERN with Nelson Belzile, Yu-Wei Chen, and John Gunn
- NSERC Operating Grant
- NSERC URSA

S. Arnott

- Ontario Ministry of the Environment, Best-in-Science, Climate effects on vertical structure in lakes and implications for food web interactions. 2007-2009
- NSERC Discovery Grant, The importance of regional and local factors in recovery from environmental stressors, 2004-2009

N. Belzile

- NSERC COMERN Network (with Y.-W. Chen, J.Gunn, Y. Alarie)
- NSERC MITHE-RN Network (with Petrie, Chen)
- NSERC Discovery Grant

J. Gunn

- NSERC/Canada Research Chair, Tier 1
- NSERC Collaborative Research and Development Grant (with York University, CVRD Inco Ltd., Xstrata Ltd.) Barriers to Biological Recovery.
- NSERC Discovery Grant, Effects of warmwater invasive species on lakes recovering from acidification.
- NSERC URSA
- OMOE, Fish biomonitoring in Dorset and Sudbury area
- OMNR, S.C. Ontario Biodiversity Survey
- CFI “Aquatic Restoration Ecology Lab” (AREL)
- CVRD Inco Ltd., Junction Creek Restoration
- Canadian Wildlife Service, NORDIC Biodiversity Survey
- HRDC, Youth Canada Internships
- Environment Canada, Youth Internship
- HRSDC, Job Creation Partnership Program Interns
- NOHFC, Environmental Data Management Intern
- OMNDM, Summer Student Subsidies

T. Johnston

- NSERC, Strategic Grant, An exploration of inter-individual variability in reproductive potential in iteroparous fish stocks (Leggett et al., 2002-2006)
- Northern fisheries research (Johnston, Ontario Ministry of Natural Resources, Aquatic Research and Development, Base Operating Funds, 2004 – ongoing)

B. Keller

- CVRD Inco Limited, Aquatic Restoration Group (ARG) support
- Xstrata Limited, ARG support
- Ontario Ministry of the Environment, ARG support
- Environment Canada, Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN) support
- CVRD Inco Limited, NOBIBN support
- Newmont Canada Ltd., NOBIBN support
- Williams Operating Corp., NOBIBN support
- Goldcorp Inc., NOBIBN support
- Placer Dome Limited, NOBIBN support
- Ontario Ministry of the Environment, NOBIBN support
- Ontario Parks, Evaluating Habitat Suitability for Wild Aurora Populations in their Native Lakes
- FedNor, Environmental Technologist for Mining-Impacted Waters
- HRDC – Career Focus, Biostatistician Intern

C. Ramcharan

- NSERC Discovery Grant, New directions in lake foodwebs

N. Yan

- NSERC Discovery Grant, Impacts of multiple stressors on zooplankton in Canadian Shield Lakes
- MOE Grant, Assessing zooplankton changes in Canada's inland lakes
- CFI, Operations of the FLAMES lab
- Premier's Research Excellence Award, Quantifying the impacts of multiple stressors on Canadian freshwater zooplankton

Co-op Unit Staff 2006

Ramsey House:

Elizabeth Bamberger - Business Manager
Chad Bouchard- Communications Intern - FedNor
John Gunn – Canada Research Chair, LU
Tom Johnston - Fisheries Scientist, MNR
Bill Keller – Limnologist, MOE
Karen Oman – Research and Administration

Laurentian University Science Building:

Yves Alarie – Biosystematics
Peter Beckett- Education and Outreach
Nelson Belzile - Environmental Chemistry
Dave Pearson - Urban Lakes Coordinator/Science Communication
Micale Prévost- Research Technician
Charles Ramcharan - Aquatic Ecologist

Water House:

Andrea Ford - Data Manager
Jocelyne Heneberry - Monitoring Coordinator, MOE
Shannon MacPhee – Limnology Technician
Jason McCourt – Environmental Officer, MOE
Natalie Webster - Limnology Technician

Fish House:

Jason Houle – Senior Fisheries Technician/ Data Manager
Scott Kaufman – Extension Biologist
Lee Haslam – Senior Fisheries Technician, MNR

Bug House:

Kim Fram – Invertebrate Taxonomy
Chantal Sarrazin-Delay - Biomonitoring Biologist
Lynne Witty - Invertebrate Taxonomist
Nikki Boucher – FedNor intern
Sarah Vascotto - Biostatistician

Ph.D., M.Sc. and B.Sc. (Honours) Students Supervised:

Kelly Lippert	Dallas Linley	Shannon MacPhee
Kristin Mulligan	Natalie Webster	Dave Hasek
Amanda Valois	Matt Moles	Andreas Luek
Adrianna Hoogenboom	Erika Genrich	Lisa Porter
Yoandri Suarez Megna	Laura Cook	Evan Fairn
Becky Olacke	R. McAlister	Yen Thi Hoang Truong
Russell Polack	Cai Mei-Fang	Dan Yang
Alison Derry	Angela Strecker	Johanna Pokorny
Liz Hatton	Margot Hessing-Lewis	Justin Shead
Rebecca Milne	Michelle Zanuttig	Paul Larochelle
Lianne Michel	Ashley Tremblay	Leah James
Michael Pedruski	Esther Chan	Lisa Duke
Megan MacLennon		

Aquatic Technologists, HRSDC:

Dorothy Robb	Michelin Gosselin	Nikki Boucher
Dan Dechaine	Erin MacLachlin	Sam Chretien
Kyla Standeven	Shannon Ross	Natalie Boulrice

Field Technicians and Research Assistants:

Megan Chute	Roch Gareau
Paule Cholette	Steven Sarrazin

