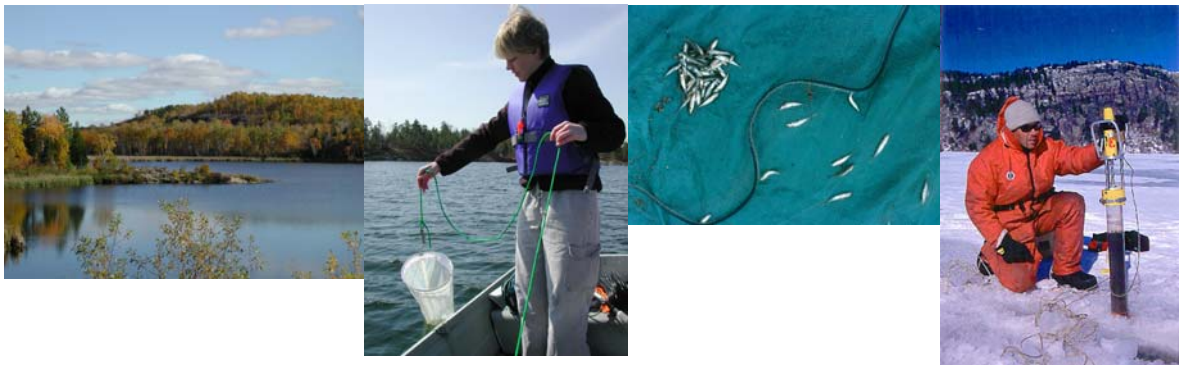
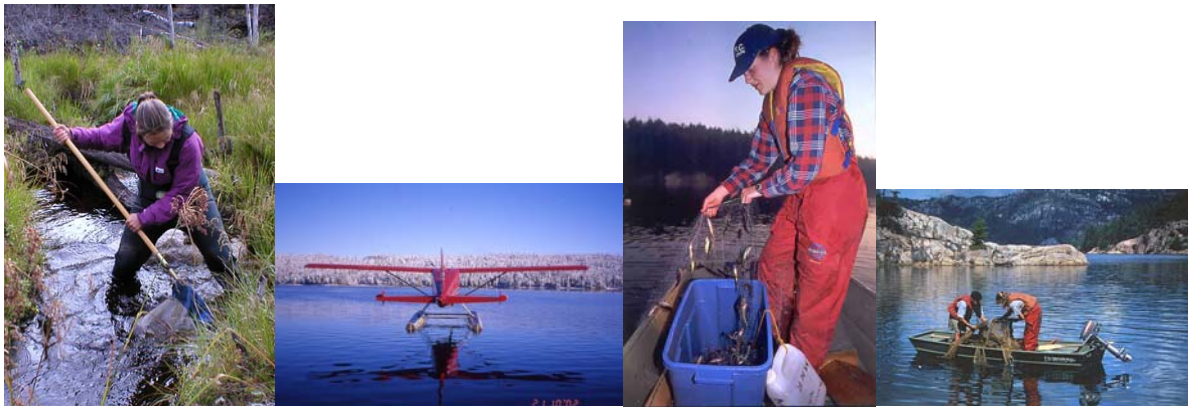


# Cooperative Freshwater Ecology Unit
# Annual Report
# 2005

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



# Cooperative Freshwater Ecology Unit
# Annual Report 2005

## Living with Lakes Centre Planning – Moving to the Next Step

Lake Centre planning progressed well in 2005. Presentations were made to numerous groups and agencies, emphasizing the wide variety of goals for the "Living with Lakes Centre of Excellence in Aquatic Restoration" including: enhanced aquatic research and monitoring, training and retaining HQP in Northern Ontario, demonstrating the best of energy efficiency and sustainable workplace design, and development of international science in aquatic restoration.

In 2005, Inco and FedNor agreed to commit $300K each to the Detailed Design Phase of the project, adding to the $800K from CFI and OIT already committed to the project. The Northern Ontario Heritage Fund also tentatively approved $1M for the construction phase. We hope for announcements of other major industry and government support for the capital construction phase, early in 2006.

## Science Communication Graduate Diploma Program

The Co-op Unit has been an enthusiastic supporter during the development of the new Graduate Diploma in Science Communication recently approved as a joint program of the University and Science North. David Pearson from the Co-op Unit is the Laurentian Co-Director of the program along with Chantal Barriault of Science North. There are other similar programs in Australia and Europe but this is the first of its kind in North America. Eight fulltime and 2 part time students were enrolled in September 2005, including Karen Oman who is working on contract at the Co-op Unit. A maximum of 15 students will be accepted for 2006-2007. Students take 10 courses, including a research project and a 4 to 8 week internship in an organization involved in communicating science. This year's students are considering placements at Canadian Geographic, Discovery Channel, MNR, MOE, the Canadian Foundation for Innovation, CBC, and others being arranged for late March to May. A field trip to Toronto in late November

included a day at the MOE Environmental Monitoring and Reporting Branch hosted by Ed Piché, the Director, and Carl Griffith, the ADM.

Check out the program at www.sciencecommunication.ca
More information from dpearson@laurentian.ca

## Core Monitoring Programs

2005 was a very busy, very successful field year at the Co-op Unit. All the core monitoring and assessment programs at the Co-op Unit were maintained or enhanced. A major challenge for the future of these large, important studies includes maintaining the key staff positions needed to implement the field programs, process the large numbers of biological samples, and manage and analyse the massive and complex databases.

### Aquatic Restoration Group

### Sudbury Environmental Study Lakes

The Sudbury Environmental Study (SES) contains two main program areas which complement each other, the Intensive and Extensive Monitoring lakes: i) SES Intensive is a set of 14 lakes monitored monthly during the ice-free season for a range of physical, chemical, and biological parameters. These lakes are within 100 kilometres of Sudbury. This research allows an assessment of the long-term and seasonal variations for a large set of parameters; ii) SES Extensive is a set of 44 lakes monitored once per year for a full collection of chemical parameters and occasionally for zooplankton. These lakes are also located within a 100 kilometre range from Sudbury. Because of their larger geographic distribution compared to the intensive lakes, researchers are able to determine how widespread the detailed patterns viewed in the Intensive lakes are. These long-term monitoring programs are key elements in developing our scientific understanding of how northern Ontario lakes are responding to multiple environmental stressors.

During 2005, we again sampled the 14 Intensive lakes and 44 Extensive lakes, including zooplankton sampling on the extensive lakes. Additional work included collecting single mid-summer chemistry and zooplankton samples from 33 Urban lakes in Sudbury as well as 24 Reference lakes located within the Extensive lakes survey zone. We also completed monthly sampling on 5 additional lakes within the city of Sudbury, using protocols similar to those used for our Intensive Monitoring Program. As a result, we have maintained our ability to track the responses of these lakes to reduced acid deposition, and to determine how recovery from acidification will interact with other large scale stressors like climate change.

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

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

During the development of this biomonitoring network (2003-2005), over 400 reference and impacted lakes and streams have been sampled across northern Ontario. Phase One models have been completed and will soon be accessible to partners via Environment Canada's website. Work in 2005 focused on refining the current models with the additional data collected during this year's field studies. We are also conducting comparisons of our assessment methods with methods used in other studies to determine if other large datasets can be merged with our database.

Fish Biodiversity Survey:

A major addition to the monitoring program was the inclusion of the international standard NORDIC fish surveys for the 14 MOE intensive study lakes in Sudbury as well as the 9 MOE "A" lakes and 22 spatial reference lakes in the Dorset/Algonquin Park area. The spatial reference lakes included 6 of MNR's Fisheries Assessment lakes in Algonquin Park. In 2005, the fish survey work was also extended to include 6 small Canadian Wildlife Service study lakes bringing the total number of NORDIC lakes sampled by the Co-op Unit to 234 since 1999 and contributing to an international data base of over 2000 lakes. Funding support for the 2005 surveys was provided by MOE, MNR, CWS, and NSERC (CRC, CRD, Discovery). A total of 1121 tissue samples of sport fish species from 50 surveyed lakes were provided to the MOE in 2005 for contaminant analysis (Hg, PCB) to be reported in the upcoming edition of the Guide to Eating Ontario Sport Fish.

**NSERC CRD Program- Barriers to Biological Recovery**

The 4 year $760 K Collaborative Research Development project, involving principal investigators – J. Gunn, B. Keller, N. Yan, and C. Ramcharan and industrial partners G.Watson, Inco Ltd. and M. Butler, Falconbridge Ltd., was approved in March, 2005.

The project is designed to determine whether two habitat factors, residual metal contamination, and reduced biodiversity of re-assembling communities, are key regulators of the recovery of fish and zooplankton in Sudbury lakes. To date 4 undergraduate, 4 M.Sc., 3 Ph.D. and 1 Post-Doctoral students as well as 1 research associate and 6 technicians have been supported by the grant.
Inco Ltd. hosted the first CRD meeting on Nov. 22, 2005. The second meeting is on Feb. 23, 2006 in association with the Sudbury Restoration Workshop.

**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. The final workshop for this project will be held in spring 2006.

**Climate Change Case Study**

The Co-op Unit is a lead partner in Laurentian University's successful proposal to the Climate Impacts and Adaptation Program to examine the vulnerability of the City of Greater Sudbury to the potential impacts of climate change. The proposal was selected from among 133 submissions from across Canada and has been designed to be a case study applicable to other communities. Climate scenarios for 2020, 2040 and 2080 based on several global models will be considered. The project will study, with the help of stakeholders, how well Sudbury's socioeconomic sectors are likely to be able to adapt to the impacts of the climate arising from the scenarios, and what the barriers to adaptation might be. The sectors have been grouped into five fields: natural and managed ecosystems, water, municipal infrastructure (including emergency preparedness), health, and socio-economics. This approach will ensure integration across the sectors. Sudbury's attributes as a bilingual, medium-sized Canadian Shield community,

dependent on natural resources will enable the case study to provide insights that are applicable elsewhere. Our track record with successful partnerships was also a key factor in the success of the proposal.

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 for 1 year. It is anticipated that this will expand into a multi-year, multi-faceted project.

**NSERC Invasive Species Network**

Dr. Norm Yan (York University) and his team have been awarded a large multi-year grant to support an invasive species research network for Canada. Norm will serve as the co-lead for the Great Lakes/Central Canada portion of the work, but also has a substantial individual research program to deliver.

**Conferences and Workshops**

Dr. Shelley Arnott (Queen's University), and Dr. Norm Yan, Co-organizers for the Second North American Biennial Cercopagid Workshop, Queen's University Biology Station, Kingston, ON, April 26-28, 2005

Presentations:

- Strecker, A. and Arnott, S. E. *Bythotrephes* - induced changes in zooplankton community structure and grazing in boreal lakes
- Shead, J. and Arnott, S. E. Planning the third 46 lake Killarney re-survey: Is there interest in this sparsely invaded landscape?
- Arnott, S. E. and Campbell, L.. Plans for quantifying influences of *Bythotrephes* on energy flow and Hg partitioning in foodwebs

**Field Courses**

Methods in Aquatic Biodiversity Assessment

- G. Morgan and L. Haslam, Coordinators.
- J. Gunn, B. Keller, M. Malette, and C. Ramcharan, Invited Instructors. May 16-20, 2005

Students were introduced to the field methods in aquatic biodiversity assessment in this preliminary course. The course was held in Sudbury at the MNR District office and at the Co-op Unit. Participants in the course were first trained in boat safety and obtained their Pleasure Boat Operators Card. They then received extensive in-class and lab training in use of sampling equipment, proper survey

design, data management, species identification, and sample processing methods. Students participated in teams in an actual NORDIC netting survey of area lakes and obtained training in benthic invertebrate sampling as well. Lectures on invasive species and impacts and use of the Reference Condition Approach were provided. This modular course is being expanded from a 5 day to a 10 day course and has been submitted for approval as an LU credit course as part of the Ontario Universities' Program in Field Biology (OUPFB).

Limnology of Stressed and Recovering Aquatic Ecosystems

- Dr. Shelley Arnott, Instructor. Angela Strecker TA. August 21 to Sept. 3. Killarney Provincial Park.

On alternate years, the Arnott Lab and Killarney park research facilities play host to a OUPFB course offering university students an introduction to limnological field techniques. Ten students from various Ontario universities participated in 2005. Students explore Killarney park and participate in individual or group experiments and projects, giving them excellent hands-on experience in limnological research.

## International Outreach and Students

J. Gunn and C. Greco participated in a number of site visits to Reynosa and Matamoros, Mexico in 2005 to assist in a Sustainable Cities Initiative, to help these cities improve their natural environments. In July, J. Gunn and L. Bamberger met with delegates from Jamaica at Cambrian College to discuss sustainable and energy efficient design features of the planned Lake Centre building. The Co-op Unit also hosted an exchange student from France, Adeline Cadet, throughout the summer of 2005.

On the research front, international collaborations were developed by many of the Co-op Unit scientists. Nelson Belzile spent his sabbatical in China and was very involved in science exchange through invited lectures at many Universities. Also, Norm Yan was able to attract a Ph.D. student from Mexico, Martha Salgado-Celise, a CONACYT scholarship student, to participate in the CRD research project.

**Publications**

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


Aherne, J., Clair, T.A., Dennis, I.F., Gilliss, M., Couture, S., McNicol, D., Weeber, R., Dillon, P.J., Keller, W., Jeffries, D.S., Page, S. and Cosby, B.J. 2005. Dynamic modeling of lakes in eastern Canada. In, M. Posch, J. Slootweg and J.P. Hettelingh (editors). Modelling and mapping of critical thresholds in Europe: status report 2005. Co-ordination Centre for Effects, Netherlands Environmental Assessment Agency, Bilthoven, The Netherlands.

Alarie, Y. and Bilton, D. T. 2005. Larval morphology of the new adephagan family Aspidytidae (Coleoptera: Adephaga) with phylogenetic implications. *Annals of the* Entomological Society of America *98(4): 417-430.*

Alarie, Y. and Watts, C.H.S. 2005. Larval morphology of four species of the *Hyphydrus lyratus* species-group (Coleoptera: Dytiscidae: Hydroporinae). *Australian Journal of Entomology 44 (3): 244-25.*

Alarie, Y. 2005. World Catalogue of Insects, volume 3, Dytiscidae (Coleoptera). *Annals of the Entomological Society of America* 98: 150.

Arnott, S. E., Dodson, S., Magnuson, J. J., and Colby, A. 2005. Lakes as islands. *In* Lakes in the Landscape: Insights and Concepts from the North Temperate Lakes LTER from 1981-2000. *Edited by* J. T. Magnuson, K. Kratz, and B. Benson. Oxford University Press.

Arnott, S. E., Jackson, A., and Alarie, Y. 2005. Water Beetle Assemblages in Lakes Recovering from Acidification. Freshwater Biology. In press.

Belzile, N., Chen, Y.-W., Gunn, J.M., Tong, J., Alarie, Y., Delongchamp, T., and Yang, C-Y. 2006. The effect of selenium on mercury assimilation by freshwater organisms. Can. J. Fish. Aquat. Sci. 63:1-10.

Binks, J., Arnott, S. E., and Sprules, W.G. 2005. Local factors and colonist dispersal influence biotic recovery from cultural acidification. Ecological Applications. 15: 2025-2036.

Binks, J.A., Morgan, G.E., Malette, M.D., and Gunn, J.M. 2005. Sexual differences in life history traits of northern pike (*Esox lucius*) in Boreal Shield lakes. J. Fish. Biol. Submitted.

Boeing, W.J., Wissel, B., and Ramcharan, C.W. 2005. Costs and benefits of *Daphnia* defense against Chaoborus in nature. Can. J. Fish. Aquat. Sci. 62:1286-1294.

Boeing, W.J., Ramcharan, C.W., and Riessen, H.P. 2005. Reaction norm of depth selection behavior by *Daphnia pulex*: Variation due to clone body size, and kairomone intensity. Hydrobiologia. Accepted.

Cahill, K.L., Gunn, J.M., and Futter, M.N. 2005. Modelling ice cover, timing of spring stratification, and end-of-season mixing depth in small Precambrian Shield lakes. Can. J. Fish. Aquat. Sci. 62(9):2134-2142.

Cai, M.-F., Chen, Y.-W., Dang, Z., and Belzile, N. 2005. The passivation of pyrrhotite by surface coating. Chemosphere, 61: 659-667.

Cena, C.J., Morgan, G.E., Malette, M.D., and Heath, D.D. 2005. Inbreeding, outbreeding and environmental effects on genetic diversity in 46 walleye (*Sander vitreus*) populations. Molecular Ecology, 2005.

Chen, Y.-W., Li, Y., Cai, M.-F., and Belzile, N. 2006. Preventing oxidation of iron sulphide minerals by polyethylene polyamines. Minerals Engineering, 19.

Chen, Y.-W., Zhou, M.D., Tong, J., and Belzile, N. 2005. Application of photochemical reactions in the speciation of selenium in natural waters by hydride generation atomic fluorescence spectrometry. Analytica Chimica Acta, 545, 142-148.

Chen, Y.-W., Zhou, X.L., Tong, J., and Belzile, N. 2005. Photochemical behavior of inorganic and organic selenium compounds in various aqueous solutions. Analytica Chimica Acta, 545, 149-157.

Clair, T.A., Aherne, J., Dennis, I.F., Gillis, M., Couture, S., McNicol, D., Weeber, R., Dillon, P.J. , Keller, W., Jeffries, D.S., Page, S., Timoffee, K., and Cosby, B.J. 2005. Past and future changes to acidified eastern Canadian lakes: a geochemical modeling approach. Applied Geochemistry. Under review.

Frost, T. M., Fischer, J.M., Klug, J. L., Arnott, S. E., and Montz, P. M. 2005. Trajectories of zooplankton recovery in the Little Rock Lake, WI whole-lake acidification experiment. Ecological Applications, Accepted May 2005.

Graham, M.D., Vinebrooke, R.D., Findlay, D.L., Nicholls, K.H., Heneberry, J. and Keller, W. 2006. Regional responses of boreal lakes to environmental change: a 20 year analysis of phytoplankton. In prep.

Gunn, J.M., Beckett, P.J., Lautenbach, W.E., and Monet, S. 2006. Sudbury, Canada: From pollution record holder to award winning restoration site. *In* Restoration Design. *Edited by* R.L. Frances. CRC Press. In review.

Gunn, J.M., Selinger, W., Snucins, E. and Morgan, G. 2005. Use of the Nordic standard method to assess recovery of Lake trout (*Salvelinus namaycush*) populations in NE Ontario after decades of acidification. International Conference on Acid Deposition, Prague 2005 for publication in Water, Air and Soil Pollution. Submitted.

Heneberry, J., Keller, W., McNicol, D., and Weeber, R. 2005. Characterization of crustacean zooplankton communities in 33 small lakes near Sudbury, Ontario. Unpublished report, Cooperative Freshwater Ecology Unit.

Hunt, L.M., and Morgan, G. 2005. Examining Policy Preferences of Recreationists: A Case of a Fisheries Management Plan. Leisure/Loisir, 29(2): 377-395.

Hyatt K.D., Ramcharan, C.W., McQueen, D.J., and Cooper, K.L. 2005. Trophic triangles and competition among vertebrate (*Oncorhynchus nerka, Gasterosteus aculeatus*) and macroinvertebrate (*Neomysis mercedis*) planktivores, in Muriel Lake, British Columbia, Canada. Ecoscience 12:11-26.

Jeffries, D.S., Antoniades, D.M., Bourne, A., Carignan, R., Cheng, L., Clair, T.A., Couture, S., Dillon, P.J., Gagnon, C., Gilliss, M., Hilderman, M., Keatly, B., Keller, W., Mallory, M.L., McEachern, P.M., McNicol, D.K., Michelutti, N., Moser, K.A., Pienitz, R., Raymond, B., Ruhland, K.M., Scheuhammer, A.M., Turner, M.A., Weeber, R.C., and Wolfe, A.P. 2005. Aquatic Chemistry, Lake Status, Data Description. P. 3-4, In D. Jeffries , D. McNicol, and R. Weeber. (2005). Chapter 6: Effects on Aquatic Chemistry and Biology. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Jeffries, D.S., Clair, T.A., Couture, S. , Franklyn, J., Gagnon, C., Keller, W., McNicol, D.K., Norouzian, F., and Weeber, R.C. 2005. Aquatic Chemistry, Lake Status, Current Chemical Status. P. 5-13, In D. Jeffries, D. McNicol, and R. Weeber (2005). Chapter 6: Effects on Aquatic Chemistry and Biology. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Jeffries, D.S., Clair, T.A., Couture, S., Dillon, P.J., Franklyn, J., Keller, W., McNicol, D.K., Norouzian, F., Paterson, A.M., Turner, M.A., and Weeber, R.C. 2005. Aquatic Chemistry, Changes in Lake Chemistry, Trend Analyses. P. 13-25, In D. Jeffries, D. McNicol, and R. Weeber (2005). Chapter 6: Effects on Aquatic Chemistry and Biology. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Jeffries, D.S., Clair, T.A., Couture, S., Dillon, P.J., Dupont, J., Keller, W., McNicol, D.K., and Turner, M.A. 2005. Aquatic Chemistry, Changes in Lake Chemistry, Factors Other than Deposition that Influence Trends. P. 25-29, In D. Jeffries, D. McNicol, and R. Weeber (2005). Chapter 6: Effects on Aquatic Chemistry and Biology. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Jeffries, D.S., Clair, T.A., Couture, S., Dillon, P.J., Keller, W., McNicol, D.K., and Weeber, R.C. 2005. Lakes from Regional Monitoring Programs, Chemical Recovery. P. 5-8, In R.C. Weeber , D.S. Jeffries and D.K. McNicol (2005). Chapter 7: Recovery of Aquatic Ecosystems. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Johnston, T.A., Miller, L.M., Whittle, D.M., Brown, S.B., Wiegand, M.D., Kapuscinski, A.R. and Leggett, W.C.. 2005. Effects of Maternally Transferred Organochlorine Contaminants on Early Life Survival in a Freshwater Fish. Environmental Toxicology and Chemistry, 24(10): 2594-2602.

Johnston, T.A., Wiegand, M.D., Leggett, W.C., Pronyk, R.J., Dyal, S.D., Watchorn, K.E., Kollar, S., and Casselman, J.M. 2005. Hatching success of walleye embryos in relation to maternal and ova characteristics. Aquaculture. Submitted.

Keller, W., Heneberry, J., and Leduc, J. 2005. Linkages between weather, dissolved organic carbon, and cold-water habitat in a Boreal Shield lake recovering from acidification. Can. J. Fish. Aquat. Sci. 62(2):340-346.

Keller, W., Heneberry, J., Leduc,J., Gunn, J.M. and Yan, N. 2006. Variations in epilimnion thickness in small Boreal Shield lakes: relationships with weather, transparency, and acidification. Env. Mon. Asses. In press.

Keller, W., Yan, N.D., Gunn, J.M., and Heneberry, J. 2006. Recovery of acidified lakes: lessons from Sudbury, Ontario, Canada. Water Air Soil Pollut. Under Review.

Lang, C.Y., Chen, Y.-W., Tong, J., Wang, M., and Belzile, N. 2005. Determination of total mercury in porewater of lake sediments: control of interference from dissolved organic carbon and sulfide. Canadian Journal of Analytical Sciences and Spectroscopy, 50, 111-118.

McQueen, D.J., Hyatt, K.D., Rankin, D.P., Ramcharan, C.W. 2005. Lake Fertilization and enhanced growth of juvenile sockeye salmon at Woss Lake, British Columbia: A food web analysis. Can. J. Fish. Aquat. Sci. Submitted.

Miller, K.B., Alarie, Y., Wolfe, G.W. and Whiting, M. F. 2005. Association of adults and larvae of Holometabola using DNA sequences: the larvae of *Philodytes umbrinus* (Motschulsky) (Coleoptera: Dytiscidae). Systematic Entomology 30: 499-509.

Purchase, C.F., Collins, N.C., Morgan, G.E., and B.J.Shuter. 2005. Predicting Life History Traits of Yellow Perch from Environmental Characteristics of Lakes. Trans. Am. Fish. Soc. 134:1369-1381.

Purchase, C.F., Collins, N.C., Morgan, G.E., and B.J. Shuter. 2005. Sex-specific covariation among life-history traits of yellow perch (Perca flavescens). Evolutionary Ecology Research 7: 549-566.

Reynoldson, T.B., Brereton, C.I., Keller, W., and Sarrazin-Delay, C. 2005. Development of a northern Ontario benthic invertebrate reference condition approach (RCA) biomonitoring network to meet metal mining environmental effects monitoring requirements. Phase 1. Technical Report, Cooperative Freshwater Ecology Unit, Sudbury.

Shuter, B.J., Lester, N.P., LaRose, J., Purchase, C.F., Vascotto, K., Morgan, G., Collins, N.C., and Abrams, P.A. 2005. Optimal life histories and food web position: linkages among somatic growth, reproductive investment, and mortality. Can. J. Fish. Aquat. Sci. 62:738-746.

Snucins, E. 2004. Sport Fish in Acidified Ontario Lakes. P. 22, In R.C. Weeber, D.K. McNicol and D.S. Jeffries. (2005). Chapter 7: Recovery of Aquatic Ecosystems. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Strecker, A. and Arnott, S. E. 2005. Interaction of multiple stress agents in boreal lakes: invasion of *Bythotrephes* and acidification. Canadian Journal of Fisheries and Aquatic Sciences. 62: 2450-2462.

St.Louis, V.L., Sharp, M.J., May, A., Barker, J., Kirk, J.L., Kelly, D.J.A., Arnott, S.E., Keatley, B., and Smol, J.P. 2005. Some sources and sinks of monomethyl and inorganic mercury on Ellesmere Island in the Canadian High Arctic. Environmental Science and Technology 39:2686-2701.

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, In press. Final acceptance, December 2005.

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. Submitted.

Weeber, R.C., Bowman, M.F., Brook, R.W., Champoux, L., Keller, W., Kirk, D.A., Legare, S., MacPhee, S., McNicol, D.K., Reid, R.A., Snucins, E., and Somers, K.M. 2005. Invertebrates. P, 29-38, In D. Jeffries, D. McNicol, and R. Weeber (2005). Chapter 6: Effects on Aquatic Chemistry and Biology. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Weeber, R.C., Brook, R.W., Jeffries, D.S., Keller, W., McNicol, D.K., Paterson, A.M., Snucins, E., Somers, K.M., Vinebrooke, R.D., Winter, J.G., and Yan, N.D. 2005. Lakes from Regional Monitoring Programs, Lakes Near Large Point Sources. P. 8-21, In R.C. Weeber , D.S. Jeffries and D.K. McNicol (2005). Chapter 7: Recovery of Aquatic Ecosystems. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Weeber, R.C., Jeffries, D.S., Keller, W., McNicol, D.K., and Turner, M.A.. 2005. Summary. P. 51-55, In R.C. Weeber , D.S. Jeffries, and D.K.McNicol (2005). Chapter 7: Recovery of Aquatic Ecosystems. In *2004 Canadian Acid Deposition Science Assessment,* [CD-ROM]. (2005). Environment Canada.

Witty, L. and Sarrazin-Delay, C. 2006. Illustrated Guide to Northern Ontario Invertebrate Benthos. In prep.

## Invited Presentations

Alarie, Y. 2005. Recognizing Discontinuity in the Continuum: the Core of Insect Systematics. Universidad de Oriente, Santiago de Cuba, May 5th, 2005. Invited Speaker.

Arnott, S. E. 2005. Local and regional determinants of community structure: rebuilding communities following disturbance. Miami University, Zoology Department, Nov. 2005.

Belzile, N., and Chen Y.-W. 2005. The environmental importance of selenium and its protective role against mercury toxicity. Watershed Ecosystems Graduate Program, Trent University, Peterborough, Canada. Invited.

Belzile, N., and Chen, Y.-W. 2005. Methodological approach for studying the cycling of toxic trace elements in sediments. Sichuan University, School of Chemistry, Chengdu, China. Invited.

Belzile, N., Chen, Y.-W., Gunn, J.M., and Alarie, Y. 2005. Toxic trace elements in freshwater aquatic organisms. Chengdu University of Technology, Department of Material, Chemistry and Chemical Engineering, Chengdu, China. Invited.

Belzile, N., Chen, Y.-W., and Gunn, J.M. 2005. Lake sediments as indicators of chemical recovery. Chengdu University of Technology, Department of Material, Chemistry and Chemical Engineering, Chengdu, China. Invited.

Belzile, N., Chen, Y.-W., Gunn, J.M., and Alarie, Y. 2005. Mercury and selenium in aquatic organisms. Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China. Invited.

Belzile, N., Chen, Y.-W., and Gunn, J.M. 2005. Environment contamination and geochemistry of lake sediments. Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China. Invited.

Belzile, N., Chen, Y.-W., and Gunn, J.M. 2005. The use of lake sediments to study environmental contamination and recovery. Guilin University of Technology, Department of Natural Resources and Environmental Engineering, Guilin, China. Invited.

Belzile, N., Chen, Y.-W., Gunn, J.M., and Alarie, Y. 2005. Mutual interaction between trace elements in living organisms. South China University of Technology, Department of Environmental Engineering, Guangzhou, China. Invited.

Belzile, N., Chen, Y.-W., Gunn, J.M., and Alarie, Y. 2005. The protective action of selenium on mercury toxicity. International Academic Meeting on Analytical Technologies for Geological Exploration, Guangdong Material Building Centre, Guangzhou, China. Invited.

Belzile, N., Chen, Y.-W., and Gunn, J.M. 2005. Effects of mining activities and efforts for environmental recovery. International Academic Meeting on Analytical Technologies for Geological Exploration, Guangdong Material Building Centre, Guangzhou, China. Invited.

Belzile, N., Gunn, J.M., and Chen, Y.-W. 2005. Contamination and recovery in a mining environment: the Sudbury case. Pontificia Universidad Catolica de Chile, Hydraulic and Environmental Engineering, Santiago, Chile. Invited.

Belzile, N., Chen, Y.-W., Gunn, J.M., and Alarie, Y. 2005. Selenium and mercury interactions in the aquatic food web. Universidad de Chile, Ecological Sciences, Santiago, Chile. Invited.

Belzile, N., and Chen, Y.-W. 2005. Biogeochemistry of toxic trace elements: analytical and environmental aspects. Universidad de Santiago de Chile, Geographical Engineering, Santiago, Chile. Invited.

Chen, Y.-W., and Belzile, N. 2005. Chemical and photochemical nature of selenium and its speciation for environmental studies. International Academic Meeting on Analytical Technologies for Geological Exploration, Guangdong Material Building Centre, Guangzhou, China. Invited.

Chen, Y.-W., and Belzile, N. 2005. Analytical protocol for the determination and speciation of trace elements in environmental samples. Sichuan University, School of Chemistry, Chengdu, China. Invited.

Chen, Y.-W., and Belzile, N. 2005. Determination and speciation of selenium in environmental samples and geochemical cycling. Chengdu University of Technology, Department of Material, Chemistry and Chemical Engineering, Chengdu, China. Invited.

Chen, Y.-W., and Belzile, N. 2005. Geochemical and photochemical properties of selenium and speciation in environmental samples. Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China. Invited.

Gunn, J.M., and Keller. W. 2005. Recovery of acid damaged lakes in Sudbury, Canada, area. ESA Intercol Joint Meeting. Montreal, Quebec. August 9, 2005.

Gunn, J.M. 2005. History fo Environmental Research in Killarney Park. Air Quality Committee Meeting, International Joint Commission, Killarney Mountain Lodge, Killarney. September 14, 2005.

Gunn, J.M. 2005. Research and monitoring potential for Killarney. Ontario Parks Planning Meeting., “Ecological Integrity”. Killarney Park. October 13, 2005.

## Conference and Workshop Presentations

Alarie, Y., and Miller, K.. 2005. Associating life stages of insects using DNA sequence data: Examples from diving beetles (Coleoptera: Dytiscidae). Annual meeting of the Entomological Society of America, Fort Lauderdale, FL, USA, November 6- 9, 2005.

Alarie, Y. and McAlister, R. 2005. A survey of the biodiversity and seasonal abundance of mosquitoes (Diptera:Culicidae) in the Sudbury region. Ontario Biology Day, Sudbury, On. March 11th-12th, 2005.

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.

Belzile, N., Chen, Y.-W., Delonchamp, T. & Gunn, J.M. 2005. Evidence of selenium antagonism on mercury assimilation in Sudbury lakes food webs. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Belzile, N., Chen, Y.-W., Gunn, J.M., Tong, J., Alarie, Y., Delonchamp, T., and Lang, C.-Y. 2005. Bioaccumulation of selenium and mercury in freshwater aquatic organisms: a protective effect. 40th IUPAC Congress, Beijing, China.

Casselman, J.M., Leggett, W.C., Johnston, T.A., Casselman, S., and Herra, T. 2005. Otolith growth of fishes in relation to thermal requirements, environment, and climate. Oral presentation at Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Chen, Y.-W., Li, L., Belzile, N., and Truong, Y. 2005. Speciation of selenium in environmental samples. 40th IUPAC Congress, Beijing, China.

Derry, A., Arnott, S.E., and Boag, P. 2005. Ecological sorting of zooplankton metapopulations in response to selection from historical and contemporary environmental gradients. Ecological Society of America, Montreal,Que.

Derry, A., Arnott, S.E., and Boag, P. 2005. Disturbance history as a selective force for evolution of acid tolerance: implications for colonization and biological recovery in historically-damaged lakes. Canadian Conference for Fisheries Research (CCFFR) and Canadian Society of Limnology (SCL) meeting in Calgary, January 5-7, 2006.

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.

Forrest, J., and Arnott, S.E. 2005. Changes in local conditions do not influence zooplankton community responses to immigration. Ecological Society of America, Montreal, Que.

Forrest, J., and Arnott, S.E. 2005. Dispersal, nutrient, enrichment, and diversity of a crustacean zooplankton community, Canadian Conference for Fisheries Research, Windsor, ON, Canada, January 6-9, 2005.

Genrich, E. and Gunn, J.M. 2006. Testing the use of benthic macroinvertebrates as an indicator or 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.

Gunn, J.M. 2005. Habitat vs. exploitation experiment revisited. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Gunn, J.M., Greco, C., Vasseur, L., Salazar, C., and Lautenbach, B. 2005. Sudbury: From pollution record holder to a model system for Canada's Sustainable Cities Initiative. International Conference on Acid Deposition, Prague, Czech Republic. June, 2005.

Hatton, E.C., Campbell, L.M., Arnott, S.E. 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, 2006.

Johnston, T.A., Moles, M.D., Schulte-Hostedde, A.I., Herra, T., and Leggett, W.C. 2005. The relationships between body condition indices and the lipid and moisture contents of two freshwater fishes. Oral presentation at Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

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, 2006.

Kaufman, S.D., Gunn, J.M., and Morgan, G.E. 2005. Community based differences in fish activity using muscle enzymes. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

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, 2006.

Keller, W., Yan, N.D., Gunn, J.M., and Heneberry, J. 2005. Recovery of acidified lakes: lessons from Sudbury, Ontario, Canada. International Conference on Acid Deposition. Prague, Czech Republic. June, 2005.

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, 2006.

Lippert, K., Gunn, J.M. and Morgan, G. 2005. Use of Nordic method assessment techniques to evaluate the effects of invasive species on fish communities recovering from acidification. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Moles, M.D., Johnston, T.A., Robinson, B. W., Herra, T., and Leggett, W.C. 2005. Does lipid availability limit reproductive effort in walleye, *Sander vitreus*? Oral presentation at Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Morgan, G.E., Snucins, E., and Gunn, J.M. 2005. Nordic biodiversity assessment method: Applications for climate change and invasive species research. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Ramcharan, C.W., and Hart, D. 2005. Potential effects of the invasion of *Bythotrephes* on planktivorous fish – a food web simulation model. Ontario Exotic Invaders Workshop, Kingston ON. May, 2005.

Ramcharan, C.W., Keller, W., and Yan, N.D. 2005. Effects of herbivore composition on community clearance rates. ASLO Summer Meeting, Santiago de Compostela, Spain. June, 2005.

Ramcharan, C.W., Keller, W., and Yan, N.D. 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, 2006.

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.

Strecker, A., and Arnott, S. E. 2005.Responses of zooplankton community structure and function to an invasive predator in boreal lakes. ASLO Summer Meeting, Santiago de Compostela, Spain. June, 2005.

Strecker, A., and Arnott, S. E. 2005. *Bythotrephes*-induced changes in zooplankton community structure and grazing in boreal lakes. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

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, 2006.

Webster, N., Gunn, J.M., Keller, B., and Ramcharan, C. 2005. Experimental lake mixing: simulating global climate change effects on shield lakes. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

Woods, S., Haslam, L., and Gunn, J. 2005. Bio-logging of core body temperature of lake trout to assess thermal habitat use and climate change effects. Canadian Conference for Fisheries Research and Canadian Society of Limnology (SCL) meeting, Windsor, ON, Canada, January 6-9, 2005.

## Theses Completed

Forrest, J. 2005. Effects of dispersal and disturbance on zooplankton community structure and function. MSc Thesis. Queen's University.

Hessing-Lewis, M. 2005. Assessing the potential for Eelgrass restoration in the Squamish Estuary, British Columbia. MSc Thesis. Queen's University.

Kaufman, S. 2005. Walleye (*Sander vitreus*) and predator/ prey interactions in lakes with and without alternative larger prey, lake herring (*Corogonus artedi*). MSc. Thesis. Department of Biology, Laurentian University.

Mantysaari, Dallas and Vine, Luke. 2005. Increasing colonization of *Hyalella azteca* in Sudbury area lakes; evidence of biological recovery. B.Sc. Honours. Laurentian University.

Stach, Lee, and Bulloch, Jane. Prevalence of alphasynuclein aggregations in the brains of white sucker (*Castostomus commersoni*) from metal contaminated lakes in the Sudbury, Ontario region. B.Sc. Honours. Laurentian University.

Truong, Y. T. H. 2005. Reduction of selenite under controlled conditions. M.Sc. Laurentian University.

Webster, Natalie. Use of a lake mixer to simulate climate change effects on the limnology of a small Boreal Shield lake. B.Sc. Honours. Laurentian University.

Woods, Sarah. Determining the thermal habitat use of lake trout (*Salvelinus namaycush*) using a digital data-logging device. B.Sc. Honours. Laurentian University.

## Research Grants

**Y. Alarie**

- NSERC Research Networks, for COMERN with Nelson Belzile, Yu-Wei Chen, and John Gunn
- NSERC Equipment Grant (with A. Schulte-Hostedde, J. Litzgus, and M. Anand)
- NSERC Operating Grant
- NSERC URSA

**S. Arnott**

- Mountain Equipment Coop, Water quality in Killarney Park lakes
- Ontario Ministry of Natural Resources, An assessment of *Bythotrephes* distribution in Killarney Park
- Ontario Ministry of the Environment, The impact of *Bythotrephes* on lakes recovering from acidification
- NSERC Discovery Grant, The importance of regional and local factors in recovery from environmental stressors

**N. Belzile**

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

**J. Gunn**

- NSERC/Canada Research Chair, Tier 1
- NSERC Collaborative Research and Development Grant (with York University, Inco Ltd., Falconbridge 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)
- 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**

- Inco Limited, Aquatic Restoration Group (ARG) support
- Falconbridge Limited, ARG support
- Ontario Ministry of the Environment, ARG support
- Environment Canada, Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN) support
- 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, Invertebrate Taxonomy Intern

**C. Ramcharan**

- NSERC Discovery Grant, New directions in lake foodwebs
- CFI/OIT, Equipment for foodweb studies in boreal lakes

**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 2005**

Ramsey House:
Elizabeth Bamberger - Business Manager
John Gunn – Canada Research Chair, LU
Tom Johnston - Fisheries Scientist, MNR
Bill Keller – Limnologist, MOE
Karen Oman – Environmental Data Management Intern, NOHFC

Laurentian University Science Building:
Yves Alarie – Biosystematics
Nelson Belzile - Environmental Chemistry
Dave Pearson - Urban Lakes Coordinator
Charles Ramcharan - Aquatic Ecologist
Patricia Rohn- Research Technician

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

Fish House:
Jason Houle - Fisheries Technician
Scott Kaufman – Extension Biologist
Julie Leduc - Data Manager
Mike Malette - Data Manager
George Morgan - Extension Biologist

Bug House:
Kim Fram – Invertebrate Taxonomy Intern, FedNor
Lee Haslam – Senior Fisheries Technician, MNR
Chantal Sarrazin-Delay - Biomonitoring Biologist
Lynne Witty - Invertebrate Taxonomist

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

| | | |
|---|---|---|
| Kelly Lippert | Scott Kaufman | Dallas Linley |
| Sarah Woods | Natalie Webster | Dave Hasek |
| Amanda Valois | Matt Moles | Luke Vine |
| Dallas Mantysaari | Adrianna Hoogenboom | Erika Genrich |
| Yoandri Suarez Megna | Laura Cook | Evan Fairn |
| Beacky Olacke | R. McAlister | Yen Thi Hoang Truong |
| Russell Polack | Cai Mei-Fang | Dan Yang |
| Alison Derry | Angela Strecker | Jessica Forrest |
| Liz Hatton | Margot Hessing-Lewis | Justin Shead |
| Rebecca Milne | Bonnie Matthews | |

Aquatic Science Assessment Surveyors and Fisheries Technologists, HRSDC:

| | | |
|---|---|---|
| Dorothy Robb | Michelin Gosselin | Nikki Boucher |
| Dan Dechaine | Erin MacLachlin | Sam Chretien |
| Dennis Epp | Angele Francoeur | Stephen Spooner |

Field Technicians and Research Assistants:

| | | |
|---|---|---|
| Megan Chute | Michael Nadeau | Vicki Sarkijarvi |
| Joshua Woods | Patrick Barnes | |
| Emily Lemieux | Dhruv Nanda | |
| Paule Cholette | Tom Dwyer | |