Canadian Conference for Fisheries Research
Conférence Canadienne de la Recherche sur les Pêches

Society of Canadian Limnologists
Société Canadienne de limnologie

Society of Wetland Scientists
Société des scientifiques des zones humides

Toronto, 6 - 8 January 2011

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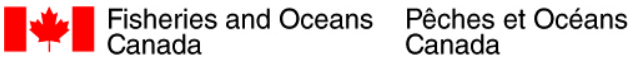

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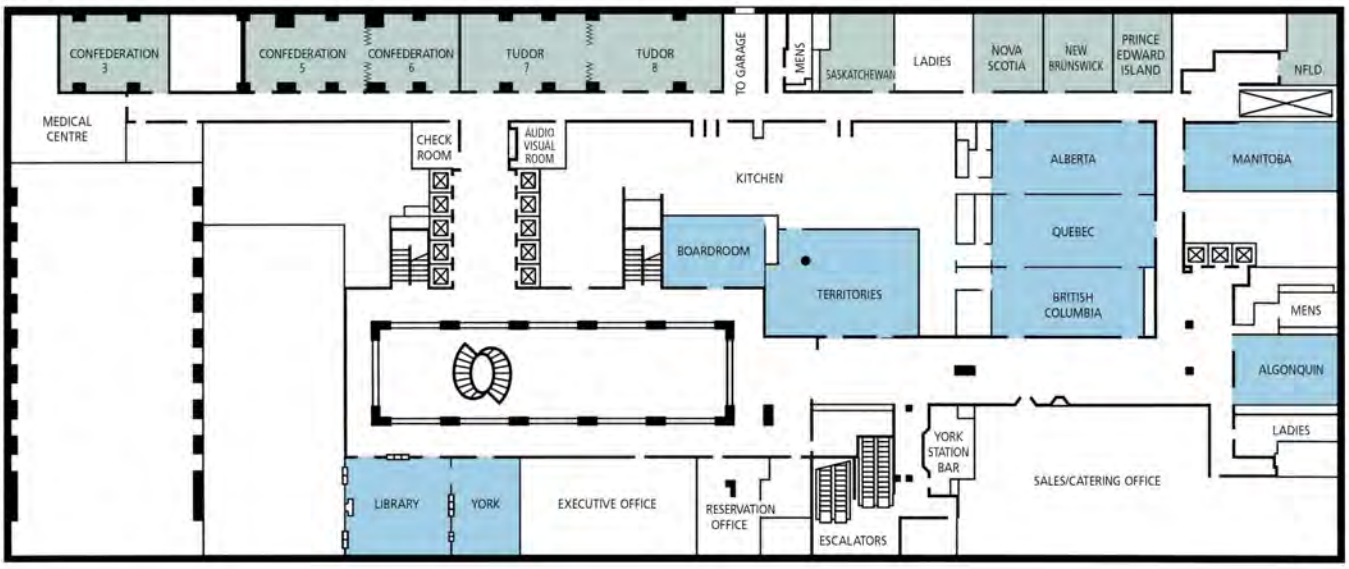
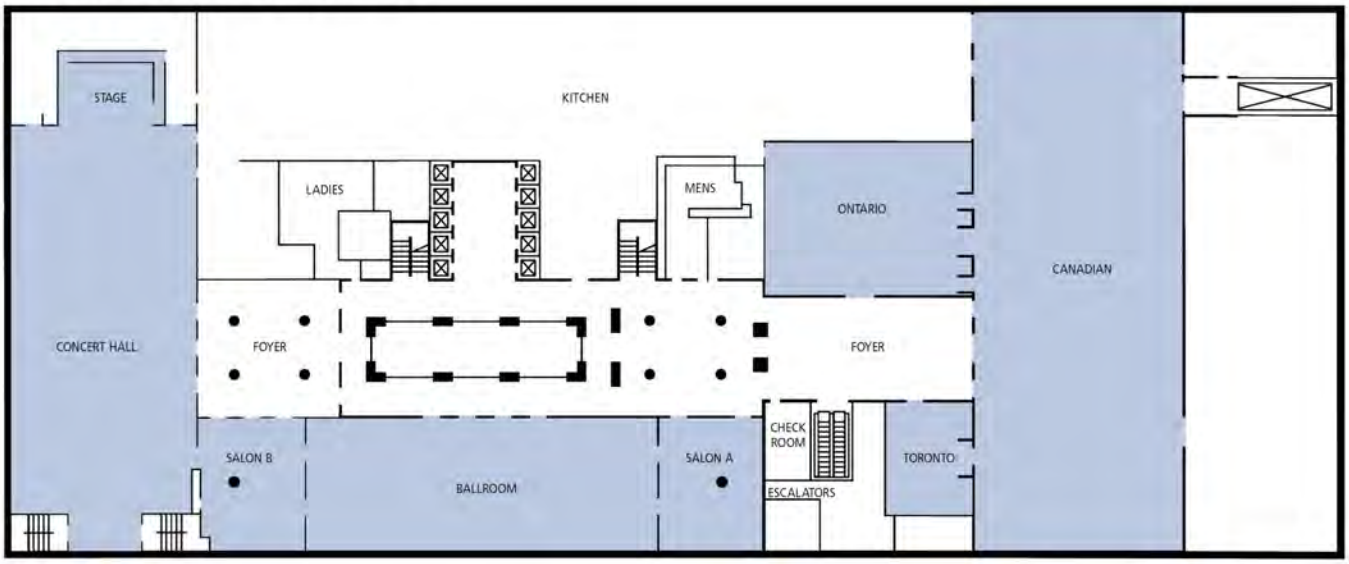
Conference Floor Plans

MAIN MEZZANINE FLOOR

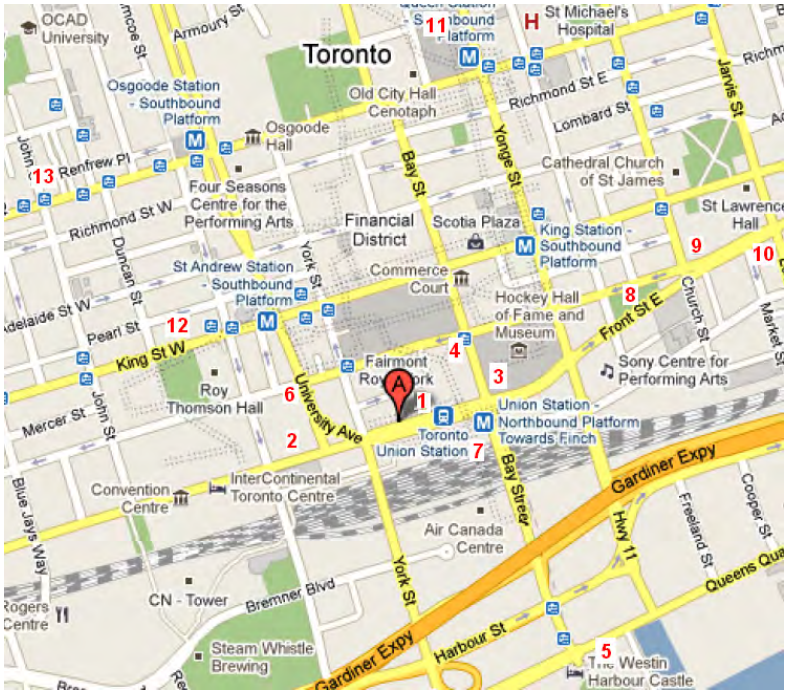


CONVENTION FLOOR



Guide to Restaurants Near the Hotel

There is a wide choice of restaurants, pubs and cafes surrounding and within the Royal York hotel (marked with an A). A few have been listed below, however there are many options not listed here including fast-food outlets in the Union Train Station (7) directly across the street as well as the ubiquitous Toronto hot dog vendors on the street. A wide variety of restaurants can be found east along Front Street (8) including the C'est What brew pub (9) as well the historic St. Lawrence Marker (10). Last, downtown Toronto's largest mall can be found north on Yonge St. at the Eaton Center (11).



Under 10$ per entrée
Croissant Tree [C] (1)
Jugo Juice [C] (1)
Starbucks Coffee [C] (9)
Tim Hortons [C B L] (9)

10 – 15$ per entrée
Spring Rolls [L D E] (1)
Bagel Stop [B L C] (3)
Swiss Chalet Rotisserie [L D] (2)
Purple Pepper Cafe [L D A] (5)
Druxy's Famous Deli [L D] (1)
C'est What [L D P A] (9)

15 – 25$ per entrée
Casey's Bar and Grill [L D A] (1)
Jack Astor's Bar and Grill [L D A] (2)
OverDraught Irish Pub [L D P] (2)
Marche Restaurant [B L D] (4)
Lucas Cafe [L D V A] (6)
Oyshi / Ichiban Sushi [L D E] (5)

25$ and up per entrée
Joe Badali's Ristorante [L D A] (2)
Loose Moose Tap and Grill [L D P A] (2)
The Mizzen [B L D V] (5)

[C] Café; [B] Breakfast; [L] Lunch; [D] Dinner; [P] Pub Food; [A] American Food; [E] Ethnic Food

Toronto Neighbourhoods

Outside of the Financial District and the St. Lawrence Market area surrounding the hotel are many neighbourhoods that each have their own style and even greater variety in restaurants, bars, shopping and entertainment. The enclosed map also indicates the Entertainment District (12) which is home to theaters and the Toronto Symphony Orchestra as well as Queen St. West which is a popular strip for shopping and bars. A small sample of these neighbourhoods includes:

Chinatown – Spadina Ave from Dundas St. to College St.

The length of Spadina from Dundas to College is crowded with Asian groceries, restaurants, malls, and shops. It is a wonderful place to have a hot bowl of Vietnamese soup, BBQ Duck, Dim Sum or stop in the Chinese Bakeries for a bun.

Kensington Market – Augusta Ave, east of Spadina Ave. and College St.

Just east of Chinatown between Dundas and College is a few blocks of vintage clothing shops, fine cheeses and meats, fresh produce, and a wide range of restaurants, bars and cafes. The neighbourhood is bohemian in nature with many shops based out of old Toronto houses. Stop for pie (Wanda's Pie in the Sky), delicious vegetarian food (Urban Herbivore), Spanish tapas (Torito) or a burrito (Big Fat Burrito).

Little Italy – College St. from Bathurst St. to Ossington Ave.

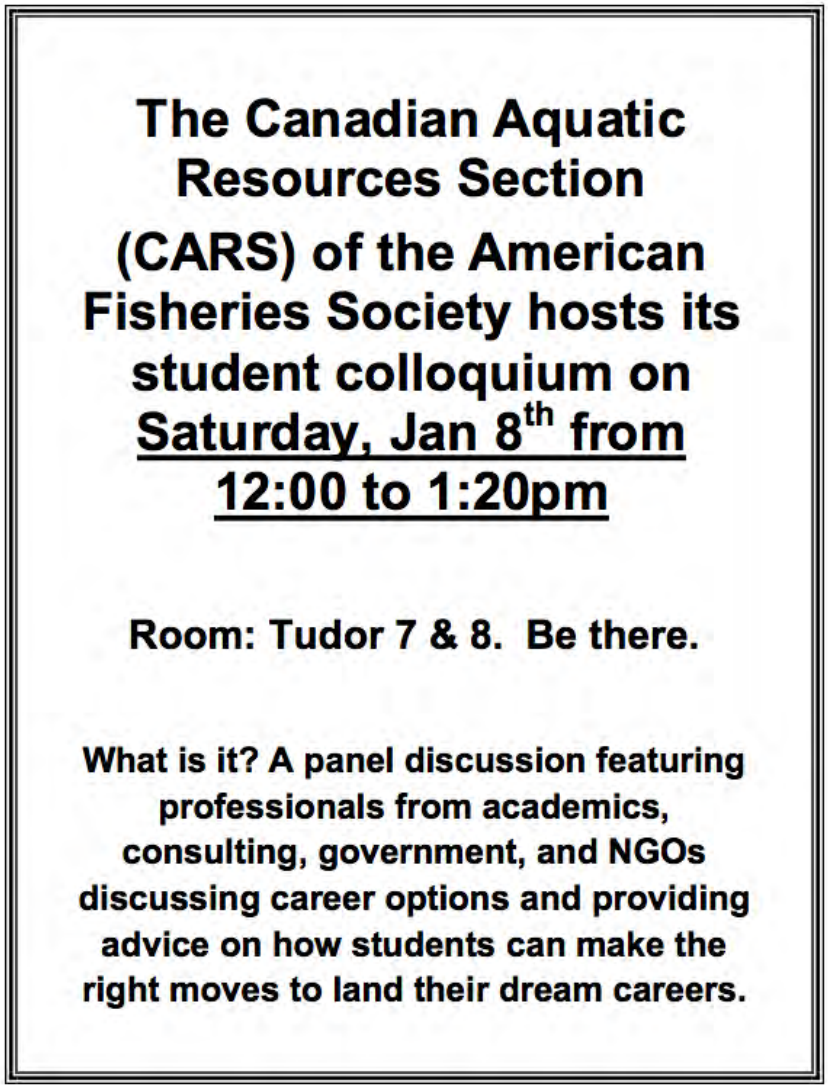
Running along College is a long strip of Italian and Portuguese restaurants, cafes, clubs and bars. A popular evening destination makes it a great place to stroll, people-watch and eat. The historic Cafe Diplomatico is the neighbourhood's Italian version of the main diner where everyone comes for a staple dish on the heated patio.

The Annex – Bloor St. from Spadina Ave. to Grace St.

The Annex is just west of the University of Toronto and combines the university atmosphere with fine restaurants and upscale shopping. This neighbourhood has beautiful old Victorian houses and it is worth strolling off the main street (Bloor or Harbord St.). Some notable restaurants on Harbord near the university including the Harbord House Pub, Loire Fine French Cuisine and Splendido, consistently one of Canada's highest rated restaurants. Along Bloor everything from Lebanese, Sushi, Vegan, Carribean, French, Italian cuisine to Tap and Grills can be found.

These four neighbourhoods are quite close to each other and could provide a comfortable walking tour. Please consult the concierge of the hotel for more information on other neighbourhoods around the city.

Announcements



Credits

Front cover: Netting in Toronto Harbour. Photo credit: Shidan Murphy, Ecology and Evolutionary Biology Department, U. Toronto

CCFFR 2011 Logo (next page): QSQ giclee boutique of Toronto, *www.qsqinc.com*

Back cover (top): Electrofishing on the north shore of Lake Superior. Photo credit: Melissa Robillard, Department of Integrative Biology, U. Guelph.

Back cover (bottom): PIT-tagging (left) and monitoring the movements (antenna; right) of fish in Lake Ontario streams. Photo credit: Rob McLaughlin, Department of Integrative Biology, U. Guelph.

64th Meeting of the

Canadian Conference for Fisheries Research
Conférence Canadienne de la Recherche sur les Pêches

Society of Canadian Limnologists
SCL
Société canadienne de limnologie

and

Society of Wetland Scientists
Société des scientifiques des zones humides

The Fairmont Royal York
Toronto, Ontario
6-8 January 2011

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CCFFR/SCL/SWS/ 2011 Themes

1) Cross Country Checkup: Canadian Capture Fisheries
Évaluation de la situation: Capture des ressources halieutiques au Canada
Rob Stephenson (Robert.Stephenson@dfo-mpo.gc.ca)
Gavin Christie (Gavin.Christie@dfo-mpo.gc.ca)

2) Science and Management of Introduced Aquatic Species
État de la science et gestion des espèces aquatiques non-indigènes
Mike Fox (mfox@trentu.ca)

3) Restoration of Aquatic Habitats and Fishes
Restauration de la faune et des habitats aquatiques
Meg St. John (MStJohn@trca.on.ca)

4) Responses to Environmental Stressors: From Individuals to Ecosystems
Réponses aux agents stressants environnementaux: des individus aux ecosystèmes
Norm Yan (nyan@yorku.ca)
Jim Rusek (Jim.Rusak@ontario.ca)

5) Effects of Energy and Mass Flux on Lake Ecosystems
Flux de masse et d'énergie dans les écosystèmes lacustres
Peter Leavitt (Peter.Leavitt@uregina.ca)

6) Algal Blooms: Incidences and Responses
Les efflorescences algales: fréquences et réponses
Jennifer Winter (Jennifer.Winter@ontario.ca)
Frances Pick (frpick@uOttawa.ca)
David Bird (bird.david@uqam.ca)

7) Effects of Recent Climate Change on Lakes
Effets des changements climatiques contemporains sur les lacs
Andrew Paterson (Andrew.Paterson@ontario.ca)
Jules Blais (Jules.Blais@uottawa.ca)

8) Lake Dynamics in Nearshore Ecosystems
Dynamiques lacustres dans les écosystèmes littoraux
Helene Cyr (helene.cyr@utoronto.ca)
Melissa Coman

9) Wetlands
Les zones humides
Gordon Goldsborough (*ggoldsb@cc.umanitoba.ca*)
Barry Warner (bwarner@sciborg.uwaterloo.ca)

10) General Session
Les sessions de présentations générales

Conference Information

Registration

Registration will be is scheduled for 5:00 – 7:00 PM, Thursday, 6 January, in the Mezzanine Balcony North, 7:00 – 9:00 PM outside the opening reception in the Upper Canada Room (18th floor). On Friday 7 January, it will proceed from 8:00 – 9:00 and 10:30 – 11:30 AM in the Ballroom foyer and from 12:00 noon – 1:20 PM outside the Imperial Room.

Accessing Abstracts

We have broken from tradition this year and provided meeting attendees with a condensed program that does not include the presentation abstracts. A full program with abstracts is available in pdf format from the Program link on the CCFFR website: http://www.phys.ocean.dal.ca/ccffr/. Alternatively, you can access a printed copy of the abstracts, or obtain an electronic copy from a USB key, at the Registration Desk.

Instructions for Oral Presentations: CCFFR-SCL-SWS 2011

1. Presenters will be given a total of 20 minutes: 15 minutes for their presentation and 5 minutes for questions. **This time limit will be strictly enforced.**
2. A laptop computer, an LCD projector, a laser pointer, and (if necessary) a wireless microphone will be provided. Only PowerPoint 2003 (or more recent versions) or pdf formats will be supported.
3. Provide your presentation file on USB key or CD to the A-V assistant **20 minutes prior to the start of your session**.
4. Inform the chair of your session that you are present.

Presenters requiring space for practice can contact the registration desk.

Instructions for Poster Presentations: CCFFR-SCL-SWS 2011

1. Posters must measure no greater than 120 cm x 120 cm. Poster fonts should be of sufficient size to be read from at least 1 metre away (at least 18 pt).
2. Posters must be posted on the board with your Poster No., assigned below in Posters at a Glance
3. Posters will be displayed in the Imperial Room. They can be set up between 6:00 – 10:00 AM on Friday, 7 January. Fastening materials will be provided; the boards are compatible with both Velcro and pins.
4. Formal poster viewing is scheduled from 10:30 AM – 12:00 noon and from 5:30 – 7:30 PM (the Poster Reception), Friday, 7 January. Poster authors are asked to attend their posters at these times. Attendees will be able to view posters informally during coffee breaks and lunches, which will be held in the Imperial Room on Friday and Saturday.
5. Posters **must** be taken down 3:30 – 5:00 PM Saturday, 8 January.

Business Meetings

The annual **CCFFR** Business Meeting will be held from 10:50 AM – 12:00 noon, Friday 7 January, in the Algonquin Room. The annual **SCL** Business Meeting will be held from 10:50 AM – 12:00 noon, Friday 7 January, in the British Columbia Room. The mid-year Business Meeting of the Canadian Aquatic Resources Section of the American Fisheries Society (**CARS**) will be held from 6:30 – 8:00 AM in the York Room. Come and hear what your societies and sections are planning. **Students and PDF's are welcome!**

CARS Student Colloquium

CARS has organized a panel discussion featuring professionals from academia, consulting, government, and NGOs to discuss career options and provide advice on how students can make the right moves to land their dream careers. The Colloquium will be held from 12:00 noon – 1:10 PM in rooms Tudor 7 and 8 on Saturday, 8 January. Lunch will be provided just outside of the room.

Schedule at a Glance

Thursday, 6 January

Time	Event	Location
4:00 – 6:00 PM	CJFAS Editorial Board Meeting	Boardroom
5:00 – 7:00 PM	***Registration***	Mezzanine Balcony North
7:00 – 9:00 PM	Welcome Reception ***and Registration***	Upper Canada Room (18th floor)

Friday, 7 January

Time	Event	Location
6:00 – 10:00 AM	Exhibit and Poster Setup	Imperial Room
8:00 – 9:00 AM	***Registration***	Ballroom Foyer
8:30 – 9:00 AM	Coffee Break (sponsored by NRC Research Press)	Ballroom Foyer
9:00 – 10:30 AM	Plenary Presentations	Ballroom
10:30 – 10:50 AM	Coffee/Tea/Water ***and Registration***	Ballroom Foyer
10:30 AM – 12:00 noon	Poster Viewing, Coffee/Tea/Water	Imperial Room
10:50 AM – 12:00 noon	CCFFR Business Meeting	Algonquin Room
10:50 AM – 12:00 noon	SCL Business Meeting	British Columbia Room
12:00 noon – 1:20 PM	Buffet Lunch (included with registration)	Imperial Room
12:20 – 1:10 PM	SCL Student Meeting	Manitoba Room
1:20 – 5:00 PM	Theme Sessions (with 3 PM break)	Various Session Rooms
5:30 – 7:30 PM	Poster Reception	Imperial Room

Saturday, 8 January

Time	Event	Location
6:30 – 8:00 AM	CARS Mid-Year Meeting	York Room
8:00 AM – 12:00 noon	Theme Sessions (with 10 AM break)	Various Session Rooms
12:00 noon – 1:10 PM	CARS Student Colloquium (includes lunch)	Tudor 7 and 8
12:00 noon – 1:20 PM	Buffet Lunch (included with registration)	Imperial Room
1:20 – 5:00 PM	Theme Sessions (with 3 PM break)	Various Session Rooms
3:30 – 5:00 PM	Remove Posters and Exhibits	Imperial Room

Plenary Abstracts

J.C. Stevenson Memorial Lecture

INVASIVE SPECIES AND ALTERNATIVE GLOBAL FUTURES FOR FRESHWATER ECOSYSTEMS

Julian Olden
School of Aquatic & Fishery Sciences, University of Washington Box 355020, Seattle, WA 98195 USA
(email: olden@uw.edu)

Invasive species stand accused of ecological insubordination, mass murder, and other horrific crimes against nature. Ecologists have reacted by using militaristic terms such as “battle”, “harm”, “destroy”, and “meltdown” when communicating about these species. Although the use of such war metaphors in science is not new and often packs political punch, they have also led to a drastically limited perception of non-native species within society. I argue for a reconsideration of our managerial ethos towards freshwater invasive species with the hope that it encourages a constructive discourse about the undertones of invasion biology: our grief, our challenges, our opportunities and even our hopes. Freshwater ecosystems now contain a species blend of the old and the new; we must decide as a society what our future will look like, where we can control it and where we cannot. Drawing from a rich body of literature and my lab’s research I deploy a futuristic approach to postulate the possible, probable, and preferable alternative global scenarios of freshwater ecosystems in response to biological invasions and the worldviews and myths that underlie them. By capturing the essential elements of this complex issue in a fairly small number of alternative futures, my hope is that society will begin to move toward a common understanding and possible resolution and collective action (or inaction) in response to invasive species in a rapidly changing world.

F.H. Rigler Memorial Award Lecture

SPREAD AND MANAGEMENT OF BIOLOGICAL INVASIONS IN THE GREAT LAKES AND INLAND LAKES

Hugh MacIsaac
Director, Canadian Aquatic Invasive Species Network, Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON, Canada N9B 3P4 (email: hughm@uwindsor.ca)

Introductions of nonindigenous species (NIS) may have profound effects on lake biodiversity, and limit effective management of aquatic resources. Prevention is the most important component of NIS management, particularly for aquatic ecosystems where early detection and rapid response may prove very difficult. Prevention requires that managers identify and quantify risks posed by different vectors that may transmit NIS to aquatic ecosystems. The Great Lakes currently support at least 182 established NIS. Construction of the Welland Canal in 1829, and the lock system between the Saint Lawrence River and Lake Ontario in 1847 and between Lakes Superior and Huron in 1855, facilitated movement of transcontinental ships and their associated NIS throughout the Great Lakes. The modern seaway was opened in 1959 to accommodate larger vessels. Since that time, ballast water carried by international vessels has accounted for at least 55% of the 59 NIS that have been introduced to the system. Sixty-eight percent of these NIS are Eurasian, with strong representation - including invasive zebra and quagga mussels and round gobies - from the Black Sea basin. Development of internal waterways - notably the Danube-Main-Rhine canal - has allowed interbasin dispersal within Europe, strategically placing nuisance NIS in key freshwater ports (e.g. Rotterdam, Antwerp) from which they were subsequently transferred to the Great Lakes. Laws enacted in 1993 and 2006 require ships with fully and partially filled ballast tanks, respectively, to exchange ballast on the open ocean. No new ballast-mediated NIS have been reported in the lakes since 2006, suggesting ballast management has reduced the risk of further invasions. However, resting stages produced by invertebrate species can accumulate in ballast sediments and are not affected by prolonged exposure to salt water; effective management of this sub-vector requires that ships minimize sediment and resting stage accumulation by 'swishing' ocean water through these tanks whenever possible. Hull fouling was previously implicated in at least two invasions of the Great Lakes, and a recent study indicated an apparent risk of further introductions. Work conducted as part of the Canadian Aquatic Invasive Species Network examined exterior surfaces of international vessels operating on the Great Lakes and found only one additional species capable of living in the Great Lakes that was not already present in the system, suggesting risk of further invertebrate invasions via this mechanism is low. An emerging risk pertains to live garden and aquarium trades, which sell species that pose establishment risks. Some of these species, including water hyacinth, hydrilla and water lettuce, could pose significant invasion threats to Canadian waterways under scenarios of climate warming.

Once NIS successfully colonize the Great Lakes, a host of natural and especially human-mediated mechanisms may transfer these species to inland lakes. We have developed a series of models for a number of invaders that explore spread to inland lakes. I will profile two case studies for the spiny waterflea *Bythotrephes longimanus* and zebra mussel *Dreissena polymorpha*. These models may assist in prioritizing management efforts to curtail widespread invasions of inland lakes.

Rob Peters Award Lecture
Saturday, 1:20 PM (Energy and Mass Flux Session, Algonquin Room)

ALTERED DISSOLVED ORGANIC MATTER COMPOSITION IN RIVERS WITH AGRICULTURAL LAND USE

Wilson*, Henry F. [1,2], M. A. Xenopoulos[3], N. Xu[2], D.E. Butman[2], P.A. Raymond[2], J.E. Saiers[2]
[1]Yale Institute for Biospheric Studies, Yale University, New Haven, Connecticut, USA. [2]School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, USA. [3]Biology Department, Trent University, Peterborough, Ontario. (email: henry.wilson@yale.edu)

Dissolved organic matter (DOM) represents an important flux of energy and nutrients from terrestrial to stream systems. Here we examine the influence of agricultural land use on the composition and concentration of DOM in streams of contrasting land use. Watersheds in Ontario with fewer wetlands, increased cropland area, and increased nitrogen loading exhibit altered composition and decreased structural complexity of DOM. A variety of mechanisms may control these watershed patterns. Longitudinal changes in composition and character examined in detail within a single mixed land use watershed indicate that alterations in structure of DOM may relate to increased autochthonous loading of algal DOM over row-crop dominated reaches; however, diurnal patterns observed at a sub-set of additional sites indicate increased heterotrophic activity in cropland dominated streams. Experiments examining the lability of DOM leached from soils under a variety of crop rotations and management systems indicate that DOM from annual-crop dominated systems is initially more humified and less labile than perennial-crop systems. Aqueous incubations of this DOM show that the more humic components of these samples are preferentially microbially degraded. Preliminary results examining the relationship between DOM age (^{14}C) and composition in rivers draining a variety of landscapes within the continental United States indicate that simplified DOM structure may be more strongly related to increased processing (older signature expected) than to algal production (younger signature expected).

Plenary: Friday Morning, 7 January

Room	Ballroom
9:00	**Opening remarks**
9:10	**J.C. Stevenson Memorial Lecture** Invasive species and alternative global futures for freshwater ecosystems – Julian Olden
9:50	**F.H. Rigler Memorial Award Lecture** Spread and Management of Biological Invasions in the Great Lakes and Inland Lakes - Hugh MacIsaac
10:30	**Break – Ballroom Foyer and Imperial Room**
10:50	**Poster Viewing Session – Imperial Room** **CCFFR Business Meeting – Algonquin Room** (**Students/PDF's welcome!**) **SCL Business Meeting – British Columbia Room** (**Students/PDF's welcome!**)
12:00	**Lunch – Imperial Room**
12:20	**SCL Student Meeting – Manitoba Room**

Oral Presentations: Friday Afternoon, 7 January

Room	Alberta	Salon A	BC	Quebec	Algonquin	Manitoba
Session	**Aquatic Habitats and Fishes**	**Wetlands**	**Environmental Stressors**	**Nearshore Ecosystems**	**General**	**General**
1:20	**MOVING A SMALL BOREAL LAKE – THE FIRST THREE YEARS POST-RELOCATION** Connors*, K., Russel, C. and K. Munnock	**FISH UTILIZATION OF SMALL, HYDROLOGICALLY CONNECTED COASTAL MARSHES OF EASTERN GEORGIAN BAY, LAKE HURON** Midwood*, J. and P. Chow-Fraser	**EVALUATING THE IMPACT OF METAL MINING ON BENTHIC ALGAL COMMUNITIES IN ARCTIC RIVERS USING A REFERENCE CONDITION APPROACH: A CASE STUDY IN THE SOUTH NAHANNI RIVER WATERSHED, NWT.** Thomas*, K, R. Hall, G. Scrimgeour, and D. Haggarty	**SALINITY IS IRRELEVANT! "LAKE" DYNAMICS IN NORTHUMBERLAND STRAIT, A MARINE NEAR-SHORE ECOSYSTEM** Hanson* JM.	**EVIDENCE OF DIEL VERTICAL MIGRATION IN LAKE TROUT** Cruz-Font*, L., B.J. Shuter, P.J. Blanchfield	**CONTROLS ON PHYTOPLANKTON BIOMASS IN SUBARTIC LAKES: NUTRIENT LIMITATION AND ZOOPLANKTON GRAZING** Symons*, C.C., S.E. Arnott, and J.N. Sweetman
1:40	**THE CREATION OF A HABITAT BANK IN THE TORONTO REGION** St. John*, M., S. Doka, G. MacPherson, L. Matos,C. K. Minns, R. Portiss, W. Snodgrass, and B. Valere	**RESPONSE OF THE ZOOPLANKTON COMMUNITY TO MICROHABITAT VARIATIONS IN LONG POINT MARSH, LAKE ERIE** Thomasen*, S and Chow-Fraser, P.	**BEHAVIOURAL AND PHYSIOLOGICAL CONSEQUENCES OF A NATURAL STRESSOR: IMPLICATIONS OF NEST PREDATION PRESSURE** Gravel*, M. A., C. D. Suski and S. J. Cooke	**CHARACTERIZING PATTERNS OF NEARSHORE AND WHOLE-LAKE WATER TEMPERATURES IN THE GREAT LAKES** Trumpickas*, J., B.J. Shuter, and C.K. Minns	**EFFECTIVENESS OF PULSE FLOWS TO INDUCE UPSTREAM MOVEMENT OF AN IMPERILED STOCK OF PACIFIC SALMON IN A SHORT REGULATATED RIVER** Hasler*, C., E. Guimond, B. Mossop, S. G. Hinch, and S. J. Cooke	**EMPIRICAL MODELS FOR PREDICTING THE EXCRETION OF NUTRIENTS (N AND P) BY AQUATIC METAZOANS: TAXONOMIC DIFFERENCES IN RATES AND ELEMENT RATIOS** Sereda*, Jeff M, Jeff J. Hudson
2:00	**OTOLITH ISOTOPIC ANALYSIS OF THE AMERICAN EEL (*ANGUILLA ROSTRATA*): ESTIMATING THERMAL HISTORY AND STOCK ORIGIN** Holden*, C.V., J.M. Casselman, T.K. Kyser, and L.A. Marcogliese	**LANDSCAPE-SCALE INFLUENCES ON LEAST BITTERN (*IXOBRYCHUS EXILIS*) HABITAT USE IN SOUTHERN ONTARIO COASTAL MARSHES** Smith-Cartwright*, L., and Chow-Fraser, P.	**EFFECTS OF MULTIPLE STRESSORS ON THE BIOENERGETICS OF LAKE SIMCOE FISHES** Rennie, M.D. and D.O. Evans	**MIXING AND STRATIFICATION IN THE EPILIMNION OF LAKE OPEONGO** Pernica*, P. and Wells, M.	**MIGRATION AND SURVIVAL OF ATLANTIC SALMON (SALMO SALAR) SMOLTS AND KELTS IN THE BAY D'ESPOIR FIORD, SOUTH COAST NEWFOUNDLAND** Robertson*, M.J., J.B. Dempson, C.J. Pennell, G. Furey, M. Bloom, M. Shears, L.M.N. Ollerhead, K.D. Clarke, R. Hinks and G. J. Robertson	**RELATIONSHIPS BETWEEN ZOOPLANKTON COMMUNITY STRUCTURE AND PHOSPHATE TURNOVER TIMES IN LAKE FOODWEBS** Vandergucht*, D.M., Sereda, J.M. and J.J. Hudson
2:20	**THE EFFECTS OF COOL AND VARIABLE TEMPERATURES ON THE SPAWN DATE, GROWTH AND OVER WINTER MORALITY OF A WARMWATER FISH IN SMALL AND CONSTRUCTED COASTAL EMBAYMENTS OF LAKE ONTARIO** Murphy*, S. C., N. C. Collins, S. E. Doka	**THE EFFECTS OF SEASONS AND GRAZING ON THE AMBOSELI WETLANDS, SOUTHERN KENYA** Sarkar*, S., D. Western, and W. D. Taylor	**WHOLE-SYSTEM HABITAT REMOVALS – ARE THEY HARMFUL ALTERATIONS OF FISH HABITAT?** Smokorowski, K.E., Pratt, T.C., Geiling, W.G., and E.R. Timusk*	**THE NEARSHORE SHUNT: THREE DIMENSIONAL MODELING OF DREISSENID MUSSEL EFFECTS IN NEARSHORE AND OFFSHORE WATERS OF LAKE ERIE** Spillman, C.M., M.R. Hipsey, S.A. Bocaniov, A. N. Schwalb, and R.E.H. Smith*	**HYDROLOGIC CORRELATES OF ACTIVITY IN LOTIC BULL TROUT** Taylor*, M.K., C.T. Hasler, C.S. Findlay, B. Lewis, S.G. Hinch, D. Schmidt, and S.J. Cooke[1]	**PHOTOCHEMICAL MINERALIZATION OF DISSOLVED ORGANIC NITROGEN TO AMMONIA IN PRAIRIE LAKES** Hunter, K., J. Sereda, D. Vandergucht and J. Hudson*
2:40	**BEHAVIOUR AND PASSAGE SUCCESS OF UPSTREAM MIGRATING LAKE STURGEON IN A VERTICAL SLOT FISHWAY** Thiem*, J. D., T. R. Binder, P. Dumont, D. Hatin, J. W. Dawson, C. Katopodis and S. J. Cooke	**USE OF ECOLOGICAL INDICATORS TO ASSESS THE QUALITY OF GREAT LAKES COASTAL WETLANDS** Cvetkovic*, M., and Chow-Fraser, P.	**INTRAINDIVIDUAL REPEATABILITY OF THE ACUTE STRESS RESPONSE IN BLUEGILL SUNFISH (*LEPOMIS MACROCHIRUS)* AND ITS LINKS WITH INDIVIDUAL CONDITION** Cook*, K.V., C.M. O'Connor, S.H. McConnachie, K.M. Gilmour, and S. J. Cooke	**TURBULENCE AND TEMPERATURE VARIABILITY IN THE NEAR SHORE BENTHIC BOUNDARY LAYER OF LAKE OPEONGO** Coman*, M. and M. Wells	**ROSEWAY BASIN RIGHT WHALE CRITICAL HABITAT: SPACE-TIME VARIATION IN THE PREY-FIELD AND ASSOCIATED WATER MASSES** Davies*, K., C. T. Taggart and K. Smedbol	**DISSOLVED ORGANIC P IN EPLIMENTIC WATER: FACT OR ARTIFACT?** Taylor*, W.D. and D.R.S. Lean
3:00	**Break – Imperial Room**					

Oral Presentations: Friday Afternoon, 7 January

Room	Alberta	Salon A	BC	Quebec	Algonquin	Manitoba
Session	**Aquatic Habitats and Fishes**	**Wetlands**	**Environmental Stressors**	**Nearshore Ecosystems**	**General**	**General**
3:20	**RISK ASSESSMENT OF FISH PASSAGE OPTIONS FOR THE DAM ON THE BLACK STURGEON RIVER** Smyth*, E., R. McLaughlin, and M. Koops	**PREDICTING THE EFFECT OF WATER LEVEL DECLINE ON CONNECTIVITY OF COASTAL WETLANDS IN EASTERN GEORGIAN BAY, LAKE HURON** Fracz*, A and Chow-Fraser, P.	**NEW CURRENTS IN MARINE-DERIVED NUTRIENTS DELIVERED TO ATLANTIC RIVERS: TRACKING INCORPORATION WITHIN STREAMS** Samways*, K. M., R.A. Cunjak, and B.S. Graham	**ERODIBILITY AND TRANSPORT BEHAVIOR OF DREISSENID MUSSEL DEPOSITS IN THE NEARSHORE ZONE** McLean*, K., Stone, M., Smith, R., and Droppo, I.	**FINE SCALE POPULATION STRUCTURE AND DISPERSAL OF JUVENILE STEELHEAD IN THE BULKLEY RIVER, BRITISH COLUMBIA** Wellband*, K.W., Atagi, D., Koehler, R. and D.D. Heath.	**SAMPLING NON-WADEABLE RIVERS IN SOUTHERN ONTARIO WITH A SMALL BENTHIC TRAWL: WHAT HAVE WE BEEN MISSING?** Barnucz*, J. and N.E. Mandrak
3:40	**DIFFERENCES IN ANTIPREDATOR BEHAVIOUR BETWEEN WILD AND HATCHERY-REARED JUVENILE ATLANTIC SALMON** Jackson*, C.D. and G.E. Brown.	**CARP AND CULVERTS: PREPARING TO RESTORE DELTA MARSH, ONE OF THE LARGEST COASTAL WETLANDS IN NORTH AMERICA** Goldsborough*, L. G., Wrubleski, D. A. and Ball, G.	**GENETIC STRUCTURE AND GENE FLOW AMONG POPULATIONS OF THE THREATENED EASTERN SAND DARTER (*AMMOCRYPTA PELLUCIDA*) IN TWO CANADIAN RIVERS** Ginson*, R, A. Kagabo, R. Walter, N.E. Mandrak, C. Beneteau, and D. D. Heath	**PHYSICAL FORCES AFFECT NUTRIENT LIMITATION OF PHYTOPLANKTON IN NEARSHORE AREAS OF LAKES** Cyr*, H.	**NATURAL AND HUMAN-MEDIATED GENE FLOW AMONG ONTARIO'S INLAND LAKE POPULATIONS OF WALLEYE (*SANDER VITREUS*)** Walter*, R.P., C.J. Cena, G.E. Morgan, and D.D. Heath.	**10 YEARS OF MONITORING: STREAM AND RIVER FISH BIODIVERSITY AND URBANIZATION WITHIN 9 WATERSHEDS ACROSS THE TORONTO REGION** Moryk*. J, and S. Jarvie
4:00	**THE PREDATOR RECOGNTION CONTINUUM: NEOPHOBIC RESPONSE TO NOVEL CHEMICAL CUES IN TRINIDADIAN GUPPIES** Brown*, G.E. and Elvidge, C.K.	**THE ONTARIO REPTILE AND AMPHIBIAN ATLAS** Carabetta*, M., J. Urquhart	**THE EFFECTS OF TURBIDITY ON THE BEHAVIOUR AND PHYSIOLOGY OF ENDANGERED PUGNOSE SHINER (*NOTROPIS ANOGENUS*) AND CONGENERS** Gray*, S. M., F. M. E. Bieber, L. J. Chapman, N. E. Mandrak	**EFFECTS OF WATER CURRENTS AND SMALL-SCALE MIXING ON SPATIAL ZOOPLANKTON DISTRIBUTIONS IN THE NEAR SHORE OF A LAKE** Sprules*, W.G., P. Pernica, M. Coman and M. Wells	**DISTRIBUTION AND GENETIC DIFFERENTIATION OF HYBRIDIZING BLUE MUSSELS (*MYTILUS*) IN THE CANADIAN ATLANTIC PROVINCES** Shields* JL, E Kenchington, DD Heath	**LONG TERM MONITORING OF LAKE TROUT IN LAKE SIMCOE: DYNAMICS OF STOCKED AND NATURAL POPULATIONS** Dolson*, R., and La Rose, J., A.
4:20	**INCORPORATING LAKES WITHIN THE RIVER DISCONTINUUM: LONGITUDINAL CHANGES IN ECOLOGICAL CHARACTERISTICS IN STREAM–LAKE NETWORKS** Jones*, N. E.	**USING A HIGH-RESOLUTION ACOUSTIC CAMERA (DIDSON) TO ESTIMATE FISH ABUNDANCE AND MOVEMENT IN A LAKE ERIE COASTAL WETLAND** Kowalski, K. P.	**SLOW BUT NOT STEADY: *IN SITU* CONTAMINANT EXPOSURE AND ALTERED BEHAVIOUR IN ROUND GOBIES** Marentette*, J.R., S.K. Tong, G. Wang, M. Taves, N. Sopinka, S. Balshine	**FISH DISTRIBUTION IN THE LITTORAL ZONE OF LAKES: COULD DAILY VARIATION IN WIND DIRECTION CONTRIBUTE TO EXPLAIN HABITAT USE?** Bermingham*, T., D. Boisclair, and S.Gauthier	**SUPPLEMENTAL STOCKING OF BROOK TROUT (*SALVELINUS FONTINALIS*) IN ALGONQUIN PARK: IMPACT ON GENETIC STRUCTURE OF WILD POPULATIONS** Alshamlih*, M., Wilson, C.	**ONTARIO'S BROAD-SCALE LAKES MONITORING PROGRAM: DESIGN AND INITIAL RESULTS** Amos*, J., S. Sandstrom, K. Armstrong, H. Ball and N. Lester
4:40	**A REVIEW OF ADVANCES IN AQUATIC ECOSYSTEM CLASSIFICATION: HOW SHOULD ONTARIO PROCEED?** Melles*, S.J., Jones, N. and B. Schmidt	**RELATIONS BETWEEN GREAT LAKES WATER LEVELS AND WETLAND PLANT COMMUNITIES** Wilcox*, DA	**TEMPORAL TRENDS IN MERCURY CONCENTRATIONS OF LARGE-BODIED FISHES IN NORTHERN ONTARIO LAKES** Tang*, R.W.K., Johnston, T.A., Gunn, J.M.	**QUANTIFYING SIZE AND SHAPE OF LAKES – ADVANCES IN, AND COMPARISONS OF APPROACHES** Kim*, J.-W. and D.A. Jackson	**MOLECULAR PHYLOGENY OF THE FAMILY LEPISOSTEIDAE** Glass*, W.R., L.D. Corkum and N.E. Mandrak	**EXTINCTION DEBT AND LAND-USE LEGACIES: PAYING THE PIPER FOR ANTHROPOGENIC IMPACTS TO FRESHWATER FISHES** Poos*, M., M. Koops, and J.M.R. Curtis
5:30	**Poster Reception: Viewing and Dinner Planning – Imperial Room**					

Oral Presentations: Saturday Morning, 8 January

6:30	**CARS Mid-Year Meeting – York Room**					
Room	**Alberta**	**BC**	**Manitoba**	**Algonquin**	**Library Room**	**Quebec**
Session	**Introduced Aquatic Species**	**Capture Fisheries**	**Environmental Stressors**	**Algal Blooms**	**General**	**Climate Change**
8:00	**FISH INVASIONS IN THE MID-ATLANTIC REGION OF THE UNITED STATES** Lapointe*, N. W. R.	**OVERVIEW OF THE NSERC CANADIAN CAPTURE FISHERIES RESEARCH NETWORK** Stephenson*, Robert L.	**IMPACTS OF CALCIUM DECLINE ON DAPHNIID ASSEMBLAGES OF STRATIFIED AND UNSTRATIFIED ONTARIO LAKES** Cairns*, A. and N. D. Yan	**ALGAL BLOOMS IN ONTARIO LAKES: REPORTS SINCE 1994** Winter*, J.G., A.M. DeSellas, R. Fletcher, L. Heintsch, A. Morley, L. Nakamoto and K. Utsumi.	**SPERM COMPETITION AND ALTERNATIVE REPRODUCTIVE TACTICS IN CHINOOK SALMON** Flannery, E., D. Heath, T. Pitcher*	**INTER-ANNUAL VARIABILITY IN ICE BREAK-UP DATES BETWEEN 1900 AND 2004 IN LAKE MENDOTA, WISCONSIN** Sharma*, S., Magnuson, J.J. and Carpenter, S.C.
8:20	**RANGE EXPANSION BY INVASION: GENETIC CHARACTERIZATION OF INVASION OF THE GREENSIDE DARTER AT THE NORTHERN EDGE OF ITS DISTRIBUTION** Heath*, D.D., C.L. Beneteau, R.P. Walter, and N.E. Mandrak.	**THE DECISION ANALYSIS AND ADAPTIVE MANAGEMENT (DAAM) PROJECTS: EVOLUTION OF A FISHING INDUSTRY/ACADEMIC PARTNERSHIP** Reid, K., Meisenheimer, P.J.R.*, Jiao, Y. and T. Nudds*	**CONNECTING LAKE CALCIUM DECLINE TO CLIMATE VARIABILITY: FUTURE CALCIUM TRENDS PREDICTING FOR RED CHALK LAKE** Yao*, H., C. McConnell, R. Ingram, A. Paterson, C. Jones, J. Rusak and K. Somers	**SPATIO-TEMPORAL DISTRIBUTION IN CYANOBACTERIA RECRUITMENT, GROWTH AND BLOOMS IN A OLIGO-MESOTROPHIC LAKE** Hrivnakova*, Z.; Planas, D.; Juneau, P. et Jourdain, M.	**SPERM TRAITS IN WILD AND FARMED CHINOOK SALMON** Lehnert*, S., D.D. Heath, and T.E. Pitcher	**THE THERMOCLINE INDUCED MIXING EXPERIMENT (TIMEX): A CLIMATE CHANGE EXPERIMENT** Gunn*, J.M., B.E. Beisner, A. Cantin, Y.T. Prairie, M. Amyot, J. Chetelat
8:40	**FIGHTERS, NOT LOVERS? INVASION FRONT ROUND GOBY** Groen, M. N. Sopinka, J. Marentette, A. Reddon, J. Brownscombe, M. Fox, and S. Balshine*	**CONSIDERATION OF UNCERTAINTY IN THE DESIGN AND USE OF HARVEST CONTROL RULES** Jiao, Y., Reid*, K. and T. Nudds	**INVESTIGATIONS INTO THE EFFECTS OF DECLINING CALCIUM ON FRESHWATER CRAYFISH AND POTENTIAL INTERACTIONS WITH MULTIPLE ADDITIONAL STRESSORS** Edwards*, Brie A., Donald A. Jackson, Keith M. Somers, and Vern R.E. Lewis	**RESPONSE OF ALGAL COMMUNITIES IN LAKES 277 AND 442 TO ADDITIONS OF PHOSPHORUS, NITROGEN AND IRON** McCabe*, S.K., and L. Molot	**MALE MATE CHOICE REINFORCES NATURAL SELECTION FOR MHC NUCLEOTIDE DIVERGENCE IN TWO POPULATIONS OF CHINOOK SALMON** Neff*, B.D., Evans, M.L. and D.D. Heath	**INTER- AND INTRA-ANNUAL VARIABILITY IN LAKE THERMAL STRUCTURE AND CRUSTACEAN ZOOPLANKTON COMMUNITIES** MacPhee*, S., S.E. Arnott and B. Keller
9:00	**THE RATE OF SPREAD AND RELATIVE PREDATION RATES OF ROUND GOBY IN THE TRENT SEVERN WATERWAY** Brownscombe*, J.W. and Fox, M.G.	**SPATIAL-TEMPORAL ANALYSIS OF A COMMERCIAL FISH SPECIES** Posluns*, E., P. Winger, and R. Gillespie	**CRUSTACEAN ZOOPLANKTON SEDIMENTARY ASSEMBLAGES FROM LOW CALCIUM LAKES OF THE EXPERIMENTAL LAKES AREA** Jeziorski*, A. Paterson, A. M., Cumming, B. F., and J. P. Smol	**IRON-CONTROL OF ALGAL BLOOMS IN A FRESHWATER LAKE** Orihel*, D., R. Vinebrooke, L. Wilson, and D. Schindler	**MATE CHOICE AND SEXUAL CONFLICT AFFECT GENETIC COMPATIBILITY AT IMMUNE GENES IN CHINOOK SALMON** Garner*, S.R., Bortoluzzi, R.N., Heath, D.D. and B.D. Neff	**USING AN EMPIRICAL MODEL OF LAKE TEMPERATURE PROFILES DURING STRATIFICATION TO ASSESS THE IMPACT OF CLIMATE WARMING ON HABITAT FOR FISH** Minns*, C.K., B.S. Shuter, and A. Polakowska
9:20	**MODELING THE ESTABLISHMENT OF INVASIVE SPEICES: HABITAT AND BIOTIC INTERACTIONS INFLUENCING THE ESTABLISHMENT OF *BYTHOTREPHES LONGIMANUS*** Wang*, L. and D. A. Jackson.	**ACCOUNTING FOR POPULATION SPATIAL HETEROGENEITY IN STOCK ASSESSMENTS: APPLICATION TO LAKE ERIE WALLEYE *SANDER VITREUS*** Berger*, A.M. M.L. Jones, Y. Zhao, and J.R. Bence.	**DAPHNIID GROWTH ALTERED BY THE INTERACTION OF LOW CALCIUM AND PREDATOR KAIROMONE STRESS** Linley*, R.D.; Riessen, H.P. , Altshuler, I. and Yan, N.D.	**REMOTE SENSING OF THE HARMFUL ALGAE *ALEXANDRIUM FUNDYENSE* IN THE BAY OF FUNDY, CANADA** Forget*, M.-H., E. Devred, S. Sathyendranath, T. Platt, E. Horne, J. Martin, T. Losier, L. Delaney, P. Smith	**THE EFFECT OF MAYFLY (*HEXAGENIA* SPP.) BURROWING ACTIVITY ON EGG HATCHING AND SUBSEQUENT NYMPH DEVELOPMENT** Green*, E., Ciborowski, J.J.H. and L.D. Corkum	**NUTRIENT AND TEMPERATURE: SYNERGISTIC DRIVERS OF CONTEMPORARY CYANOBACTERIA DYNAMICS** Taranu*, Z., Zurawell, R., Pick, F. and I. Gregory-Eaves
9:40	**BUILDING A COMPREHENSIVE DATA SET OF THE DISTRIBUTION OF DREISSENID MUSSELS AND SPINY WATER FLEA (*BYTHOTREPHES LONGIMANUS*) IN ONTARIO** Brinsmead*, J., MacDonald, F. and P. Shaw	**SPATIAL DYNAMICS IN FISHERIES STOCK ASSESSMENT** Truesdell*, S., D. Hart and Y. Chen	**FUTURE CALCIUM DECLINES WILL NOT STOP THE SPREAD OF THE INVASIVE SPINY WATER FLEA *BYTHOTREPHES* ACROSS THE CANADIAN SHIELD** Kim*, N., Walseng, B., and N.D. Yan	**DEGRADATION OF PARTICULATE AND DISSOLVED MICROCYSTIN-LA FROM A SENESCING *MICROCYSTIS* BLOOM *IN VITRO* AND *IN SITU*** Zastepa*, A., Pick, F., Blais, J.	**ENVIRONMENTAL, PREDATION, AND SPATIAL PREDICTORS OF CLADOCERAN COMMUNITIES FROM 50 LAKES IN NORTHWESTERN ONTARIO** Kurek*, J., Weeber, R.C. and J.P. Smol	**ALGAL BIOMASS RESPONSE TO RECENT WARMING IN THE LAKE OF THE WOODS, ONTARIO** Paterson*, A.M., Rühland, K.M., Hyatt, C.V., Michelutti, N., and Smol, J.P.
10:00	**Break – Imperial Room**					

Oral Presentations: Saturday Morning, 8 January

Room	Alberta	BC	Manitoba	Algonquin	Library Room	Quebec
Session	**Introduced Aquatic Species**	**Capture Fisheries**	**Environmental Stressors**	**Algal Blooms**	**General**	**Climate Change**
10:20	**IDENTIFYING HIGH RISK AREAS FOR ESTABLISHMENT OF ASIAN CARPS IN THE GREAT LAKES: A BIOENERGETICS AND FOOD WEB APPROACH** Currie*, W.J.S., M.A. Koops, N.E. Mandrak and B. Cudmore	**INCORPORATING AN ECOSYSTEM APPROACH INTO THE ASSESSMENT AND MANAGEMENT OF NORTHERN DOLLY VARDEN CHAR STOCKS** Howland*, K., C. Gallagher, N. Mochnacz, M.J. Roux, S.Sandstrom, R.Tallman and J. Reist	**ANOMALOUS ALGAL BLOOMS RELATED TO CHANGES IN GRAZING PRESSURE CAN BE LINKED TO LAKE-WATER CALCIUM DECLINE IN KING'S COUNTY, NOVA SCOTIA** Korosi*, J.B., Burke, S., Thienpont, J.R., and J.P. Smol	**DAILY CYANOBACTERIAL DYNAMICS IN THREE EUTROPHIC RECREATIONAL LAKES AND THEIR CORRELATION WITH WEATHER** Bird*, D.F.	**ADAPTIVE TRADEOFFS IN GROWTH AND METABOLISM BETWEEN JUVENILE COHO AND STEELHEAD** Van Leeuwen, T.E., Rosenfeld*, J.S., and Richards, J.G.	**ABRUPT CHANGES IN HUDSON BAY LOWLAND LAKES, NORTHERN ONTARIO: WARMING-RELATED SIGNALS FROM DIATOMS AND OTHER PALEOINDICATORS** Rühland*, K.M., Paterson, A.M., Keller, W., Michelutti, N., and Smol, J.P.
10:40	**PHENOTYPIC PLASTICITY AND MORPHOLOGICAL DIFFERENTIATION IN NATIVE AND NON-NATIVE PUMPKINSEED UNDER VARYING WATER VELOCITIES** Yavno*, S. and M.G. Fox	**BEHAVIOURAL INTERACTIONS BETWEEN FLATFISH AND COMMERCIAL GROUND GEAR ON THE NEWFOUNDLAND GRAND BANK** Underwood*, Melanie J., Paul D. Winger, George Legge, and Stephen J. Walsh	**EVIDENCE FOR THE LOSS OF CALCIPHILIC DAPHNIA SPECIES IN ONTARIO SHIELD LAKES ASSOCIATED WITH CA DECLINE OF LAKE WATERS** Yan*, N.D., A. Cairns, M.E. Palmer, J.A. Rusak, A. Jeziorski, B. Keller, and A. Paterson	**CAN WE PREDICT THE OCCURRENCE OF NUISANCE ALGAL BLOOMS BASED ON WATERSHED AND LIMNOLOGICAL FEATURES OF LAKES AND RIVERS?** Vis*, Chantal	**USING LIFE HISTORY TO PREDICT THE SENSITIVITY OF FRESHWATER UNIONID MUSSEL POPULATIONS TO HUMAN INDUCED PERTURBATIONS** Young*, J.A.M., M.A. Koops and T.J. Morris	**MARKED CHANGES IN SCALED CHRYSOPHYTE ASSEBLAGES IN SIX BOREAL LAKES, NORTHWESTERN ONTARIO, SINCE PRE-INDUSTRIAL TIMES** Flear*, K., Wiltse, B., Paterson, A.M., and Cumming, B.F.
11:00	**PREDICTED REPRODUCTIVE RESPONSES AND SUBSEQUENT DISPERSAL OF INTRODUCED PUMPKINSEED *LEPOMIS GIBBOSUS* UNDER CONDITIONS OF CLIMATE CHANGE IN ENGLAND** Zięba*, G., M. G. Fox, L. Vilizzi & G. H. Copp	**OCCURENCE AND MITIGATION OF FRESHWATER TURTLE BYCATCH IN INLAND COMMERCIAL HOOP NET FISHERIES** Larocque*, S.M., S.J Cooke, and G. Blouin-Demers	**DETECTION OF TEMPORAL TRENDS OF ALPHA AND GAMMA CHLORDANES IN LAKE ERIE FISH COMMUNITIES USING DYNAMIC LINEAR MODELING** Azim*, E., M. Letchumanan, A. Rayesh, Y. Shimoda, S. Sadraddini, G. Arhonditsis, Satyendra Bhavsar	**THE DEEP ALGAL BLOOM: SEASONAL EVOLUTION AND PRODUCTION OF DEEP CHLOROPHYLL MAXIMA IN THE LAURENTIAN GREAT LAKES** Silsbe*, G., R. Hecky, S. Guildford, and R. Smith	**BIOLOGICAL SIGNIFICANCE OF THERMAL REFUGIA FOR JUVENILE ATLANTIC SALMON DURING EXTREME HEAT EVENTS IN THE MIRAMICHI RIVER** Cunjak*, R., Fitzgerald, M. & Linnansaari, T.	**PHYTOPLANKTON SENSITIVITY TO ULTRAVIOLET RADIATION VARIES AMONG CLEAR AND BROWN-WATER CANADIAN SHIELD LAKES** Harrison*, J.W. and Smith, R.E.H.
11:20	**ASSESSING THE POTENTIAL RISKS OF FERAL, NON-NATIVE FATHEAD MINNOW *PIMEPHALES PROMELAS* IN EUROPE UNDER CURRENT AND FUTURE PREDICTED CLIMATIC CONDITIONS** Godard, M. J., J. R. Britton, G. Zięba, G. Davies & G. H. Copp	**POTENTIAL FACTORS INFLUENCING LAKE TROUT CATCHABILITY IN THE LAKE WHITEFISH GILL-NET FISHERY ON LAKE HURON** Langseth*, B., A. Cottrill, and M.L. Jones	**THE INTERPLAY BETWEEN LOCAL ENVIRONMENTAL CONDITIONS AND ALLEE EFFECTS IN DETERMINING THE POPULATION GROWTH AND ESTABLISHMENT OF A ZOOPLANKTON SPECIES IMPACTED BY A REGIONAL STRESSOR** Gray, D.K. and S.E. Arnott.	**HARMFUL BLOOMS IN RECOVERING SYSTEMS: ARE OUR MANAGEMENT MODELS MISSING THE TARGETS? BAY OF QUINTE REVISITED** Watson*, S. B.	**A YEAR IN THE LIFE OF *LOTA LOTA*: SEASONAL VARIATION IN CATCH AND REPRODUCTIVE DEVELOPMENT OF BURBOT IN A BOREAL LAKE** Cott*, P. A., T. A. Johnston and J. M. Gunn	**AUTUMN WATER VELOCITY DISTURBANCE THRESHOLD DETERMINES CHANGE IN BENTHIC MAROINVERTEBRATE COMMUNITY STURCUTRE** White*, M. S., C. L. Sarrazin-Delay and W. Keller.
11:40	**INFLUENCE OF THE EXOTIC PREDATORY CLADOCERAN *BYTHOTREPHES LONGIMANUS* ON THE VERTICAL DISTRIBUTION OF ZOOPLANKTON PREY IN INLAND LAKES OF THE CANADIAN SHIELD** Jokela*, A., Arnott, S.E. and Beisner, B.	**SELECTIVE PROPERTIES OF TRAPS FITTED WITH PLASTIC BARRIERS IN THE SOUTHWESTERN GULF OF ST. LAWRENCE SNOW CRAB (*CHIONOECETES OPILIO*) FISHERY** Grant, S. M., W. Hiscock, and R. Sullivan	**CARBON DYNAMICS AND FOOD WEB STRUCTURE IN OIL SANDS RECLAIMED WETLANDS** Kovalenko*, K.E., Ciborowski, J.J.H., Daly, C., Dixon, D.G., Farwell, A.J., Foote, A.L., Frederick, K.R., Gardner Costa, J.M., Hornung, J.P., Kennedy, K., Liber, K., Roy, M.C., Slama, C.A., Smits, J.E.G., Wytrykush, C.M.		**EVALUATION OF THE BEHAVIOUR, PHYSIOLOGY AND SURVIVAL OF MUSKELLUNGE THAT ARE CAPTURED AND RELEASED BY SPECIALIZED ANGLERS** Landsman*, S. L., H. Wachelka, C. D. Suski, and S. J. Cooke	**CLIMATE CHANGE MODULATES STRUCTURAL AND FUNCTIONAL LAKE ECOSYSTEM RESPONSES TO INTRODUCED ANADROMOUS SALMON** Selbie*, D. T., J. N. Sweetman, P. Etherton, K. D. Hyatt, D. P. Rankin, B. P. Finney, and J.P. Smol
12:00	**Lunch – Imperial Room** **CARS Student Colloquium (including lunch service) -- Tudor 7 & 8**					

Oral Presentations: Saturday Afternoon, 8 January

Room	Alberta	BC	Manitoba	Algonquin	Library Room	Quebec
Session	**Introduced Aquatic Species**	**Capture Fisheries**	**Environmental Stressors**	**Energy and Mass Flux**	**General**	**Climate Change**
1:20	**DOES FISH COMMUNITY COMPOSITION INFLUENCE THE ESTABLISHMENT OF INTRODUCED SPECIES IN ONTARIO LAKES?** Alofs*, K. M. and D. A. Jackson.	**VALIDATION OF REFLEX ACTION MORTALITY PREDICTORS FOR USE BY STAKEHOLDERS TO MANAGE BYCATCH MORTALITY: ENDANGERED INTERIOR FRASER COHO SALMON BYCATCH IN BEACH SEINES** Raby*, G.D., M.R. Donaldson, S.G. Hinch et al.	**SPECIES TURNOVER OF DAPHNIA IN LAKES OF CENTRAL ONTARIO** Lemmen*, K. D., D.K. Gray and S. E. Arnott	**ALTERED DISSOLVED ORGANIC MATTER COMPOSITION IN RIVERS WITH AGRICULTURAL LAND USE** Wilson*, H.F., M. A. Xenopoulos, N. Xu, D.E. Butman, P.A. Raymond, J.E. Saiers **Rob Peters Award Lecture**	**HOW IS THE WATER? THE CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS WATER QUALITY INDICATOR** Guy*, M., J-F. Bibeault and J. Boyer	**CLIMATE INDUCED CHANGES IN ANNUAL TO SEASONAL PROCESSES CONTROLLING PRODUCTION AT MULTIPLE TROPHIC LEVELS IN OSOYOOS LAKE, BC** Hyatt, K., M. Stockwell*, D. P. Rankin, and D. McQueen
1:40	***HEMIMYSIS ANOMALA* IN LAKE ONTARIO: IMPACTS ON THE NEARSHORE FOOD WEB** Yuille*, M.J., Johnson, T.B. and Arnott, S.	**THE RELATIVE ROLES OF STRESS, INJURY, AND RECOVERY GEARS ON THE MIGRATORY BEHAVIOUR AND SUCCESS OF SOCKEYE CAPTURED AND RELEASED IN THE LOWER FRASER RIVER** Nguyen*, V.M., G.D.Raby, M.R.Donaldson, A.G. Lotto et al.	**FOOD WEB DYNAMICS IN LAKES RECOVERING FROM METAL STRESS AND ACIDIFICATION** Luek*, A.; Morgan, G.E.; Wissel, B.; Gunn, J.; Ramcharan, C.W.	**THE ENERGY-MASS (Em) FLUX FRAMEWORK: AN INTEGRATIVE APPROACH TO QUANTIFY EFFECTS OF CLIMATE, HUMANS, AND BIOTA ON LAKES** Leavitt*, P.R. L. Bunting, E. Mathie, D.E. Schinder, and Chapman Conference Climate Integrator Synthesis Group.	**A BAYESIAN MODEL AVERAGING APPROACH FOR SETTING WATER QUALITY CRITERIA IN HAMILTON HARBOUR, ONTARIO, CANADA** Ramin*, M., and G.B. Arhonditsis	**ASSESSING THE EFFECTS OF SNOWMELT AND RAINFALL ON LIMNOLOGICAL CONDITIONS OF THERMOKARST LAKES IN THE OLD CROW FLATS, YT** Balasubramaniam*, A. R. I. Hall, B. B. Wolfe and J. N. Sweetman
2:00	***IN SITU* ASSESSMENT OF LAMPRICIDE TOXICITY TO AGE-0 LAKE STURGEON** O'Connor*, L.M., T. C. Pratt, T. B. Steeves, and B.E. Stephens	**UNDERSTANDING THE CONSEQUENCES OF FISHERIES CAPTURE AND HANDLING ON ADULT MIGRATING PACIFIC SALMON IN THE FRASER RIVER, B.C.** Donaldson*, M.R., S.G. Hinch, D.A. Patterson, A.P. Farrell, K.M. Miller, G. Raby, J.O. Thomas, D. Robichaud, K. English, and S.J. Cooke	**DO DAILY TEMPERATURE FLUCTUATIONS IN STREAMS HAVE AN IMPACT ON THE STANDARD METABOLISM RATE OF ATLANTIC SALMON PARR (*SALMO SALAR*)?** Beauregard*, D and D. Boisclair	**PATTERNS AND CAUSES OF LANDSCAPE SYNCHRONY OF PHYSICAL, CHEMICAL, AND ECOLOGICAL CHARACTERISTICS OF LAKES** Vogt*, Richard J., James A. Rusak, Alain Patoine,Peter R. Leavitt	**ENVIRONMENTAL RISK ASSESSMENT AND ADAPTIVE MANAGEMENT IMPLEMENTATION IN LAKE SIMCOE: A BAYESIAN APPROACH** Gudimov*, A., Shimoda, Y., Arhonditsis, G.B.	**COMBINING PALEOLIMNOLOGICAL METHODS AND AERIAL PHOTOS TO TRACK HYDROECOLOGICAL RESPONSES OF A THERMOKARST LAKE IN THE OLD CROW FLATS (YUKON, TERRITORY, CANADA) TO RECENT CLIMATE VARIABILITY** MacDonald*, L. A., K. W. Turner, A. M. Balasubramaniam, B. B. Wolfe, R. I. Hall and J. N. Sweetman
2:20	**SPACE USE OF SEA LAMPREY APPROACHING TRAPS ON THE ST. MARYS RIVER** Bravener*, G. and McLaughlin, R.	**QUANTIFICATION OF FILLET DISCOLOURATION IN COMMERCIALLY HARVESTED YELLOWTAIL FLOUNDER (*LIMANDA FERRUGINEA*)** Kenney*, J., P. Winger, and T. Rahman	**ENVIRONMENTAL MEDIATION OF ANTIPREDATOR STRATEGIES IN JUVENILE ATLANTIC SALMON** Elvidge*, C. K. and G. E. Brown	**WHAT DOES BENTHIC ALGAL PRODUCTION CONTRIBUTE TO THE TOTAL SYSTEM?** Scott*, C. E. and H. Cyr	**DETERMINATION OF THE CAUSES OF CYANOBACTERIA BLOOMS THROUGH WATER QUALITY MONITORING AND ASSESSMENT OF DESBARATS LAKE, JOHNSTON TOWNSHIP, ONTARIO** Verdone*, L. and Nürnberg, G.K.	**SHIFTS IN THE AQUATIC MIDGE COMMUNITY OF BAKER LAKE, NUNAVUT; AN INDICATOR OF PRONOUNCED 20TH CENTURY ENVIRONMENTAL CHANGE** Medeiros*, A. S., and R. Quinlan
2:40	**USE OF OLFACTORY CUES AS REPELLENTS FOR SEA LAMPREY (*PETROMYZON MARINUS*): POTENTIAL DIRECTIONS FOR POPULATION MANAGEMENT** Imre*[,1], I., G.E. Brown[2], R.A. Bergstedt[3], and R. McDonald[4]	**FATE OF ATLANTIC BLUEFIN TUNA IN AN EXPERIMENTAL RECREATIONAL CATCH-AND-RELEASE FISHERY** Stokesbury*, M. J. W., J. D. Neilson and S. J. Cooke	**SAMPLING AND ENVIRONMENT RELATED MORTALITY IN SHORTNOSE STURGEON LARVAE** Usvyatsov* S., Watmough J. and Litvak M.K.	**DO TERRESTRIAL INPUTS SUBSIDIZE, SUBSTITUTE FOR, OR SUBTRACT FROM CONSUMER PRODUCTION IN LAKE FOOD WEBS?** Solomon*, C.T., S.E. Jones, and B.C. Weidel	**CANCELLED**	**LOCAL PHYSIOGRAPHIC CONTROLS ON THE RESPONSES OF ARCTIC LAKES TO CLIMATE WARMING IN SIRMILIK NATIONAL PARK, NUNAVUT, CANADA** Devlin*, J.E. and S.A. Finkelstein
3:00	**Break – Imperial Room**					

Oral Presentations: Saturday Afternoon, 8 January

Room	Alberta	BC	Manitoba	Algonquin	Library Room	Quebec
Session	**Aquatic Invasive Species/General**	**Capture Fisheries**	**Environmental Stressors**	**Energy and Mass Flux**	**General**	**Climate Change**
3:20	**ROUND GOBY (*NEOGOBIUS MELANOSTOMUS*) NEST PREFERENCE AND ATTRACTION TO EGG ODOURS** Corkum*, L.D., T. Dawson, W. Glass, K-B. Raasch and S. Yavno	**FISHING PRESSURE AND BASELINES IN CORAL REEF FISH COMMUNITIES IN THE EASTERN INDIAN OCEAN** Ruppert*, J.LW., M.-J. Fortin, M.J. Travers and M.G. Meekan	**THE RESPONSE OF GLACIAL RELICT SPECIES TO THE LOSS OF COLD-WATER HABITAT** Blanchfield*, P.J., Paterson, M.J., Putt, A. and Mills, K.H.	**INTRODUCING THE ROLE OF HIGHLY UNSATURATED FATTY ACIDS IN PLANKTON MODELS** Perhar*, G. and G. Arhonditsis.	**EXAMINATION OF ECOSYSTEM MANAGEMENT OPTIONS IN HAMILTON HARBOUR USING FOOD WEB MODELING** Hossain*, M., M. Koops, K. Minns and G. Arhonditsis	**DETERMINING THE IMPACT OF PERMAFROST DEGRADATION ON LAKES FROM THE WESTERN CANADIAN SUB-ARCTIC USING LAKE SEDIMENTS** Thienpont*, J.R., Rühland, K.M., Pisaric, M.F.J., Kokelj, S.V., Blais, J.M., Kimpe, L.E., and J.P. Smol
3:40	**HEATED COMPETITION: HOW CLIMATE CHANGE WILL AFFECT COMPETITIVE INTERACTIONS IN FRESHWATER FISH SPECIES** Fobert*, E., M. G. Fox and G. H. Copp	**"FISHING THE LINE" AROUND REGULATORY CLOSURES: AN EXAMINATION OF FISHING EFFORT AROUND THE BROWN'S BANK SPAWNING CLOSURE ON THE SCOTIAN SHELF** van der Lee*, A., D. Gillis, P. Comeau, P. Hurley, and J. Black	**ARE THERMALLY SENSITIVE SLOPE WATER FISHES CLIMATE CHANGE CANARIES? RESPONSES TO THE NORTH ATLANTIC OSCILLATION** Fisher*, J.A.D., K.T. Frank, and W.C. Leggett	**NITROGEN AND CARBON STABLE ISOTOPIC VARIATION OF SURFACE SEDIMENTS FROM ALBERTA AND QUEBEC** Botrel*,M., R. Maranger and I. Gregory-Eaves	**ROM-TM: A TRANSIENT MODEL OF RIVER ECOSYSTEM OXYGEN METABOLISM** Chen, G., W. Taylor, and S. Schiff	**COUPLED PH-DOC THRESHOLDS GOVERN MERCURY BIOACCUMULATION IN ARCTIC LAKES ALONG A GRADIENT OF PERMAFROST THAWING** French*, T. D., A. Houben, S. V. Kokelj, X. Wang, M. F. J. Pisaric, J. R. Thienpont, P. deMontigny, J. P. Smol and J. M. Blais
4:00	**COMPARISON OF DIFFERENT FUNCTIONAL CLASSIFICATIONS OF THE LAURENTIAN STREAM FISH COMMUNITIES AND THEIR RELATIONSHIP TO LOCAL ENVIRONMENTAL CONDITIONS** Chamberland*, J-M and D. Boisclair	**INFERED INFORMATION NETWORKS IN A COMMERCIAL FISHERY USING VESSEL MONITORING DATA: FISHING PERFORMANCE AND VESSEL ASSOCIATION** Gillis*, D.M, Rijnsdorp, A. and Poos, J.J.	**ECOLOGICAL CHANGES DUE TO MULTIPLE ANTHROPOGENIC STRESSORS IN MUSKOKA-HALIBURTON, ONTARIO** Hadley*, K., A. Paterson, and J.P. Smol	**BIOAVAILABILITY OF PHOSPHORUS IN THE BEAVER RIVER WATERSHED OF LAKE SIMCOE, ONTARIO: ARE ALL FORMS OF PHOSPHORUS EQUALLY AVAILABLE?** Miles*, JJ, Dillon, PJ, North, RL and Eimers, MC	**CHANGES OVER TIME OF ORGANO-CHLORINE AND METAL BASED CONTAMINANTS IN FISH** Gardner*, W.M., D. S Jefferies, K. E. Smokorowski	**CREATING THE FOUNDATION FOR DROUGHT RECONSTRUCTIONS: CONSISTENT PATTERNS IN DIATOM ASSEMBLAGES ACROSS DEPTH GRADIENTS IN EIGHT LAKES FROM NORTHWESTERN ONTARIO (CANADA)** Kingsbury*, M. V., Laird, K. R., Cumming, B.F.
4:20	**RANDOMNESS IN FISH COMMUNITIES COMPOSITION: RESOLVING DIFFERENCES IN THE LITERATURE** Jackson*, D.A.	**USING TWO WAYS OF UNDERSTANDING: SCIENCE AND TRADITIONAL KNOWLEDGE TO EXAMINE EFFECTS OF ENVIRONMENTAL CHANGE ON ARCTIC CHAR** Knopp*, J. A., C. Furgal, J. D. Reist, Sachs Harbour Hunters and Trappers Committee and the Community of Sachs Harbour	**THE ROLE OF FLOODING ON LIMNOLOGICAL CONDITIONS OF FLOODPLAIN LAKES IN THE PEACE-ATHABASCA DELTA, NORTHERN ALBERTA, CANADA** Wiklund*, J. R. Hall and B. Wolfe	**REGULATION OF UREA TRANSPORT IN LOTIC ECOSYSTEMS OF THE CANADIAN PRAIRIES** Phillips*, V. J. A., J. Ziegler, P.R. Leavitt	**THE SIGNIFICANCE OF NON-SIGNIFICANT RESULTS IN A NOVEL EXPERIMENTAL SCALLOP DREDGING BENTHIC HABITAT IMPACT STUDY: INCORPORATING FISHING INTENSITY AS A COVARIATE** LeBlanc*, S., H. Benoît and H. Hunt	**EFFECTS OF CLIMATE CHANGE ON WATER AVAILABILITY: AN INVESTIGATION OF DROUGHT FROM A DRAINAGE LAKE IN NORTHWESTERN ONTARIO** Ma*, S., M.V. Kingsbury, K.R. Laird and B.F. Cumming
4:40	**SODIUM CHLORIDE AND SODIUM/CALCIUM EFFECTS ON A NATIVE *DAPHNIA* SPECIES FROM SOFT WATER LAKES** Celis-Salgado*, Martha P., Dewing, J., Keller, B. and Yan, N. D.	**CANADIAN ARCTIC FISHERIES – PAST, PRESENT AND FUTURE** Tallman*, R. F. and R. Young	**MACROPHYTE COMMUNITIES AS INDICATORS OF AGROCHEMICAL STRESS** Dalton*, R.L., Pick, F.R. and Boutin, C.	**THE INFLUENCE OF FOOD ENERGY FROM HEADWATER LAKES ON DOWNSTREAM COMMUNITIES** McCracken*, H. L. and Cunjak, R. A.	**FISH COMMUNITY RESPONSES TO THE EXPANSION OF EELGRASS HABITAT IN NEWMAN SOUND, NEWFOUNDLAND** Cote*, D., R.S. Gregory, C. Morris, D. Schneider and D. Methven	**LARGE-MAGNITUDE SHIFTS IN EFFECTIVE MOISTURE BASED ON DIATOM AND CHRYSOPHYTE ASSEMBLAGES IN A CLIMATICALLY-SENSITIVE REGION OF NORTHWESTERN ONTARIO** Haig*, A., R. Laing, M. Kingsbury, K. Laird, and B. Cumming
5:00	**End**					

Posters-at-a-Glance, Imperial Room

Capture Fisheries		
P1	Grant	DEVELOPMENT OF AN EGRESS WINDOW TO REDUCE THE CAPTURE OF SUB-LEGAL SIZE WAVED WHELK (*BUCCINUM UNDATUM*) IN CONICAL TRAPS
P2	Underwood	DEVELOPMENT OF AN UNDERWATER CAMERA SYSTEM TO OBSERVE THE HARVESTING TECHNIQUES OF COMMERCIAL SPECIES
P3	Underwood	BEHAVIOURAL INTERACTIONS BETWEEN FLATFISH AND COMMERCIAL GROUND GEAR ON THE NEWFOUNDLAND GRAND BANK
Science and Management of Introduced Aquatic Species		
P4	Campbell	DIETARY PREFERENCE FOR *HEMIMYSIS ANOMOLA* BY A REPRESENTITIVE NATIVE FISH
P5	Devlin	COMPARISON OF THREE SAMPLING METHODS TO MONITOR ONTARIO STREAM CRAYFISHES
P6	Ives	FOOD FOR THOUGHT: WHAT ARE *HEMIMYSIS ANOMALA* EATING IN LAKE ONTARIO AND THE UPPER ST. LAWRENCE?
P7	Kelly	DIFFERENTIAL IMPACTS OF THE INVASIVE PREDATORY CLADOCERAN *BYTHOTREPHES LONGIMANUS* ON ZOOPLANKTON BIODIVERSITY AND COMMUNITY COMPOSITION IN CANADIAN AND NORWEGIAN LAKES
P8	Phillips	THE BENTHIC CONSEQUENCES OF CRAYFISH RANGE EXPANSION IN WESTERN CANADA
P9	Stasko	AN APPROACH TO QUANTITATIVELY LINK FOOD WEB DYNAMNICS TO ENVIRONMENTAL VARIATION USING STABLE ISOTOPES
P10	Wang	EFFECTS OF SAMPLE SIZE AND SPECIES DISTRIBUTION PATTERNS ON THE PERFORMANCE OF SPECIES DISTRIBUTION MODELS
Aquatic Habitats and Fishes		
P11	Connors	MOVING A SMALL BOREAL LAKE - WHAT IS INVOLVED? APPLICATION OF A WHOLE LAKE COMPENSATION PLAN UNDER THE FEDERAL *FISHERIES ACT*
P12	Granados	FISH HOOKS INDUCE COMMUNITY CHANGE
P13	Hatry	DEVELOPMENT OF A NATIONAL FISH PASSAGE INVENTORY FOR CANADA: CANFISHPASS

P14	Hulsman	BEFORE-AFTER-CONTROL-IMPACT APPROACHES TO ASSESSING LAKE AND STREAM HABITAT MANIPULATIONS ON THE BARRENLANDS TUNDRA NEAR LAC DE GRAS, NORTHWEST TERRITORIES
P15	Mahlum	DOES THE DENDRITIC CONNECTIVITY INDEX WORK? TESTING THE RELATIONSHIP BETWEEN STRUCTURAL AND FUNCTIONAL CONNECTIVITY
P16	Préfontaine	DETECTING CHANGE IN FISH COMMUNITIES USING PROBABILITY OF DETECTION
P17	Tremblay	THE CHIPPEWAS OF GEORGINA ISLAND FIRST NATION TAKES ACTION TO PROTECT AND RESTORE FISH HABITAT BY FORMING A FISH HABITAT MANAGEMENT PLAN AND BY ENGAGING THE COMMUNITY
Responses to Environmental Stressors: From Individuals to Ecosystems		
P18	Arseneau	RECENT EVIDENCE OF BIOLOGICAL RECOVERY FROM ACIDIFICATION IN THE ADIRONDACKS (NY, USA): BUILDING A REGIONAL PALEOLIMNOLOGICAL PERSPECTIVE
P19	Biastoch	A REFERENCE CONDITION APPROACH FOR BENTHIC MACROINVERTEBRATE BIOMONITORING OF ARCTIC STREAMS
P20	Bond	GROWTH AND SPATIAL DISTRIBUTION OF FISHES IN HYDROPEAKING AND NATURAL RIVERS OF NORTHERN ONTARIO
P21	French	POLYCHLORINATED BIPHENYL CONCENTRATIONS ARE INCREASING IN LAKE ST. CLAIR AND LAKE ERIE FORAGE FISH: A RESULT OF THE DREISSENID MUSSEL INVASIONS?
P22	George	AN UNPRESIDENTED INCIDENCE OF TILAPIA MASS MORTALITY DUE TO STREPTOCOCCUS INFECTION IN THE WHITE NILE AT JEBEL AULIA DAM, SUDAN
P23	Jackson	ZOOPLANKTON COMMUNITY RECOVERY FOLLOWING THE CESSATION OF ACIDIFICATION
P24	Nagrodski	FISH STRANDING IN FRESHWATER SYSTEMS: SOURCES, CONSEQUENCES, AND MITIGATION
P25	Xu	MODELING THE SEASONAL AND INTERANNUAL VARIABILITY OF PERUVIAN ANCHOVY POPULATION DYNAMICS: LINKING ENVIRONMENTAL CONDITIONS WITH FISH
Algal Blooms: Incidences and Responses		
P26	Beaulieu	CYANOBACTERIAL BLOOMS IN CANADA: DEVELOPING REGIONAL AND CONTINENTAL PREDICTIVE MODELS
P27	Bradley	THE EFFECTS OF PAST INDUSTRIAL DAMMAGE AND CURRENT URBANIZATION ON PHYTOPLANKTON COMMUNITIES IN SUDBURY LAKES

P28	Orihel	DO HIGH MICROCYSTIN CONCENTRATIONS ONLY OCCUR AT LOW N:P RATIOS?
P29	Verschoor	TEMPORAL PATTERNS OF HYPOLIMNETIC DISSOLVED OXYGEN, PHOSPHORUS, SULFIDE AND IRON IN FOUR SMALL LAKES IN CENTRAL ONTARIO AND HAMILTON HARBOUR
Effects of Recent Climate Change		
P30	Gantner	LAKE FOOD WEBS IN THE NORTHWESTERN CANADIAN TUNDRA - CAN CLIMATE INDUCED PERMAFROST THAW SLUMPING AFFECT FISHERIES HABITAT?
P31	Gillespie	EFFECT OF EXPERIMENTAL DEEPENING OF THE THERMOCLINE ON FISH COMMUNITY BIOMASS AND TROPHIC ECOLOGY
P32	Hasnain	ECOLOGICAL TEMPERATURE METRICS AS PREDICTORS OF CLIMATE CHANGE IMPACTS ON NORTH AMERICAN FRESHWATER FISH COMMUNITIES
P33		Cancelled
P34	Griffiths	INVESTIGATING THE ROLE OF THE ST. ELIAS ICE FIELDS IN MODULATING REGIONAL CLIMATE IN THE SOUTHWEST YUKON TERRITORY
P35	Otu	THE EFFECTS OF DROUGHT ON THE PATTERN OF SEASONAL WATER COLUMN MIXING IN LAKE BOSOMTWE, GHANA (WEST AFRICA): IMPLICATIONS OF CLIMATE CHANGE ON THE ARTISINAL FISHERY
Lake Dynamics in Nearshore Ecosystems		
P36	Chavarie	OCCURRENCE OF MULTIPLE SHALLOW-WATER MORPHOTYPES OF LAKE TROUT (*SALVELINUS NAMAYCUSH*) IN GREAT BEAR LAKE, NWT
P37	Luszczek	LIMNOLOGICAL CONTROLS AND SPATIAL VARIATION IN LITTORAL MACROINVERTEBRATES COMMUNITIES ACROSS CENTRAL AND EASTERN NUNAVUT, CANADA
P38	Malkin	POTENTIAL EFFECTS OF A DEEP CHLOROPHYLL MAXIMUM IN THE COASTAL ZONE OF A LARGE CLEAR LAKE
Wetlands		
P39	Szkokan-Emilson	INTERNAL PROCESSING OF NUTRIENTS AND METALS IN WETLANDS AND ASSOCIATED FLUXES: IMPORTANCE TO EARLY SUCCESSIONAL AQUATIC COMMUNITIES IN RECOVERING WATERSHEDS
General Session		
P40	Becker	AQUATIC INSECTS AS AN AQUATIC ENERGY SUBSIDY TO RIPARIAN CONSUMERS IN THE OLDMAN RIVER BASIN

P41	Bielefeld	AN ASSESSMENT OF MERCURY IN NORTHERN PIKE (*ESOX LUCIUS*) FOOD WEBS IN CONTRASTING WATERSHEDS
P42	Blanchfield	THE FATE OF FARMED RAINBOW TROUT RELEASED FROM COMMERCIAL AQUACULTURE OPERATIONS IN LAKE HURON
P43	Brown	GENERALIZATION OF PREDATORS AND NON-PREDATORS BY JUVENILE RAINBOW TROUT: LEARNING WHAT IS AND WHAT IS NOT A THREAT
P44	Crisovan	SIZE-SELECTIVE MORTALITY OF WESTERN BASIN LAKE ERIE WALLEYE
P45	Davidson	ALLOCATION PATTERNS, RELIABLE SIGNALLING AND SPERM QUALITY IN RELATION TO CAROTENOID BASED SEXUAL SIGNALS IN REDSIDE DACE
P46	Elvidge	SIZE-MEDIATED RESPONSE TO PUBLIC CUES OF PREDATION IN A TROPICAL STREAM FISH
P47	Gallagher	POPULATION ASSESSMENT AND BIOLOGICAL CHARACTERISTICS OF ANADROMOUS NORTHERN FORM DOLLY VARDEN (*SALVELINUS MALMA MALMA*) IN THE YUKON TERRITORY AND NORTHWEST TERRITORIES
P48	Flinn	NITROGEN MASS AND ISOTOPE BALANCE OF A NATURAL AND AN ARTIFICALLY FERTILIZED BOREAL SHIELD LAKE
P49	Gutowsky	FISH MOVEMENT AND MIGRATION STUDIES IN THE LAURENTIAN GREAT LAKES: HISTORICAL PERSPECTIVES, MANAGEMENT ISSUES, AND FUTURE RESEARCH OPPORTUNITIES
P50	Hanson	THE MOLTING ENZYME CHITOBIASE TO ESTIMATE SECONDARY PRODUCTIVITY IN FRESHWATER ECOSYSTEMS: A REVIEW
P51	Hogg	EFFICACY OF SEINING TO PROVIDE AN INDEX OF BLACKSTRIPE TOPMINNOW (*FUNDULUS NOTATUS*) POPULATION STATUS
P52	James	USING SPRING CLOSURE ZONES TO PROTECT SPAWNING WALLEYE IN WABASCA LAKES, ALBERTA
P53	Janjua	EVALUATION OF FISH DIETARY NICHES IN AN OLIGOTROPHIC LAKE BY GUT CONTENT AND STABLE ISOTOPE ANALYSIS
P54	Johnson	THE EFFECTS OF INBREEDING ON SPERM QUALITY IN LAKE TROUT
P55	Johnston	ONTOGENETIC PATTERNS IN ISOTOPIC COMPOSITION OF NORTHERN FISHES
P56	Malcolm	IDENTIFICATION OF NORTHERN PIKE SPAWNING SITES IN SOUTH LAKE, RIDING MOUNTAIN NATIONAL PARK, MANITOBA, USING VHF TELEMETRY
P57	Malka	RETENTION OF ACQUIRED PREDATOR RECOGNITION BY ‘SHY’ VERSUS ‘BOLD’ JUVENILE RAINBOW TROUT: THE EFFECTS OF PREY BEHAVIOURAL TACTICS

P58	Murchie	EVALUATION OF TWO NON-CHEMICAL ANESTHETICS FOR INTRACOELOMIC IMPLANTATION OF ELECTRONIC TAGS IN WALLEYE
P59	Neff	EFFECTS OF REGIONAL-SCALE GEOLOGICAL CHANGES ON PATTERNS IN FISH ASSEMBLAGES
P60	O'Connor	NSERC HYDRONET: A NATIONAL RESEARCH NETWORK TO PROMOTE SUSTAINABLE HYDROPOWER AND HEALTHY AQUATIC ECOSYSTEMS
P61	Pagnucco	EFFECTS OF LAKE CHUB ON SURVIVAL AND BEHAVIOUR OF LONG-TOED SALAMANDER LARVAE
P62	Reid	LOCAL AND REGIONAL POPULATION GENETIC STRUCTURE OF THE THREATENED CHANNEL DARTER IN ONTARIO
P63	Rosamond	N_2O EMISSIONS FROM AN IMPACTED RIVER IN SOUTHERN ONTARIO: IMPLICATIONS FOR N-CYCLING PROCESSES AND GLOBAL BUGDETS
P64	Schiff	LINKING O_2, P AND N IN A LARGE IMPACTED RIVER IN S. CANADA: ISOTOPIC INSIGHTS FOR ECOLOGY AND BIOGEOCHEMISTRY
P65	Sorce	PALEOLIMNOLOGICAL INVESTIGATION OF RESPONSES IN FOOD WEB DYNAMICS BEFORE AND AFTER A PISCIVORE MANIPULATION IN MOUSE AND RANGER LAKE, ONTARIO
P66	Toobaie	THE EFFECT OF FOOD ABUNDANCE ON AGGRESSIVENESS AND TERRITORY SIZE OF JUVENILE RAINBOW TROUT, *ONCORHYNCHUS MYKISS*
P67	Turgeon	SPILLOVER IN AN EXPERIMENTAL MODEL FISHERY: INFLUENCE OF DENSITY, HABITAT QUALITY AND FUNCTIONAL CONNECTIVITY ON IMMIGRATION FROM PROTECTED TO HARVESTED AREAS
P68	Turner	INFLUENCE OF DISPERSAL AND SPECIES INTERACTIONS ON ZOOPLANKTON COMMUNITY STRUCTURE
P69	Usvyatsov	FEEDING ECOLOGY OF THE SHORTNOSE STURGEON IN THE SAINT JOHN RIVER, NB, CANADA
P70	Venkiteswaran	SEASONAL RESPONSE OF AQUATIC COMMUNITY METABOLISM TO MUNICIPAL EFFLUENTS IN RIVERS
P71	Weir	TEMPO AND MODE OF EVOLUTIONARY CHANGE IN SECONDARY SEXUAL CHARACTERISTICS IN RICEFISH (FAMILY ADRIANICHTHYIDAE)
P72	Wilson	REGIONAL METAPOPULATION STRUCTURE OF BROOK TROUT IN NORTHERN LAKE SUPERIOR
P73	Wozney	GENETIC ASSESSMENT OF POPULATION STRUCTURE OF SISCOWET LAKE TROUT (*SALVELINUS NAMAYCUSH SISCOWET*) IN LAKE SUPERIOR
P74	Rusak	LITTORAL MACROINVERTEBRATE DIVERSITY IN SPACE AND TIME: RULE #1 - THERE ARE NO RULES

ABSTRACTS

64th Meeting of the

Canadian Conference for Fisheries Research
Conférence Canadienne de la Recherche sur les Pêches

Society of Canadian Limnologists
Société canadienne de limnologie

and

Society of Wetland Scientists
Société des scientifiques des zones humides

Toronto, Ontario 6-8 January 2011

Abstracts for oral and poster presentations are combined and in alphabetical order by presenter

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DOES FISH COMMUNITY COMPOSITION INFLUENCE THE ESTABLISHMENT OF INTRODUCED SPECIES IN ONTARIO LAKES?

Alofs*, K. M. and D. A. Jackson.
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Climate change is predicted to alter the range limits of many fish species, including smallmouth bass (*Micropterus dolomieu*). Shifting species distributions will produce novel species assemblages and may significantly alter species interactions and lake community composition. Ecological theory suggests that a species is more likely to invade when it occupies a niche which is unused by the resident community and consequently that more diverse communities should be more resistant to invasions. Using historical and contemporary data on species occurrences in Ontario lakes, we examine whether particular types of fish communities are more vulnerable to species introductions. While controlling for environmental variation (including lake size, morphometry and location), we test whether pre-existing community composition differs between paired lakes where introduced species are present and absent. Our results should help resource managers to evaluate the relative risks to lake communities across Ontario and beyond.

Oral CCFFR (Introduced Aquatic Species)

SUPPLEMENTAL STOCKING OF BROOK TROUT (*SALVELINUS FONTINALIS*) IN ALGONQUIN PARK: IMPACT ON GENETIC STRUCTURE OF WILD POPULATIONS

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Brook trout stocking comprises almost 20% of fish stocked in the province of Ontario, with approximately 1.5 million fish stocked annually into Ontario's inland lakes. For most of the 20th century, brook trout populations in Algonquin Park were stocked with two non-native strains: domesticated (Hills lake) strain and a 'wild' strain (Nipigon Lake). Two decades after these stocking practices ended, we tested for the long-term consequences of stocking on the genetic structure of native brook trout populations in Algonquin Park. Twenty-seven self-sustaining Algonquin Park populations and representative broodstock fish from the two stocking sources were sampled and genotyped for 14 polymorphic microsatellite loci. Results of Bayesian assignment tests identified three primary populations clusters. Genotype frequency based method (ONCOR) demonstrated that out of the 27 sampled lakes 12 had native genes, 8 had the Hills strain genes, and the remaining 7 were of mixed ancestry. Principal Component Analysis (PCA) ordination of the genetic data resulted in three significant axes which explained 60% of the variation and identified native, introduced, and admixed populations, as well as detecting watershed-level differences among native park populations. Tests showed concordant results of high to no genetic introgression in wild populations. Levels of admixture in stocked populations was variable and not predictable from stocking history or intensity, with several native populations showing no evidence of introgression despite repeated historical stocking. While genetic introgression from the non-native wild strain was minimal, genetic effects from historical stocking of the Hills Lake strain were readily apparent in stocked populations.

Oral CCFFR (General Session)

ONTARIO'S BROAD-SCALE LAKES MONITORING PROGRAM: DESIGN AND INITIAL RESULTS

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The province of Ontario, with over 250,000 lakes and thousands of kilometres of rivers, supports a recreational fishery of two million anglers spending over 2.3 billion dollars a year on fishing-related expenses. In 2008, Ontario initiated a broad-scale lakes monitoring program aimed at reporting on the current and changing state of inland lake fishery resources. Within each fisheries management zone, a stratified random sample of lakes is used to assess the condition of fishery resources. The primary sampling components are: (1) a spring water chemistry survey, (2) summer depth-stratified index netting of the fish community, and (3) seasonal aerial surveys of angling activity. Reporting is done on a 5-year cycle. The program aims to sample 5% of lakes larger than 20 hectares within each 5-year cycle. Half of the lakes selected in the first cycle are designated as fixed sites – to be re-sampled in subsequent cycles. The other half of the sample is a stratified random sample of lakes picked in each cycle (i.e. variable sites). Whereas a fixed site design maximizes power to detect changes, the inclusion of variable sites improves the precision of status reporting. Approximately 600 lakes have been sampled to date. Selected results will be presented that highlight variation in the abundance of popular sport fish (walleye (*Sander vitreus*), lake trout (*Salvelinus namaycush*) and smallmouth bass (*Micropterus dolomieux*)) and fish community structure. Because this program uses a proposed North American gillnet standard for sampling fish communities, its results are potentially comparable to results obtained by other agencies adopting this standard.

Oral CCFFR (General Session)

RECENT EVIDENCE OF BIOLOGICAL RECOVERY FROM ACIDIFICATION IN THE ADIRONDACKS (NY, USA): BUILDING A REGIONAL PALEOLIMNOLOGICAL PERSPECTIVE

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The Adirondack region of New York (USA) has been significantly impacted by acid deposition. Since the implementation of the 1990 Clean Air Act Amendments, the area has shown improvements in water chemistry. However, little work has been done to assess biological recovery in the region. Assessing biological recovery is often difficult due to a lack of long-term monitoring data but paleolimnology can overcome this difficulty. Paleolimnological studies reconstruct the environmental histories of lakes using the physical, chemical, or biological characteristics of lake sediments. The goal of this investigation was to identify if biological recovery has followed chemical recovery in three acid-impacted Adirondack lakes, using paleolimnological techniques. Changes in the lakes' chrysophyte and cladoceran fossil assemblages were analyzed from ca. 1760-present in ^{210}Pb dated sediment cores. Multivariate statistics were applied to compare changes in fossil species composition with measured changes in chemical and climatic variables. Recent (post-ca. 1995) declines in chrysophyte species with low pH optima suggest that biological recovery from acidification is occurring in the study lakes. However, recent (post-ca. 1970) increases in colonial chrysophyte taxa suggest that the species assemblages are not returning to their pre-disturbance state, likely due to an influence of climate warming. The cladocera remain unresponsive to increasing pH and several local/regional factors may be preventing their recovery (i.e. predation, calcium depletion, climate warming, etc.). This study provides evidence that biological recovery is underway in the Adirondacks but that recovered assemblages are unlikely to return to their pre-disturbance state due to other environmental factors.

Poster SCL (Environmental Stressors)

DETECTION OF TEMPORAL TRENDS OF ALPHA AND GAMMA CHLORDANES IN LAKE ERIE FISH COMMUNITIES USING DYNAMIC LINEAR MODELING

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The dynamic linear modeling (DLM) analysis was performed to predict the long-term temporal trends of two toxic compositions of chlordane pesticide, alpha chlordane (*CLDA*) and gamma chlordane (*CLDG*) in skinless-boneless muscle tissues of a number of sport fish species in Lake Erie, while considering the fish length as a covariate. The *CLDA* models for the coho salmon, channel catfish, rainbow trout and common carp predicted continuous decreasing trends of the contaminants during the entire survey period (1976-2007). The *CLDG* models demonstrated the similar trends for the coho salmon, channel catfish and common carp. These fish species had higher levels of observed *CLDA* and *CLDG* in their muscle tissues. Both the predicted *CLDA* and *CLDG* levels in freshwater drum, smallmouth bass, walleye, white bass, whitefish and yellow perch decreased until the mid 80s and remained stagnant for the remaining period. This group of fish species had lower observed body burdens for the both contaminants. The pesticide biotransformation process, food and feeding habits of the fish species, reduction of contaminant levels in the environment, the food web alterations induced by the introduction of aquatic invasive species are some proposed hypotheses responsible for these discrepancies in different fish species in Lake Erie.

Oral CCFFR (Environmental Stressors)

ASSESSING THE EFFECTS OF SNOWMELT AND RAINFALL ON LIMNOLOGICAL CONDITIONS OF THERMOKARST LAKES IN THE OLD CROW FLATS, YT

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The areal extent and vulnerability of arctic freshwaters to climate warming is of major concern to communities in northern regions. Increasingly, it is understood that shifts in hydrological processes (i.e., precipitation and evaporation), and not air temperature alone, are the primary factors driving change in arctic lake water balances. However, the effects of these changes on chemical and biological processes within lakes are not well known, but are needed to predict the impacts of future climatic changes on arctic aquatic ecosystems. Using hydrological information gained from water isotope tracers ($\delta^{18}O$ and $\delta^{2}H$), this research characterizes relationships between dominant types of precipitation (i.e., snowmelt and rainfall) and measured limnological parameters (e.g., nutrients, major ions, pH, and choloropyll-*a*) for 56 thermokarst lakes in the Old Crow Flats, YT. Principal components analysis of data obtained from the 2007 ice-free season, combined with non-parametric statistical tests, showed that *snowmelt-dominated* lakes have significantly ($p < 0.05$) higher nutrient concentrations and slightly more acidic pH values compared to *rainfall-dominated* lakes. These patterns are evident throughout the ice-free season. *Snowmelt-dominated* lakes are generally located adjacent to hillslopes with boreal vegetation, in contrast to *rainfall-dominated* lakes, which generally have sparse tundra vegetation and catchments of low-relief. These results indicate that the interaction of snowmelt and terrestrial catchments plays a key role in the delivery of nutrients to lakes, and that the limnological effects of this process extends well beyond the brief spring melt period. This research provides the basis for predicting limnological responses to changes in climate conditions.

Oral SCL (Climate Change)

SAMPLING NON-WADEABLE RIVERS IN SOUTHERN ONTARIO WITH A SMALL BENTHIC TRAWL: WHAT HAVE WE BEEN MISSING?

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Non-wadeable river systems are one of the most challenging freshwater habitats in which to conduct fisheries sampling. Challenges are due to their diverse habitats including varying depths, flows and substrates, which require a variety of gears to sample effectively such as seines, backpack electrofishers, boat electrofishers, trammel nets, trapnets, hoopnets, and gillnets. The use of small, specialized benthic trawls has been very successful in sampling small- to medium-sized fishes in large, non-wadeable rivers in the American Midwest; however, this method had not been used in the Great Lakes basin. During 2009, Fisheries and Oceans Canada conducted trawling surveys of the Thames River. Thirty-one trawling sites were sampled over a 30 kilometre reach of river. Trawling data from 2009 was compared to 90 historical seining sites (2003, 2006) in adjacent wadeable areas to examine differences in the fish assemblage between the wadeable nearshore habitats and non-wadeable main channel habitats.

Oral CCFFR (General Session)

CYANOBACTERIAL BLOOMS IN CANADA: DEVELLOPING REGIONAL AND CONTINENTAL PREDICTIVE MODELS

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Cyanobacteria blooms can negatively impact water quality and recreational use of water bodies. Most research in the field has focused on drivers of total cyanobacteria dominance and abundance at regional or global scales, with little detail on how scale might affect these models. By using several large sets of regional data from Alberta, Ontario, Quebec and British Columbia, we will develop empirical models for cyanobacteria dominance and abundance using nutrient, temperature and watershed data as predictors and identify whether they differ at regional and continental scales. We will also identify predictors of important cyanobacterial functional groups (e.g. nitrogen-fixers, potentially toxic-producing species) at these scales. With our work, one of our goals is determine whether a regional model from Ontario (for example) could be applied with reasonable confidence to a lake in a different region. As there has been a recent increase in the reports of cyanobacteria blooms in many Canadian lakes, there is a growing need to better understand cyanobacteria blooms and provide scientifically-sound information to lake managers.

Poster SCL (Algal Blooms)

DO DAILY TEMPERATURE FLUCTUATIONS IN STREAMS HAVE AN IMPACT ON THE STANDARD METABOLISM RATE OF ATLANTIC SALMON PARR (*SALMO SALAR*)?

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Standard metabolism rate (SMR) is an essential parameter in the development of bioenergetics models. In standard methodologies, the estimation of SMR is typically carried out on fish that are kept at a constant temperature for an extended period before measurements are taken. However, in natural streams, fish experience daily variations in water temperature. The acclimatization to a constant temperature in laboratory experiments could lead to an underestimation of SMR relative to that of fish found in natural environments. The objectives of this study were: (1) to determine the effect of daily temperature fluctuations on SMR of Atlantic salmon parr, and (2) to test a new laboratory protocol that incorporates the effect of fluctuating temperatures. In this study, 150 wild salmon parr collected from the Ouelle River (Qc) were acclimatized to three different temperature regimes representing the natural conditions found in the Ouelle River in August 2009: mean daily fluctuation (20 ^{o}C ±1.5 ^{o}C); maximum daily fluctuation (20 ^{o}C ±2.5 ^{o}C); and constant (20 ^{o}C). For the first objective, salmon parr from each group were put in an intermittent-flow respirometer at a constant temperature of 20 ^{o}C to calculate the oxygen consumption rate during 24 hours, at an interval of 15 minutes. For the second objective, the same methodology was followed; however the respirometers were installed in temperatures corresponding to the acclimatization basins of each group. Preliminary analysis suggests that salmon exposed to daily fluctuating temperatures have a higher SMR than salmon exposed to a constant temperature.

Oral CCFFR (Environmental Stressors)

AQUATIC INSECTS AS AN AQUATIC ENERGY SUBSIDY TO RIPARIAN CONSUMERS IN THE OLDMAN RIVER BASIN

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Movement of aquatic insects from the aquatic ecosystem to the terrestrial ecosystem may be important as a food source in arid, grassland ecosystems such as the Oldman River basin (OMRB). Using stable isotopes as tracers, our research has shown that δ^{13}C‰ and δ^{15}N‰ signatures of consumers resemble aquatic insect signatures near the river and shift gradually toward terrestrial insect signatures farther away (>100m). Using a simple mixing model, we are able to determine the proportion of food sources to the diet of high trophic level consumers. Spiders, which are rather sedentary, should have isotope signatures that reflect the range of dispersion of aquatic insects from the water body. Further, birds should also reflect this gradient, although the larger foraging ranges of birds may make the gradient more difficult to quantify. Currently, the OMRB experiences high levels of water diversion or withdrawal to support agriculture and domestic use. Consequent decrease in flow and channel width may cause biologically significant impacts to the adjacent upland

Poster CCFFR (General Session)

ACCOUNTING FOR POPULATION SPATIAL HETEROGENEITY IN STOCK ASSESSMENTS: APPLICATION TO LAKE ERIE WALLEYE *SANDER VITREUS*

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Most organisms elicit behavioral responses in accordance with spatial habitat features to satisfy particular life history traits (e.g., foraging strategy or reproductive behavior), which results in patterns of abundance across the landscape. Variation among behaviors in space and time sets the context for interpreting how ecological processes influence population dynamics. Migration is one such process that can have a profound effect on the spatial structure of a population. However, migratory fish species are intrinsically difficult to study because reliable movement information used to quantify migration is typically hard to gather. The goal of this research is to investigate the utility of spatially-referenced statistical catch-at-age stock assessment models when explicit movement information is limited. We apply several alternative assessment models to Lake Erie walleye – a population that displays age-specific differences in the extent of post-spawn migrations – to investigate the importance of accounting for spatial heterogeneity in stock assessments. Results from the most parsimonious assessment model (based on deviance information criterion) highlighted the importance of estimating region-specific selectivity and catchability parameters. Incorporating spatial structure through region-specific estimation procedures decreased estimates of total age-2 and older walleye abundance in the most recent year by 11% (23% for age-7 and older walleye) over an assumed homogenous population assessment model. Results exemplify the importance of spatial fishery management, particularly when a fishery is regulated through harvest policies that translate estimated abundances into catch quotas.

Oral CCFFR (Capture Fisheries)

FISH DISTRIBUTION IN THE LITTORAL ZONE OF LAKES: COULD DAILY VARIATION IN WIND DIRECTION CONTRIBUTE TO EXPLAIN HABITAT USE?

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The littoral zone of lakes has long been recognized to support the highest fish biomass and biodiversity of these ecosystems. A better understanding of the determinants of habitat quality in the littoral zone may be useful for conservation purposes. The objectives of this study were to identify the environmental conditions that best explain 1) spatial variations of fish habitat use along the littoral zone of lakes and 2) temporal/day-to-day variations of fish habitat use in the littoral of lakes. We used a visual underwater sampling method in which divers identified, counted and estimated the size of all fish observed at 20 m intervals over the complete perimeter of the littoral zone of three small Canadian Shield lakes 3 times at weekly interval from late-July to early-August. The sampling was accomplished during a 5-h time period centered around noon to survey when fishes are known to be less active. Environmental conditions were quantified both inside the 20 m segment (local environmental conditions) and on the shore adjacent to these segments. The distribution patterns in the complete littoral zone differed markedly among days. Preliminary analyses using a forward selection modelling approach indicated that local environmental conditions like substrate size and macrophyte cover were the first order predictors of fish habitat use for most fish species but that variations in wind direction , and hence, effective fetch could contribute to explain daily variation in fish distribution pattern.

Oral CCFFR (Nearshore Ecosystems)

A REFERENCE CONDITION APPROACH FOR BENTHIC MACROINVERTEBRATE BIOMONITORING OF ARCTIC STREAMS

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The Canadian Arctic is experiencing changes such as a warming climate and increased development; however, there are currently no stream biomonitoring programs designed for detecting changes in Arctic stream ecosystems, given their distinctive differences from temperate ecosystems. My objective is to develop a Reference Condition Approach (RCA) for a collaborative biomonitoring program in Iqaluit, NU, between York University and the Nunavut Research Institute. Many temperate biomonitoring programs utilize an RCA, which is a suite of minimally-disturbed stream sites that captures the naturally occurring variance in benthic macroinvertebrate communities in the region. From 2008 to 2010, 25 minimally-disturbed stream riffle sites outside of Iqaluit, and six riffle sites located on two streams flowing through or near Iqaluit, were sampled for benthic macroinvertebrates, water chemistry, and physical characteristics. The minimally-stressed sites comprise the RCA, and test sites have been compared to it with multimetric indices, such as the Shannon-Weiner diversity index and the Hilsenhoff family biotic index, and also multivariate analyses, to ultimately plot the test site in the same ordination space as the RCA. The 'distance' of the test stream site's community structure from similar Reference Condition sites indicates the degree of 'stress' the stream has experienced, and this stress is considered to be anthropogenic.

Poster SCL (Environmental Stressors)

AN ASSESSMENT OF MERCURY IN NORTHERN PIKE (*ESOX LUCIUS*) FOOD WEBS IN CONTRASTING WATERSHEDS

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Under the Clean Air Regulatory Agenda (CARA), a regulatory framework for air emissions, Environment Canada is studying lakes impacted by major mercury (Hg) emitters. The objective of this study is to assess the localized impact of Hg pollution from major industry on lakes in two areas, the Precambrian shield of northern Saskatchewan and Manitoba and the boreal plain of central Alberta, and to discuss differences in food web biomagnification based on variation between the two study locations. The shield lakes are relatively isolated, are surrounded by boreal forest and have received emissions from the Hudson Bay Mining and Smelting complex in Flin Flon, MB since 1930. The central Alberta lakes are highly productive and receive inputs from the surrounding urban and agricultural landscape in addition to emissions from a complex system of four large coal-fired power plants, in operation since the 1950's. In the summer of 2009, we collected northern pike (*Esox lucius*), forage fish, benthic invertebrates and zooplankton from 5 lakes in each area. Mean fish length, weight and age were similar for both areas. It was hypothesized that high productivity in central Alberta would lead to lower fish Hg levels due to faster growth rates, however the fish appear to be growing at the same rate in both areas despite local climate differences. Hg levels in fish did not reflect those of the water and sediment, for which there were very high values in lakes near the smelter at Flin Flon. Rather, they were relatively low (below consumption guidelines of 0.5 µg/g) with the exception of one anomalously high lake far to the north west of the Flin Flon smelter (mean THg 1.22±0.57 µg/g), possibly due to low deep lake pH. Ongoing research will involve characterizing food webs using $\delta^{15}N$ and $\delta^{13}C$ stable isotopes and the use of $\delta^{15}N$ and Hg regressions to determine biomagnification rates within each lake.

Poster SCL (General Session)

DAILY CYANOBACTERIAL DYNAMICS IN THREE EUTROPHIC RECREATIONAL LAKES AND THEIR CORRELATION WITH WEATHER

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A collaborative epidemiological study of the effects of cyanobacterial toxins and coliform bacteria on swimmer health was undertaken in 3 eutrophic recreational lakes in southern Quebec. Here we consider the ecology and dynamics of the cyanobacterial plankton. Cyanobacterial communities were counted and species identified on a daily basis over a two and a half month summer period in 2009. We collected taxonomic and limnological data twice weekly at limnetic stations, and collected samples for taxonomy daily at 4 to 5 shoreline stations per lake. Here, we consider the relationship between wind, water column stratification, taxonomic and biomass variation among stations, and particulate and dissolved microcystin concentrations. The biomass of individual species varied by more than 5 orders of magnitude at different stations over the summer. The most intense blooms, characterized by dense accumulations of floating cyanobacterial scum, were associated with cloudy periods and an absence of wind. Wind movement of surface populations meant that day-to-day variations of particular toxic species could be more than 100,000 fold (from undetectable one day to bloom levels the next and then back to undetectable). There was no statistical evidence of competition among species. These extreme dynamics at the shoreline stations are further evidence that the cyanobacteria represent a unique functional group.

Oral SCL (Algal Blooms)

THE RESPONSE OF GLACIAL RELICT SPECIES TO THE LOSS OF COLD-WATER HABITAT

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Lake trout (*Salvelinus namaycush*), a top predator, and *Mysis diluviana*, an important food source for lake trout, but also a plankton predator, are two glacial relict species that co-occur in many deep, oligotrophic lakes across Canada. The habitat of these glacial relicts is primarily defined by cold, well-oxygenated waters. We examined changes in the distribution of lake trout and their *Mysis* prey in response to the decline of available cold-water habitat that occurred over a 7-year period in a small boreal lake (Lake 375; 23 ha, Z_{max}=26 m) at the Experimental Lakes Area (ELA). Habitat loss occurred through decreased concentrations of hypolimnetic oxygen in Lake 375 that were driven by increased nutrient inputs and limited lake mixing. *Mysis* occupied a progressively smaller fraction of the lake and densities decreased from 85 m^2 to 7 m^2 as dissolved oxygen in the hypoliminion declined over the 7-year period. We observed a complete loss of available habitat for lake trout during peak stratification in the year of greatest hypolimnetic oxygen depletion. Lake trout exhibited a progressively shallower pelagic distribution, but did not show any immediate negative responses to the loss of habitat volume. Instead, abundance, growth and condition of lake trout increased throughout this period in response to increased densities of forage fish and possibly the concentration of *Mysis* prey. We contrast the different population-level responses by these glacial relict species to the loss of habitat in the context of whole-ecosystem shifts in trophic status.

Oral CCFFR (Environmental Stressors)

GROWTH AND SPATIAL DISTRIBUTION OF FISHES IN HYDROPEAKING AND NATURAL RIVERS OF NORTHERN ONTARIO

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Deviation from a river's natural flow regime is considered to be one of the most serious and continuing threats to lotic ecosystems. Peaking hydroelectric facilities, which are designed to adjust the level of power generation in accordance with hourly energy demand, can dramatically alter the quantity and quality of habitat available to benthic invertebrates and fish. In this study, we examined the growth and spatial distribution of slimy sculpin (*Cottus cognatus*) along longitudinal and lateral gradients in two hydropeaking and eight natural Lake Superior tributaries. We hypothesized that (1) the permanently-wetted channel would support a greater number of faster growing fish than the varial zone; and (2) the highest densities and growth rates of sculpin would be observed at upstream sites (near the dams) and would decrease with distance downstream as a result of the 'dam effect'. Sites were sampled for benthic organic matter, benthic invertebrates, and fish in 2009 and 2010. Growth was examined using otolith microstructure, and quantified using the von Bertalanffy growth function. Preliminary results indicate that (1) very few fish are using the varial zone, which can cover nearly half of the river's width at peak flow; (2) habitats below dams support a greater abundance of fishes than habitats further downstream in peaking rivers, and (3) despite higher abundances, sculpin found below dams have higher growth rates than those found further downstream or in natural rivers. Results from this study demonstrate the importance of standardizing flow conditions for fish monitoring programs in peaking rivers, and help in the defining of a dam's zone of influence.

Poster CCFFR (Environmental Stressors)

NITROGEN AND CARBON STABLE ISOTOPIC VARIATION OF SURFACE SEDIMENTS FROM ALBERTA AND QUEBEC

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Nitrogen and carbon stable isotopic signature from lake surface sediment has been widely used in paleolimnology as an indicator of past environmental change. Carbon stable isotopes ($\delta^{13}C$) have been related to past change in lake productivity whereas change in nitrogen stable isotopes ($\delta^{15}N$) is generally explained by increased nitrogen loading from sewage inputs or fertilizer use. However, some studies have shown that $\delta^{15}N$ can be related to trophic status and internal nitrogen cycling. As such, there is uncertainty as to what are the factors controlling $\delta^{15}N$ and $\delta^{13}C$ of lake sediments, particularly in shallow lakes which have not been studied in great detail. Therefore, the objective of this study is to determine which set of variables explain significant variation in sedimentary $\delta^{15}N$ and $\delta^{13}C$ over a broad trophic gradient and a wide range of lake and watershed morphometries. Surface sediment where collected from 24 Alberta lakes and 40 lakes from southern Quebec. Limnological, morphometric, land-use and climatic variables will be included in the analysis. The study is also being complemented by a detailed seasonal study of nitrogen cycling in three lakes that span a strong trophic gradient. Overall, our goals are to advance our understanding of nitrogen and carbon cycling and the interpretation of paleolimnological records.

Oral SCL (Energy and Mass Flux)

THE EFFECTS OF PAST INDUSTRIAL DAMMAGE AND CURRENT URBANIZATION ON PHYTOPLANKTON COMMUNITIES IN SUDBURY LAKES

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Sudbury, Ontario is a well known area which suffered heavy disturbances from past mining activities. Ongoing urban and industrial growth in the area has also become another stressor, particularly in freshwater ecosystems. Phytoplanktons are a commonly used indicator of environmental change and may show an urban signal here. Using long-term water chemistry and phytoplankton data from four urban lakes and four remote lakes, we attempted to identify which stressors more strongly effect phytoplankton community composition. A series of PCA and RDA analyses revealed that the urban lakes were separated into two groups. Clearwater and Lohi Lakes were characterized by higher metal levels which decreased over time, and a change from acid-tolerant phytoplankton, such as dinoflagellates and chlorophytes, towards a dominance of chrysophytes, a common trend in acidified lakes. These lakes began to resemble the remote lakes over time suggesting that recovery was occurring. The remaining two urban lakes, Hannah and Middle Lakes, were more urban influenced with high levels of salts and other ions, as well as TKN and DOC, likely a result of urban inputs such as road salts and fertilizers. This was reflected by an increase in diatoms over time and a co-dominance of chrysophytes. In general, the main driver of phytoplankton in this area was past mining activities (pH and metals), which continue to affect these lakes. It is likely that the effect of urban pressures will become more manifest in city lakes, as past mining influences (mainly residual metals) continue to diminish.

Poster SCL (Algal Blooms)

SPACE USE OF SEA LAMPREY APPROACHING TRAPS ON THE ST. MARYS RIVER

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We combined acoustic telemetry and occupancy models to examine the space use of sea lamprey (*Petromyzon marinus*) approaching traps in the St. Marys River. Within the Laurentian Great Lakes, the sea lamprey is an aquatic invasive fish species that parasitizes and often kills large native fishes. It is the target of a bi-national control program. There have been ongoing efforts to improve trapping efficiency in the St. Marys River because conventional control methods are not feasible due the river's size. In 2008 and 2009, we quantified the movement paths of 63 spawning-phase sea lamprey released downstream of two trapping sites. Movement paths were used to test whether the sea lamprey moved upriver using a common route along which they could be intercepted with a trap. It was clear from visual inspection that individuals differed markedly in their movement paths. We then divided the study areas into 10 X 10 m grid cells and used occupancy models to test whether there were places (grid cells) where sea lamprey were more likely to be found, or whether space use was relatively uniform across grid cells. The probability of occupancy differed among grid cells and was highest for grid cells in the deepest water during evening hours. Our findings support the current philosophy of deploying a small number of traps in targeted areas where sea lamprey are expected to be abundant and demonstrates how analyses of movement paths using occupancy models can be used to identify potential trap sites.

Oral CCFFR (Introduced Aquatic Species)

BUILDING A COMPREHENSIVE DATA SET OF THE DISTRIBUTION OF DREISSENID MUSSELS AND SPINY WATER FLEA (*BYTHOTREPHES LONGIMANUS*) IN ONTARIO

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Invading species are one of the leading causes of the loss of our aquatic biodiversity. With over 250,000 inland lakes, the challenge of tracking the spread of established aquatic invasive species in Ontario is indeed daunting. Through the Invading Species Awareness Program, a partnership between the Ontario Ministry of Natural Resources and the Ontario Federation of Anglers and Hunters, a long-term database is being developed over a broad geography for Dreissenid mussels and *Bythotrephes longimanus*. In 2008, OMNR initiated a broad-scale lakes monitoring program which includes an aquatic invasive species monitoring protocol. The program aims to sample 5% of lakes larger than 20 ha in the province every 5 years. Half of the lakes selected in each 5-year cycle are designated as fixed sites – to be re-sampled in subsequent cycles. The other half of the sample is a stratified random sample of lakes selected in each cycle. The invasive species protocol involves 3 vertical plankton hauls on each lake. In the first 2 years of the program, almost 300 lakes have been sampled for AIS. Results from these first 2 years will be presented. This data set will be combined with the OMNR/OFAH Invading Species Watch program's data. The Invading Species Watch program is a volunteer based monitoring program that uses similar methodologies. Since 1998, over 500 lakes have been monitored through this program. The results of both programs and other confirmed observations of species of interest are combined into one data set that is maintained by the OFAH.

Oral CCFFR (Introduced Aquatic Species)

THE PREDATOR RECOGNTION CONTINUUM: NEOPHOBIC RESPONSE TO NOVEL CHEMICAL CUES IN TRINIDADIAN GUPPIES

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Growing bodies of literature have argued that the avoidance of predator cues by potential prey may either be innate (genetically fixed) or acquired (learned predator recognition). Several conflicting studies involving salmonids have demonstrated both mechanisms, sometimes within the same species. The predator recognition continuum argues that spatial and temporal variability in predation risk may select for reliance on learned responses, the genetic fixation of predator cue recognition, or a neophobic response in which prey initially avoid novel cues and then adjust subsequent behavioural responses based on experience. To test the prediction that intensity of predation risk selects for neophobic responses, we exposed wild caught Trinidadian guppies from low and high predation risk populations to the chemical cues of a novel predator (tilapia). Guppies from the high predation risk population exhibited strong antipredator responses to the novel odour, while guppies from the low risk population did not discriminate between the novel odour and a distilled water control. A companion field study comparing the avoidance of novel cues in high, intermediate and low risk populations confirmed these results, indicating that the intensity of avoidance of novel cues was directly related to ambient predation risk. These results suggest that classifying predator avoidance as either 'innate' or 'learned' might be a misleading oversimplification.

Oral CCFFR (Aquatic Habitats and Fishes)

GENERALIZATION OF PREDATORS AND NON-PREDATORS BY JUVENILE RAINBOW TORUT: LEARNING WHAT IS AND WHAT IS NOT A THREAT

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Learned recognition of novel predators allows prey to respond to ecologically relevant threats. Presumably, prey could minimize the costs associated with learning the identity of both predators and non-predators by making educated guesses on the identity of a novel species based on their similarities with known predators and non-predators, a process known as generalization. Here, we tested whether juvenile trout had the ability to generalize information from a known predator (experiment 1) or a known non-predator (experiment 2) to closely related but novel species. In experiment 1, we taught juvenile rainbow trout to recognize a predatory pumpkinseed (*Lepomis gibbosus*) by pairing pumpkinseed odour with conspecific alarm cues (or a distilled water control). We then tested them for a response to pumpkinseeds and to novel longear sunfish (*Lepomis megalotis*; same genus as pumpkinseed), rock bass (*Ambloplites rupestris*; same family as pumpkinseed) or yellow perch (*Perca flavenscens*; different family). Trout exhibited strong learned recognition of pumpkinseed and longear odour and a weak learned response to rock bass odour but no recognition of yellow perch (i.e., not different from distilled water controls). In experiment 2, we used latent inhibition to teach trout about the harmless nature of pumpkinseed. During subsequent predator learning trials, trout did not learn to recognize either pumpkinseed nor longear odour as potential threat, but learnt that rock bass and yellow perch were threatening. Taken together, these results demonstrate that rainbow trout can generalize learned recognition of both predator and non-predator odours based on the phylogenetic relatedness of predators.

Poster CCFFR (General Session)

THE RATE OF SPREAD AND RELATIVE PREDATION RATES OF ROUND GOBY IN THE TRENT SEVERN WATERWAY

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The distribution, rate of spread, and relative predation rates of round goby *(neogobius melanostomus*) were studied in the Trent Severn Waterway in 2009 and 2010. Distribution was monitored using the angling removal technique across the upstream and downstream edges of the round goby range. Results showed dramatic increases in abundance at the edges of their range and limited range expansion during the summer months (from May to August). Rapid range expansion (9.13 km) was observed between August and May, indicating that most migration occurs in fall, winter, and spring. The relative predation rates of round goby were also assessed, comparing the center of their range to the downstream edge in the Trent River using tethering trials. Round goby were tethered to the bottom by inserting a hook below the dorsal fin, with 2 m of fishing line for movement. Three sites were compared from each area, with three trials at each site. Predation rates were significantly higher at center sites (average: 77%) than downstream sites (50%). The hook tethering the round goby often caught predators (25% catch rate). Smallmouth bass were by far the most common round goby predator caught (84%) followed by brown bullhead catfish (7%) and rock bass (6%). Although predation rates were very high, the results of these trials suggest that the predator community is responding to the presence of round goby in the Trent River. This reveals another advantage for movement of individuals in addition to less intraspecific competition for food.

Oral CCFFR (Introduced Aquatic Species)

IMPACTS OF CALCIUM DECLINE ON DAPHNIID ASSEMBLAGES OF STRATIFIED AND UNSTRATIFIED ONTARIO LAKES

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Widespread recent declines in calcium (Ca) are raising concerns about possible interactive effects of Ca decline with climate warming in Canadian lakes. Our survey of 304 Ontario lakes documented reduced frequency of occurrence of five daphniid species (*D. longiremis*, *D. dubia*, *D. mendotae*, *D. retrocurva* and *D. pulicaria*) at low Ca levels, particularly in unstratified lakes. Lower critical thresholds determined from logistic regression models for these daphniid species ranged from 1.3-1.7 mg/L of Ca, similar to reproductive thresholds identified for *D. pulex* in the laboratory. The frequency of occurrence of *D. ambigua* and *D. catawba,* acid-tolerant taxa, declined with Ca in unstratified, but not in stratified lakes. Six of the seven species, all but *D. retrocurva*, were less likely to occur in unstratified lakes, and five of these were more sensitive to low Ca in unstratified lakes. We hypothesize this is attributable to augmented energy demands in the low Ca, higher temperature environments of unstratified lakes. Patterns of occurrence with pH and Ca were independent, suggesting that benefits of recovery from lake acidification are, in part, being offset by falling Ca levels.

Oral SCL (Environmental Stressors)

DIETARY PREFERENCE FOR *HEMIMYSIS ANOMOLA* BY A REPRESENTITIVE NATIVE FISH

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In recent years, the Great Lakes have been subject to numerous foreign species invasions due to the abundance of ships carrying stowaways in their ballast tanks. One recent invader is the Ponto-Caspian mysid, *Hemimysis anomola*, for whom establishment in the Great Lakes has dramatic predicted effects. Since invasions can alter food webs and ecosystem functioning, the ability to confidently place *H. anomola* into the food web will facilitate the determination of possible effects on native ecosystems. However, since their invasion, studies have shown huge variability in the percentage and species of fish consuming *H. anomola*. These discrepancies suggest that feeding preference for *Hemimysis* over other species may be influenced by environmental conditions. We tested this hypothesis by examining how bottom substrate and prey density influence preference of yellow perch (*Perca flavescens*) for the invader *H. anomola* to *Echinogammarus ischnus* (a regular prey item). Under low and medium prey densities, *E. Ischnus* and *H. anomola* were equally consumed on sand, but fewer *E. Ischnus* were eaten on cobble, probably due to their use of the cobble refuge. *H. anomola* were equally consumed on both substrates, suggesting that they eschewed the refuge provided, and remained in the water column. Under high density treatments, *H. anomola* were preferentially consumed on both substrate types, suggesting a preference by the perch for the mysid. These results indicate that both density and substrate influence consumption rates of yellow perch, which may help explain the variation in *Hemimysis* consumption across the Great Lakes Basin.

Poster CCFFR (Introduced Aquatic Species)

THE ONTARIO REPTILE AND AMPHIBIAN ATLAS

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Ontario's reptiles and amphibians are becoming increasingly rare. In fact, three quarters (18 of 24) of Ontario's reptile species are listed as species at risk. Amphibians are in global decline. Reptiles and amphibians are a unique part of Ontario's biodiversity. We need up-to-date information to monitor changes in the ranges of reptile and amphibian species and fluctuations in their population numbers. We also rely on these data to determine if a species is at risk or in decline, and to identify and manage important habitat for rare reptiles and amphibians. Ontario Nature has initiated a new Ontario Reptile and Amphibian Atlas project. The objective of the atlas project is to improve our knowledge of the distribution and status of Ontario's reptiles and amphibians by collecting observation submissions from the public, carrying out field surveys and amalgamating existing databases.

Oral SWS (Wetlands)

SODIUM CHLORIDE AND SODIUM/CALCIUM EFFECTS ON A NATIVE *DAPHNIA* SPECIES FROM SOFT WATER LAKES

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Sodium chloride as rock salt is one of the most widely used types of de-icers for winter road maintenance in temperate North America. Road and highway melting snow carries the salt off the roads, increasing both sodium and chloride concentrations in receiving ditches, rivers and lake waters. In consequence, in many lakes of the southern Boreal Shield the levels of sodium are increasing. Permissible salt concentrations in freshwaters are currently based on tests with standard species such as *Daphnia magna* and *Ceriodaphnia dubia*, and they indicate levels of tolerance (acute LC50's as well as chronic maximum levels) in the range of grams per litre. However, levels have not been assessed with native softwater Daphnia species in soft-waters. We ran a series of 14 day partial life cycle, static with renewal bioassays with *Daphnia pulicaria*, a native cladoceran resident of the Boreal Shield soft water lakes. The tests were performed in a soft water medium (FLAMES medium) under controlled conditions in culture chambers; the animals were fed the green algae *Pseudokirchneriella subcapitata*. We determined the sodium chloride tolerance, and the sodium and calcium mixes that allow the survival of *D. pulicaria* in soft water. We found the range of tolerance to salt in soft water to be more than an order of magnitude less than the current acute and chronic limits recommended for freshwater. This indicates that the current recommended levels for sodium chloride may be too high to protect this native *Daphnia* in soft waters.

Oral SCL (General Session)

COMPARISON OF DIFFERENT FUNCTIONAL CLASSIFICATIONS OF THE LAURENTIAN STREAM FISH COMMUNITIES AND THEIR RELATIONSHIP TO LOCAL ENVIRONMENTAL CONDITIONS

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Assessing the relationship between fish density and environmental conditions is useful to identify habitat features contributing to the perpetuation of fish populations. Functional classifications grouping species that share characteristics represents an alternative to single species-environment models and could simplify the development of habitat models. We compared groups of species created on basis of three sorts of characteristics: alimentary, phenotypic, and patterns of co-occurences. Our goal was to find which of these three approaches produced groups with the strongest relationship with local environmental conditions at the mesohabitat scale. The dataset used to answer this question consisted in 51 stream sections of 100 m in length distributed in two watersheds of the Laurentian region of Québec. Visual surveys were performed by 2-3 calibrated snorkellers that swam the river sections upstream while identifying and counting fish of each species and size-classes. We used a combination of Kmeans partitioning, Kendall coefficient of concordance global and *a posteriori* tests, and compared the groupings. The groupings based on the diet and the phenotypic similarities tended to put the size classes of a same species into different groups more often than the grouping based on patterns of co-occurrence, in which the vast majority of the size classes of a same species were significantly associated. Preliminary analyses using redundancy analysis (RDA) between the groups formed by each approach and environmental descriptors suggest that the groups based on diet and phenotypic similarities are poorly related to local environmental conditions, compared to the ones based on patterns of co-occurence.

Oral CCFFR (general session)

OCCURRENCE OF MULTIPLE SHALLOW-WATER MORPHOTYPES OF LAKE TROUT (*SALVELINUS NAMAYCUSH*) IN GREAT BEAR LAKE, NWT

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Sympatric trophic polymorphism is commonly observed among fishes in the Canadian Arctic due to the relaxation of competition and the presence of "empty" niches. The resulting morphological variation can sometimes be subtle but other times it can be large enough to cause the misidentification of morphs. In contrast to other large lake trout lakes, such as Laurentian Great Lakes, which support one or two deep- plus one shallow-water morph, cluster analysis suggests an exceptional case of up to four different lake trout morphs co-existing in the shallow waters of Great Bear Lake (along with a deep-water form). We combined classical morphometric/meristic measures with shape analysis (geometric morphometrics) to quantify morphological differences among shallow-water lake trout from Great Bear Lake. The most important differences among morphotypes are associated with variation in head and fin measurements, whereas body shape variation is less distinctive. These patterns are consistent with many evolutionary adaptations in fish, which involve traits associated with feeding and swimming. Because the extent of variation among morphs might be explained by the timing or degree of their segregation and/or the strength of the selection that contributed to the divergence, we also examined variation among Great Bear Lake's five arms to determine patterns across different regions of the lake. The findings of this research should advance our understanding of trophic polymorphism in northern lakes, and have implications for management of lake trout stocks.

Poster CCFFR (Lake Dynamics in Nearshore Ecosytems)

ROM-TM: A TRANSIENT MODEL OF RIVER ECOSYSTEM OXYGEN METABOLISM

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A transient model (hereafter referred to as "ROM-TM") has been developed to quantify river ecosystem metabolic rates and reaeration rates from field observations of diel dynamics in both dissolved oxygen (DO) and δ^{18}O-DO. An inverse modeling approach is applied in ROM-TM. Key parameters describing the main metabolic processes, the gas exchange process, and the isotopic fractionation process, such as P_m, a, R_{20}, k and a_R, can be abstracted by best-fitting to field data. ROM-TM is programmed using MATLAB (Ver. R2008a). The *fminsearch* function of MATLAB is used to find the best combination of the 5 modeled parameters minimizing the sum of square errors (SSE) between the model fitted curve and the field data. Initial starting points for every parameter in the fitting function can be provided by experience or by pre-fitting using DO data only. ROM-TM uses measured PAR and water temperature and can tease apart two metabolic processes, photosynthesis and respiration and gas exchange all of which contribute to DO change, moreover, ROM-TM has the ability to address some specific issues, such as effects of cloud cover and riparian zone on the metabolic balance, light saturation phenomenon at the ecosystem level, and so on.

Oral SCL (General Session)

TURBULENCE AND TEMPERATURE VARIABILITY IN THE NEAR SHORE BENTHIC BOUNDARY LAYER OF LAKE OPEONGO

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The occurrence of turbulence near the bed of lakes is of critical interest to biological limnologists and aquatic scientists. Turbulent mixing can transport nutrients from lake sediments into the water column and hence enhance the algal productivity in lakes. We report new observations of turbulent mixing in the near shore benthos of Lake Opeongo based upon three high-resolution temperature moorings. We show that unstable temperature profiles (characteristic of mixing events) are strongly correlated with the amplitude of the basin scale seiche, and specifically only occur after periods when there are sustained winds greater than 4 m/s. We determine that the physical process causing the benthic turbulence is shear-induced convection, rather than breaking non-linear internal waves. We use high resolution current measurements to investigate whether there is a critical upslope velocity for a given background temperature stratification before convective instability can occur. Using knowledge of shear-induced convection and our field data we discuss the likely frequency and spatial distribution of pulses of nutrients released into the food web for other lakes on the Canadian Shield.

Oral SCL (Nearshore Ecosystems)

MOVING A SMALL BOREAL LAKE – THE FIRST THREE YEARS POST-RELOCATION

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A small boreal lake (206,735 m^2) was relocated in order to access additional ore body reserves for an open pit mining operation. Under a Fisheries Act Authorization (FAA) a new lake was constructed of similar size and flow regime within the same watershed. The approved FAA for the loss of the lake included not only the construction of physical habitat features in the new lake but also the effective transplanting of various ecosystem components in an effort to simulate the establishment of the aquatic ecosystem and food chain within the new lake. Physical habitat features were constructed within the new lake to address the various life history requirements of the key resident species (yellow perch and northern pike). Construction of the new lake and relocation of the biological community form the former lake occurred over a two year period. The process involved a comprehensive sequential and labour-intensive transplantation of various vegetation and aquatic organisms (plankton, benthic invertebrates, fish). Over 1,400 aquatic plants, 600,000 benthic invertebrates, 200 plankton hauls, 40,000 forage fish and 10,000 sport fish (yellow perch and northern pike) were successfully relocated to the new lake. The aquatic vegetation, benthic invertebrate and fish community were closely monitored for three years post-construction to assess the success of the habitat compensation and ecosystem stability. The success and progress of the constructed habitat and the transferred ecological components will be discussed.

Oral CCFFR (Aquatic Habitats and Fishes)

MOVING A SMALL BOREAL LAKE - WHAT IS INVOLVED? APPLICATION OF A WHOLE LAKE COMPENSATION PLAN UNDER THE FEDERAL *FISHERIES ACT*

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In order for a mine to access additional ore reserves under a small boreal lake (206,735 m^2), the lake had to be removed and relocated. Under a *Fisheries Act* Authorization (FAA) a new lake was constructed as compensation for the loss of the original lake. The approved FAA included not only the construction of physical habitat features in the new lake but also the effective transplanting of various ecosystem components in an effort to stimulate the establishment of the aquatic ecosystem and food chain within the new lake. The new lake was constructed of similar size and flow regime within the same watershed. Physical habitat features were constructed within the new lake to address the various life history requirements of the key resident species. Construction of the lake and physical habitat features was conducted during the winter months over a two year period. The actual relocation of the lake commenced in early spring of 2006 through to early November and involved a comprehensive, sequential and labour-intensive transplantation of various vegetation and aquatic organisms (plankton, benthic invertebrates and fish). Target numbers for each of the transplants were met and well exceeded for each component of the lake relocation. Over 1,400 aquatic plants, 600,000 benthic invertebrates, 200 plankton hauls, 40,000 forage fish, and 10,000 sport fish (yellow perch and northern pike) were successfully relocated. The project represents one of the first whole boreal lakes in Canada to be successfully relocated.

Poster CCFFR (Aquatic Habitats and Fishes)

INTRAINDIVIDUAL REPEATABILITY OF THE ACUTE STRESS RESPONSE IN BLUEGILL SUNFISH (*LEPOMIS MACROCHIRUS)* AND ITS LINKS WITH INDIVIDUAL CONDITION

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Cortisol is frequently measured in fish to assess their response to environmental stressors following the theory that chronic elevation of cortisol is detrimental to individual health and fitness. The physiological stress response displays considerable but poorly understood individual variation. Previous research suggests this variation has strong behavioural and ecological correlates. The currently acceptable and standard protocol in stress physiology is to sample each specimen only once. Following this method, data interpretation must then adhere to the strict assumption that the stress response is repeatable within an individual. Although responsiveness has shown repeatability in laboratory populations of fish, it is rarely tested in wild animals. When explored, results have been varied. Reasons underlying these inconsistencies remain unknown but there is recent evidence that intra-individual variation in hormone titers may be related to individual condition, having implications for standard physiological sampling practices of fish exposed to environmental stressors. By holding wild fish under constant conditions and repeatedly blood sampling following exposure to standardized stressors, repeatability of the stress response was assessed and intra-individual variation examined relative to individual condition indices. Results demonstrate that the stress response is contextually repeatable but intra-individual variation is affected by body condition and recent stress history. These findings highlight the importance of exploring individual variation, provide information essential to further research assessing varying levels of cortisol as a mechanism to explain responses to stress, and will additionally attempt to offer an explanation as to why inconsistencies in repeatability of the stress response may exist within an individual.

Oral CCFFR (Environmental Stressors)

ROUND GOBY (*NEOGOBIUS MELANOSTOMUS*) NEST PREFERENCE AND ATTRACTION TO EGG ODOURS

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The Round Goby is a successful invader, owing to its parental care, colonial breeding habits and broad diet. Parental males guard and maintain fertilized eggs. Whenever parental males leave nests to chase intruders, conspecifics enter nests and consume eggs. Previous studies showed that non-reproductive adult females were attracted to reproductive female odours, owing perhaps to food (egg) odours. Egg odours may be attractants and cannibalism could be adaptive if food resources are limited. We examined the preferences of parental males towards different combinations of nest sizes and openings in a field experiment in Lake Erie. We repeatedly deployed 75 PVC tube nests (in sets of 5) and 40 box nests (2 sizes: 15 cm x 15 cm and 30 cm x 30 cm) with small (3 x 3 cm) and large (6 cm x cm) openings (in sets of 4) from May to August. Males selected nests with small rather than large openings regardless of nest size. Reproductive success (surface area of eggs in nests) was related to male size (R^2=0.21). Using a lab flume, we showed that juvenile and adult (reproductive and non-reproductive) female Round Goby exhibited no preference between conspecific and heterospecific (Rainbow Trout) egg odours when food was withheld. With food, only juveniles preferred conspecifc rather than heterospecific egg odours ($P<0.05$). The notion that non-reproductive females track reproductive females because of egg odours is rejected. Other explanations for the tracking of reproductive females by non-reproductive females may be ultimately linked to copying nest and/or mate choice.

Oral CCFFR (Introduced Aquatic Species)

FISH COMMUNITY RESPONSES TO THE EXPANSION OF EELGRASS HABITAT IN NEWMAN SOUND, NEWFOUNDLAND

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Eelgrass beds are key nursery habitats for marine fish as they provide enhanced growth and shelter. Unfortunately, this habitat is in decline through much of its range. In parts of Newfoundland, this habitat is expanding and provides an opportunity to see if fish communities can recover once habitat is re-established. We seined nearshore fish communities on a biweekly basis through summer and fall over a 14 year time period (1996, 1998-2009), in eelgrass and no-eelgrass sites. Fish communities in eelgrass habitats differentiated significantly from no-eelgrass sites, with fish abundance and biomass being greater in eelgrass habitats for all but two taxa. From 2001 onward, eelgrass habitat naturally expanded to sites categorized as no-eelgrass. Fish communities responded quickly with “no-eelgrass” fish communities quickly resembling “eelgrass” sites. In addition to changes associated with habitat, there were directional shifts in fish communities in both habitat types across the study period. These inter-annual shifts were much more pronounced in no-eelgrass habitat, indicating that eelgrass fish communities may be more resilient to environmental perturbations.

Oral CCFFR (General Session)

A YEAR IN THE LIFE OF *LOTA LOTA*: SEASONAL VARIATION IN CATCH AND REPRODUCTIVE DEVELOPMENT OF BURBOT IN A BOREAL LAKE

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We investigated the variation in catch and annual reproductive cycle of a Burbot (*Lota lota maculosa*) population in Windy Lake (46° 36' N, 81° 27' W) a medium-sized (1111 ha) boreal shield lake in northeastern Ontario, Canada. Burbot (n = 450) were sampled monthly over a full year, and every two weeks in January and February using baited long-lines. Males began to enter spawning condition by mid January, preceding females by about 2 weeks. Spent females first appeared in the catch in early February and the last unovulated females were captured in the third week of February. Ages of spawning fish ranged from 5 to 13 years for both sexes. Gonads grew most rapidly in the fall and peaked in size by January. Males produced gonads as large as those of the females, a trait not seen in other boreal fish species, suggesting that sperm competition is important. With increased female gonadosomatic index there was a reduction in hepatosomatic index and the lipid content of the liver, indicating that energy stored in the liver is integral to female reproductive development. No such trend was evident with males. Catch-per-unit-effort was lowest during the spawning period and highest before and after the spawn. Burbot may use both investment and capital breeding strategies, with the latter potentially being more important for females of this species. This study represents the only documented account of the annual reproductive cycle for a Burbot population.

Oral CCFFR (General Session)

SIZE-SELECTIVE MORTALITY OF WESTERN BASIN LAKE ERIE WALLEYE

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Walleye are ecologically and economically important in Lake Erie. As a top predator, the species influences the lake's foodweb through the top-down cascade control. Walleye is also extensively harvested by both the commercial gear-net fishery and recreational fishery. Commercially harvested walleye may exhibit fishing-induced size-selective mortality—the larger (or faster growing) fish of each age group are harvested from the population more quickly than the smaller (or slower growing) fish. The selection therefore, favors smaller or slowing growing fish within the population. In this study, we tested the hypothesis that size-selective mortality is occurring in the population and attempted to determine the age at which it first occurs. We estimated walleye age and length using scale back-calculation procedures. The scale samples were collected from walleye in the western and central basins of Lake Erie from 2000 to 2008. Representatives of 4 year classes (2000-2003), each covering 6 age groups (age 0-5) were examined. We also tested the hypothesis that mean length of the fish at the age when the size-selective mortality first occurs progressively decreases from the one back-calculated from young fish to that from old fish of the same year class. The study will provide better understanding of impacts of the commercial fishery on the population dynamics and management of walleye in the western basin of Lake Erie.

Poster CCFFR (General Session)

EVIDENCE OF DIEL VERTICAL MIGRATION IN LAKE TROUT

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Lake trout (*Salvelinus namaycush*) is a cold water fish species with high variation in habitat selection. Various factors influence the depth occupancy, such as temperature, oxygen concentration and prey distribution. In addition, at a daily scale, other factors like light levels can play an important role in describing depth distribution. The diel pattern of depth occupancy in lake trout was related to prey distribution for Lake Superior (Hrabik *et al*., 2006; Jensen *et al*., 2006) but a more general pattern of diel migration has not been described for other types of lakes. This study used acoustic telemetry to examine the diel vertical migration of lake trout in lakes that represent different prey availability. Two lakes in Algonquin Park: Opeongo that has cisco as main preferred prey, and Louisa, which lacks pelagic prey and sustains a population of lake trout that feeds on littoral fish and invertebrates. We also analyzed two lakes in Northwestern Ontario, Lake 373, which has *Mysis* as main food source for lake trout and Lake 626, which has yellow perch and littoral minnows. For this study we analyzed a period of 20 days during the summer which represented the warmer period, when temperature differences between the epilimnion and hypolimnion were the greatest for the season.

Oral CCFFR (General Sessions)

BIOLOGICAL SIGNIFICANCE OF THERMAL REFUGIA FOR JUVENILE ATLANTIC SALMON DURING EXTREME HEAT EVENTS IN THE MIRAMICHI RIVER

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Atlantic salmon (*Salmo salar* L.) parr show a behavioural and physiological stress response when water temperature exceeds 23 ^{o}C. Various climate change scenarios for eastern Canada predict that such water temperature thresholds will be exceeded more often. In the current study, we examined *i*) the threshold conditions for initiating behavioural thermoregulation of salmon parr *in situ*, *ii*) how the incidence of temperature stress events and proximity to thermal refugia affect the distribution and abundance of wild, juvenile salmon in a large (>60m wide) river. To answer these questions, the movements and behaviour of 635 individually Passive Integrated Transponder (PIT) tagged 1+ and 2+ Atlantic salmon parr was monitored during two field seasons (summers 2009 and 2010) in the Little Southwest Miramichi River, NB, Canada. The monitoring of movements was carried out in a 11 km river segment where various cold water refugia (seeps, tributary plumes) were identified (from airborne thermal remote sensing) and in relation to a river reach with no available cold water refugia present. In 2009, no salmon parr aggregations were observed in cold water refugia despite maximum daytime water temperatures exceeding 24 ^{o}C for seven consecutive days in mid-August (max. 26.1 ^{o}C); night-time temperatures during the corresponding period were < 23 ^{o}C. In 2010, large salmon parr aggregations were observed (involving 46 % of the PIT tagged fish) in early July when water temperature exceeded 27 ^{o}C in daytime (max. 31 ^{o}C) and remained >23 ^{o}C at night. Concurrently, large scale mortality was apparent in all salmon age classes. Salmon parr aggregations remained in place for three consecutive days when water temperature consistently exceeded ~23 ^{o}C, with the highest numbers of parr observed in mid- to late afternoon. Aggregations of 0+ Atlantic salmon were also observed when the daytime water temperature exceeded 30 ^{o}C. Most PIT tagged parr found in refugia were marked within the same river reach (within 1 km); the longest movements in response to high water temperatures were in excess of 10 km. Temperature differences in refugia ranged from ~ 4 ^{o}C to 18 ^{o}C compared with ambient water temperature. River reaches with no cold water refugia were void of tagged parr during the high temperature events and tagged fish from these areas were observed ~ 5 km up- and downstream. The number of salmon parr in aggregations was dependent on the size of the cold water refugia and ranged from 10-15 fish in small “pocket refugia” along river banks (100 cm^2) to > 10 000 parr in tributary plumes (450 m^2). Dissolved oxygen (DO) concentration remained >7.4 mg/L during high temperature events, suggesting that DO was not a factor for salmon parr to aggregate in cold water refugia.

Oral CCFFR (General Session)

IDENTIFYING HIGH RISK AREAS FOR ESTABLISHMENT OF ASIAN CARPS IN THE GREAT LAKES: A BIOENERGETICS AND FOOD WEB APPROACH

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The potential for invasion into the Laurentian Great Lakes of the Asian Silver Carp (*Hypophthalmichthys molitrix*) and Bighead Carp (*H. nobilis*) is of major concern due to their expected impact on the entire food web. In the Mississippi River system where these carps have established, they now account for more than 90% of the fishes biomass, so given the threat to the $7 billon Great Lakes economy, Canada and the US have formed the Bi-national Asian Carp Risk Assessment program. Asian carps differ from other invading freshwater fishes in that they are an active, large bodied, pump-feeding planktivore that can consume a wide variety of prey. Silver carp are considered phytoplanktivorous, consuming phytoplankton down to 3-4 microns (including cyanobacteria), but also consume a wide range of zooplankton, and while Bighead Carp are considered primarily zooplanktivorous, they also consume algal food. Both carp species are highly opportunistic feeders and will each consume members of the microbial food web. A successful invasion not only requires arrival, but also survival, establishment and spread. Asian Carp range is not likely to be restricted by temperature or water hardness, but rather food resources and spawning habitat. Here we discuss the bioenergetics and food requirements of Asian Carps. High-risk regions within the Great Lakes will be identified that could support establishment based on estimates of primary production, algae, and zooplankton including microbial food web densities.

Oral CCFFR (Introduced Aquatic Species)

USE OF ECOLOGICAL INDICATORS TO ASSESS THE QUALITY OF GREAT LAKES COASTAL WETLANDS

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Over 2000 coastal wetland complexes have been identified in the Laurentian Great Lakes, each providing critical habitat for numerous aquatic and terrestrial species. We evaluated coastal marshes throughout the Great Lakes basin using a suite of published ecological indices developed specifically for coastal wetlands of the Great Lakes *(*Water Quality Index (WQI), Wetland Macrophyte Index (WMI), and the Wetland Fish Index (WFI_{Basin})). We surveyed 181 wetlands, including 19 in Lake Superior (11%), 15 in Lake Michigan (8%), 9 in Lake Huron (5%), 92 in Georgian Bay and the North Channel (51%), 18 in Lake Erie (10%), and 28 in Lake Ontario (15%), over a ten year period (1998-2008). Water quality parameters were measured at every site, and fish and macrophyte communities were surveyed (139 and176 sites, respectively). One-way ANOVA results showed there were significant differences in wetland quality among lakes. According to the WQI, over 50% of marshes in Lakes Michigan, Erie, and Ontario were in degraded condition, while over 70% of marshes in Lakes Superior, Huron, and Georgian Bay were minimally impacted. Lake Huron and Georgian Bay had the highest proportion of wetlands in very good condition and least number of wetlands in a degraded state. The WMI and WFI showed similar results. This is the largest bi-national database of coastal wetlands and the first study to provide a snapshot of the quality of coastal habitats within the Great Lakes basin. We recommend this information be used to guide conservation and restoration efforts within the Laurentian Great Lakes.

Oral SWS (Coastal Wetlands)

PHYSICAL FORCES AFFECT NUTRIENT LIMITATION OF PHYTOPLANKTON IN NEARSHORE AREAS OF LAKES

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Nearshore sediments are a potential source of nutrients to the water column. Under the right conditions, phosphorus and nitrogen are released into oxic waters by diffusion, pumping of sediment porewater and/or resuspension of sediments. Physical forces (e.g. currents, surface waves, upwellings, internal waves) can enhance the exchange of nutrients in nearshore areas, but these effects are difficult to measure directly because bacteria and algae rapidly take up these released nutrients. In this study, I compared the type and extent of P and N limitation in inshore and offshore phytoplankton on 8 days with different wind conditions. The magnitude of nutrient limitation was measured in 3 ways: 1) *in situ* chlorophyll-specific alkaline phosphatase activity, 2) changes in algal growth rates in nutrient addition experiments, 3) suppression of alkaline phosphatase activity in nutrient addition experiments. The type and magnitude of nutrient limitation varied both spatially and temporally in the lake, and were related to wind conditions and site exposure. On windy days, nutrient limitation in offshore phytoplankton was closely related to that at upwind nearshore sites, suggesting rapid exchange of inshore-offshore waters.

Oral SCL (Nearshore ecosystems)

MACROPHYTE COMMUNITIES AS INDICATORS OF AGROCHEMICAL STRESS

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Streams within agricultural watersheds may be under considerable stress due to inadvertent exposure to agrochemicals such as fertilizers and herbicides through run-off and leaching. Macrophytes have the potential to be useful bioindicators of ecological degradation caused by agrochemicals because they are immobile and taxonomically similar to the intended targets of agrochemicals. The macrophyte community was identified at twenty-four sites located throughout an agricultural watershed, the South Nation River watershed, comprising 3919 km^2 in Eastern Ontario. Over 200 species were identified along stream banks and within the stream channels, with sites surrounded by high levels of agriculture tending to have fewer species with a higher percentage of non-native species. The sites varied in terms of their contamination with nitrate and the commonly used herbicide atrazine, with mean spring concentrations ranging from 0 to 6600 µg/L and 0 to 1.34 µg/L respectively. The relationship between macrophyte community structure and agrochemical contamination will be assessed using both species-level taxonomic data as well as trait-based assessments of the macrophyte community composition.

Oral SCL (Environmental Stressors)

ALLOCATION PATTERNS, RELIABLE SIGNALLING AND SPERM QUALITY IN RELATION TO CAROTENOID BASED SEXUAL SIGNALS IN REDSIDE DACE

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In species where males exhibit carotenoid based sexual signals, more intensely coloured males may be signaling their superior ability to cope with oxidative stress. For example, males may be mitigating deleterious oxidative damage to their sperm (which affects their functional fertility) by allocating more carotenoids to their seminal plasma. We used redside dace (*Clinostomus elongatus*), to examine whether their carotenoid based sexual signal (reddish spawning colouration) is a reliable indicator of carotenoid levels throughout their body. We used a reflectance spectrometer and a high-performance liquid chromatography system to: (1) characterize the type of carotenoids found in the flesh, muscle and seminal plasma, and (2) examine allocation patterns (and potential tradeoffs) amongst the different tissues we sampled. We discuss these results in light of honest signaling and sperm competition theory.

Poster CCFFR (General Session)

ROSEWAY BASIN RIGHT WHALE CRITICAL HABITAT: SPACE-TIME VARIATION IN THE PREY-FIELD AND ASSOCIATED WATER MASSES

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Right whales migrate to deep basin feeding habitats of the Scotia-Fundy region in late-summer to feed on diapausing Calanoid copepods. These habitats are of premiere importance to the health and reproductive potential of this critically endangered species because the whales fast throughout winter during their long migration to and from birthing grounds in Florida. A considerable amount of inter-annual variation exists in the number and health of whales returning to each of the two main Scotia-Fundy feeding areas, Roseway and Grand Manan Basins. With this in mind, our research goals are to quantify space-time (x,y,z,t) variation in the right whale prey-field and the associated water mass characteristics in Roseway Basin, estimate the carrying capacity of the habitat, and establish an explicit description of the Roseway Basin Critical Habitat. In addition, we consider how inter-annual variation in the prey-field affects the carrying capacity of the habitat and compare our results to a similar study conducted in Grand Manan Basin. We conducted three oceanographic surveys (2007, 2008, 2009) designed to collect high-resolution, basin-scale estimates of right whale food (*Calanus* sp.*)* concentration and associated water mass characteristics that explain variation in food concentration, particularly at depth. We present the results of these surveys that demonstrate a high degree of spatial and inter-annual variation in the prey-field that is linked to variation in the T-S properties of the water masses.

Oral CCFFR (Environmental Stressors)

LOCAL PHYSIOGRAPHIC CONTROLS ON THE RESPONSES OF ARCTIC LAKES TO CLIMATE WARMING IN SIRMILIK NATIONAL PARK, NUNAVUT, CANADA

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Twenty high Arctic lake and pond sites were sampled for water chemistry and modern diatom assemblages in two distinct physiographic sectors of Sirmilik National Park. Diatom assemblages differed markedly between these two regions as a function of limnological differences between them. Sites on southwestern Bylot Island were warmer, more alkaline, less dilute, had higher concentrations of nutrients, DOC and Chl-a (mesotrophic to oligo-mesotrophic), whereas sites on Qorbignaluk Headland on northern Baffin Island were deeper, very dilute, mostly oligotrophic and lower in pH. Paleolimnological records, spanning >200 years and dated by activity of 210Pb, were produced from each region to compare the responses to the recent warming. Diatom assemblages began to change around 1900 AD at both sites. At Qorbignaluk Headland, large increases in the abundance of planktonic diatoms and marked shifts in diatom community composition have taken place during the 20th century. At Bylot Island, diatom community changes began around the same time, and involve modest decreases in planktonic diatoms, and increases in reconstructed specific conductance, likely because of a decrease in the areal extent of the small lake as a response to warming. The study confirms that responses of freshwater ecosystems to climate warming will be variable depending on local physiographic factors.

Oral CCFFR (Effects of Recent Climate Change)

COMPARISON OF THREE SAMPLING METHODS TO MONITOR ONTARIO STREAM CRAYFISHES

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Populations of native crayfishes in North America are in decline, with 48% of taxa imperilled. Information on crayfish distribution, population sizes and community dynamics in Ontario streams is sparse, and a broad-scale monitoring protocol is needed to provide defensible information on invasive and native species. We compared the efficacy of three sampling methods (electrofishing, seining and hand-picking) to characterize the abundance and size-structure of crayfish populations. For each method, a removal-based sampling strategy was applied at 15 sampling units. Streams sampled represent a range of conductivities (8 to 990 µS/cm), temperatures (5.8 to 25.1°C), and substrate types. Four species were captured during sampling: *Cambarus bartonii*, *Orconectes propinquus*, *O. rusticus*, and *O. virilis*. The non-native Rusty Crayfish, *O. rusticus* was present at 65% of the sampling units and comprised the entire population at four of the eleven stream sites. Hand-picking resulted in depletion more often (47% of sample units) than electrofishing and seining (40% and 33%, respectively), but was more labour-intensive. Mean capture probabilities for stream crayfishes were generally low for all three methods (0.27 to 0.37). Thirty-eight percent of sites showed no descending removal patterns within three to five sampling passes. Seining was the least effective capture method, with no crayfish captured at half of units sampled.

Poster CCFFR (Introduced Aquatic Species)

LONG TERM MONITORING OF LAKE TROUT IN LAKE SIMCOE: DYNAMICS OF STOCKED AND NATURAL POPULATIONS

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The lake trout (*Salvelinus namaycush*) population of Lake Simcoe was nearly extirpated during the 1960's. The population was maintained through a rehabilitative stocking program which continues today, and benefits both the coldwater fish community and the recreational fishery. Naturally reproduced lake trout were observed again in 2001, providing hope of restoring a self-sustaining population. A suite of long-term monitoring program data (1980 onward) will be used to characterise the current status of the lake trout population in Lake Simcoe. Monitoring programs discussed herein include: fall index trap-netting, summer gill netting, as well as angler creel and angler catch surveys. Recent trends in relative abundance and life history characteristics of the lake trout population will be presented, including; catch per unit effort, growth, mortality, year class success, maturation, and reproductive investment. The trends, where possible, will be compared to similar analysis conducted through the previous four decades. Exploratory summaries of naturally reproduced lake trout dynamics will also be presented. The state and trends reported here will provide a baseline for measurable changes of lake trout population relative abundance and life history characteristics in the future.

Oral CCFFR (General Session)

UNDERSTANDING THE CONSEQUENCES OF FISHERIES CAPTURE AND HANDLING ON ADULT MIGRATING PACIFIC SALMON IN THE FRASER RIVER, B.C.

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During their spawning migrations, Fraser River Pacific salmon encounter capture fisheries from the recreational, commercial, and First Nations sectors. Each sector results in direct harvest, but salmon are also released under the assumption that they will recover rapidly from the capture event, resume their migrations, and ultimately survive to reach spawning areas. To test this assumption, stress physiology and telemetry studies were conducted to determine the consequences of capture fisheries and handling on physiology, behaviour and survival. In one study, Fraser River adult sockeye salmon were biopsied or radio-tagged across three treatment groups (beach seine or angling and immediate release, or 24 h recovery from angling in a net pen). Survival to spawning areas for the immediately released groups ranged between 35 and 55 %, but was only 2.9 % for the 24 h net pen and release group. Blood plasma stress indices reflected these survival patterns, where the net pen group showed 4-fold and 2-fold elevations in plasma cortisol and glucose, respectively, and depressed osmoregulatory status relative to fish sampled at capture. A follow-up telemetry study tested methods for promoting physiological recovery from capture using a specially-designed recovery bag. A third study took an experimental approach and looked at the effect of simulated fisheries capture on behaviour and survival. Striking differences among short-term survival following gill net and tangle net simulations, and interesting trends in longer term behaviour and survival were observed. Together, these studies provide greater insight into the consequences of fisheries-related encounters on migrating Pacific salmon.

Oral CCFFR (Capture Fisheries)

INVESTIGATIONS INTO THE EFFECTS OF DECLINING CALCIUM ON FRESHWATER CRAYFISH AND POTENTIAL INTERACTIONS WITH MULTIPLE ADDITIONAL STRESSORS

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The inland waters of the Precambrian Shield are facing an emerging ecological threat due to ongoing declines of various essential nutrients, especially calcium. It is believed that organisms with high calcium requirements, such as crustaceans, may be the first indicators of the negative effects of this phenomenon on aquatic ecosystems. However, very little is known about the calcium requirements of such organisms, or how the availability of calcium may interact with other potential stressors in these aquatic systems. Here we detail a set of complimentary observational and experimental studies investigating the ways in which Ca limitation can affect freshwater crayfish, and potential links between these mechanism and the patterns observed in populations across their central-Ontario range. Based on the findings, we postulate that Ca will increasingly affect the distribution and abundance of crayfish in the future, and that these effects are likely to be interactive in the context of other regional changes.

Oral CCFFR (Environmental Stressors)

ENVIRONMENTAL MEDIATION OF ANTIPREDATOR STRATEGIES IN JUVENILE ATLANTIC SALMON

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Wild fishes have been shown to incorporate multiple sources and types of complementary information into their threat-sensitive behavioural response patterns. Conversely, many recent studies have demonstrated a loss of function in damage-released chemical alarm cues under weakly acidic (pH<6.4) conditions. This effectively deprives prey fishes of an important and reliable source of information on the immediate risk of predation, and represents a non-lethal effect of ambient acidification that may exert substantial stress on affected fish populations. The present multi-year study is intended to address two main questions: 1) are there differences in the behavioural response patterns of juvenile Atlantic salmon in nursery streams of varying acidity exposed to different combinations of complementary chemical and visual predator cues, and 2) do these behavioural differences result in measurable effects (e.g. decreased survival or growth rates) at the population level? Results indicate that fish deprived of chemical information display significantly greater responses to visual cues than fish in neutral conditions, and that mean magnitudes of response to multiple complementary cues in neutral streams do not differ from the magnitudes of response to solitary visual cues in acidic streams. Moreover, it appears that the more risk-aversive strategies displayed under weakly acidic conditions are sufficient to counter the loss of chemical information and do not result in differences in growth rates or survival between populations residing in streams across a range of acidity.

Oral CCFFR (Environmental Stressors)

SIZE-MEDIATED RESPONSE TO PUBLIC CUES OF PREDATION IN A TROPICAL STREAM FISH

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Many different forms of information are publicly available to capable receivers, including damage-released chemical alarm cues. Released alarm cues are typically viewed as having two potential functions: conveying information on immediate predation risk (prey guild members), and enhancing the probability of individual survival by attracting secondary predators (interference). Whether a receiver interprets alarm cues as predatory or foraging stimuli has been shown to result from differences between ontogenetic stages of the cue sender and receiver. However, it remains unknown how receivers of different size from a species with simple life history and undifferentiated ontogenetic stages respond to cues of common origin. In order to investigate any size-dependent differences between responses, wild-caught Trinidadian jumping guabines (*Rivulus hartii*) of varying sizes were exposed to chemical alarm cues extracted from the skin of conspecifics or heterospecifics guppies (*Poecilia reticulata*) in a series of laboratory trials. In response to conspecific alarm cues, *R. hartii* subjects across the range of body sizes tested exhibited consistent, size-independent antipredator behaviours that were characterized by decreased swimming activity and foraging levels and increased refuging. Conversely, focal *R. hartii* demonstrated significant size-dependent trends in response to heterospecific alarm cues, with smaller individuals exhibiting antipredator responses and larger individuals shifting their behaviour to increased levels of activity consistent with a foraging or predatory response. These results show that the size of individual *R. hartii* receivers mediates the information conveyed by and behavioural response to public chemical alarm cues from heterospecifics.

Poster CCFFR (General Session)

ARE THERMALLY SENSITIVE SLOPE WATER FISHES CLIMATE CHANGE CANARIES? RESPONSES TO THE NORTH ATLANTIC OSCILLATION

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Aquatic species that live within narrow temperature and depth limits should be sensitive indicators of climate influences. In the mid-Atlantic Bight, Northwest Atlantic, tilefish (*Lopholatilus chameleonticeps*) and the armored searobin (*Peristedion miniatum*) occupy a narrow zone of warm water on the upper continental shelf slope. During an infamous 1882 fish kill, both species suffered mass mortality, apparently due to severe cold water conditions penetrating the upper slope. Recent reconstructions have implicated an extreme negative anomaly of the North Atlantic Oscillation (NAO) as an initiator of the mortality because contemporary negative NAO anomalies induce cold water conditions. However, the potential influence of sub-extreme NAO conditions on the abundances of these shelf slope fishes remains unknown. Using 90 years of tilefish landings and 40 years of ecosystem survey data, we examined whether inter-annual variability in the NAO was related to landings and abundance of commercially targeted and non-target species. Prior to sustained overfishing of tilefish, smoothed time series of tilefish landings and the NAO were positively correlated for 60 years, when landings lagged the NAO by five years. The five year lag may account for the slow growth of tilefish (10 cm per year) and recruitment to the fishery at ~50 cm. Occupied bottom water temperatures and abundances of armored searobin were also positively correlated with the sign of the NAO. These results reveal the influence of the NAO on thermally sensitive slope species via changes in water temperature and illustrate that overexploitation can alter the detection of climate influences on marine fish time series.

Oral CCFFR (Environmental Stressors)

SPERM COMPETITION AND ALTERNATIVE REPRODUCTIVE TACTICS IN CHINOOK SALMON

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Normally, sexual variation is thought of as differences between males and females. However, in the last two decades, research has revealed that there are also significant amounts of sexual variation within the sexes, manifested as alternative reproductive tactics (ARTs). ARTs are common in Pacific salmon, including Chinook salmon (*Oncorhynchus tshawytscha*), which exhibit large guard type males (known as "hooknoses") and small precocious sneaky males (known as "jacks"). We tested the sneak/guard hypothesis as it relates to investment in spermatogenesis in alternative reproductive tactics. The sneak/guard hypothesis predicts that jacks, who always face sperm competition risk, will invest relative more into spermatogenesis compared to hooknose males. In order to test this prediction, a range of sperm related traits were measured in both hooknoses and jacks, including relative testes weight, sperm longevity, sperm density, and sperm velocity. We found that relative testes size and sperm velocity we higher in jacks versus hooknoes. In addition to examining the relative investment in spermatogenesis among the alternative reproductive tactics, we also examined which sperm related traits are relevant in competitive fertilization situations using in-vitro fertilization trials (and subsequent paternity analyses) between hooknoses and jacks.

Oral CCFFR (General Session)

MARKED CHANGES IN SCALED CHRYSOPHYTE ASSEBLAGES IN SIX BOREAL LAKES, NORTHWESTERN ONTARIO, SINCE PRE-INDUSTRIAL TIMES

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Over the past several decades, many boreal lakes across Canada's Precambrian Shield have experienced an increase of taste and odour issues. In these low-alkalinity, nutrient-poor lakes, taste and odour problems are often associated with algal blooms of colonial chrysophytes. Because blooms of colonial chrysophytes have been recorded across a wide geographic area, climate change is hypothesized as one of several factors to be influencing the occurrences of the blooms. Since boreal lakes are affected by multiple regional stressors (e.g. acid rain, development), it is difficult to assess the impact of individual stressors on water quality. Therefore, to better understand the effect of climate change on colonial chrysophyte blooms, relatively undisturbed lakes from the Experimental Lakes Area (ELA), were chosen in order to minimize the influence of watershed disturbance, acidic deposition and fish stocking as complicating factors. Sediment cores spanning the last 200 years were retrieved from six small (<500 ha) ELA lakes, and scaled-chrysophyte assemblages will be analyzed at a sub-decadal from pre-industrial (pre-1850's) to modern times. Each core has been dated using the constant rate of supply model based on measurements of 16 to 20 samples for ^{210}Pb activity. Results indicate that each lake has experienced substantial changes in the chrysophyte community since pre-industrial times, with colonial species showing large shifts occurring over the past several decades. This study will allow for a greater understanding of the effects of recent climate change on water quality in temperate freshwater lakes.

Oral SCL (Effects of Recent Climate Change)

NITROGEN MASS AND ISOTOPE BALANCE OF A NATURAL AND AN ARTIFICALLY FERTILIZED BOREAL SHIELD LAKE

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This research examines the historical and current state of the nitrogen mass and isotope balances of two boreal shield lakes, one artificially fertilized and the other natural, at the Experimental Lakes Area, Ontario, Canada. The artificially fertilized lake has been part of a 40 year nutrient addition eutrophication study. This lake originated as an oligotrophic boreal shield lake which, due to the experimental nutrient loading, has now become a highly eutrophic system that sees annual cyanobacteria blooms in summer. The natural lake remains in an oligotrophic state that provides a reliable reference lake to compare balances with as there is an extensive data set extending back many years. The artificially fertilized lake has seen increasing dependence on nitrogen fixation to supply nitrogen demand due to changes in the external experimental nitrogen fertilization. As a result, the mass and isotope balances of the fertilized and natural lakes should be significantly different. The isotopic balance should provide a clear understanding of the importance of the new fixed nitrogen from the atmosphere by showing the degree to which the algal blooms rely on this nitrogen for their growth. To further illustrate this point, a sediment core from the artificially fertilized lake will be presented to demonstrate the changing ^{15}N isotopic signature over the course of the long term eutrophication experiment and how it relates to nitrogen fixation. It is hoped that this research will provide a better understanding of the controls on eutrophication which will allow for improved management of such systems.

Poster SCL (General Session)

HEATED COMPETITION: HOW CLIMATE CHANGE WILL AFFECT COMPETITIVE INTERACTIONS IN FRESHWATER FISH SPECIES

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Climate change is considered a key threat to the structure and function of ecosystems. One way in which it is predicted to disrupt ecosystem structure is by enhancing the invasiveness of some existing non-native species. One such fish species is the pumpkinseed, *Lepomis gibbosus*, a warm-water species native to North America that is considered the third most successful introduced fish species in Europe. Although invasive in southern Europe, the pumpkinseed is currently considered 'non-invasive' in the UK, but is one of six established non-native fish species recently predicted to benefit from climate warming. Early, unsubstantiated claims from France that the pumpkinseed has been responsible for the decline of native Eurasian perch *Perca fluviatilis*, a cool-water fish, have never been tested. Using heated and ambient temperature experimental ponds, our study examined the competitive interactions between introduced *L. gibbosus* and native *P. fluviatilis*, and how these interactions are likely to change under climate warming conditions. Results indicate that in early summer, when water temperatures were well below the optimal growth temperature for pumpkinseed, perch had a negative impact on pumpkinseed growth. However, in mid-to-late summer, when water temperatures were closer to optimal temperatures for pumpkinseed growth, pumpkinseed appeared to be the superior competitors, impeding perch growth. Overall, the results of our experiment suggest that introduced pumpkinseed may have a growth advantage over native perch in some Continental European countries, where optimal temperatures for pumpkinseed growth are achieved earlier in the year. This is not likely to be the case in the UK unless temperatures increase beyond the 2–3° C predicted by current climate models.

Oral CCFFR (Introduced Aquatic Species)

REMOTE SENSING OF THE HARMFUL ALGAE *ALEXANDRIUM FUNDYENSE* IN THE BAY OF FUNDY, CANADA

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Alexandrium fundyense, a toxic dinoflagellate blooming every summer in the Bay of Fundy, constitutes a health threat to humans through consumption of contaminated shellfish and fish. Physical, biological and optical variables were measured both in situ and in the laboratory in spring and summer of 2007, 2008, 2009 and 2010. The size classes and types of phytoplankton present in the Bay of Fundy at the time of sampling, determined by HPLC pigment data, showed a phytoplankton community dominated by microphytoplankton with a variation in the community structure (dinoflagellates and diatoms). The relationship between the occurrence of *Alexandrium fundyense* and diatoms was investigated from a decadal time-series of remotely sensed data and *in situ* taxonomic counts. Moreover, the optical properties (absorption and fluorescence spectra) of 12 cultures of diatoms and dinoflagellates, including *Alexandrium fundyense,* grown under stable conditions were measured and results will be presented. An *in situ* fluorometer was designed according to the scientific evidence uncovered from the culture work and was used in the field in summer 2010.

Oral CCFFR (Algal Blooms)

PREDICTING THE EFFECT OF WATER LEVEL DECLINE ON CONNECTIVITY OF COASTAL WETLANDS IN EASTERN GEORGIAN BAY, LAKE HURON

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Coastal wetlands of eastern Georgian Bay are known to support critical spawning and nursery habitat for the fish community of Lake Huron. Some coastal wetlands can become hydrologically disconnected (stranded) from Georgian Bay when lake elevation drops below the wetland entrance. Loss of connectivity is undesirable because restricted fish access means loss of critical fish habitat. In addition, hydrologically stranded wetlands have very different water chemistry compared with hydrologially connected wetlands and this may have implications for wetland biota. To predict the effect of water level decline on the connectivity of coastal wetlands in eastern Georgian Bay, we randomly selected 103 wetland complexes (>2 ha in size) between Severn Sound and Key River and visited them during 2010. For each site, we determined the sill elevation and calculated corresponding wetland area. Sill elevations ranged from 162.94 m to 176.06 m above sea level (asl). We calculated total area of wetlands that would become hydrologically disconnected as a function of sill elevations. Wetland area is extremely susceptible to water level changes between 173 and 176 meters (asl), and we estimate that half of the wetlands of eastern Georgian Bay would become hydrologically disconnected with Georgian Bay if water levels dropped to 174.1 m (asl).

Oral SWS (Wetlands)

COUPLED PH-DOC THRESHOLDS GOVERN MERCURY BIOACCUMULATION IN ARCTIC LAKES ALONG A GRADIENT OF PERMAFROST THAWING

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Canada's western Arctic is one of the most rapidly warming places on Earth. In the Inuvik (68°21'54.60" N, 133°42'27.37" W) area, warming has resulted in the expansion of talik beneath lakes; in turn, thaw slumps have formed along the shoreline of many of the thousands of small lakes in the area. We compared total Hg (THg) bioaccumulation (BAF) in macro-invertebrates (mostly *Gammarus*) from lakes having thaw slumps (15 disturbed) to that in lakes without slumps (15 controls). [THg] in water decreased as the degree of slumping increased ($r = -0.60$, $p = 0.019$), yet the [THg] in invertebrates from disturbed lakes was similar to that in controls. However, Hg bioavailability (BAF) was highest in disturbed lakes; that is, the [THg] in invertebrates from disturbed lakes was higher than that in controls in relation to the total amount of Hg in the water. This finding suggests that permafrost thawing in the western Arctic has increased the sensitivity of lake ecosystems to Hg inputs. The CH_3Hg : THg in water was higher in the disturbed lakes (up to 12% CH_3Hg) than in controls ([CH_3Hg]<DL) with this increasing bioavailability in the disturbed lakes. A striking finding was that THg BAF had a threshold response to [DOC] along the gradient of permafrost thawing: the [DOC] threshold was 16 mg/L C for alkaline lakes (disturbed) and 9–10 mg/L C for acidic lakes (controls). The threshold differences were related to varying degrees of competition for oxide exchange sites occurring among ionic Hg and metallic cations (e.g., Fe^+, Al^+, Mn^+) along the pH (slumping covariate) gradient.

Oral SCL (Effects of Recent Climate Change)

POLYCHLORINATED BIPHENYL CONCENTRATIONS ARE INCREASING IN LAKE ST. CLAIR AND LAKE ERIE FORAGE FISH: A RESULT OF THE DREISSENID MUSSEL INVASIONS?

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The production and use of polychlorinated biphenyls (PCBs) have been restricted in North America since the 1970s; yet, PCBs are still detected in all components of the Great Lakes ecosystems. Our objective was to determine how total PCB concentrations in spottail shiner (*Notropis hudsonius*) changed over the period 1975–2007 in the lower Great Lakes region. Trends were best described by three basic models: (1) piecewise models where concentrations followed a decreasing trend before the break point (*T*) and an increasing trend post-*T* (Lake St. Clair, eastern Lake Erie, and upper Niagara River sites); (2) piecewise models where concentrations decreased both pre- and post-*T* but where the rate of decline post-*T* was less than that pre-*T* (western Lake Erie and Niagara River's Tonawanda Channel sites); and (3) linear models where concentrations declined at a constant rate across the entire temporal range (lower Niagara River and western Lake Ontario sites). Piecewise models best described the trends in shallow areas that are susceptible to full water column mixing whereas constant-slope models best described trends in deeper areas. For piecewise models, *T* typically occurred during the years 1988–1992. Two events coincided with this timing: (1) the dreissenid mussel (*Dreissena* spp.) invasions and (2) a shift towards warming summer temperatures. It appears that dreissenid mussels have played a major role in altering temporal PCB trends in Lake St. Clair and Lake Erie.

Poster SCL (Environmental Stressors)

POPULATION ASSESSMENT AND BIOLOGICAL CHARACTERISTICS OF ANADROMOUS NORTHERN FORM DOLLY VARDEN (*SALVELINUS MALMA MALMA*) IN THE YUKON TERRITORY AND NORTHWEST TERRITORIES

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Dolly Varden is a culturally important species for Inuvialuit and Gwich'in peoples. There are six confirmed populations of anadromous Dolly Varden in Canada that contribute to a mixed stock fishery along the Beaufort Sea coast. Additionally, harvesting occurs in the Mackenzie River Delta targeting Dolly Varden primarily from the Rat River. With the exception of the Rat River, assessment information for other populations is outdated. With the recent creation of an integrated fisheries management plan for northern form Dolly Varden in Canada we have begun to develop a standardized, comprehensive approach for assessment of these populations. Our approach expands on existing methods used in the Rat River to improve the quality and utility of the data. We are conducting multiple mark-recapture studies where fish are tagged during the fall at spawning/overwintering areas over two consecutive years and recaptured the following year at the same location allowing us to obtain multiple abundance estimates, survival and mortality rates, along with information on growth, movements and maturity cycles. Biological data collected during tagging studies include length, sex and maturity. Additionally, DIDSON sonar is being used to enumerate populations concurrently with mark-recapture events to help validate abundance estimation methods, and obtain information on the return migration. Future assessments will continue using data collected from existing harvest-based monitoring programs and a new program to obtain catch and biological information along the Beaufort Sea coast. Results from research activities in the Rat, Big Fish and Babbage rivers in 2009 and 2010 are presented.

Poster CCFFR (General Session)

LAKE FOOD WEBS IN THE NORTHWESTERN CANADIAN TUNDRA - CAN CLIMATE INDUCED PERMAFROST THAW SLUMPING AFFECT FISHERIES HABITAT?

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Climate Variability and Change (CVC) in the Arctic is expected to have impacts on the hydro-ecology of freshwater ecosystems. Changes in the physical and chemical environments of the landscape and related aquatic habitats, and alterations to the processes that act on freshwater ecosystems are expected. The effects of such changes on structure and function of Arctic lake food webs are not well understood. Trophic controls (top-down vs. bottom-up) within the lakes are thought to determine this structure. Top-down control through fish has not been assessed in the study lakes and very little is known about the exact role that fish play in the overall food web structure. To address the question, we conducted a fish food web survey in 26 tundra lakes in the Northwest Territories. The three objectives were: the characterisation of the aquatic food web using stable isotope signatures of $\delta^{15}N$ and $\delta^{13}C$), 2) determine the relative importance of top-down vs. bottom-up controls within the food web, 3) explain fish community composition or absence of fish using lake- and landscape-specific factors. Collection methods included netting, trap sets, electro-fishing, angling, zooplankton tows, and sampling of benthic invertebrates. We present results of our fish survey and food web characterization that provide evidence of top-down control affecting the food web structure in certain fish-bearing lakes, but not conclusively in others. We also discuss the importance of lake morphology, connectivity to the nearest fish bearing lake and other lake- and landscape-specific factors that could be affecting fish community establishment and distribution in the context of past, present, and projected CVC in the region.

Poster CCFFR/SCL (Effects of Recent Climate Change)

CHANGES OVER TIME OF ORGANO-CHLORINE AND METAL BASED CONTAMINANTS IN FISH

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The Turkey Lakes Watershed, in Northern Ontario, has been the subject of intensive research into the effect of anthropogenic perturbations on the biota (aquatic and terrestrial) since 1979. Three species of fishes (Burbot, Brook Trout, and White Sucker) were analysed for organo-chlorine (OC) and metal based contaminants at various times over a 20 year period. Contaminant levels in precipitation, available from Environment Canada, were examined and compared with fish contaminant levels for trends. Generally, OC and metal contaminant levels in both fish and precipitation have been decreasing since the mid 1990's. The effect this decrease may have had on overall fish populations will be discussed.

Oral CCFFR (General Session)

MATE CHOICE AND SEXUAL CONFLICT AFFECT GENETIC COMPATIBILITY AT IMMUNE GENES IN CHINOOK SALMON

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Capture fisheries contribute to a multi-billion dollar global salmon trade, but many stocks are suffering from dwindling returns or have been extirpated entirely. Perhaps surprisingly, many aspects of natural breeding in salmonids, including the role of mate choice in promoting offspring genetic quality, are poorly understood. This lack of knowledge may be hindering the effectiveness of artificial breeding programs that aim to protect and supplement wild salmon. Here, we used observations of Chinook salmon in semi-natural spawning channels to explore the role of mate choice in promoting genetic quality. We found that females prefer mates that increase the genetic diversity of their offspring at the immune genes of the Major Histocompatibility Complex (MHC). Increased MHC diversity has been shown to improve resistance to a broad range of pathogens, and, based on other studies, the increase in diversity could lead to a 10% increase in survivorship for the offspring of choosy Chinook females. Females expressed this mating preference by directing aggression predominantly towards MHC similar males. Interestingly, in strongly male-biased populations, aggressive males were able to circumvent female choice, reducing the genetic diversity at the MHC and any potential genetic benefit in immunity. Our data suggest that incorporating aspects of mate choice into breeding programs can promote genetic quality and may help to improve the success of artificial breeding programs.

Oral CCFFR (General Session)

AN UNPRESIDENTED INCIDENCE OF TILAPIA MASS MORTALITY DUE TO STREPTOCOCCUS INFECTION IN THE WHITE NILE AT JEBEL AULIA DAM, SUDAN

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In aquaculture ponds and natural water streams pathogens including bacteria, fungi, and parasites are always present, but a healthy fish's immune system prevents them from becoming a problem. However, stress weakens fishes' immune systems and lead to infection by bacteria, etc. That was what happened when a consultant working for an international organization transported 60,000 live tilapia fingerlings, crowded in fiberglass water tanks and without following the transport technological and acclimatization procedures, released the live fingerlings in the White Nile at Jebel Aulia dam, Sudan, during June 2010 when the water level was low and temperature above 25C. As a result, about five tons of tilapia 25-700 grams died after a week along 40 kilometers. This mass mortality of only tilapia species caused confusion and affected Khartoum fish market as consumers abstained from buying fish.
Laboratory water analysis and examination of infected fish showed no harmful effects due to pesticides and heavy metals but, high levels of bacteria. Clinical signs of affected fish included anorexia, lethargy, skin melanosis, hyperemia and pectoral hemorrhages in the anal region and over the fins, hemorrhagic and necrotic lesions involving the skin, exophthalmia with periocular hemorrhages, corneal opacity and an erratic spiral swimming motion, a curved body with abdominal distention. At autopsy, the spleen, kidney and liver were swollen and the abdominal cavity contained bloody exudates. These were typical signs of streptococcal infection. This paper reports the details of this unfortunate incidence and what should be undertaken to avoid similar ecological catastrophes in the future.

Poster CCFFR (Environmental stressors)

EFFECT OF EXPERIMENTAL DEEPENING OF THE THERMOCLINE ON FISH COMMUNITY BIOMASS AND TROPHIC ECOLOGY

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A SolarBee® lake mixer was used to deepen that thermocline (from 4 to 7.5m) in one basin of a small (18ha) three basin lake (Lac Croche) to test the effects of changing wind speed and other climate factors on fish habitat use and trophic interactions. Prior to the manipulation in 2008 the experimental lake had a small reproducing lake trout population even though the hypolimnion was anoxic (DO <1ppm below 5m) throughout much of the year. The fish community was dominated by creek chub, brown bullhead and white suckers. After installation of the mixer the thermocline set up at 4, 6 and 7.5m in the 3 basins. In 2009 we used depth stratified sampling procedures (Nordic method) to assess effects on the fish populations. The community fish biomass increased with thermocline depth and the decreased zones of anoxia. Changes in creek chub abundance were responsible for the significant increase in fish biomass. Stable isotope (^{13}C, ^{15}N) analysis showed that creek chub exhibited changes in trophic niche dimensions indicative of potential changes in both diet and trophic position.

Oral SCL (Effects of Recent Climate Change)

INFERED INFORMATION NETWORKS IN A COMMERCIAL FISHERY USING VESSEL MONITORING DATA: FISHING PERFORMANCE AND VESSEL ASSOCIATION

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The harvest of fish begins with the acquisition of information and culminates with their capture. Information may come from previous sets, previous seasons, other fish harvesters, or government agencies. The quality and dynamics of fishery information could impact the performance of individual vessels and ultimately the relationship between nominal fishing effort and fishing mortality. However, we have little data on actual or potential information exchange in most commercial fisheries. Vessel monitoring systems (VMS) provide regular records of the geographical position of entire fleets throughout a fishing season. Though usually employed to monitor regulatory compliance, the data generated also allows the detailed spatial examination of fishing activities. Here, we develop a procedure using VMS data to infer network structure among fishing vessels and then we examine the relevance of this network to individual vessel performance. Vessel activities throughout the season are inferred from VMS records based upon a Gaussian mixture model. A network is constructed based upon vessel proximity while fishing. Vessel performance is estimated by the value of the annual catch standardized by days fishing, vessel horsepower, and non-fishing time at sea. Our spatially inferred network demonstrates behavioural differences among individual vessels that will be relevant to their realized fishing power. This has implications for the interpretation of catch rate time series, the choice of "index vessels" to monitor catch rate, and fishery management through the targeted regulation or removal of specific vessels from an active fleet.

Oral CCFFR (Capture Fisheries)

GENETIC STRUCTURE AND GENE FLOW AMONG POPULATIONS OF THE THREATENED EASTERN SAND DARTER (*AMMOCRYPTA PELLUCIDA*) IN TWO CANADIAN RIVERS

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Habitat fragmentation, caused by anthropogenic or natural processes, can have negative impacts on persistence of populations as it increases geographic distances between them. Increased geographic distances can reduce gene flow among populations leading to genetic isolation. Also, when population sizes are low, increased negative genetic impacts of isolation on populations can result in population extirpation. Eastern sand darters (*Ammocrypta pellucida*), have a high dependence on fine, sandy substrates, and this combined with their critically small population sizes causes major conservation concerns for this species. This study focused on determining the genetic structure and estimating gene flow of eastern sand darter populations from two neighbouring Ontario watersheds, the Thames and Grand Rivers. Our study analyzed the genetic composition of eight populations of eastern sand darters using 10 recently developed microsatellite loci. Allelic richness was tested for each population to determine genetic diversity and pairwise F_{ST} results showed high genetic differentiation among populations of the same watershed. Analysis of molecular variance showed that a higher proportion of the genetic variation was attributable among populations within watersheds, rather than between watersheds. These results suggest a high level of isolation in the populations of eastern sand darters, especially within the Thames River. Understanding the genetic structure of populations and ultimately gene flow between populations is important in determining the conservation status of a species. The high level of genetic differentiation in Canadian eastern sand darters warrants conservation actions that are appropriate for the population level rather than watershed levels.

Oral CCFFR (Environmental Stressors)

MOLECULAR PHYLOGENY OF THE FAMILY LEPISOSTEIDAE

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The family *Lepisosteidae* is an ancient group of fishes found exclusively in the western hemisphere. The family consists of seven extant species in two genera (*Lepisosteus* and *Atractosteus*), ranging from southern Canada into Central America. Despite the broad range of the family this remains a relatively understudied group of fishes. We present a phylogeny of the family based on published molecular sequences. Mitochondrial gene sequences for cytochrome b and cytochrome oxidase I were downloaded from the genbank database for each species. Sequences for the bowfin (*Amia calva*) were used as an outgroup for the analysis. Sequences were aligned using the computer software MEGA v4. A 285 base pair sequence was used to create a phylogenetic tree based on the neighbour-joining and maximum parsimony methods (bootstrapped 1000 permutations). Evolutionary relationships and dispersal patterns can be inferred based on the phylogenetic relationships and current distributions of the species. The results of our molecular phylogeny show good agreement with phylogentic trees based on physiological characters. The two species most closely related were *A. spatula* and *A. tristoechus*. *L. osseus* and *L.* oculatus were also closely related to each other. *L. platyrhinchus*, however, tended to group more closely with the members of the genus *Atractosteus* rather that the others in the genus *Lepisosteus*. The information gained through this analysis will add to the body of knowledge for this understudied group of native top predators.

Oral CCFFR (General Session)

ASSESSING THE POTENTIAL RISKS OF FERAL, NON-NATIVE FATHEAD MINNOW *PIMEPHALES PROMELAS* IN EUROPE UNDER CURRENT AND FUTURE PREDICTED CLIMATIC CONDITIONS

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Although a common species as an experimental test animal and in the ornamental pet fish trade (‘rosy red’ variety), the North American cyprinid, fathead minnow *Pimephales promelas*, has rarely been reported as established feral populations. Indeed, besides garden pond populations, feral populations have been reported in four European countries (Belgium, France, Germany, United Kingdom) only, and published data on the environmental biology of these introduced populations is scarce. As fathead minnow is one of six fish species predicted to benefit from [2–5°C] and hydrological variability), there is great need for data on the environmental biology of the introduced populations in order to assess the potential current and future risks associated with this species in Europe. To this end, life-history and back-calculated growth were investigated in two feral populations of fathead minnows discovered in open ponds on a farm near York (England). Introduced over 10 years ago as a contaminant of a consignment of ‘pinhead’ larvae of golden orfe, the ornamental variety of ide *Leuciscus idus*, the fathead populations consisted of naturally pigmented, some ‘rosy red’ specimens, and mixtures thereof. The fish were collected in early May 2009, prior to the onset of spawning, and processed in the laboratory for studies of body morphology, back-calculated growth, diet, and length and age at maturity. The results are discussed in light of previous risk pre-screening analysis of the species, the potential risk posed by the species to inland waters of the UK, and the application of a new tool to assess the potential impact of management options (do nothing, containment, eradication).

Oral CCFFR (Introduced Aquatic Species)

CARP AND CULVERTS: PREPARING TO RESTORE DELTA MARSH, ONE OF THE LARGEST COASTAL WETLANDS IN NORTH AMERICA

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Delta Marsh, on the south shore of Lake Manitoba in central Manitoba, has become highly turbid over the past four decades. There has also been a near-total loss of submersed macrophytes and emergent plant islands from marsh bays, deteriorating water quality and more frequent phytoplankton blooms, and encroachment of hybrid cattails (*Typha X glauca*) into shallow inshore areas. These change are due, we believe, to the stabilization of lake water levels in 1961, increases in nutrient loading from the surrounding landscape, and invasion by Common Carp. A multi-stakeholder restoration project is underway, with the first step, exclusion of large Common Carp, anticipated to begin in 2012. For the past two years (2009-2010), we have been monitoring the size demographics of Common Carp populations moving between Delta Marsh and Lake Manitoba. The purpose is to design barred screens to exclude Common Carp while permitting passage by native species such as Walleye, Northern Pike, and White Sucker. Data on fish passage through experimental screens of varying bar spacing (5 to 8 cm) will be presented, along with information on the timing of fish movement and the size structure of the large fish community in the marsh. We are also monitoring water quality (turbidity, chemistry) and submersed macrophyte distribution as a baseline for evaluating the relative success of Common Carp exclusion at increasing water clarity and permitting reestablishment of marsh vegetation.

Oral SWS (Wetlands)

FISH HOOKS INDUCE COMMUNITY CHANGE

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The habitat heterogeneity hypothesis posits a concordant increase in species diversity with structural complexity. Heterogeneity increases dimensionality and consequently, habitat availability. Fish hooks were installed in estuary sites in the Toronto Harbour to increase structural complexity. Multivariate analyses were applied to electrofishing data to determine the fish assemblage response to the installation of shoals, brush bundles and log cribs. Principle Coordinates Analysis (PCoA), a multivariate method that represents site similarity though distance as a function of species composition, indicated directional change coincident with the fish hooks. Regressions between PCoA site scores and individual species abundances across sites indicated prior to construction, the fish community was composed of cyprinids and centrarchids, while piscivores were absent. However, following the increase in habitat heterogeneity, piscivores were detected in the assemblages. Thus, fish hooks facilitate the persistence of higher trophic levels and are powerful remediation tools.

Poster CCFFR (Aquatic Habitats and Fishes)

SELECTIVE PROPERTIES OF TRAPS FITTED WITH PLASTIC BARRIERS IN THE SOUTHWESTERN GULF OF ST. LAWRENCE SNOW CRAB (*CHIONOECETES OPILIO*) FISHERY

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This study examined the selection of snow crab (*Chionoecetes opilio*) in traps fitted with plastic barriers (i.e., collars) designed to reduce the by-catch of white shell, soft shell, and sub-legal size hard shell male snow crab. The extended SELECT (Share Each LEngth's Catch Data) analysis method was applied to fishing effort data from a traditional trap, traps fitted with 12, 18, and 24 cm high collars, and a small mesh control trap. Symmetric logistic and asymmetric Richards equations were used to express selectivity curves with logistic, Richards, and split p-parameters of each trap-type and shell hardness category in the SELECT model calculated by the maximum likelihood method. Model preference was based on likelihood ratio tests and Akaike's Information Criterion (AIC). Selectivity analyses indicate the capture of snow crab in collared traps is influenced by body size (i.e., carapace width; CW) not shell hardness. Selectivity curves indicate no improvement over the traditional trap in carapace width at 50% retention (CW_{50}) with the addition of a 12 cm collar. Estimates of CW_{50} increased with an increase in collar height for all shell hardness categories and exceeded the minimum legal size (i.e., $CW_{50} > 95$ mm) in the 18 and 24 cm collar traps. This contributed to a 36-67% reduction in CPUE of legal size crab. It is concluded that plastic collars are not a suitable barrier to soft or white shell snow crab while loss of legal size crab with increased size selectivity of 18 and 24 cm collars precludes the utility of collar traps to reduce by-catch of sub-legal size crab.

Oral CCFFR (Capture Fisheries)

DEVELOPMENT OF AN EGRESS WINDOW TO REDUCE THE CAPTURE OF SUB-LEGAL SIZE WAVED WHELK (*BUCCINUM UNDATUM*) IN CONICAL TRAPS

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The objective of this study was to develop a means to reduce the capture of sub-legal size waved whelk (*Buccinum undatum*) in small mesh (51-64 mm) conical traps. To achieve this, egress windows were incorporated above the bottom ring of a trap to produce openings of sufficient width to allow sub-legal size whelk to be released as a string of traps is being hauled to the surface. Analysis of the passage of sub-legal size whelk through three egress window sizes revealed that a 30 mm wide window was most suitable. Trap selectivity experiments that simulated a vertical surge in a controlled environment were carried out with a 23.7 kg sample of waved whelk of which 32.5% was sub-legal size (<63 mm shell length). Selectivity experiments revealed that when a trap with 30 mm wide egress windows is oriented at an angle of 40-45º from horizontal an average of 29-36% of the sub-legal size whelk can be removed during simulated two minute vertical surge duration and vertical surge distances of 0.3-1 m. Low percentages (3-4%) of legal-size whelk were emitted when the trap was oriented at 40-45º and all whelk were observed to pass through the egress window. Increasing the angle of the trap to 70-75º resulted in whelk being emitted through the entrance on top of the trap. To avoid loss of whelk through the entrance it is recommended at sea testing be conducted by affixing traps to the mainline so that they hang at an angle of 40-45º during haul back.

Poster CCFFR (Capture Fisheries)

BEHAVIOURAL AND PHYSIOLOGICAL CONSEQUENCES OF A NATURAL STRESSOR: IMPLICATIONS OF NEST PREDATION PRESSURE

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Predation pressure is considered an important selective force able to influence the behaviour, morphology and physiology of prey individuals. Our work focuses on nest predation pressure in a species which provides parental care, where it is not the parent who faces immediate predation threat but vulnerable offspring. Our research sets out to examine the individual and intergenerational consequences of nest predation pressure using the smallmouth bass as a model. We have collected data on 6 populations of nesting smallmouth bass over a 3 year period. Our research has shown that nesting males from lakes of high predation pressure are more often engaged in behavioural antipredator activities and have overall higher activity levels than males from lakes of low predation pressure. The behavioural implications for larvae are more complex but the quality and size of parents seems to play a key role. Furthermore, recovery following a simulated predator attack was influenced by predation pressure, where larvae from sites with high predation pressure had lower active metabolic rates and recovered more quickly from exercise than larvae from sites of low predation pressure. Together, our work shows that a natural stressor can have significant behavioural and physiological implications for both parents and larvae of a nest-guarding species.

Oral CCFFR (Environmental Stressors)

THE INTERPLAY BETWEEN LOCAL ENVIRONMENTAL CONDITIONS AND ALLEE EFFECTS IN DETERMINING THE POPULATION GROWTH AND ESTABLISHMENT OF A ZOOPLANKTON SPECIES IMPACTED BY A REGIONAL STRESSOR

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Several factors are thought to influence the fate of small populations, including resource and habitat availability, dispersal levels, interspecific interactions, mate limitation, and demographic stochasticity. Recent field studies suggest that Allee effects resulting from mate limitation can prevent the reestablishment of sexual zooplankton species following a disturbance. In this study we explore the interplay between Allee effects and local environmental conditions in determining the population growth and establishment of two acid-sensitive zooplankton species that have been impacted by regional anthropogenic acidification. We conducted a factorial design field experiment to test the impact of pH and initial organism densities on the per capita population growth (r) of the sexual copepod *Epischura lacustris* and the seasonally parthenogenetic cladoceran *Daphnia mendotae*. The results of our field experiment demonstrated that local environmental conditions can moderate the impacts of Allee effects for *E. lacustris*: Populations introduced at low densities had a significantly lower r at pH 6 than at pH 7. In contrast, r did not differ between pH 6 and 7 environments when *E. lacustris* populations were introduced at high densities. *D. mendotae* was affected by pH levels, but not by initial organism densities. Our study indicates that environmental conditions and mate limitation can interact to determine the fate of small populations of sexually reproducing zooplankton species. If a more rapid recovery of acid-damaged zooplankton communities is desired, augmentation of dispersal levels may be needed during the early phases of pH recovery in order to increase the probability of establishment for mate-limited zooplankton species.

Oral SCL (Environmental Stressors)

THE EFFECTS OF TURBIDITY ON THE BEHAVIOUR AND PHYSIOLOGY OF ENDANGERED PUGNOSE SHINER (*NOTROPIS ANOGENUS*) AND CONGENERS

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Increasing turbidity in aquatic ecosystems associated with deforestation and near-shore development, is a key environmental stressor for freshwater fishes worldwide. In Canada, the persistence of the Endangered Pugnose Shiner, *Notropis anogenus*, is potentially threatened by this stressor, yet we know little about how increases in turbidity influence their behaviour, physiology, and ultimately their fitness. We tested for sub-lethal impacts of turbidity on the behaviour and physiology of adult Pugnose Shiner and the closely related Blackchin Shiner (*N. heterodon* – not at risk). We used a progressive acclimation experiment, in which turbidity was increased from 0 to 10 NTU over a 16-day period, and behavioural observations were recorded daily to assess school cohesion and activity levels. Results suggest that increased turbidity leads to a breakdown in social cohesion (reduced schooling behaviour) of the Pugnose Shiner under relative low turbidity (~10 NTU). Schooling behaviour of Blackchin Shiner was less affected. These results were obtained using very low levels of turbidity compared to those found at historical Pugnose Shiner locations, suggesting that even minor environmental disturbance may be detrimental. Ongoing studies of critical swimming speed in shiners acclimated to low and high turbidity will be used to detect effects of turbidity on swim performance. Together, these studies will contribute to the recovery strategy for Pugnose Shiner and other threatened freshwater fishes by identifying thresholds of turbidity that affect behaviour and performance.

Oral CCFFR (Environmental Stressors)

THE EFFECT OF MAYFLY (*HEXAGENIA* SPP.) BURROWING ACTIVITY ON EGG HATCHING AND SUBSEQUENT NYMPH DEVELOPMENT

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Hexagenia are burrowing mayflies commonly found in soft sediments of shallow waters. The ecological and evolutionary dynamics of *Hexagenia* can be influenced by resting eggs hatching from sediments. Eggs require oxygen (2 mg/L) and warmth (>8^{o} C) to hatch. However, eggs are found buried beneath the sediment surface, where anoxia stops development. Bioturbation, resulting from burrowing activity of nymphs, may cause egg burial and lead to developmental arrest or increased mortality in the cohort. Alternatively, it could cause the subsequent return of eggs to upper layers where development resumes. To study the role of bioturbation on egg distribution and hatching, eggs were placed in aquaria lacking or containing burrowing nymphs. The proportion of unhatched to hatched eggs at different depths was measured repeatedly over time to determine hatch timing and success. We quantified early instar nymph development by measuring hatchlings' head widths and body lengths. Preliminary results support our hypothesis that burrowing activity would bury eggs, reduce hatching incidence, broaden the range of hatching times, and cause wider size frequency distributions in hatchlings. This could explain the formation of the multiple cohorts that are such a common feature of *Hexagenia* populations. While, eggs have evolved traits allowing them to survive extended periods of burial and therefore increase likelihood of survival in suboptimal conditions, nymphal egg burial may be an evolved behavior, reducing competition in subsequent life stages.

Oral SCL (General Session)

INVESTIGATING THE ROLE OF THE ST. ELIAS ICE FIELDS IN MODULATING REGIONAL CLIMATE IN THE SOUTHWEST YUKON TERRITORY

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Northwestern North America is one of the most rapidly warming regions of the world, with average temperatures rising at approximately three times the global average. Along the southwest margin of the Yukon Territory lies the Wrangell-St. Elias Ice fields, the world's largest, non-polar, glaciated region. The few paleoclimate records produced from this area have recorded relatively complacent climate trends compared to other high-latitude/high altitude sites. We hypothesize that these cryospheric features have moderated regional climate warming. We present Holocene-scale diatom and chironomid stratigraphies and temperature reconstructions for a lake located 20 km from the glaciers. Both the biological indicators were found to be relatively stable over the period of recent climatic change, but have undergone major shifts over the Holocene. With global ablation of the "permanent" ice features, recognizing the role they play in local- to regional-scale climate processes is important. This work provides valuable regional data for downscaling global climate models, and for the development of comprehensive adaptation strategies in the Yukon.

Poster SCL (Effects of Recent Climate Change)

ENVIRONMENTAL RISK ASSESSMENT AND ADAPTIVE MANAGEMENT IMPLEMENTATION IN LAKE SIMCOE: A BAYESIAN APPROACH

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The historical water quality character of the Lake Simcoe has been changed by anthropogenic influences and the need to integrate environmental concerns with socioeconomic values required robust modeling tools. As part of these efforts we developed a network of eutrophication models to represent the vertical water quality profiles depicting the complex interplay among hydrodynamics, chemistry, and biology of the Lake Simcoe and its major segments – Kempenfelt and Cook's Bays – in order to reveal the major causal connections among phosphorus loading, sediment-water interactions, and plankton community response.

The parameterization of the models is performed with Bayesian inference techniques which allow rigorous assessment of uncertainty associated with the exogenous loadings, the model structure and parameters. The network of models are used (i) to elucidate the key factors responsible for the occurrence of phytoplankton blooms; (ii) to assess the exceedance frequency and confidence of compliance with different water quality standards; (iii) to optimize the sampling design of future monitoring programs of the system; and (iv) to provide a realistic framework that can be regularly updated and therefore serve as a long-term monitoring tool for evaluating the potential effects of a variety of scenarios (e.g. urbanization/land-use changes, climate change, invasion of exotic species, alternative restoration practices) on ecosystem functioning.

Oral SCL (Algal Blooms)

FIGHTERS, NOT LOVERS? INVASION FRONT ROUND GOBY

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It is often reported that successful invasive species often have a generalist diet, wide environmental tolerance, and short generation times. However, the role of behaviour as a factor influencing the invasion process remains hotly debated. Previous research, suggests that more aggressive or bold individuals are more likely to disperse, and thus be more likely to make up the invasion front. Alternatively, individuals on the invasion may be those members of the population that are competitively excluded from the long established areas and therefore will exhibit reduced aggression. In this study, we shed light on this issue by quantifying the levels of intra-specific aggression in the round goby, *Neogobius melanostomus*, an invasive fish that has spread through the Great Lakes with unprecedented speed. Male round goby were collected from the invasion front and from an established population in the Trent River. We size matched fish from each collection site and then staged resource contests (for shelter) between them. Invasion front fish won more contests and tended to perform more aggressive acts overall. Invasion front fish were not more active or bold prior to the contest and the types of aggressive displays used did not differ between fish from the invasion front and from established areas. Our results suggest that competitive and aggressive behaviours promote, not dampen, the spread of invaders.

Oral CCFFR (Introduced Aquatic Species)

THE THERMOCLINE INDUCED MIXING EXPERIMENT (TIMEX): A CLIMATE CHANGE EXPERIMENT

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The TIMEX project involves the experimental alteration of the thermal structure of Lac Croche, a three basin 18 ha oligotrophic lake, to simulate some of the effects of anticipated climate change. A BACI design was used with one reference year (2007) and 3 post treatment years, and a gradient of treatments (0, 1.5, 3.0m thermocline deepening) imposed across 3 basins. Thermocline deepening led to increased overall heat content and bottom temperatures and was associated with increased phytoplankton, benthic invertebrate and fish biomass. PCO_2 and CO_2 flux to the atmosphere greatly increased in the basin with the deepest thermocline. Stable isotope analysis revealed a similar pattern of increased exposure to CO_2 in both fish and mayflies based on depleted ^{13}C stable isotope signatures. Preliminary data suggest major changes in [Hg] also occurred across basins. This ongoing study is now entering the recovery phase.

Oral SCL (Effects of Recent Climate Change)

FISH MOVEMENT AND MIGRATION STUDIES IN THE LAURENTIAN GREAT LAKES: HISTORICAL PERSPECTIVES, MANAGEMENT ISSUES, AND FUTURE RESEARCH OPPORTUNITIES

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Resource management agencies in the Laurentian Great Lakes routinely conduct studies of fish movement and migration to understand the temporal and spatial distribution of fishes within and between the lakes and their tributaries. This literature has never been summarized and evaluated to identify common themes and future research opportunities. We reviewed 107 studies with the goal of summarizing existing studies on the movement and migration of fishes in the Laurentian Great Lakes. The most commonly studied species were lake trout (*Salvelinus namaycush*), walleye (*Sander vitreus*), and lake sturgeon (*Acipenser fulvescens*). Studies relied mainly on mark-recapture techniques with comparatively few using newer technologies such as biotelemetry, hydroacoustics, or otolith microchemistry/isotope analysis. Most movement studies addressed questions related to reproductive biology, stocking, habitat use, and effects of environmental factors on movement. Movement-related knowledge gaps were identified through the literature synthesis and a survey distributed to Great Lakes fisheries managers. Future studies on emigration/immigration of fishes through lake corridors, the dispersal of stocked fishes and of stock mixing were identified as being particularly important given their potential for developing lake- or region-wide harvest regulations and stocking strategies. The diversity of tools for studying fish movement across multiple years and various spatial scales has created opportunities to address key science questions and management needs. Addressing these needs has the potential to improve upon existing fisheries management practices within the complexity of multi-jurisdictional governance in the Laurentian Great Lakes.

Poster CCFFR (General Session)

HOW IS THE WATER? THE CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS WATER QUALITY INDICATOR

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According to Canadians, fresh water is Canada's most important natural resource and water quality is consistently ranked as a major environmental concern. Since 2005, the Canadian Environmental Sustainability Indicators (CESI) have reported on environmental quality in Canada. Built on the CCME water quality index, the CESI Freshwater Quality Indicator provides a ranking between excellent and poor for 165 water quality monitoring sites across Canada. Water quality is ranked by comparing water quality monitoring data to water quality guidelines for 8-10 parameters considered important in each region. Based on data from 2005-2007, water quality in Canadian rivers and lakes was rated "fair" or better at the majority of sites; 39% of sites were rated "good" or "excellent", 43% were considered "fair" and the remaining 18% of sites ranked "marginal" or "poor". Phosphorus is the parameter that exceeds water quality guidelines most often making it a major concern for freshwater quality in Canada. While the indicator does a good job reporting on water quality across Canada, we are still unable to report year–over-year trends. Recent development of a method to calculate confidence intervals for the scores provides hope for a way to say whether water quality in Canada is getting better or worse.

Oral SCL (General Session)

ECOLOGICAL CHANGES DUE TO MULTIPLE ANTHROPOGENIC STRESSORS IN MUSKOKA-HALIBURTON, ONTARIO

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The onset of biological recovery from acidification, the continued influence of climate-driven ecological change and the appearance of novel stressors such as calcium decline, oligotrophication and increased recreational development all play critical roles in shaping the chemistry and biology of lakes in South-Central Ontario. Here we revisit a suite of lakes previously sampled in 1992, which provide a diverse cross-section of the limnological and ecological variability of the region. Using paleolimnological protocols, we compare recent sediments (2007) with surface sediments from 1992. Changes in fossil diatom communities within these sites provide valuable information on the current trajectory of biological change in Ontario shield lakes. During this 15 year period six out of seven key water chemistry variables (calcium concentration, conductivity, dissolved organic carbon, total nitrogen, pH and sulphate concentration) have undergone significant change. These chemical changes have lead to marked biological change in the diatom communities of many of our study lakes. *Cyclotella stelligera, Asterionella formosa, Fragilaria crotonensis, Tabellaria flocculosa* str. IIIp, *Aulacoseira ambigua and Asterionella ralfsii* var. *americana* account for over 50% of the variation between the 2007 and 1992 biological assemblages. Analysis of similarity performed on our 46 lake dataset indicate greater biological change has occurred in the 15 years between sampling periods than occurred between the first sampling in 1992 and preindustrial times (~1850). Given the result we have seen, a recovery to pre-industrial (pre-1850) species assemblages no longer seems a realistic management goal particularly in light of novel stressors impacting the region.

Oral SCL (Environmental Stressors)

LARGE-MAGNITUDE SHIFTS IN EFFECTIVE MOISTURE BASED ON DIATOM AND CHRYSOPHYTE ASSEMBLAGES IN A CLIMATICALLY-SENSITIVE REGION OF NORTHWESTERN ONTARIO

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As a consequence of human-induced climate changes, fluctuations in effective moisture are predicted to intensify, thereby influencing the hydrology of watersheds throughout the Boreal Shield region. To assess lake-level changes over the past two millennia, sediment cores were obtained from in the pelagic zone near the ecotone between pelagic and benthic diatom assemblages (P:B boundary) from Gall Lake, a headwater lake in northwestern Ontario. P:B boundary shifts were reconstructed using a diatom-based inference model developed from 54 surface samples collected across a water-depth transect in Gall Lake. A multi-proxy approach using changes in diatom and scaled chrysophyte assemblages was used to reconstruct changes in the P:B boundary to reconstruct movements associated with drought (i.e. increase in benthic diatom taxa would be associated with either a drop in lake level, or an increase in light transparency) over the last two-thousand years. Chrysophyte analysis provided insight on stratification related to the movement of the P:B boundary. The P:B boundary shift of largest magnitude and longest duration was characterized by increased benthic diatoms, substantially greater diatom richness and diversity (rarefied), and lower abundances of colonial chrysophytes, and occurred during the Medieval Climate Anomaly, a well-known period of exceptionally low effective moisture in central North America. The inferred changes are much greater than changes in this zone during the period of instrumental records, suggesting that this region is more climatically-sensitive than originally thought.

Oral SCL (Effects of Recent Climate Change)

SALINITY IS IRRELEVANT! "LAKE" DYNAMICS IN NORTHUMBERLAND STRAIT, A MARINE NEAR-SHORE ECOSYSTEM

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Northumberland Strait is a stressed, semi-enclosed, marine coastal ecosystem; however, a dearth of quantitative studies has resulted in the lack of baseline data against which to test for changes in ecosystem health. An ambitious four-year research plan (a DFO Ecosystems Research Initiative) was developed in 2007 to quantify the structure of this highly dynamic water body beginning with identification of water masses and currents and progressing through to fishes and large decapod crustaceans. In the first phase, numerical models of movements of water and sediments were developed and are being tested empirically using newly-developed MAPs technology. Aggregate biomass models (e.g., spatially explicit nutrient and biomass pools, size-spectra, biodiversity measures, pelagic and demersal food web) are being developed to describe the mass and flux of nutrients and energy in the Strait for both the pelagic and demersal energy cycles (including potential coupling). The eventual goal is to develop full ecosystem-level models (e.g., mass-balance and nutrient loading/flux) for use in integrated management programs based that must account for fisheries removals and changes in land-use policies.

Oral CCFFR (Nearshore Ecosystems)

THE MOLTING ENZYME CHITOBIASE TO ESTIMATE SECONDARY PRODUCTIVITY IN FRESHWATER ECOSYSTEMS: A REVIEW

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Chitobiase is one of two molting enzymes (the other being chitinase) used to cleave chitin polymers that comprise the exoskeleton of aquatic arthropods. Following molting this enzyme is released into the water and can be quantified by a simple fluorescence assay. The standing activity and it's rate of production has been used as a measures of: 1) secondary production rates; 2) moulting rates; and 3) developmental biomass for entire crustacean zooplankton communities under laboratory and field conditions. Yet, despite its relative methodological ease, chitobiase has only been used sporadically as an ecological tool to monitor and quantify secondary production, especially in freshwater systems. In this paper we reviewed all the available literature pertaining to the use of chitobiase as a measure of secondary productivity and make the following recommendations for future research: 1) current methodologies be further validated, e.g., quality assurance and quality control measures be adopted, enzyme storage conditions and times be experimentally confirmed; 2) the relationship(s) between biomass and standing chitobiase activity and rates of production be elucidated for different types of arthropod communities, e.g., lotic versus lentic systems, planktonic versus benthos dominated systems and; 3) that the variation in activity relative to life history stage and/or body size for different taxonomic groups be characterized in order to examine the impact of stressors in laboratory-based studies and the utility of the approach as a field-based measure of community-level processes. Overall, the use of chitobiase has enormous potential as a tool in understanding secondary production in freshwater ecosystems, but extensive groundwork and validation is still required before it can be widely adopted.

Poster SCL/SWS (General Session)

PHYTOPLANKTON SENSITIVITY TO ULTRAVIOLET RADIATION VARIES AMONG CLEAR AND BROWN-WATER CANADIAN SHIELD LAKES

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Lake DOC content is influenced by precipitation, irradiance, and temperature. Climate change is altering DOC content in lakes: decreases have been observed in some areas (Schindler et al. 1996) and increases in others (Jennings et al. 2010), consistent with the notion that changes will be geographically-specific, responding to regional climate (Zhang et al. 2010). DOC is the principal attenuator of harmful ultraviolet radiation (UVR) in lakes (Morris et al. 1995) and it has been estimated that climate-induced changes in DOC will be more important in determining plankton UVR exposure than changes in stratospheric ozone (Schindler et al. 1996).

We assessed the spectral sensitivity of phytoplankton from 6 Canadian Shield lakes of varying transparency (~2-12 mg/L DOC) to UVR-induced photoinhibition. The maximum quantum efficiency of PSII photochemistry (Fv/Fm) was monitored using a PAM fluorometer during 120-min exposures to irradiance treatments of varying spectral quality and a subsequent 150-min exposure to low PAR. Phytoplankton from clear lakes showed high UVR resistance relative to those from browner waters, particularly in the long-UVAR. Low-PAR recovery efficiency was correlated with UVR resistance, but UVR sensitivity was not strongly related to algal nutrient status. Taxonomic composition varied among lakes and may have been both shaped by, and responsible for, differential susceptibility to UVR stress.

Further work is needed to quantify the relative contributions of physiological acclimation, genetic adaptation and population selection to the observed differences in community UVR sensitivity. It is possible that climate-related changes in UVR transparency could contribute to changes in phytoplankton community composition.

Oral SCL (Effects of Recent Climate Change)

EFFECTIVENESS OF PULSE FLOWS TO INDUCE UPSTREAM MOVEMENT OF AN IMPERILED STOCK OF PACIFIC SALMON IN A SHORT REGULATATED RIVER

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A three-year study was carried out to assess the effectiveness of pulse flows on the upstream migration of a summer-run Chinook salmon population. During the months of July and August, radio-telemetered fish were released into the hydropower-impacted reach of the Puntledge River on Vancouver Island. The goal was to assess whether or not fish moved upstream, ascended natural barriers, moved away from the turbine outlet pool, and had changes in energy-use during pulse flows. Findings indicated that some pulse flows stimulated upstream movement although that was not always the case. Passage of natural barriers was only higher during an abnormal pulse flow where flows reached twice that of the prescribed flow. Some fish moved away from the turbine outlet pool during pulse flows and energy-use was unchanged. Though it is unclear as to the effectiveness of the pulse flows on the Puntledge River summer-run Chinook salmon population, no negative impacts were observed.

Oral CCFFR (General Session)

ECOLOGICAL TEMPERATURE METRICS AS PREDICTORS OF CLIMATE CHANGE IMPACTS ON NORTH AMERICAN FRESHWATER FISH COMMUNITIES

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Habitat temperature is a major determinant of performance and activity in fish. We examined the relationship between six temperature metrics describing the growth (optimal growth temperature and final temperature preferendum), survival (upper incipient lethal temperature and critical thermal maximum), and reproduction (optimum spawning temperature and optimum egg development temperature) requirements of North American freshwater fish species. Our results suggest that all metrics were highly correlated, especially those within each life process. Values for different metrics fell into distinct groups that were associated with thermal preference classes, reproductive guilds, and spawning season. These close associations suggest new ways in which thermal performance data can be used to predict climate change impacts on North American freshwater fish communities.

Poster CCFFR (Effects of Recent Climate Change)

DEVELOPMENT OF A NATIONAL FISH PASSAGE INVENTORY FOR CANADA: CANFISHPASS

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Barriers resulting primarily from anthropogenic activities (e.g., hydropower development, irrigation, flood control, low flow augmentation) can prevent the upstream migration of fish, reducing the connectivity of river systems. As a result, great efforts have been devoted to the design and installation of fish passage facilities to enable the movement of fish across barriers. However, the literature is generally short of scientific papers dealing with fish passage design and effectiveness, making it difficult for those developing fish passage projects to determine which fishway designs are most appropriate for a given system and target species. One approach for providing information to support future fish passage projects is through the development of databases that contain detailed accounts of fish passage facilities. Described here is the development of a national fish passage database in Canada (called CanFishPass) intended to serve as a repository for information that has previously been difficult to find. The database includes detailed information such as the location, engineering details, hydraulic characteristics, and biological effectiveness of the various fish passage facilities, as well as photographs and engineering drawings when available. The database is searchable by species, fishway type, and ecozone, and includes a reference section comprised of both peer-reviewed and "grey" literature. It is anticipated that the database will serve as an important resource for future fish passage development projects enabling quantitative analyses, while also serving as the first inventory of all fish passages in Canada. Although efforts to date have been focused on Canada, the expansion to a global inventory of fish passage facilities would enable opportunities to learn directly from studies in other regions.

Poster CCFFR (Aquatic Habitats and Fishes)

RANGE EXPANSION BY INVASION: GENETIC CHARACTERIZATION OF INVASION OF THE GREENSIDE DARTER AT THE NORTHERN EDGE OF ITS DISTRIBUTION

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The Greenside Darter, until recently a species of special concern, expanded their Canadian range and is now common and wide-spread in the Grand River watershed (GRW). The goal of this study was to genetically characterize the GRW Greenside Darter invasion to identify if population was a human-mediated or natural range expansion. The conservation implications of this difference are substantial: a human-mediated introduction has a high potential for negative impacts on pre-existing species and community interactions, as well as for establishing a population with reduced genetic diversity of questionable conservation value. Greenside Darter were sampled in the GRW, the three known native watersheds in Canada, and one site in Ohio. We estimated population genetic parameters and used genotype assignment to identify likely introduction sources based on eight microsatellite loci. Populations in the GRW showed no evidence for recent or historical population bottlenecks, and the most likely source for the introduction was the Thames River watershed, over 450 km away by shortest water distance. There is also substantial population genetic structure among the sampled sites in the GRW. Thus, the current widespread and abundant distribution of the Greenside Darter in the GRW is not the result of recent expansion of native fish, but likely due to human-mediated introductions into at least three sites in the GRW, followed by rapid population growth. Although the GRW Greenside Darter are introduced, they harbour considerable genetic diversity and represent an important northern range extension for this species.

Oral CCFFR (Introduced Aquatic Species)

EFFICACY OF SEINING TO PROVIDE AN INDEX OF BLACKSTRIPE TOPMINNOW (*FUNDULUS NOTATUS*) POPULATION STATUS

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Blackstripe Topminnow (*Fundulus notatus*) is a small surface-feeding fish, assessed as a species of Special Concern in Ontario and nationally. It was first discovered in Ontario in 1972 and is found in turbid streams and rivers of southwestern Ontario. We investigated the efficacy of single-pass seining to provide an index of population status, as well as providing information to update the current distribution of Blackstripe Topminnow. Effectiveness was evaluated using a removal-based approach at 21 closed and 21 open sampling units. Blackstripe Topminnow were captured at 15 of 16 historic locations and detected in 26 of 42 sampling units. Of those units where Blackstripe Topminnow was detected, it was only captured during the first pass 50% of the time. Detection during the first pass was slightly more frequent at closed sampling units (54%) than open sampling units (46%). Catch data allowed for removal-based population estimates at only 31% of units where the species was caught. Mean capture probability was 0.46. For both open and closed units, length data indicates a selective bias towards larger individuals being captured during the first sampling pass.

Poster CCFFR (General Session)

OTOLITH ISOTOPIC ANALYSIS OF THE AMERICAN EEL (*ANGUILLA ROSTRATA*): ESTIMATING THERMAL HISTORY AND STOCK ORIGIN

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American eel (*Anguilla rostrata*) populations are declining dramatically, best documented by recruitment decreases in the St. Lawrence River system. Increasing temperatures and changing oceanic conditions have been implicated. Otolith isotopic ratios of oxygen are a unique and precise way of quantifying thermal history. Whole otolith solution chemistry and gas source mass spectrometry were used to examine otoliths of young stocked eels (age 1-4 yrs) collected in 2008-2010 and wild eels (age 2-5 yrs), sampled 1976-2009 from the upper St. Lawrence River. Otolith temperatures were compared and evaluated as predictors of estimated habitat temperatures. Mean habitat temperature was calculated for the otolith growing season, using mean daily water temperatures. The first annual increment had a significantly lower temperature (-1.5^{o}C) than habitat temperature; second and third increments were significantly higher (+2.1^{o}C and +3.3^{o}C); while the fourth was significantly lower (-12.8^{o}C) and variable. These age trends in otolith temperature are explained by behaviour, thermal niche, and possibly length of growing season. Age, or amount of thermal exposure, had a greater effect on otolith temperature than body size (growth rate). Otoliths also reflected differences in annual water temperature. Otolith isotopic signatures of δ^{13}C and δ^{18}O enable differentiation between young wild (99% accurate) and stocked (70% accurate) eels (ages 2- 5 yrs). This is produced by differences in thermal habitat and carbon accretion. Stable isotope analysis of otoliths can help us better understand the thermal and ecological associations of eels as well as quantify the importance of rising water temperature on declining abundance and recruitment.

Oral CCFFR (Aquatic Habitats and Fishes)

EXAMINATION OF ECOSYSTEM MANAGEMENT OPTIONS IN HAMILTON HARBOUR USING FOOD WEB MODELING

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Hamilton Harbour is an embayment at the western tip of Lake Ontario. The Harbour was identified as one of the most polluted sites in the Great Lakes by the Water Quality Board of the International Joint Commission in 1985. As a consequence, a multidisciplinary environmental remedial action plan (RAP) to restore the ecosystem health and to maintain the integrity of the local biotic communities has begun. However, the recent invasion of Zebra mussels and Round goby in the Harbour has called into question RAP's target in successfully creating a sustainable, self–reproducing native fish community. To assess the potential for success of the RAP's targets in the areas of fish and wildlife habitat restoration, an energy budget model has been developed using the Ecopath with Ecosim software. Our primary research questions are to examine: (1) to what extent the ecosystem functioning has been transformed by the significant anthropogenic disturbances and the subsequent restoration efforts, and (2) how realistic is the goal to alter the current Harbour ecological state and to meet the objectives of the Hamilton Harbour and Watershed Fisheries Management Plan. Our analysis also argues that any further water quality improvements in the Harbour should be viewed in the context of a combined bottom-up and top-down control.

Oral CCFFR (General Session)

INCORPORATING AN ECOSYSTEM APPROACH INTO THE ASSESSMENT AND MANAGEMENT OF NORTHERN DOLLY VARDEN CHAR STOCKS

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Dolly Varden char in the western Arctic of Canada are culturally important with anadromous stocks having been historically fished in a number of locations. Substantial declines have been observed in two of the six known anadromous stocks. Although these declines were initially believed to have resulted from overharvest, the lack of recovery in some cases, despite fishery closures, coupled with observations of habitat change in spawning and overwintering areas suggest that environmental factors may play an important role in regulating populations in these river systems. In recent years DFO has begun to take a more holistic ecosystem approach and consider other factors in the assessment of fisheries. In this particular case we are developing models of habitat use and availability, and tracking changes in other fish species that coexist with Dolly Varden. We will discuss our approach for integrating this information into our stock assessments to evaluate the relative impacts of harvest versus larger scale ecosystem drivers on population dynamics of Dolly Varden.

Oral CCFFR (Capture Fisheries)

SPATIO-TEMPORAL DISTRIBUTION IN CYANOBACTERIA RECRUITMENT, GROWTH AND BLOOMS IN A OLIGO-MESOTROPHIC LAKE

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Nutrients control potentially toxic cyanobacteria expansion in aquatic ecosystems. Meanwhile, cyanobacteria blooms occurring more and more often in lakes with nutrient limited epilimnetic waters seem unexplained. Only a few studies have investigated cyanobacteria recruitment and growth in an oligo-mesotrophic lake. The aim of this study is to determine which environmental factors control cyanobacteria recruitment, their growth and community structure in a small lake with low phosphorus concentration (<5µg/L) in epilimnion. Cyanobacteria recruitment in water-sediment boundaries of pelagic and littoral habitats was measured with upward traps. Algal distribution was measured with a fluoroprobe and growth with Pulse Amplitude Modulated fluorescence. In the water column, temperature, oxygen and pH profiles were measured with a multiparametric sonde; light with a quantimeter. Discrete samples of water column were collected for nutrient, chlorophyll and specific composition analyses. Water column stability was assessed with temperature variations recorded in the summer with *in situ* thermistor chains. Results show that (1) littoral and pelagic cyanobacteria species recruited are different, (2) algae growth is related to light and stability in water column, (3) phosphorus in hypolimnion allows cyanobacteria to grow in metalimnion.

Oral SCL (Algal Blooms)

PHOTOCHEMICAL MINERALIZATION OF DISSOLVED ORGANIC NITROGEN TO AMMONIA IN PRAIRIE LAKES

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A handful of marine, estuary and river studies have demonstrated that significant amounts of ammonia are produced photochemically from dissolved organic nitrogen (DON). However, the extent of photoammonification processes in lakes is largely unknown. We examined the significance of photoammonification processes in 15 lakes from the Northern Interior Plains of Canada. These lakes represent a broad range in trophic status (total phosphorus range of 5-260 µg L^{-1}) and dissolved organic nitrogen concentration (269 – 1435 µg L^{-1}). Lake filtrate (<0.2 µm) was exposed to artificial ultraviolet radiation (UVR) for four hours (SunTest Solar Simulator, 250 W m^{-2}). Ammonia concentrations, measured immediately after UVR treatment, increased significantly in 8 of the 15 lakes (4 to 92 % increase in NH_3 concentration, 0.84 – 2.85 µg L^{-1} NH_3 was produced). This represented a conversion of 0.18 – 0.3% of the DON pool to NH_3. Ammonia production was also observed in another three of the 15 lakes, but this increase was non-significant. The level of NH_3 production was significantly and positively related to DON concentration. The remaining 4 lakes did not respond to UVR treatment. In summary, these rates of photoammonification are comparable to those found in other aquatic systems.

Oral SCL (General Session)

BEFORE-AFTER-CONTROL-IMPACT APPROACHES TO ASSESSING LAKE AND STREAM HABITAT MANIPULATIONS ON THE BARRENLANDS TUNDRA NEAR LAC DE GRAS, NORTHWEST TERRITORIES

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Availability of quality habitat for all life stages is required for an ecosystem to achieve its potential productive capacity. In compliance with the "no net loss" provisions of the Canadian *Fisheries Act*, Diavik Diamond Mines, Inc. has proposed two compensation projects that will increase habitat quality of small lake-outlet streams and improve connectivity of small lakes to the greater Lac de Gras watershed. As part of a before-after-control-impact design to assess these projects, we are sampling seven lakes and streams for fish, invertebrates, primary producers, hydrology, and habitat characteristics over three years to establish baseline conditions of these systems. Lake fish assemblages consist mainly of arctic grayling (*Thymallus arcticus*), lake trout (*Salvelinus namaycush*), round whitefish (*Prosopium cylindraceum*), burbot (*Lota lota*), and longnose sucker (*Catostomus catostomus*). Because of low, diffuse flows and cascades that obstruct upstream movement of fish from Lac de Gras, streams support few fish. Stream communities are instead diverse assemblages of invertebrates, especially dipterans, crustaceans, Oligochatea, Mollusca, and Hydrachnidia. Stream and lake riparian zones are dominated by boulders, mosses, grasses, forbs, and shrubs. Water quality is similar among streams while all seven lakes are oliogotrophic. After the habitat manipulations are completed in the autumn of 2011, community structure and system productivity will continue to be studied for two years to assess effects on physical, chemical, and biological characteristics of these small, arctic lakes and streams.

Poster CCFFR (Aquatic Habitats and Fishes)

CLIMATE INDUCED CHANGES IN ANNUAL TO SEASONAL PROCESSES CONTROLLING PRODUCTION AT MULTIPLE TROPHIC LEVELS IN OSOYOOS LAKE, BC

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Signature effects of recent climate change in the southern interior of British Columbia include: increased annual and seasonal means of air and water temperature (0.8-1.8 ^{o}C); increased summer wind velocities; decreased average snow-pack; shifts in regional hydrographs involving earlier and proportionately larger peaks of river runoff and increased intensity and duration of seasonal drought. Seasonal production processes in Osoyoos Lake are controlled by alternations between classical, bottom-up nutrient-driven production variations and production variations dominated by riverine discharge. Climate change has induced a string of recent drought years accompanied by changes in Osoyoos Lake that include: reductions to annual phosphorus loading; extended intervals of high surface temperature; increasing epiliminial depth; increased abundance of cyanophytes; reductions in summer water transparency; extended intervals of hypoxia in the hypolimnion; decreased rearing volumes and lower mean fall weights for juvenile sockeye salmon rearing there. GCM projections of future climate change indicate that Osoyoos Lake is likely to become increasingly dominated by bottom-up processes that will alter water quality and pose a significant threat to the persistence of both anadromous and resident coldwater fishes.

Oral CCFFR (Effects of Recent Climate Change)

USE OF OLFACTORY CUES AS REPELLENTS FOR SEA LAMPREY (*PETROMYZON MARINUS*): POTENTIAL DIRECTIONS FOR POPULATION MANAGEMENT

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Sea lamprey invaded most of the Great Lakes in the early 20th century and caused an abrupt decline in the population densities of a variety of native fish species. The integrated management of this invasive species is composed of chemical (lampricide) applications, low head barrier dams, adult trapping and sterile male release. Recently, there has been an increased emphasis on the development of control methods alternative to lampricide applications. We propose as an alternative method the use of olfactory cues as repellents for sea lamprey population management. Based on the available evidence, we suggest that injury-released chemical alarm cues, cues released by predators and chemical deterrents show promise as repellents for sea lamprey and further research should be directed at determining whether sea lamprey show an avoidance response to these types of olfactory cues. From a management perspective, these olfactory cues could be used to restrict sea lamprey access to spawning grounds. Repellents could also be used together with attractants like sex pheromones to manipulate sea lamprey movements, similar to the "push-pull" strategies utilized with insect pests.

Oral CCFFR (Introduced Aquatic Species)

FOOD FOR THOUGHT: WHAT ARE *HEMIMYSIS ANOMALA* EATING IN LAKE ONTARIO AND THE UPPER ST. LAWRENCE?

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Hemimysis anomala, (HA) the bloody red shrimp, is the latest known invader of the Great Lakes basin, having first been recorded in lakes Michigan and Ontario in 2006. Since then HA have been found in all of the Great Lakes except Superior, as well as in several locations along the St. Lawrence River. Sampling has found high density sites in both lentic and lotic environments and noted the ability of HA to integrate into contrasting food webs. As of yet, the food sources consumed by HA and their effects on food web higher trophic levels are unknown. Nevertheless, such information is necessary to accurately assess the impacts of this invader on the Great Lakes ecosystem. Samples of HA and concurrent food web items were collected between 2008 and 2010 from several sites in both Lake Ontario and the St. Lawrence River which were repetitively sampled over the year. Samples were processed for carbon and nitrogen stable isotope analysis to evaluate the diet and trophic position of HA. Mixing models were used to determine the fraction of the HA diet contributed by benthic sources (as measured as periphyton, snails) versus pelagic sources (POM, zooplankton, mussels) at each site. Trophic levels were also compared using baseline corrected $\delta^{15}N$ values for each site. Analyses have shown some significant differences between the populations studied in the St. Lawrence and Lake Ontario, including differences in reliance on benthic and pelagic carbon sources, as well as differences in $\delta^{15}N$ values relative to a site specific baseline.

Poster SCL (Introduced Aquatic Species)

DIFFERENCES IN ANTIPREDATOR BEHAVIOUR BETWEEN WILD AND HATCHERY-REARED JUVENILE ATLANTIC SALMON

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Recent laboratory studies suggest that hatchery-breeding programs inadvertently select for reduced predator avoidance, however few tests have been conducted under natural conditions. We tested the potential effects of 'hatchery selection' on the antipredator behaviour of juvenile Atlantic salmon in a semi-natural field study. We compared the response to standardized predation cues of wild caught, F1 (offspring of wild caught adults) and F2 (two generations in the hatchery)YOY salmon (from the same source population). Wild caught YOY exhibited strong, stereotypic responses to the predation threat, while F2 YOY showed only weak responses. Interestingly, F1 YOY were intermediate to wild caught and F2 YOY. The observation that wild caught and F2 YOY were consistently different supports the hypothesis that even two generations of hatchery rearing is sufficient to select for maladaptive responses to predators under natural conditions. The observation that F1 YOY were intermediate to wild caught and F2 YOY suggests that individual experience may also play a significant role on the observed lack of stereotypical responses to predation threats under more natural conditions. Given the current decline of many salmonid populations across North America and the controversy regarding the effectiveness of hatchery programs for conservation use, the results of this study may be useful to determine an appropriate course of action for hatcheries designed for conservation and restoration.

Oral CCFFR (Aquatic Habitats and Fishes)

RANDOMNESS IN FISH COMMUNITIES COMPOSITION: RESOLVING DIFFERENCES IN THE LITERATURE

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Ecologists often analyze communities in order to determine the importance of biotic, abiotic and/or spatial factors in structuring species composition. An implicit assumption in these analyses is that the communities differ from random. Several studies have explicitly tested and shown fish communities to be non-randomly structured, whereas other studies have shown that they do not meet this assumption. I examine this question of whether fish communities are non-random in their species composition using many datasets drawn from a range of different types of aquatic ecosystems. My results show a strong departure from randomness across this range of systems. Furthermore, I demonstrate the underlying characteristics of fish communities that have led to discrepancies in the literature about whether fish communities are randomly structured or not.

Oral CCFFR (General Session)

ZOOPLANKTON COMMUNITY RECOVERY FOLLOWING THE CESSATION OF ACIDIFICATION

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Terrestrial and aquatic ecosystems near Wawa, Ontario underwent severe acidification due to the long-term operation of an iron mining and smelting operation. Previous work has shown lakes to have lost all fish species composition and pH nearing values of 3. Smelting operations ceased in 1998, but no active restoration program was developed. Despite this lack of active restoration, formerly acidified lakes have shown recovery ranging from 3 to 4 pH units and major changes in related chemical conditions – essentially unmatched elsewhere. In conjunction with this recovery in water chemistry, zooplankton communities in these formerly acidified lakes show comparable communities to those found in reference lakes from the surrounding region. Former open-pit mines, now flooded but lacking surface-water connections, demonstrate the importance of colonization in establishing or re-establishing communities in damaged ecosystems.

Poster SCL (Environmental Stressors)

USING SPRING CLOSURE ZONES TO PROTECT SPAWNING WALLEYE IN WABASCA LAKES, ALBERTA

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Domestic and recreational harvest is a potential threat to the sustainability of walleye populations in North and South Wabasca lakes. In 2008, spring closure zones were established surrounding two inlets, Drowned-horse Creek and Willow River, on North and South Wabasca lakes, respectively. These closure zones prevent the harvest of walleye on spawning grounds during early spring. From 2008 to 2010, 65 mature walleye implanted with radio tags (41 in the North and 24 in the South) were tracked using radiotelemetry to determine both the spatial and temporal effectiveness of the closure zones. We monitored fish movements before, during and shortly after the spawning season from April to July using both boat and aerial surveys. Peak spawning activities occurred from May 3 to 16 in both basins. Over the course of the study, the majority (>50%) of tagged fish occupied the closure zones in both basins throughout the spawning period from May to mid-June, after which they randomly distributed within each lake. We observed 100% fidelity of tagged fish within lakes during the spawning period in 2009 but some inter-basin movements occurred in 2010. To determine the genetic relatedness of fish between sites tissue samples were collected and were compared using microsatellite markers. Although fish movement between basins was limited during the spawning period, pairwise F_{ST} comparisons between spawning locations indicated no genetic differentiation between groups. Thus, the spring closure zones were successful in protecting spawning walleye temporally and spatially in Wabasca lakes and will aid in the sustainability of these fisheries.

Poster CCFFR (General Session)

EVALUATION OF FISH DIETARY NICHES IN AN OLIGOTROPHIC LAKE BY GUT CONTENT AND STABLE ISOTOPE ANALYSIS

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Gut content analysis, stable isotopes analysis of fish muscle and mucus with MixSIR mixing model were used to evaluate the dietary niches of five important species in oligotrophic Lake Annecy in France. Gut content analysis provided a seasonal overview and established that food resources were partitioned among the Lake Annecy fish community during summer growth period possibly limiting competitive interactions. The range of diet proportions found by MixSIR mixing was not much different from the CGA. We found that findings based on gut content or stable isotopes alone, would be feeble because of high taxonomic, seasonal and spatial variations in prey. But the combined use of gut content analysis and stable isotopes analysis provided an efficient means for confirming diets and insight into resource partitioning among coexisting fish species. We also found that the carbon and nitrogen isotope signatures of whitefish mucus were correlated with whitefish muscle signatures and could be used as a non lethal method to evaluate fish diet.

Poster CCFFR (General Session)

CRUSTACEAN ZOOPLANKTON SEDIMENTARY ASSEMBLAGES FROM LOW CALCIUM LAKES OF THE EXPERIMENTAL LAKES AREA

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The calcium (Ca) concentrations of many softwater lakes on the Canadian Shield have been in decline for several decades and a large proportion of Shield lakes are already near or below levels identified as detrimental to the fitness of large Ca-rich species such as *Daphnia pulex*. To date, due to strong correlations between pH and [Ca] in softwater regions, there have been difficulties distinguishing the impacts of declining lakewater Ca on Ca-demanding fauna from those of acidification (i.e., low pH). Here, we examine crustacean zooplankton sedimentary assemblages of three low Ca lakes (mean present-day [Ca] <2.0mg/L) from the Experimental Lakes Area (Ontario, Canada) that have experienced declines in aqueous Ca concentration since the 1980s. As this region is remote from major sources of acid deposition (mean present-day pH>6.7), pH has changed little over the period of Ca decline, and remains well above thresholds for acid-sensitive species. Changes in sedimentary zooplankton assemblages over the past ~150 years provide further evidence of reduced abundances of Ca-sensitive fauna (particularly daphniid species), independent of acidification impacts.

Oral SCL (Environmental Stressors)

CONSIDERATION OF UNCERTAINTY IN THE DESIGN AND USE OF HARVEST CONTROL RULES

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Harvest control rules are widely used by management agencies for decision-making and for promoting public awareness of the status of marine and freshwater fisheries. Many current control rules combine fishing mortality and biomass-based biological reference points. Control rules were introduced as a precaution against the influence of uncertainty and to decrease the risk of overfishing, but are compromised if the uncertainties of the biological reference points are not explicitly considered. Uncertainty has been widely acknowledged but has not been incorporated into control rule design and application. In this paper, we used a Bayesian statistical catch-at-age model to estimate uncertainties in the indicators of fishing mortality, population size, and biological reference points. We apply this model to the Lake Erie walleye (*Sander vitreus*) fishery, and by fully considering the uncertainty of the indicators, the risk of overfishing and the risk of the population being overfished can be explicitly estimated in the control rules. We suggest short and long-term approaches to incorporate uncertainty in the design of control rules. We also suggest that control rules for specific fisheries should be designed with explicit consideration of the uncertainty of the biological reference points, based on a risk level that the management agency and stakeholders agree upon.

Oral CCFFR (Capture Fisheries)

THE EFFECTS OF INBREEDING ON SPERM QUALITY IN LAKE TROUT

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The effects of inbreeding on fitness traits such as survival and reproductive success have been well documented. However, inbreeding has also been known to affect fitness in more cryptic ways, including negative effects on sperm quality. We investigated the effects of inbreeding on sperm quality in the lake trout (*Salvelinus namaycush*). In 2003, in-vitro fertilization techniques were used to create males exhibiting four levels of inbreeding (unrelated, maternal half sibs, paternal half sibs, and full sibs) and in 2009 and 2010 I collected sperm samples from sexually mature individuals arising from each of these groups. Next, I used video recordings of activated sperm and a computer-assisted sperm analysis (CASA) system, to measure sperm velocity, longevity, and density for each male. Contrary to the inbreeding depression hypothesis, my pilot data from 2009 apparently demonstrate there is minimal effect of inbreeding on any of the sperm quality metrics we measured. Results from the 2010 field season will also be discussed.

Poster CCFFR (General Session)

ONTOGENETIC PATTERNS IN ISOTOPIC COMPOSITION OF NORTHERN FISHES

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It is well recognized that the ecology of aquatic consumers may change during their lifetimes. Both the trophic ecology and habitat preferences of individuals shift as they grow, and thus, they may occupy not one niche but rather a series of ontogenetic niches during their lives. Stable isotopes are now widely used to characterize trophic interactions in freshwater food webs. It would be expected that ontogenetic patterns in feeding ecology identified through dietary studies should also be reflected in isotopic composition. Variability in isotope signatures among individuals within fish populations is often high, and some of this variability is undoubtedly due to size-based differences in trophic ecology. However, recent laboratory studies have demonstrated that the isotopic composition of aquatic organisms may also be influenced by variation in fractionation that is linked to growth rates. We examined isotopic compositions ($\delta^{13}C$ and $\delta^{15}N$) in relation to body size in a variety of species (both piscivores and benthivores) and populations (both slow- and fast-growing) of northern freshwater fishes to determine if ontogenetic patterns: i) reflect the biologies and feeding ecologies of species as determined from earlier research, and ii) vary according to conditions for growth in the environment. Understanding both the magnitude and nature of ontogenetic patterns in isotopic composition of wild fishes is essential to the interpretation of food web dynamics at community and ecosystem levels.

Poster CCFFR (General Session)

INFLUENCE OF THE EXOTIC PREDATORY CLADOCERAN *BYTHOTREPHES LONGIMANUS* ON THE VERTICAL DISTRIBUTION OF ZOOPLANKTON PREY IN INLAND LAKES OF THE CANADIAN SHIELD

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Adaptive responses by native prey species can influence the invasion success of exotic predators. The exotic predatory cladoceran *Bythotrephes longimanus* is a visual predator which occupies a shallow position in the water column. Adaptive movement by zooplankton prey could have important consequences for the long-term success of *Bythotrephes* by reducing resource availability. In 2007, a stratified survey of 14 invaded lakes was conducted to determine the diel distribution of zooplankton prey. We found that the mean proportion of daphniids and calanoid copepods was significantly lower in the epilimnion during the day than at night and the epilimnetic proportion of these individuals decreased with increasing *Bythotrephes* density. To further investigate this pattern, we conducted lab experiments in 2010 to determine the phototactic response and vertical distribution of *Daphnia* from invaded and uninvaded lakes when exposed to *Bythotrephes* kairomone. Contrary to patterns described for the Great Lakes, we found no evidence of a behavioural response in the presence of kairomone. The vertical distribution of *Daphnia* appears instead to be lake specific with overall differences in the mean position occurring between invaded and uninvaded lakes.

Oral SCL (Introduced Aquatic Species)

INCORPORATING LAKES WITHIN THE RIVER DISCONTINUUM: LONGITUDINAL CHANGES IN ECOLOGICAL CHARACTERISTICS IN STREAM–LAKE NETWORKS

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Lakes and rivers are intimately connected in an alternating series of lentic and lotic reaches in many regions. The study of lakes and their outlets in hierarchical and branching river networks has not gained the attention of stream ecologists, and little effort has been focused on synthesizing the ecology of lake–stream interactions within a drainage network. Rapid and predictable changes in the ecological characteristics of streams occur at the interface with lakes. The influence that a lake might have on a stream is dependent on its position within the stream, stream type and size, lake size and shape, and the inlet and outlet positions. Little is known about the influences of multiple lakes within stream–lake networks and how these influences are determined by network shape and pattern. Fruitful collaborations and novel insights will come from the combined efforts of limnologists, stream ecologists, and landscape ecologists. Geographic information systems and network analyses will play an important role in summarizing aquatic landscape characteristics and creating a predictive science of aquatic networks. Lakes need to be more explicitly incorporated into ecological concepts in stream ecology, and reciprocally, streams need to be incorporated into ecological concepts involving lakes for the successful management and conservation of our aquatic resources.

Oral CCFFR (Aquatic Habitats and Fishes)

DIFFERENTIAL IMPACTS OF THE INVASIVE PREDATORY CLADOCERAN *BYTHOTREPHES LONGIMANUS* ON ZOOPLANKTON BIODIVERSITY AND COMMUNITY COMPOSITION IN CANADIAN AND NORWEGIAN LAKES

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Bythotrephes longimanus is a large predatory cladoceran that is rapidly invading North American lakes, particularly in Ontario, Canada, resulting in a decline in crustacean zooplankton diversity. In contrast, *Bythotrephes* has been established in Norway for many centuries, and appears to increase zooplankton diversity in lakes where it is present. In order to determine whether the Norwegian data might prove useful in predicting the long-term consequences of *Bythotrephes* on zooplankton communities in Canada, we used univariate and multivariate statistical methods to examine zooplankton diversity and community composition in relation to the distribution of *Bythotrephes* in Canadian and Norwegian lakes. *Bythotrephes* significantly decreases cladoceran richness in Canada, but significantly increases both cladoceran and copepod richness in Norway. Higher diversity in Norwegian lakes appears to result from the reduction or removal of rare species from the community, which is compensated for by a relatively greater increase in the presence of common species that possess functional traits that can withstand *Bythotrephes* predation. Thus, the long-term impacts of *Bythotrephes* invasion in Norwegian lakes appears to select for a zooplankton community comprised of species that possess very large or very small adult body size, are spatially separated from *Bythotrephes* (vertically or horizontally), and possess anti-predator defences. However, of the 12 species found in both countries, 5 showed differing responses to the presence of *Bythotrephes*. This pattern suggests *Bythotrephes* may alter competitive interactions among prey species differently in the two countries, and thus predicting the recovery of biodiversity in Canadian lakes may not be straightforward.

Poster SCL (Introduced Aquatic Species)

QUANTIFICATION OF FILLET DISCOLOURATION IN COMMERCIALLY HARVESTED YELLOWTAIL FLOUNDER (*LIMANDA FERRUGINEA*)

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The commercial flounder fishing industry has been an extremely integral part of Newfoundland's economy since the 1960's. One way that efficiency in this industry is lost is unnecessary fillet damage inflicted through harvesting and processing techniques. Fillet discolouration is caused when physical and/or physiological trauma causes blood vessels to rupture and blood residue to pool in certain locations. This discolouration detracts from retail value, and thus must be trimmed away prior to packaging and distribution. The trimming process leads to a decrease in fillet size, and consequently a loss in total yield and profit. In efforts to decrease this discolouration, changes in harvesting and processing techniques are being tested. In order to quantify the impact of these changes on discolouration, effective and objective assessment techniques must be developed. To this end, discoloured flounder fillets were photographed and image analysis software was utilized to quantify the total area and common locations of current fillet discolouration. The results of this study will establish a standardized assessment technique, as well as a baseline from which to measure the effects of future changes to harvesting and processing techniques on fillet discolouration.

Oral CCFFR (Capture Fisheries)

LOCAL AND REGIONAL POPULATION GENETIC STRUCTURE OF THE THREATENED CHANNEL DARTER IN ONTARIO

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The Channel Darter (*Percina copelandi*) is a small benthic fish with a naturally disjunct distribution in Central Canada. Within this distribution, dams have further fragmented riverine populations in the Bay of Quinte drainage. A number of Ontario and Quebec populations are presumed extirpated, and recent sampling suggests that populations in Lake Erie and Lake St. Clair are in decline. Its disjunct distribution means that natural re-colonization of extirpated sites will likely not occur. Re-establishment efforts need to identify the location of potential source populations and the number of individuals required to establish new, self-sustaining populations. Ideally, source populations possess a high level of genetic diversity and genetic composition developed under similar historic conditions as the re-establishment site. To assess the genetic variation and relatedness of populations across its range, we used mitochondrial DNA (cytochrome-b sequence) and ten microsatellite DNA loci to genotype eight Ontario populations. Individual (STRUCTURE) and population (F_{ST}) based tests were used to characterize local and regional population structure. Microsatellite data indicate significant population differentiation across its Ontario range, and among adjacent populations. Microsatellite data will also be used to characterize the consequences of river fragmentation on the genetic characteristics of local populations along the Trent, Moira and Salmon rivers.

Poster CCFFR (General Session)

QUANTIFYING SIZE AND SHAPE OF LAKES – ADVANCES IN, AND COMPARISONS OF APPROACHES

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Lake morphology is important for function and structure of community within lakes. It may influence primary and secondary productivity, mixing depth and surface-water temperature which are closely associated with thermal habitat, winterkill, and hypolimnetic suitability of a lake. To quantify size and shape of a lake, studies generally use surface area, perimeter, maximum and mean depth, and shoreline development index as metrics. Given increasing interest in landscape ecology, our objectives were to (1) compare approaches used in limnology and terrestrial landscape ecology to quantify size and shape of Ontario lakes, and (2) examine how islands within lakes influence comparisons of lake morphology. We selected a series of lakes varying shape complexity which we scaled to five size classes (50, 100, 500, 1000, and 5000 hectares) and compared morphological measures on these lakes using principal component analysis to classify the various measures into groups of metrics. Principal component analysis revealed that most underlying variation was summarized by the first two axes. Principal component 1 was strongly associated with indices related to size aspect of lakes, such as surface area and perimeter, whereas principal component 2 was strongly associated with indices related to shape aspect of lakes, such as shoreline development index and fractal dimension index. Moreover, simply incorporating island perimeter into lake morphology greatly influenced the relationship among indices of lake morphology. Our study suggests that various approaches from landscape ecology may complement approaches in aquatic ecology and limnology.

Oral CCFFR (Nearshore Ecosystems)

FUTURE CALCIUM DECLINES WILL NOT STOP THE SPREAD OF THE INVASIVE SPINY WATER FLEA *BYTHOTREPHES* ACROSS THE CANADIAN SHIELD

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The invasive spiny water flea *Bythotrephes* is spreading rapidly across the Canadian Shield. Calcium levels have also been declining in this region, a phenomenon that will be detrimental for organisms with high calcium demands. Currently, calcium is positively correlated with *Bythotrephes* presence on the Shield, but little is known about how calcium decline might affect the future spread and establishment of this voracious predator. To answer this question, we employed a three-pronged approach. First, we measured the body calcium content of field-collected *Bythotrephes* and found it to be low, averaging 0.0298% as dry weight. Second, we conducted a 23 day bioassay in which *Bythotrephes* neonates were reared across a low calcium gradient (0.1 – 2.6 mg Ca^{++} L^{-1}), to examine potential chronic effects of low calcium on life history and somatic size. The intrinsic rate of natural increase was reduced at the lowest Ca level but remained positive, indicating positive population growth. Third, we compared *Bythotrephes* distributions on the Canadian Shield with Norway where they have long been established. The lowest calcium environment in which *Bythotrephes* has been found on the Shield is 1.6 mg Ca^{++} L^{-1}, compared to <0.5 mg Ca^{++} L^{-1} in Norway. We conclude that in the absence of other major stressors, *Bythotrephes* establishment is unlikely to be hindered by calcium declines on the Shield. Rather, since *Bythotrephes* appears to be more tolerant of calcium decline than its daphniid prey, we predict that the cumulated effect of calcium decline and the spread of *Bythotrephes* on its prey may at least be additive.

Oral SCL (Environmental Stressors)

CREATING THE FOUNDATION FOR DROUGHT RECONSTRUCTIONS: CONSISTENT PATTERNS IN DIATOM ASSEMBLAGES ACROSS DEPTH GRADIENTS IN EIGHT LAKES FROM NORTHWESTERN ONTARIO (CANADA)

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There is a need to determine potential future available water by understanding past changes in water levels; understanding the underlying ecological characteristics of using diatoms as a proxy for lake-level reconstructions is important to this process. By integrating past water-level fluctuation studies and theories, along with developing a better understanding of diatom ecology in lake systems, more effective techniques are being developed to improve drought reconstructions. Surface diatom assemblages were examined from eight lakes in northwestern Ontario collected along a depth gradient at ~1-m water-depth intervals. Three major zones, based on the composition of diatom assemblages in each lake were consistently identified in all lakes: i) a near-shore assemblage of *Achnanthes* (*sensu lato*) species and other benthic taxa (*Nitzschia, Cymbella*); ii) a mid-depth small *Fragilaria (sensu lato)/* small *Aulacoseira* zone with various *Navicula* taxa, and iii) a deep-water planktonic zone. The depths at which transitions between these zones varied among lakes, and the depth of the transition between the planktonic and benthic zones was consistent with water chemistry variables that are related to light attenuation (e.g. DOC, TP). Deeper pelagic to benthic transitions occurred in lakes with the lowest DOC and TP. Other findings include a decrease in species evenness and numbers with depth, along with an increase in scaled chrysophyte relative to diatoms. This study lays the foundation for detailed paleoclimatic studies related to changes in lake level and light transparency, based on near-shore cores taken near the transition from the pelagic to the benthic zone in boreal lakes.

Oral SCL (Effects of Recent Climate Change)

USING TWO WAYS OF UNDERSTANDING: SCIENCE AND TRADITIONAL KNOWLEDGE TO EXAMINE EFFECTS OF ENVIRONMENTAL CHANGE ON ARCTIC CHAR

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This project studying community-based monitoring (CBM) and the potential for bringing together traditional ecological knowledge (TEK) and scientific knowledge of chars intends to identify key indicators of change in char using both quantitative (char growth, environment conditions) and qualitative (TEK) data. Arctic Char (*Salvelinus alpinus*) is a staple subsistence resource for Inuit on Banks Island, NWT. In recent years, significant climate variability has been observed in the area and there are concerns about how this variability will affect subsistence resources. Communities are the first point of contact, observing these changes and the effects on their land, water and animals. Centuries of knowledge and observations about the environment and natural resources exist among Inuit hunters and fishers. TEK can expand our understanding of environmental variability and its effects on Arctic species. Further, CBM provides an opportunity to better understand the current status of species and can form the basis for understanding and preparing for future changes in Arctic species in light of a changing environment. A summary of the preliminary investigation into the growth of Arctic Char in relation to climatic conditions in five lakes on Banks Island is presented. New insights provided from TEK interviews about char and the environment, are explored. Ultimately this novel multidisciplinary research provides new insights into potential environmental indicators which could be used in CBM plans and further, is an example of how science and TEK can complement one another to provide a better understanding of northern fish species in a changing environment.

Oral CCFFR (Capture Fisheries)

ANOMALOUS ALGAL BLOOMS RELATED TO CHANGES IN GRAZING PRESSURE CAN BE LINKED TO LAKE-WATER CALCIUM DECLINE IN KING'S COUNTY, NOVA SCOTIA

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For lakes in King's County, Nova Scotia, chlorophyll *a* levels frequently exceeded water quality guidelines in 2006-2008, while total phosphorus (TP) values were lower than average. We hypothesized that reduced top-down control on phytoplankton was responsible for elevated chlorophyll *a* levels rather than nutrient inputs. We analyzed cladoceran remains and near-infrared inferred chlorophyll *a* in the sediments of Lake George to assess the potential causes of increased algal production. In the late 1980's, *Daphnia* (often considered keystone grazers) dramatically declined in abundance. At the same time, near-infrared inferred sedimentary chlorophyll *a* began to steadily increase to more than 3x background values (matching local complaints of increased algal blooms). The consistency of the timing of changes in *Daphnia* relative abundance and inferred chlorophyll *a* strongly support top-down control on algal populations, where the observed increase in lake production is reflecting a release from grazing pressure by *Daphnia*. The decline in *Daphnia* populations cannot be attributed to changes in TP, pH, thermal stratification, or predation, but instead is most likely the result of declining lake-water calcium (Ca) levels to <1.5 mg/L, generally considered a reproductive threshold for *Daphnia pulex*. Therefore, we provide, for the first time, evidence of a link between lake-water Ca decline and elevated algal production mediated through the effects of Ca decline on *Daphnia*. We suggest that the effects of Ca decline are not limited only to Ca-dependent aquatic organisms, but may affect entire aquatic food webs.

Oral SCL (Environmental Stressors)

CARBON DYNAMICS AND FOOD WEB STRUCTURE IN OIL SANDS RECLAIMED WETLANDS

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Boreal wetlands are an important player in global carbon balance but their ecosystem function is threatened by direct anthropogenic disturbance and climate change. Oil sands mining in boreal Canada leaves large areas in need of reclamation and generates considerable quantities of extraction process-affected materials. It is important to know whether reclaimed wetlands are restored to equivalent ecosystem function. We approached this by assessing carbon flows and food web structure in oil sands-affected wetlands to evaluate whether a prescribed reclamation strategy, topsoil amendment, accelerates reclaimed wetland development leading to self-sustaining peatlands. We determined carbon fluxes and measured compartment standing stocks for residual hydrocarbons, organic substrate, bacterioplankton, phytoplankton, biofilm, macrophytes, detritus, zoobenthos and aquatic-terrestrial exports (i.e. aquatic insect emergence). Most biotic compartments differed between oil-sands and reference wetlands. This difference declined with age but was still detectable in older wetlands. Macroinvertebrate trophic diversity was lower in oil sands-affected wetlands. Peat amendment appeared to speed convergence for some compartments but not others. We discuss results in the context of restoration of ecosystem function and optimization of reclamation strategies.

Oral SWS (Environmental Stressors)

USING A HIGH-RESOLUTION ACOUSTIC CAMERA (DIDSON) TO ESTIMATE FISH ABUNDANCE AND MOVEMENT IN A LAKE ERIE COASTAL WETLAND

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Research projects in the Crane Creek coastal wetland complex (Ottawa National Wildlife Refuge) are exploring wetland habitat rehabilitation strategies and their impact on Lake Erie fishes. Established methods of assessing fish assemblages (e.g., fyke nets) can be used to characterize fish (community composition and abundance) in a specific location, but provide little information on fish behavior and short-term rates of movement. From a habitat rehabilitation perspective, data on fish movement and behavior are critical to both evaluate the biological response to completed projects and guide the design of future projects (e.g., maintaining an appropriate level of hydrologic connectivity). DIDSON (Dual-frequency IDentification SONar) is a developing technology able to collect high-resolution fisheries data day or night in very shallow turbid water. A DIDSON was deployed for 11 days in Crane Creek at its connection to Lake Erie to explore how Great Lakes fishes used coastal wetland habitats. In addition to continuous DIDSON data, we collected real-time data on water quality, depth, velocity, and direction. Statistical sampling and manual analysis of the DIDSON data revealed a large abundance and flux of longnose gar and shoals of small preyfish fish accessing the wetland on a daily basis.

Oral SWS (Wetlands)

ENVIRONMENTAL, PREDATION, AND SPATIAL PREDICTORS OF CLADOCERAN COMMUNITIES FROM 50 LAKES IN NORTHWESTERN ONTARIO

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Understanding local and regional controls on community composition is a major theme in ecology and fundamental to paleolimnological studies which utilize a "space-for-time" approach to interpret environmental changes. Are spatial and temporal patterns in species abundances determined primarily by environmental gradients, local biotic interactions, and/or dispersal-related events? To address this issue, subfossil Cladocera were enumerated from the surface sediments of 50 lakes to explore the importance of three ecologically-relevant explanatory categories. We used redundancy analysis (RDA) and variation partitioning techniques to test and quantify the unique and shared effects of environmental, predation, and spatial variables as predictors of cladoceran communities. Forward-selection procedures identified nine significant variables that together explained 28.7% of variation in the community data. Four environmental variables (*i.e.*, pH, lake surface area, specific conductivity, and lakewater total aluminum concentration) explained uniquely 8.8% of the variation, which was 2.5 times greater than the unique contributions of predation and spatial variables. Results indicate that at the scale of this regional survey, cladocerans are influenced primarily by water-chemistry related variables. Predation and spatial factors, although statistically significant, assume less of a role in structuring cladoceran communities. Our paleolimnological approach indicates that dispersal limitation of cladocerans seems minimal, even across such a vast geographic area. Overall, our findings further support the utility of cladocerans as biological indicators that have important potential to adequately track environmental changes within lakes of the Boreal Shield ecozone.

Oral SCL (General Session)

EVALUATION OF THE BEHAVIOUR, PHYSIOLOGY AND SURVIVAL OF MUSKELLUNGE THAT ARE CAPTURED AND RELEASED BY SPECIALIZED ANGLERS

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Little is known about the muskellunge, *Esox masquinongy*, despite its popularity as a sport fish for many Canadian and U.S. anglers. Over the last 50 years, organizations such as Muskies Inc. and Muskies Canada have created major paradigm shifts in muskellunge angling from catch-and-kill to catch-and-release (C&R). Today, release rates approach 100% for specialized anglers. One topic that has been neglected by the research community is evaluating the biological consequences of C&R on muskellunge, particularly in light of such high release rates. We conducted a study aimed at revealing the physiological disturbances, behavioural consequences, and mortality rates of muskellunge subjected to C&R by specialized anglers. In total, 30 muskellunge were affixed with small external radio transmitters to monitor behaviour and survival after release. To assess physiological disturbance, non-lethal blood samples were taken from each tagged muskellunge plus an additional group of untagged muskellunge. We compared two types of handling practices: normal procedures used by specialized anglers and an alternative gentler procedure. Differences in physiology were minimal following angling and handling, as was post-release behaviour. All 30 tagged muskellunge survived beyond one week post-release, indicating current handling procedures may be most appropriate for anglers to employ and fisheries managers to encourage.

Oral CCFFR (General Session)

POTENTIAL FACTORS INFLUENCING LAKE TROUT CATCHABILITY IN THE LAKE WHITEFISH GILL-NET FISHERY ON LAKE HURON

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The primary commercial capture fishery in Lake Huron targets lake whitefish (*Coregonus clupeaformis*). In addition to lake whitefish, lake trout (*Salvelinus namaycush*) are caught as bycatch. Lake trout were nearly extirpated from Lake Huron in the 1950s. Stocking of lake trout has occurred since the 1970s and abundance is increasing, however a self-sustaining population has not yet been achieved. There is also evidence of increasing lake trout catchability in the gill-net fishery. However, this trend is sensitive to observation and process errors. To explain the influence of potential covariates from the fishery on the trends in catchability, we developed a standardization procedure of lake trout catch-per-effort (CPE) data using delta-lognormal models. Delta-lognormal models assume CPE is the product of two processes; a Binomial process of the probability that catch is zero, and a lognormal process of the probability that catch is positive. The potential covariates included in the model were year, season, location, depth, set type, and fishing operation. Models were built with data from commercial catch reports and with data from onboard observer reports to also assess the possible influence of reporting practices on lake trout catchability.

Oral CCFFR (Capture Fisheries)

FISH INVASIONS IN THE MID-ATLANTIC REGION OF THE UNITED STATES

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I assessed determinants of fish invasions in the Mid-Atlantic region of the United States using data from the United States Geological Survey's Nonindigenous Aquatic Species Database. Mid-Atlantic region watersheds differ considerably in nonnative species richness (NNSR) and composition, suggesting they are not equally invasible.
I analyzed species composition and temporal trends by fish invasion pathway. I analyzed relationships between ecosystem characteristics and invasibility by compiling data on watershed characteristics and correlating these with NNSR. To explain differences in nonnative species among ecosystem types, I grouped Mid-Atlantic region watersheds by nonnative community and tested for differences in ecosystem characteristics among groups. I developed and compared several approaches estimating the impact of nonnative fishes, such as surveying fisheries biologists, and compared top-ranked species among approaches.
Pathways currently posing the greatest risks included bait release, illegal introductions, and the stocking of private ponds. Highland watersheds had greater NNSR, probably because of greater habitat heterogeneity due in part to human activity. Four nonnative communities were identified and correctly predicted 80% of the time by models based on temperature and range in elevation. Species with the greatest impact differed considerably among approaches to quantifying impact. Collectively, my results can aid in reducing the effects of nonnative fish invasions by enabling managers to focus prevention efforts on high-impact species likely to invade particular ecosystems via known pathways. This work represents major advancements in invasion biology, including new links between species identity and ecosystem invasibility and the development of methods for quantifying impact.

Oral CCFFR (Introduced Aquatic Species)

OCCURENCE AND MITIGATION OF FRESHWATER TURTLE BYCATCH IN INLAND COMMERCIAL HOOP NET FISHERIES

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One of the main concerns associated with commercial fisheries is the mortality of bycatch. In general, bycatch refers to the inadvertent capture of non-targeted species that can include fish, turtles, mammals, and birds, some of which may be species at-risk. Investigation of fisheries bycatch reduction and survival has focused on marine systems, but with increasing interest in expanding inland commercial fisheries and mitigating their potential impacts, there is need for scientific information to aid in the creation and support of fishing regulations for inland waters. During a typical fishing season in southeastern Ontario, we simulated commercial fishing in small warm water lakes and quantified rates of capture for both bycatch and targeted species. Turtles represented the largest proportion of non-fish bycatch (>90%). With this documented threat to freshwater turtles, methods to reduce bycatch mortality were investigated. Primarily, methods focused on net modifications such as excluding turtles from entering nets, making available air spaces, and allowing turtles to escape. Progress was made in determining modifications that reduce bycatch mortality without affecting target fish catches. This research has both improved the understanding of bycatch occurring in these fisheries and developed potential modifications to reduce bycatch mortality which will be useful for future management and conservation decisions.

Oral CCFFR (Capture Fisheries)

THE ENERGY-MASS (Em) FLUX FRAMEWORK: AN INTEGRATIVE APPROACH TO QUANTIFY EFFECTS OF CLIMATE, HUMANS, AND BIOTA ON LAKES

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The energy-mass (Em) flux framework proposes that climate, humans and other biota regulate lake ecosystems by altering the influx of energy (E) and mass (m) through diverse direct and indirect pathways. In this view, lakes are open ecosystems that retain E and m by production of particles that are deposited as sediments, have limited capability of accessing sequestered materials, and are dependant on a continuous influx of E and m from the ectosystem, the region surrounding the lake. Physical models of the environmental forcing of lakes reveal that neither E nor m pathways are intrinsically paramount, and instead predict that the magnitude of effect of individual inputs depends on the ratio of influx to lake content. This hypothesis was tested by quantifying changes in whole-lake production arising from reciprocal transfer of fish biomass (no net change in influx), introduction of a top predator (pulsed input), and migration of anadromous semelparous salmon (continuous influx). Paleolimnological analyses confirm that ecosystem forcing by fish is a linear function of the importance of E and m subsidies relative to lake content.

Oral SCL (Energy and Mass Flux)

THE SIGNIFICANCE OF NON-SIGNIFICANT RESULTS IN A NOVEL EXPERIMENTAL SCALLOP DREDGING BENTHIC HABITAT IMPACT STUDY: INCORPORATING FISHING INTENSITY AS A COVARIATE

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Studies of the impact of mobile bottom fishing gear on benthic communities and habitats have focused primarily on comparisons between impacted and non impacted areas, or between areas experiencing different degrees of fishing, defined semi-quantitatively. There is limited scientific understanding of how fishing intensity affects the degree to which marine benthic communities are perturbed and the community's ability to recover following perturbation. To address this question, before-after-control-impact experiments using a scallop dredge with 16 different fishing intensities were performed in soft and hard substrate habitats in the southern Gulf of St. Lawrence, Canada. The experimental design controlled for ecosystem-level changes in the abundance of benthic invertebrate taxa that were unrelated to fishing. No significant short-term fishing effects were detected in either ecosystem in single taxon and multi-taxon analyses. Broad-scale changes unrelated to fishing appeared to be more important than responses to experimental fishing. A post hoc simulation of the statistical power of the experimental design and analysis was conducted. Despite generally low statistical power to detect fishing effects at low and medium fishing mortalities, significant fishing effects were even less frequent than those expected based on the power simulation for a low level of fishing mortality (5% per fishing gear sweep). This suggests that realized fishing mortalities in the experiment were generally small.

Oral CCFFR (General Session)

SPERM TRAITS IN WILD AND FARMED CHINOOK SALMON

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The expanding salmonid aquaculture industry coupled with escaping fish from those sites have raised concerns about the possible impacts of escaped farmed fish on wild fish populations. Primarily, the focus has been on behavioral and physical differences in competition between farmed and wild male Chinook salmon (*Oncorhynchus tshawytscha*). However, reproductive success of farmed fish in the wild will also depend on their relative sperm performance, given that sperm competition is known to contribute to male salmonid reproductive success. Farmed Chinook salmon are exposed, through domestication, to inbreeding, artificial selection and reduced gene flow. We hypothesize that farmed salmon would experience a decrease in sperm performance and hence competitive ability due to domestication compared to wild salmon. As well, a common practice in salmon aquaculture to prevent early maturation of males is the hormonal sex-reversal of females to create homogametic (XX) males. We hypothesize that farmed XX males would show decreased ability in sperm competition compared to that of the XY farmed males. To test these predictions, a range of sperm related traits were measured in both farmed (XX and XY) and wild Chinook salmon, including sperm longevity, sperm density, and sperm velocity. Our results provide insight into the potential impacts that escaping farmed salmon can have on spawning grounds of wild salmon populations. Further work will investigate breeding success under semi-natural conditions between wild and farmed Chinook salmon using microsatellites for parentage analysis.

Oral CCFFR (General Session)

SPECIES TURNOVER OF DAPHNIA IN LAKES OF CENTRAL ONTARIO

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Changes in the physical and biological environment of aquatic ecosystems result in periods of stress that are expected to be reflected in a number of ways, including a large turnover in species as the environment changes. This study examined the turnover in species within the *Daphnia* genus that took place during the process of recovery from acidification in lakes of the Killarney Provincial Park (Ontario). We found that over the last 35 years, *Daphnia* species have experienced a turnover rate in both buffered and recovering lakes of 10-20% between sampling dates approximately a decade apart. However, this pattern does not appear to be restricted to disturbed systems. Lakes in the Dorset region, an area approximately 250 km southeast of Killarney with similar geology, but which did not experience acidification, displayed similarly high levels of turnover over the same time period. This suggests that ecosystem disturbance is not needed to induce a high level of turnover in *Daphnia* species. One possible explanation for the high observed turnover rate is input of species from the resting egg bank. In the Killarney lakes it was observed that ephippia were abundant throughout the recovery period, as well as within the pre-disturbance sediment. These eggs proved to be viable and species hatched that are not currently present in the water column, but were found in historical surveys. These findings suggest that egg banks may act as a source for new species and the abundance and variety of eggs may help explain the observed turnover rate.

Oral SCL (Environmental Stressors)

DAPHNIID GROWTH ALTERED BY THE INTERACTION OF LOW CALCIUM AND PREDATOR KAIROMONE STRESS

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Physiological stressors are classically tested individually, but in nature organisms live in multiple stressor environments. There is mounting evidence that declining calcium levels are adversely affecting crustacean zooplankton by increasing the metabolic demands of acquiring calcium through active uptake, but calcium is only one of many possible chemical factors influencing zooplankton. Others include kairomones released by predators, which induce various morphological and behavioral defenses. To determine the individual and combined effects of predator kairomones and declining calcium on *Daphnia pulex*, we conducted a full factorial experiment, varying calcium concentration (0.5, 1.5, 2.5, 5.0 mg L^{-1}) and the presence or absence of *Chaoborus* kairomone (+/-), and monitored the effect on juvenile growth. Our analysis involved 2-way ANOVAs on length at each of the four juvenile instars. Calcium had no effect on neonate size, but did have a large effect on the size of subsequent instars. The presence of predator kairomone increased the size of both neonates and all subsequent instars. However, this kairomone effect on instars 2-4 only occurred at higher calcium concentrations. Overall, there appears to be a threshold around 1.5 mg/L calcium, below which *Daphnia* growth is reduced and the effects of predator kairomones is diminished. Under natural conditions organisms experience a variety of stressors and thus accounting for interacting effects is important, especially when these studies eventually influence environmental policy.

Oral SCL (Environmental Stressors)

FOOD WEB DYNAMICS IN LAKES RECOVERING FROM METAL STRESS AND ACIDIFICATION

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We studied fish communities and their prey in lakes with a history of heavy metal contamination and acidification. We examined fish trophic positions in the food web as well as their usage of littoral and pelagic food sources using stable carbon and nitrogen isotopes. We correlated our findings to the benthic invertebrate community present in these lakes, and compared the results found to a set of un-impacted reference lakes. In our reference lakes, trophic position of fish increased with increasing littoral use, and reliance on littoral carbon sources increased with increasing biomass of fish. In lakes with an impaired littoral invertebrate community, fish trophic position declined with increased usage of littoral food sources, suggesting a decreasing food quality. Furthermore the use of littoral food sources declined with the increase of fish biomass. The benthic invertebrate community in impaired lakes is smaller in size distribution and different in community composition. With higher reliance on littoral sources, fish have to prey on smaller individuals from lower trophic positions like chironomids, rather than foraging on larger predatory invertebrates (e.g., Anisoptera). The result is an increase of trophic position with stronger reliance on benthos. As fish biomass increases they might also rely more on a diet subsidy of pelagic macro-zooplankton (*Chaoborus*), as indicated by a decrease of littoral carbon in the diet. We suggest the potential of a reversed subsidy effect, wherein fish that normally specialize on benthic invertebrates rely on zooplankton help to maintain population biomass.

Oral CCFFR (Environmental Stressors)

LIMNOLOGICAL CONTROLS AND SPATIAL VARIATION IN LITTORAL MACROINVERTEBRATES COMMUNITIES ACROSS CENTRAL AND EASTERN NUNAVUT, CANADA

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Ecosystem structure and functioning in Arctic ecosystems is expected to change under the influence of anthropogenically-induced climate change and other human impacts. An assessment of benthic macroinvertebrates in lakes and ponds across Nunavut, Canada was undertaken to determine the current composition, diversity and natural geographic variation among these ecosystems. Over three years, zoobenthos were collected from approximately 85 lakes in Nunavut located near Repulse Bay, Arviat, Rankin Inlet, Baker Lake, Iqaluit, and Clyde River. In addition, substrate characteristics were noted and water samples were collected for major ion chemistry measurements. Organisms collected have been identified to the Family level and multivariate correspondence analysis was performed to determine which environmental variables are responsible for influencing species distributions. Patterns in biodiversity, abundance and community composition were assessed using two-way indicator species analysis (TWINSPAN) and selected biomonitoring indices. Overall, communities were dominated by non-biting midges (Diptera: Chironomidae). 'Scuds' (Amphipoda: Gammaridae) comprised the second-most dominant group, outnumbering the chironomids in lakes near Iqaluit and Rankin Inlet. Diversity was expected to change along a climate gradient (latitude), however differences were also observed between the mainland Kivalliq and Baffin Island regions. Species of the tadpole shrimp (Notostraca: Triopsidae) were found only in Rankin Inlet while the phantom midge (Diptera: Chaoboridae) was observed exclusively in lakes surrounding Iqaluit and appeared to have spread over successive years. Benthic invertebrates form an important part of Arctic aquatic food webs and detailed knowledge of their biogeography and ecology is required for the purposes of biomonitoring, environmental assessment, and predicting anthropogenically-induced aquatic changes to food webs.

Poster SCL (Nearshore Ecosystems)

EFFECTS OF CLIMATE CHANGE ON WATER AVAILABILITY: AN INVESTIGATION OF DROUGHT FROM A DRAINAGE LAKE IN NORTHWESTERN ONTARIO

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Droughts are a normal part of climate, but when they become frequent or extend for long periods, adequate water availability becomes a growing concern. While instrumental records on temperature and precipitation exist, they only extend back to a maximum of a hundred years. Changing climate requires water managers to assess water variability over longer time periods. This can be useful for providing estimates of droughts more severe than present in the instrumental records. The Winnipeg River Drainage Basin contains thousands of lakes that provide water for many commercial purposes, including fishing, and power generation. Inferences of past droughts over the past two-millennia were made from near-shore sediment cores at two different locations in Little Raleigh Lake, situated near Ignace, Ontario. These inferences were based on changes in diatom assemblages, organic matter and other indices in the sediment cores. Increases in benthic taxa suggested either a decline in lake level or an increase in water transparency, both of which are associated with modern drought. Results indicated several periods of increasing benthic diatoms during the 1st millennium, relative to the coring depth. Furthermore, the benthic taxa were also more abundant ~900 to ~1300 years ago, a well known period of aridity in central North America. Similar quantitative trends between the two core sets provide a strong case for the effectiveness of the calibration of a diatom-inferred planktonic-benthic boundary index model developed from surficial sediments along transects in Little Raleigh Lake. This study offers potential future scenarios of changing limnological conditions that exceed droughts experienced during the instrumental period.

Oral SCL (Effects of Recent Climate Change)

COMBINING PALEOLIMNOLOGICAL METHODS AND AERIAL PHOTOS TO TRACK HYDROECOLOGICAL RESPONSES OF A THERMOKARST LAKE IN THE OLD CROW FLATS (YUKON, TERRITORY, CANADA) TO RECENT CLIMATE VARIABILITY

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Remote sensing analysis of lake-rich thermokarst landscapes has documented evidence of declining lakewater surface area in response to recent warming. However, images alone cannot identify whether these observations are due to increasing drainage events associated with accelerated thermokarst activity or increasing evaporation in response to longer ice-free seasons. Here, we use paleolimnology and aerial images to identify past changes in hydroecological conditions for a thermokarst lake in the Old Crow Flats. Images of the lake show that water level declined markedly sometime between 1972 and 2001. Complacent stratigraphic profiles between ~1874-1967 indicate hydro-limnological conditions were stable. From ~1967-1989, declines in organic matter content, $\delta^{13}C$ values and pigment concentrations are interpreted to reflect an increase in minerogenic turbidity, and subsequent decline in productivity, caused by thermo-erosion of shoreline sediments from lake expansion. Increasing summer precipitation, based on an increase in cellulose-inferred lakewater $\delta^{18}O$ values, may have initiated the lake expansion phase. Several stratigraphic trends terminate ~1989 likely indicating the lake drained. We hypothesize that above-average precipitation during the previous year raised lake level and promoted further thermo-erosion of sediments that triggered lake drainage. The paleolimnological data indicate that the decline in lake level evident in the photo from 2001 is unlikely to have been caused by evaporation, but rather is a remnant of the drainage event. Based on these findings, the cause of water-level declines observed for many lakes in thermokarst landscapes, such as the Old Crow Flats, could readily be identified with simple cost-effective sediment core analyses (e.g., loss-on-ignition). This knowledge will help to inform future predictions of hydrological conditions.

Oral SCL (Effects of Recent Climate Change)

INTER- AND INTRA-ANNUAL VARIABILITY IN LAKE THERMAL STRUCTURE AND CRUSTACEAN ZOOPLANKTON COMMUNITIES

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Climate change will alter the variation in properties related to lake thermal structure. Increased environmental variability may promote greater diversity in crustacean zooplankton communities. We used correlations and multivariate techniques to examine the range of variability in lake thermal structure and crustacean zooplankton communities, and to relate the two at seasonal and inter-annual scales in a small Boreal Shield lake.

Within the seasonally recurring pattern of lake thermal structure, some months were more variable than others. Crustacean zooplankton communities were more variable seasonally than from year-to-year. In particular, cladocerans were highly seasonal and associated with periods of intense warming and high water temperature, while cyclopoids were associated with end-of-season isothermal conditions. In contrast, calanoids dominated the community under all conditions, exhibited low variability at both scales, and were not strongly correlated with seasonal environmental variables.

We hypothesize that the abundance of fast-growing zooplankton such as cladocerans responds to environmental conditions seasonally and without lag. In contrast, slower-growing copepods with more complex life-history characteristics integrate a response over longer timescales. Seasonal responses to climate warming may therefore be masked at the annual scale depending on the timing of warming and species-specific life history traits. Our results indicate that seasonal responses may become directional and affect long-term mean conditions if months that are more variably affected by warming (e.g. fall) occur during critical times of growth or reproduction. Future work will examine the seasonal coupling of variability in lake thermal conditions with key developmental stages of zooplankton.

Oral SCL (Effects of Recent Climate Change)

DOES THE DENDRITIC CONNECTIVITY INDEX WORK? TESTING THE RELATIONSHIP BETWEEN STRUCTURAL AND FUNCTIONAL CONNECTIVITY

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Stream connectivity has gained considerable attention in the last ten years, resulting in an increased focus to quantify and prioritize restoration efforts. One model that is gaining momentum in stream connectivity for restoration efforts is the dendritic connectivity index (DCI). The DCI calculates stream connectivity relative to natural conditions. A key aspect of the DCI is the need to estimate the passability coefficient for barriers. To date, this has been carried out using FishXing (USFS 2003). However, it is unknown whether fish movement (i.e., functional connectivity) correlates with DCI value (which is a measure of structural connectivity) as the passability coefficients estimated in work to date have not been validated. Stream fragmentation is presumed to have altered fish community assemblages, but whether these community-level patterns correlate with rivserscape levels of connectivity is unknown. For my thesis, I will validate passability coefficients, and the DCI in seven watersheds draining into Lake Ontario to see if the biomass in this system is consistent with measures of structural connectivity. This project will illustrate how connectivity indices might be applied in a variety of dendritic systems and at community and riverscape levels to help managers prioritize watershed restoration projects.

Poster CCFFR (Aquatic Habitats and Fishes)

IDENTIFICATION OF NORTHERN PIKE SPAWNING SITES IN SOUTH LAKE, RIDING MOUNTAIN NATIONAL PARK, MANITOBA, USING VHF TELEMETRY

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Clear Lake is a 2,922 ha, mesotrophic lake, and South Lake a shallow, 203 ha, eutrophic lake, in southern Riding Mountain National Park, Manitoba. The two lakes are separated by a narrow sand isthmus which is often breached during spring melt, providing a temporary corridor between the lakes. Anecdotal evidence indicates that northern pike (*Esox lucius*) likely spawn in South Lake. To determine whether pike do spawn in South Lake, and to identify spawning habitat selection, we attached external VHF transmitters to 19 female pike captured in Clear Lake at the end of March, 2010. We also inserted a micro-transmitter into the oviduct of each fish, with the intention that it would be expelled during spawning. Fish were tracked throughout April to determine where each micro-transmitter was deposited. Fifteen micro-transmitters were located, all in South Lake, and all fish implanted with a micro-transmitter were found in South Lake during the spring. In May we sampled for eggs at five of the transmitter deposition sites and five random sites, conducting four cluster samples at each location for a total of 20 samples each. Eggs were found at12 out of 20 samples (n=137 eggs) at micro-transmitter sites and 1 out of 20 samples (n=3 eggs) at random sites. Habitat analysis indicated that transmitter sites did not differ from random sites in water or secchi depth, but did differ in vegetation and proximity to reed beds. Hoop net sampling in August indicated the presence of young-of-the year pike. South Lake is an important spawning area and nursery for northern pike.

Poster CCFFR (General Session)

RETENTION OF ACQUIRED PREDATOR RECOGNITION BY 'SHY' VERSUS 'BOLD' JUVENILE RAINBOW TROUT: THE EFFECTS OF PREY BEHAVIOURAL TACTICS

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While a rich literature has demonstrated the reliance of prey fishes on the acquired recognition (learning) of novel predator cues, little attention has been paid to the question of retention of learned predator cues. Here, we test the potential effects of individual behavioural tactics on the strength and retention of learned predator recognition in juvenile rainbow trout. On Day 1, individual trout were characterized as being 'shy' (latency to escape an opaque enclosure > 300 sec) or 'bold' (latency to escape < 60 sec) and then immediately conditioned (conspecific alarm cues + predator odour) or pseudoconditioned (distilled water + predator odour) to recognize pumpkinseed as a predation threat. We then tested for the recognition of pumpkinseed as a predation threat 24 hours (Day 2) and 8 days (Day 9) post-conditioning. Contrary to our initial predictions, we found no differences in the intensity of predator avoidance responses between the initial conditioning and the first recognition trials. However, during the second recognition trials on Day 9, only conditioned 'shy' trout displayed a response to the pumpkinseed odour, while conditioned 'bold' trout did not differ from pseudoconditioned controls. These results suggest that individual behavioural tactics have a significant influence on the 'memory retrieval window' associated with the learned recognition of predators.

Poster CCFFR (General Session)

POTENTIAL EFFECTS OF A DEEP CHLOROPHYLL MAXIMUM IN THE COASTAL ZONE OF A LARGE CLEAR LAKE

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Deep chlorophyll maxima (DCMs) are common features of oligotrophic ecosystems and are often associated with regions of elevated primary production. Yet, the consequences of DCMs on trophic transfer are not well understood. We observed from water column profiles that a DCM in the coastal zone of Lake Ontario appears to intersect with the lake bottom during early stratification and hypothesized that elevated food supply near the lake bottom may be nourishing nearshore benthic suspension feeders. We compared growth rates of Quagga Mussels (*Dreissena bugensis*) caged at the lake bottom compared with mussels suspended at 2 m above the bottom. We concurrently monitored chlorophyll fluorescence at three heights above the lake bottom, together with near-bottom water column velocity, at three coastal stations running a cross-shore transect. Over the summer-fall season mussels grew at a significantly slower rate on the lake bottom relative to suspended mussels, indicating growth inhibition due to persistent seston depletion. In contrast, over the preceding three month period (spring-summer), mussel growth rate on the lake bottom was high and not significantly different than suspended mussels. Mean chlorophyll fluorescence near the lake bottom was significantly higher during the spring-summer mussel growth experiment. Water velocity profiles confirmed that elevated near-bottom chlorophyll fluorescence did not arise from resuspension but was part of a DCM. We suggest that coastal zone Quagga Mussels, during the onset of density stratification, are supplied with sufficient nourishment through development of a DCM to overcome the diffusion limitation that inhibits their growth later in the stratified season.

Poster SCL (Nearshore Ecosystems)

SLOW BUT NOT STEADY: *IN SITU* CONTAMINANT EXPOSURE AND ALTERED BEHAVIOUR IN ROUND GOBIES

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Activity level can influence foraging, home range size, predator evasion and reproduction, and activity decisions can be modulated by an animal's physiologic state. Sublethal contaminant exposure is one physiological challenge that is known to affect activity in lab-exposed individuals, but rarely are the consequences of exposure under natural conditions explored. We examined activity levels of invasive round gobies (*Neogobius melanostomus*) collected from habitats of high and low contamination in Hamilton Harbour, Lake Ontario. The Harbour is a Canadian Area of Concern with a long history of industrial and urban pollution. Round gobies from more contaminated sites were less active, took longer to explore a novel area, tired sooner following a chase and recovered activity faster after a simulated predator attack than fish from cleaner areas. A mark-recapture study of 881 fish in the field showed sex differences in movement, but did not reveal pronounced differences between cleaner and contaminated areas. Although long-term fitness consequences of these behavioural changes in the wild remain unclear, an increase in vulnerability to predation in contaminated areas may affect local population dynamics and attract predators. Greater predation on vulnerable contaminated prey may accelerate the rate of trophic transfer of contaminants in foodwebs affecting piscivorous waterbirds, sportfishes and even humans.

Oral CCFFR (Environmental Stressors)

RESPONSE OF ALGAL COMMUNITIES IN LAKES 277 AND 442 TO ADDITIONS OF PHOSPHORUS, NITROGEN AND IRON

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Lake 227 in the Experimental Lakes Area in northwestern Ontario has been artificially fertilized with phosphorus (P) since 1990. Based on the high P input, very low N/P ratio and dominance by nitrogen fixing *Aphanizomenon* from mid June to mid July most years, the lake is considered to be N-limited. We used short-term nutrient enrichment tests in bottles in an attempt to identify limiting nutrients in Lake 277 and Lake 442 which was used as an unfertilized reference. Our study explored whole algal community responses (chlorophyll) as well as shifts in dominant species to additions of P, Fe and N alone or in combination in 500 ml bottles. After six to twenty-two days the bottles were filtered for chlorophyll, and samples were preserved for cell counts. Results to date show that the only communities with significant chlorophyll increases to nutrient additions were those that were incubated for twenty-two days (7 and 14 days had no effect), indicating a long lag phase after adding nutrients to the bottles.

Oral SCL (Algal Blooms)

THE INFLUENCE OF FOOD ENERGY FROM HEADWATER LAKES ON DOWNSTREAM COMMUNITIES

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Using carbon and nitrogen stable isotope analysis, our research aims to determine how food webs in shallow headwater lakes contribute energy to downstream communities. During spring and summer of 2008 and 2009 organisms (primary producers to secondary consumers) were collected from three lakes and their outflow streams in New Brunswick, Canada. Data were analysed using a one isotope, two-source mixing model to determine contributions of carbon sources, graphically represented in δ13C vs. δ15N bi-plots and by comparing δ13C producer & consumer isotope values vs. distance from headwaters. Results showed distinct carbon isotope values for lake derived nutrients (LDN) (phytoplankton: δ13C = -35.1) vs. stream derived nutrients (SDN) (periphyton: δ13C = -25.9). Primary consumers (i.e. filter-feeding Simuliidae, Hydropyschidae) in the stream sites became increasingly dependent on SDN as distance from the headwater lake increased (up to 1km downstream). However, other feeding guilds did not show this trend (i.e. Heptageniidae, Limnephilidae) regardless of proximity to the lake. Higher tropic groups (i.e. predatory *Cordulegaster sp.* and *Salvelinus fontinalus*) showed trends similar to the filter-feeding invertebrates confirming that LDN sustains lotic food webs for considerable distances downstream of headwater lakes. The results are directly applicable to current management issues since they exemplify cross-ecosystem connectivity, complexity and the overall importance of headwater lakes in supporting their downstream communities.

Oral CCFFR (Energy and Mass Flux)

ERODIBILITY AND TRANSPORT BEHAVIOR OF DREISSENID MUSSEL DEPOSITS IN THE NEARSHORE ZONE

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Dreissenid mussels have altered particle transport dynamics in the near shore environment of the Great Lakes by intercepting, retaining and recycling suspended solids that were previously exported to the offshore environment. Particulate materials filtered from the water column by *dreissenids* are subsequently released as either feces or pseudofeces (undigested materials). Accordingly, this bio-transformation process alters the nature (grain size distribution, settling velocity and density) and transport properties (critical shear stress for erosion, erosion rates and bed stability) of particulate matter excreted by mussels. While knowledge of the transport characteristics of this material is required to refine particle transport dynamics and energy flow models in the Great Lakes, few studies have been conducted to quantify these processes directly.

In this study, experiments were conducted in an annular flume to determine the critical shear stress for erosion, erosion rates and bed stability of *dreissenid* biodeposits. Biodeposits and surface sediments were collected from mussel beds located in Lake Ontario and placed into the flume with filtered lake water. Critical shear stress for erosion was measured under different flow conditions and after three different consolidation periods (2, 7 and 14 days). The morphological characteristics and grain size characteristics of suspended solids in the flume were determined using conventional optical microscopy. Sediment properties (porosity, particle morphology, settling velocity and density) were evaluated. The results show that erosion characteristics and sediment transport properties were strongly influenced by bed age and the presence of mussels.

Oral SCL (Nearshore Ecosystems)

SHIFTS IN THE AQUATIC MIDGE COMMUNITY OF BAKER LAKE, NUNAVUT; AN INDICATOR OF PRONOUNCED 20TH CENTURY ENVIRONMENTAL CHANGE

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An examination of the subfossil remains of the Chironomidae, the dominant aquatic invertebrate taxa represented in Arctic lakes and ponds, was conducted on a sediment core of Baker Lake, Nunavut. Each interval of the core was sampled at ½ cm resolution and ^{210}Pb dating was used to establish a chronology. The downcore analysis of over 60 taxa was applied to a surface calibration set collected from 65 lakes across the eastern Canadian Arctic. As surface-water temperature was identified in Canonical Correspondence Analysis (CCA) as a primary variable structuring midge communities, a paleo-temperature transfer function was generated from subfossil midge assemblages. The application of a temperature inference model generated from the surface collection indicated a 3ºC increase in mid-summer surface water temperature for Baker Lake over the last 60 years. This was represented by a pronounced decline, and subsequent extirpation, of several cold-water indicator taxa beginning at approximately 1940 and reaching 0% relative abundance at approximately 1992. Subsequently, several taxa indicative of warmer conditions first appear in sediments beginning in the 1940s and increase in abundance in more recent sediments. There is also the arrival of *Cladotanytarsus mancus* gr., a warm-water adapted taxa indicative of higher nitrogen, in recent sediments (circa 1980), which increases to 12% of the total chironomid community by the top sediment interval. Thus, the gradual decline of cold-water adapted taxa, and subsequent increase of several taxa indicative of warmer regions, is a strong signal of recent climate warming within Baker Lake.

Oral SCL Theme (Effects of Recent Climate Change)

A REVIEW OF ADVANCES IN AQUATIC ECOSYSTEM CLASSIFICATION: HOW SHOULD ONTARIO PROCEED?

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OMNR and its partners have identified a need for an aquatic ecosystem classification system, which would provide a consistent spatial framework for inventory and monitoring of aquatic ecosystems throughout Ontario. We review characteristics and approaches to classification of flowing waters around the world, paying particular attention to the progression of ideas in stream ecology and the impact that theoretical developments have had on classification methodologies. Early European and North American classifications were biotic and based on dominant game fish species. Classifications developed between 1911 and 1987 focused on ordering streams sequentially into longitudinal zones, thus incorporating ideas of stream order, dynamic equilibrium, and the river continuum concept. The idea that the '*valley rules the stream*' has been dominant since 1975 with more and more catchment-based predictors in use. Currently, most aquatic classifications incorporate the conceptual framework of hierarchy theory by creating multi-level classifications based on a variety of variables collected at different spatial scales. Landscape-scale network topology is just beginning to be incorporated into classifications (e.g., using lake order or drainage network position variables), but there are no accepted metrics to capture lake-stream network topologies. Indeed, many classifications focus on riverine systems alone – ignoring lakes, wetlands, and groundwater. Ontario is unique in several respects: large parts of the north are sparsely populated and poorly sampled, and the Province is literally covered in lakes. Any classification system developed here will need to include lakes and focus on abiotic variables that capture lake, wetland, and river network flows in addition to geoclimatics.

Oral CCFFR (General Session)

FISH UTILIZATION OF SMALL, HYDROLOGICALLY CONNECTED COASTAL MARSHES OF EASTERN GEORGIAN BAY, LAKE HURON

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Coastal wetlands in eastern Georgian Bay, Lake Huron provide critical spawning and foraging habitat for majority of fish species. Sustained low water levels will alter habitat in these wetlands and could disconnect them from the Bay, preventing access for fishes. In order to manage these wetlands and maintain fish community diversity, it is essential to understand how fish, especially small forage species, utilize small, locally-situated wetlands. In the summer of 2010 we assessed the fish metacommunity in two regions, Tadenac Bay and Moon Island. In each area, we surveyed 5 locally situated wetlands four times. Fish captured in each wetland were tagged with a wetland specific marker; this allowed us to assess movement of fishes among wetlands at different spatial scales, as well as estimate population sizes of the most common species. In total, 5702 fish were tagged and 146 of these were recaptured (2.6 %). Pumpkinseeds (*Lepomis gibbosus*) were the most common species, accounting for 70% of the total catch. Other common species included largemouth bass (*Micropterus salmoides*), bluntnose minnow (*Pimephales notatus*) and yellow perch (*Perca flavescens*). Majority of fishes did not travel beyond the wetland they were originally tagged in. Our results will 1) help government agencies develop useful guidelines to group wetland complexes for protection in this geologically unique region of the Great Lakes, and 2) help predict how fish communities will adapt to a loss of habitat in these small wetlands as water levels continue to decline.

Oral SWS (Wetlands)

BIOAVAILABILITY OF PHOSPHORUS IN THE BEAVER RIVER WATERSHED OF LAKE SIMCOE, ONTARIO: ARE ALL FORMS OF PHOSPHORUS EQUALLY AVAILABLE?

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Eutrophication of freshwater ecosystems results when water is enriched with inorganic nutrients that increase the growth of algae. This condition can be accelerated by an increase in the supply of phosphorus from the influence of industry, sewage treatment and primary agricultural activities. High levels of phosphorus (and thus plant productivity) have become a problem in Lake Simcoe, Ontario since the 1980's. This has threatened the available levels of oxygen for freshwater fish, and has created foul odours and unpalatable drinking water. The Ontario Ministry of the Environment is implementing a Lake Simcoe Protection Plan to reduce the amount of nutrients, primarily phosphorus, entering the lake. This phosphorus reduction program may need to consider that all phosphorus is not equally bioavailable**.** My study will test the hypothesis that land use affects the fraction of bioavailable phosphorus in the Beaver River watershed, which is a major inflow of Lake Simcoe. To do this, I will measure the fraction of phosphorus which can related to bioavailable phosphorus in stream water draining different land uses, specifically wetlands, agricultural and forested areas, and assess changes over time. Preliminary results have shown that of the three land use types considered, total phosphorus and bioavailable phosphorus concentrations are highest in stream water draining agricultural land compared with forested and wetland areas. However, thus far the percentage of bioavailable phosphorus (relative to total P) appears to be fairly consistent across the three land use types.

Oral SCL (Energy and Mass Flux)

USING AN EMPIRICAL MODEL OF LAKE TEMPERATURE PROFILES DURING STRATIFICATION TO ASSESS THE IMPACT OF CLIMATE WARMING ON HABITAT FOR FISH

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A geometric model of seasonal lake temperature profiles is demonstrated. The model is a seasonal extension of the late summer profile model developed by Mackenzie-Grieve and Post (CJFAS 63:788-797 2006). In the model, temperature profiles over the stratified period are described using seven parameters: the Julian dates for the start and end of stratification and of peak stratification when the surface temperature peaks; the minimum and maximum temperatures; and the depth and steepness of the thermocline. The model is fitted using nonlinear least squares. Sample datasets and model fits are shown. When the model is linked to the hypsometric curve for a lake and a temperature suitability model for a target fish species, the habitat volume integral over the period of stratification can be computed. The impacts of climate warming can be assessed by adjusting some of the model parameters; increasing surface temperatures are accompanied by a proportional lengthening of the period of stratification. This empirical temperature model provides a simpler alternative to the data- and computer-intensive physics-based models.

Oral CCFFR (Effects of Recent Climate Change)

10 YEARS OF MONITORING: STREAM AND RIVER FISH BIODIVERSITY AND URBANIZATION WITHIN 9 WATERSHEDS ACROSS THE TORONTO REGION

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Many changes have occurred within the Toronto region's watersheds since the arrival of European settlers. As Canada's largest City expands, the landscape in and around the region continues to be modified with numerous changes influencing our aquatic habitats. Measuring and reporting on the state of the fish community and how it changes with urban sprawl offers a way for agencies, regional and local municipalities, community groups, and other stakeholders to identify when development practices and/or management strategies need to be modified such that undesirable trends in fish biodiversity can be reversed or prevented. Data from the Toronto and Region Conservation Authority's (TRCA) Regional Watershed Monitoring Program indicates a negative relationship between urbanization, quantified through road density, and several metrics such as native fish species richness, index of biotic integrity, and water quality. Certain road density thresholds have been identified where we lose the majority of our native species and are eventually left with only 4 tolerant fish species present at our most urbanized sites. Further analysis of specific stressors associated with urbanization, and their effect on native fish assemblages is pending.

Oral CCFFR (General Session)

THE EFFECTS OF COOL AND VARIABLE TEMPERATURES ON THE SPAWN DATE, GROWTH AND OVER WINTER MORALITY OF A WARMWATER FISH IN SMALL AND CONSTRUCTED COASTAL EMBAYMETNS OF LAKE ONTARIO

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Coastal embayments have been and will continue to constructed in the Great Lakes to improve warmwater habitat, however, we know very little about how warmwater fishes are affected by the input of relatively cold lake water. Using two embayments with higher and lower amounts of cold water input from Lake Ontario, we compare the spawn dates, summer growth and overwinter survival of age-0 pumpkinseed. Differences ($\leq$5°C) in embayment temperatures resulted in large pumpkinseeds age $\geq$1 avoiding the cooler embayment (57-79 mm) and occupying the warmer embayment (57-141 mm), and spawning in the warmer embayment occurred earlier (May 24 – August 20) in the summer than in the cooler embayment (July 18 – August 20). This difference in spawn time allowed many age-0 pumpkinseeds in the warmer embayment to accumulate sufficient energy reserves to survive the winter, but very few, if any, age-0 pumpkinseeds in the cooler embayment were able to survive over the winter. However, in a year when embayment temperatures were similar, the age $\geq$1 pumpkinseeds were similarly-sized in the warmer (75-149) and cooler (64-137 mm) embayments, spawning occurred at approximately the same time (June 7 - July 25), and both sites produced young capable of surviving the winter. Using data on water temperature and fish growth, we predict that most of the constructed embayments near Toronto, Ontario, are too cold to produce warmwater fish. Nevertheless, we find pumpkinseed age $\geq$1 in locations unable to produce age-0 fish, confirming a metapopulation among embayments.

Oral CCFFR (Aquatic Habitats and Fishes)

FISH STRANDING IN FRESHWATER SYSTEMS: SOURCES, CONSEQUENCES, AND MITIGATION

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When water levels drop in lentic and lotic freshwater ecosystems, fish can become stranded, either completely out of water, or in small, isolated pools, often having negative consequences for individuals. Stranding is a widespread phenomenon that occurs from anthropogenic (e.g., canal drawdown, hydropeaking, vessel-induced drawdown) and natural (e.g., floods, drought, winter ice dynamics) processes and has the potential to affect all life stages of fish. Here we summarize existing research on fish stranding in freshwater, discuss the consequences and mitigation options arising from previous research, and highlight current knowledge gaps. Most research pertaining to fish stranding has focused on anthropogenic activities. However, there is a paucity of research on fish stranding due to natural events such as drought, floods, and winter ice dynamics. Extensive research on salmonids downstream of hydropeaking dams has demonstrated that stranding can lead to negative consequences for fish populations and communities. Comparatively little is known about non-salmonid species or in other contexts, and in general little is known about the factors that are associated with stranding. These current knowledge gaps make it difficult to develop mitigation strategies. This review will provide fisheries managers with a much needed guide to fish stranding which should aid in supporting management decisions and identifying knowledge gaps that need to be addressed to improve the science and practice of fish stranding prediction and mitigation.

Poster CCFFR (Environmental Stressors)

MALE MATE CHOICE REINFORCES NATURAL SELECTION FOR MHC NUCLEOTIDE DIVERGENCE IN TWO POPULATIONS OF CHINOOK SALMON

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Sexual selection is an important mechanism contributing to the evolution of adaptive traits. Yet, for most species, little is known about among population variation in sexual selection or the potential interplay between sexual and natural selection. Here, we used semi-natural spawning channels and genetic parentage analysis to investigate variation in mating behaviours and preferences exhibited by the Quinsam River and Little Qualicum River populations of Chinook salmon located on Vancouver Island, B.C. We found that mating behaviours differed significantly between the two populations, particularly in the frequency of male courting and intersexual aggressive acts. Males were observed frequently courting females in both populations, but male courting rate was only effective in obtaining enhanced reproductive success in the Quinsam population, where this tactic was more prevalent. Male courting in both populations was directed towards females that were dissimilar at the immune genes of the major histocompatibility complex (MHC) class I locus and this behaviour translated into increased nucleotide divergence in offspring in the Quinsam population. Interestingly, increased divergence at this locus is associated with higher survivorship in the Quinsam population, which suggested males perform adaptive MHC-dependent mate choice.

Oral CCFFR (General Sessions)

EFFECTS OF REGIONAL-SCALE GEOLOGICAL CHANGES ON PATTERNS IN FISH ASSEMBLAGES

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A variety of factors have been identified as being particularly influential in structuring lotic fish communities. It is generally thought that local patterns are the result of the regional species pool passing through a series of environmental filters, and studies have demonstrated that regional-scale factors are important in determining various aspects of fish community structure. In this study, we identify the broad geographical patterns in low-order lotic fish community composition in south-central Ontario using multivariate analyses on historical survey data (1970s) to assess patterns in relation to the Shield. Our results show that there are significant differences in both the abiotic and biotic composition of Shield and off-Shield lotic systems. In general, Shield systems are characterized by higher water velocity, dissolved oxygen, woody debris and discharge while having lower conductivity, alkalinity, water temperature, turbidity and pH. Shield fish communities appear to be a subset of the total species pool found off-Shield, with few clear indicator species, and represent a subset of certain functional traits relating to temperature, substrate and geomorphology preferences, trophic position, and reproductive behaviors. This analysis suggests that the conditions on the Canadian Shield are an important regional filter in determining lotic fish community composition in south-central Ontario, in conjunction with other known factors such as climate and post-glacial dispersal.

Poster CCFFR (General Session)

THE RELATIVE ROLES OF STRESS, INJURY, AND RECOVERY GEARS ON THE MIGRATORY BEHAVIOUR AND SUCCESS OF SOCKEYE CAPTURED AND RELEASED IN THE LOWER FRASER RIVER

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In British Columbia, a Selective Fishing Policy was adopted for Pacific salmon fisheries to protect the weaker stocks while allowing abundant stocks to be harvested. However, upon interaction with fishing gear, fish experience varying degrees of injury and stress. But which factor is the major cause of impairment or mortality? Management strategies to minimize injury or stress could be different. From a mechanistic perspective, knowing the cause of mortality for wild migratory fish would be useful and only few studies have attempted to differentiate the relative contribution of stress and injury to mortality. Furthermore, other solutions to discard mortality in B.C. include the use of recovery boxes in an attempt to revive fish prior to release. These boxes have been successfully tested in marine waters, however, in freshwater, different stressors exist and how fish respond to injury may also differ. In 2010, we conducted an experiment using sockeye in the Fraser River to test the relative roles of stress and injury on migration behaviour and fate as well as the potential for recovery boxes to enhance survival. Experimental injury and stress were imparted using gillnet material and air exposure as per the following treatments: 1) high injury/low stress; 2) high injury/high stress; 3) low injury/low stress; 4) low injury/high stress. Fish were radio tagged and released, then tracked to spawning grounds using a watershed-wide telemetry array. We discuss the findings in the context of increasing the survival of adult Pacific salmon from capture fisheries that are discarded in freshwater.

Oral CCFFR (Capture Fisheries)

IN SITU ASSESSMENT OF LAMPRICIDE TOXICITY TO AGE-0 LAKE STURGEON

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Larval Sea Lampreys are controlled in streams by a chemical larvicide 3-triflouromethyl-4-nitrophenol (TFM). Laboratory and field exposure tests have demonstrated that TFM can also be toxic to caged age-0 Lake Sturgeon (<100 mm). In 2008, we used age-0 Lake Sturgeon in the Mississagi and Aux Sables Rivers, tributaries to Lake Huron, to compare their survival to two TFM treatments: a) Sturgeon Protocol, 1.2 x MLC, a TFM treatment regime designed to have reduced toxicity to age-0 Lake Sturgeon, and b) Full Treatment Protocol, 1.4 x MLC the standard TFM treatment for larval Sea Lampreys. A total of 20 cages of 5 age-0 Lake Sturgeon were distributed in the Mississagi River, 10 in each treatment segment, and in the Aux Sables River, 10 cages for the controls. Fish ranged in size from 57 – 101 mm. Survival rates were not statistically different ($p = 0.414$) between either the treatments or the control and survival was high at 93%. In 2010, this study was expanded to include 5 additional streams following the *in situ* cage protocol utilizing the standard TFM treatment protocol. Five tributaries, the Whitefish and Kaministiquia (Lake Superior; Canada), Two Hearted (Lake Superior; USA), Millecoquins, Sturgeon (Lake Michigan; USA). In each river, 20 treatment and 10 control cages were distributed. Lake Sturgeon were similar in size to those used in 2008. Survival of age-0 Lake Sturgeon ranged from 80 to 100% in the treatment and 94 to 100% in the control cages.

Oral CCFFR (Introduced Aquatic Species)

NSERC HYDRONET: A NATIONAL RESEARCH NETWORK TO PROMOTE SUSTAINABLE HYDROPOWER AND HEALTHY AQUATIC ECOSYSTEMS

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NSERC HydroNet is a newly created, collaborative national research network whose overall mandate is to promote sustainable hydropower in Canada through a better understanding of the effects of hydroelectric operations on aquatic ecosystems. Specifically, the network will develop new knowledge and new tools to assess, minimize, and mitigate the effects of hydropower on fish and their habitats, will improve the decision-making process associated with hydropower operations, and will reduce conflict among stakeholders. The development of science-based practical solutions will be useful to both our present and future industry and government partners, as well as to the general public. NSERC HydroNet, supported by NSERC's Strategic Networks and Collaborative Research and Development grant programs, comprises 15 academic scientists from across the country who are working closely with Fisheries and Oceans Canada and three major hydroelectric companies (Nalcor, Manitoba Hydro and BC Hydro). The research program is focused on three complementary projects: 1) an ecosystemic analysis of the productive capacity of fish habitats (PCFH) in rivers and the evaluation of the biological, physical and chemical drivers of PCFH; 2) the mesoscale modeling of PCFH in lakes and rivers; and, 3) the prediction of the entrainment risk for fish in hydropower reservoirs relative to generation operations, by combining behavioural ecology and hydraulic engineering. This poster will introduce members of the scientific community to NSERC HydroNet, the collaborative network and the numerous associated projects.

Poster CCFFR (General Sessions)

IRON-CONTROL OF ALGAL BLOOMS IN A FRESHWATER LAKE

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Eutrophication of freshwaters is generally attributed to excessive nutrient inputs, but sulfur pollution may be exacerbating this global problem by stimulating internal phosphorus loading in lakes. Because sulfur forms insoluble complexes with iron, sulfur may render lakes deficient in the element that sequesters phosphorus in sediments. However, the role of iron in controlling the trophic state of freshwaters is poorly elucidated due to its antagonistic effects on primary productivity. Iron is an essential micronutrient that stimulates algal growth, if other nutrients are in adequate supply. In contrast, iron increases the phosphorus-binding capacity of sediments which may inhibit algal growth, if phosphorus is in short supply. We tested these competing hypotheses by adding different amounts of iron to fifteen mesocosms in an iron-deficient hypereutrophic Canadian lake. Iron reduced phosphorus levels, decreased algal biomass, and suppressed cyanobacterial dominance. This research suggests that iron may act as a master variable controlling lake trophic state, and that the consequences of sulfur pollution on iron availability – and hence water quality – in freshwaters need to be considered.

Oral SCL (Algal Blooms)

DO HIGH MICROCYSTIN CONCENTRATIONS ONLY OCCUR AT LOW N:P RATIOS?

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Over the last few decades, the production of hepatoxins by freshwater cyanobacteria has emerged as a major public health concern. Cyanobacterial hepatoxins have been responsible for the deaths of humans, livestock, and pets in many countries. Globally, the most commonly found hepatotoxins in algal blooms are the microcystins. Microcystins are monocyclic heptapeptides produced by several cyanobacterial species, including *Microcystis* and *Anabaena*. Because cyanobacteria tend to dominate in lakes when the ratio of nitrogen-to-phosphorus (N:P) in the water column is low, we hypothesize that high concentrations of microcystins only occur at low N:P ratios. We address this hypothesis using two different approaches (experimental and natural survey). First, we manipulated N:P ratios in enclosures installed in a hypereutrophic lake by precipitating and sequestering phosphorus with iron amendments. In this experiment, microcystins concentrations were inversely related to N:P ratios, but the relationship exhibited a strong threshold. Microcystin concentrations were only above World Health Organization's drinking water quality guidelines (1 µg L^{-1} microcystin-LR) when the N:P ratio was below the threshold value, and were consistently below water quality guidelines when the N:P ratio was above the threshold value. To determine if the relationship observed between N:P ratio and microcystin concentrations in our experiment is prevalent in other systems, we synthesized nutrient and microcystin data from freshwater lakes across Canada. In our poster, we will examine if the relationship between N:P ratio and microcystin in our lake data set follows an inverse-threshold curve, and determine the range of threshold values among lakes.

Poster SCL (Algal Blooms)

THE EFFECTS OF DROUGHT ON THE PATTERN OF SEASONAL WATER COLUMN MIXING IN LAKE BOSOMTWE, GHANA (WEST AFRICA): IMPLICATIONS OF CLIMATE CHANGE ON THE ARTISINAL FISHERY

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The Sahel region, West Africa is a semi-arid ecotone bounded by the northern Sahara Desert and southern Guinea Coast rainforest that is particularly vulnerable to drought during recent climate change. Unfortunately, few meteorological or environmental records exist to understand long-term trends in drought frequency or severity over West Africa. Currently, an excellent candidate is the lacustrine sediment records from Lake Bosomtwe, Ghana. Lake Bosomtwe is a meteorite impact crater formed one million years ago, which acts as a rain gauge, with periods of drought resulting in reduced water levels. Paleoclimatic reconstructions of the one million year sediment record must first begin with an examination of how recent sediments are formed. Here we present two years of water column sampling of temperature, oxygen, nutrients (C, N, P) and chlorophyll a concentrations during 2004-2007 in relation to sediment trap samples. Results show that the short dry season of August is a critical time deep-water nutrient renewal needed for primary production. Here we explore the teleconnections between water column mixing patterns in Lake Bosomtwe in the Guinea Coast and drought periodicity in the Sahel region. Prolonged drought since 1969 may dampen primary production in the surface waters and restrict fisheries recruitment and overall fisheries yields in Lake Bosomtwe. Paleoclimatic reconstructions and global circulation models predict greater drought periodicity over West Africa and understanding the effect of drought on these environments will better aid governments to enact an effective drought preparedness plan.

Poster SCL (Effects of Recent Climate Change)

EFFECTS OF LAKE CHUB ON SURVIVAL AND BEHAVIOUR OF LONG-TOED SALAMANDER LARVAE

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Fish can affect amphibian larvae directly through consumption or indirectly by eliciting antipredator behaviours that reduce fitness. Because of predation, long-toed salamanders (*Ambystoma macrodactylum*) typically breed in fishless water bodies. Linnet Lake (Waterton Lakes National Park, Alberta) represents the unusual situation where salamanders coexist with a small-bodied cyprinid, lake chub (*Couesius plumbeus*). We assessed the role of lake chub in the decline of this salamander population through field observations and laboratory experiments. We used mark-recapture techniques to estimate the size of the two populations. The adult salamander population had decreased by 60% in 14 years with little evidence of successful reproduction. In contrast, a large, breeding population of lake chub was present. Predation experiments documented that lake chub 70 – 100 mm could consume salamander larvae < 40 mm. We also observed cannibalism in salamander larvae. In a second series of behavioural experiments, larvae responded to lake chub by reducing activity and increasing refuge use, especially during the day. Larvae did not respond to potentially predaceous conspecifics. Coexistence of fish and salamanders in Linnet Lake may result from a dynamic interplay between periodic extirpation of fish by winter hypoxia and of salamanders by predation, punctuated by episodes of re-colonization or strong recruitment of either species.

Poster CCFFR (General Session)

ALGAL BIOMASS RESPONSE TO RECENT WARMING IN THE LAKE OF THE WOODS, ONTARIO

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A warmer climate will affect important lake-water properties and biota in numerous and often surprising ways. Recent data from high-resolution ^{210}Pb-dated sediment cores from several locations in the Lake of the Woods revealed strong, coherent shifts in diatom assemblage relative abundances since the early 1900s. Compositional changes were significantly correlated with air temperature records over the past century that show a warming trend, and to changes in lake ice phenology. Building on previous findings, we examine spectrally-inferred determinations of chlorophyll *a* (Chl *a*) in lake sediment cores as a measure of past changes in aquatic primary production across this large, complex lake. Visible reflectance spectroscopy is a rapid, non-destructive technique that has been recently validated against known histories of lake production in Arctic, boreal and prairie lakes. At multiple sites in the Lake of the Woods, we report rises in lake sediment Chl *a* concentrations since the mid-1900s, with more marked increases since the early 1980s. When compared to long-term trends in measured and diatom-inferred water quality (e.g., total phosphorus concentrations), and to air temperature records, regression analyses reveal that climate measures are much stronger predictors of Chl *a* concentrations over time. These data suggest that a warming climate, directly through changes to the physical structure of lakes, and indirectly through its impact of chemical cycles, may exacerbate algal blooms in moderately-enriched lakes. This has direct implications in the Lake of the Woods, where there is a perception among the general public that algal blooms have increased in severity in recent years.

Oral SCL (Effects of Recent Climate Change)

THE FATE OF FARMED RAINBOW TROUT RELEASED FROM COMMERCIAL AQUACULTURE OPERATIONS IN LAKE HURON

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The fate of farmed fish after escape from commercial freshwater aquaculture operations is poorly understood. Yet, the extent to which these fish might impact freshwater ecosystems is dependent upon their survival and distribution in the wild. We simulated small- and large-scale escape events from two commercial aquaculture operations in the North Channel of Lake Huron over a 2-year period. We use a combination of telemetry (120) and Floy (1000) tags to determine the fate of escaped farmed rainbow trout (*Oncorhynchus mykiss*). Escaped fish showed limited site fidelity (~15% after 3 months), and once released dispersed quickly from the farms. Escaped rainbow trout were capable of long distance movements (up to 360 km) and were commonly recaptured at commercial farms, in near-shore areas or in streams. Escapees were able to maintain high growth rates both at and away from the farms. Rainbow trout in this study experienced low survival (~50%) with angling and predation accounting for a majority of mortality. Evidence of long term survival (>1 year) was also detected. The ecological consequences of long-distance dispersal and high growth may be off-set by the low survival of escaped rainbow trout. The results of this study are the first attempt to understand the potential risks that farmed fish may pose to the Lake Huron fish community and ecosystem.

Poster CCFFR (General Session)

INTRODUCING THE ROLE OF HIGHLY UNSATURATED FATTY ACIDS IN PLANKTON MODELS

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Several studies emphasize the importance of highly unsaturated fatty acids (HUFAs) at the most variable and least predictable link in aquatic food webs: the plant-animal interface. Defined as chains of 18 or more carbons (with multiple double bonds), the inability of consumers and predators to synthesize de novo these potentially growth-limiting molecules makes them a critical factor in any diet. Studies have demonstrated a wide range of fatty acid profiles in primary producers, forcing herbivorous zooplankton to differentially retain fatty acids to meet somatic requirements. Co-limitation with elemental resources may exist, while both empirical and modeling studies suggest food webs with high biochemical quality primary producers may attain inverted biomass distributions with efficient energy transfer among trophic levels. Given the overwhelming evidence of the HUFA importance on the energy flow in aquatic food webs, there is a surprising gap in the literature of predictive frameworks accounting for their role. Here, we demonstrate a HUFA explicit plankton population model that combines the effects of macronutrients and biochemical molecules to more accurately portray the plant-animal interface. We address several hypotheses proposed in the literature associated with the nature of intracellular and intraorganismal regulation processes and their capacity to drive population level dynamics. Our work strives to not only show the gap in the knowledge, but the knowledge in the gap.

Oral CCFFR (Energy and Mass Flux Session)

MIXING AND STRATIFICATION IN THE EPILIMNION OF LAKE OPEONGO

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In a lake, the epilimnion is the layer directly below the free surface that extends downwards to the strongly stratified seasonal thermocline region. The epilimnion responds to changes in wind stress and heat flux and is commonly illustrated as the zone of active mixing. However, this layer often displays intermittent mixing and a non-uniform temperature profile. Using field data from July and August 2009 we report observations of persistent micro-stratification in the epilimnion of Lake Opeongo, Ontario. The epilimnion was isothermal for only approximately 20% of July and August 2009, while for almost 40% of that period there was a temperature difference in the epilimnion of $\Delta T \geq 2^{\circ}C$. The presence of turbulence and active mixing in the epilimnion was estimated by measuring the frequency of temperature inversions from a fast response thermistor chain. Our observations stress the importance of small but persistent temperature difference of the order of $1^{o}C$ within the epilimnion, which can control the surface mixing in lakes with moderate winds. We discuss the implications of this micro-stratification for the distribution of biology in the surface waters of Lake Opeongo.

Oral SCL (Nearshore Ecosystems)

THE BENTHIC CONSEQUENCES OF CRAYFISH RANGE EXPANSION IN WESTERN CANADA

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Canadian water bodies are experiencing a dynamic fluctuation in orconectid crayfish ranges. In particular, the range of *Orconectes virilis*, Canada's most widespread crayfish, is expanding westward into previously uninhabited water bodies of Alberta. This crayfish species is known to have dramatic effects on benthic environments, and its invasion may have adverse consequences for Western-Canadian water bodies. We used two paths of study to assess the potential impact this crayfish may have on the benthic community; first with an experimental crayfish mesocosm study, and second by placing these results in the context of survey information throughout the Saskatchewan River system already possessing *O. virilis*. Crayfish decreased biodiversity, and assumed the role of dominant omnivore, altering the abundance and biomass of the macroinvertabrate assemblage. The establishment of crayfish in this range frontier may already be changing the benthic communities of the North Saskatchewan River and having potential consequences on forage resources for game fish. However, the multi-faceted approach to assessment we demonstrate here could be used as a tool for assessing the impact of future range expansions in this lotic system with invaders such as the rusty crayfish or zebra mussel.

Poster SCL (Introduced Aquatic Species)

REGULATION OF UREA TRANSPORT IN LOTIC ECOSYSTEMS OF THE CANADIAN PRAIRIES

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Urea is the most popular N-fertilizer used in the world. Recent experimental studies in the Canadian Prairies have shown that direct application of urea can degrade water quality in P-rich systems. However, little is known about the transport and degradation processes that control the export of urea from the landscape to receiving freshwaters. To evaluate whether urea from land is exported by lotic systems to lakes, we surveyed a ~225 km reach of a headwater stream to a receiving lake in central Saskatchewan, and conducted in situ experiments to estimate how urea degraded under diverse environmental conditions. Analyses reveal that while urea is degraded substantially during transport, export of terrestrial sources to lakes was regulated mainly by river discharge. In addition, point source influence was apparent only during low flow regimes. Ultimately, urea produced through urban and agricultural activities is transported effectively to downstream lakes, where it can degrade water quality.

Oral SCL (Energy and Mass Flux)

EXTINCTION DEBT AND LAND-USE LEGACIES: PAYING THE PIPER FOR ANTHROPOGENIC IMPACTS TO FRESHWATER FISHES

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Understanding the temporal impacts of land-use change on endangered species is not only important for effective land-use planning, but for conservation of biodiversity. However, in many cases the loss of species from fragmented landscapes occurs long after the original loss of habitat, a phenomenon known as extinction debt. Extinction debt refers to the time lag between when an extinction threshold has been reached and the time when actual extinction occurs. In this study we determine the existence and length of extinction debt from land-use change using the Endangered redside dace (*Clinostomus elongatus*); a species whose decline has been almost exclusively linked to changes in land-use change. To model extinction thresholds we used: 1) species specific projections from historical data, 2) population viability analyses using life history information, and 3) general relationships between aquatic species and land-use change. In all cases, we found that redside dace populations have likely already reached an extinction threshold. We then developed a retrospective analysis of land-use data from 1966-2006 to determine the temporal length of extinction debt. Using general mixed models, we show that the legacy of land-use change had an influence on redside dace distributions up to forty years later. These results suggest that the legacy of land-use may be much higher then currently realized. As such, models which fail to incorporate extinction debt from habitat fragmentation are likely under-estimating rates of degradation, suggesting current habitats may be more suitable then they actually are.

Oral CCFFR (General Session)

SPATIAL-TEMPORAL ANALYSIS OF A COMMERCIAL FISH SPECIES

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Abstract - In the 1960s, Geographic Information Science (GIS) emerged as a useful tool for decision makers in resource management. As a result of increasing conservation needs in fisheries, considerable research has gone into the use of GIS in visualizing spatial patterns of fish stocks. The yellowtail flounder (*Limanda ferruginea*) fishery in Newfoundland still lacks a comprehensive GIS showing fish location and distribution over space and time. Logbook data of yellowtail flounder catch taken from several commercial fishing vessels over the period 1990 to 2010 was examined by using interpolation and advanced spatial and temporal analysis tools in ArcGIS 9.3. The results of this study will help to better understand the temporal dynamics of yellowtail flounder distribution, an important commercial species.

Oral CCFFR (Capture Fisheries)

DETECTING CHANGE IN FISH COMMUNITIES USING PROBABILITY OF DETECTION

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Lester et.al's 1996 study; which investigated the statistical power to detect change in fish communities using traditional index fishing surveys (CPUE), indicated that a dauntingly large amount of effort would be required to statistically detect a halving or doubling in abundance. This analysis also found year-to-year variation to be the limiting factor for statistical power. We explored the ability of modified presence-absence statistics; specifically a probability of detection analysis (POD), to detect change in fish communities. This differs from previous uses of presence-absence data as it takes into consideration the possibility that the organism studied is present at a site but goes undetected. We expect that POD will be proportional to abundance (CPUE) at low densities and independent of abundance (relatively constant around 1) at mid to high densities. This plateau would represent a background of constancy against which it would be easier and faster to detect change than the more variable background that CPUE offers. We compared POD to CPUE using an OMNR electrofishing data set from Lake Huron. Preliminary results provide evidence of an upward slope and plateau in estimates of POD. Further analyses will determine if these properties are sufficient to create the constant background needed for more precise detection of change. We will also examine how POD as well as occupancy analyses compare across habitats, gear types and water bodies. The use of POD to detect change faster and with less effort has the potential to be a huge asset for future fisheries conservation endeavors.

Poster CCFFR (Aquatic Habitats and Fishes)

VALIDATION OF REFLEX ACTION MORTALITY PREDICTORS FOR USE BY STAKEHOLDERS TO MANAGE BYCATCH MORTALITY: ENDANGERED INTERIOR FRASER COHO SALMON BYCATCH IN BEACH SEINES

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In the Fraser River of British Columbia, fishers incidentally capture endangered interior Fraser River coho salmon (*Oncorhynchus kisutch*) when targeting other Pacific salmon species. Regulations require that coho salmon are released under the assumption that they will survive to spawn although this assumption has never been tested. We used radio telemetry with fixed-station receivers to monitor migration success of 50 interior Fraser River coho salmon following incidental capture in First Nations beach seine fisheries. A reflex assessment technique (RAMP – Reflex Action Mortality Predictors) was used to measure the condition of fish at release and to predict migration success following capture. Individuals with greater reflex impairment at release experienced significantly higher rates of migration failure. Reflex impairment was also significantly correlated with fishery handling time. Biopsy showed that captured coho salmon had experienced physiological disturbance characteristic of exhaustive exercise and hypoxia, with cortisol and lactate plasma concentrations significantly correlated with time entangled in fishing gear. This study provides fisheries managers with a first direct estimate of discard mortality for interior coho salmon caught in fresh water. Moreover, this is the first validation of RAMP in a wild setting, which based on our findings, has the potential to be used by fishers to make adjustments in fishing behaviour in real time to improve condition and reduce mortality and by managers as a means of identifying problems that deserve management attention. RAMP is an easy, rapid and inexpensive approach to predicting mortality and measuring vitality, and performed better than physiological tools which cannot easily be used by stakeholders.

Oral CCFFR (Capture Fisheries)

A BAYESIAN MODEL AVERAGING APPROACH FOR SETTING WATER QUALITY CRITERIA IN HAMILTON HARBOUR, ONTARIO, CANADA.

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Skeptical views of the scientific value of mathematical modeling argue that there is no true model of an ecological system, but rather several adequate descriptions of different conceptual basis and structure. Rather than picking the single “best-fit” model to predict future system responses, we can use Bayesian model averaging to provide a weighted average of the forecasts from different models. This project aims to examine whether the combinations of several models can improve our predictive capacity and therefore the value of modelling in the context of ecosystem management. This exercise will be based on a complex 12-state variable ecological model and a simpler plankton model that considers the interplay among phosphate, detritus, and generic phytoplankton and zooplankton state variables. The case study will be the Hamilton Harbour, Ontario, Canada. The posterior samples of each model parameter will be generated using Markov Chain Monte Carlo simulations as implemented in the WinBUGS software. These posterior samples will then be used to calculate posterior probabilities for each model. Predictions from the two models will be combined into a Bayesian model average using the respective posterior probabilities from each model as weights. Hence, by acknowledging that models from different areas of the complexity spectrum have different strengths and weaknesses, the Bayesian model averaging will be used to improve the predictive capacity and to overcome the ambiguity surrounding the model selection or the risk of basing ecological forecasts on a single model.

Oral CCFFR (General Session)

THE DECISION ANALYSIS AND ADAPTIVE MANAGEMENT (DAAM) PROJECTS: EVOLUTION OF A FISHING INDUSTRY/ACADEMIC PARTNERSHIP

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This paper describes the evolution of the DAAM Project at its 6-year anniversary. Historically, the Great Lakes commercial fishing industry relied on consultants for expert alternative analyses, and to advocate for industry in discussions with agencies and other stakeholders. In 2003, quota cuts prompted industry to again entertain contracted consultants to evaluate alternative stock assessment methods and management strategies for Lake Erie walleye and yellow perch. In anticipation of criticism from agencies and other stakeholders about the integrity of contracted research, the Ontario Commercial Fisheries' Association granted research funds to academics. Industry leadership was initially hesitant about lack of control over the process, results, or their dissemination. Academics were similarly wary about how their research might be perceived and accepted by peers for the same reason. Discussions lead to a better appreciation of the role of science in reducing key uncertainties underpinning business decision-making, and the first DAAM Project began in 2004. Despite the establishment of an arm's length relationship between the industry sponsors and the academics, agencies and some stakeholders remained skeptical. Through three successive funding phases, the DAAM project has evolved a close, collaboration between academia and the commercial fishing industry; one where academics provide transparent and accountable analyses, and an informed commercial fishing industry takes them under advisement in negotiations with agencies. As part of the Canadian Capture Fisheries Research Network, the DAAM project now includes agency scientists and managers and continues to address industry-motivated areas of research.

Oral CCFFR (Capture Fisheries)

EFFECTS OF MULTIPLE STRESSORS ON THE BIOENERGETICS OF LAKE SIMCOE FISHES

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Lake Simcoe has undergone dramatic changes over the past 25-30 years; anthropogenic activity and settlement in the watershed has increased dramatically, accompanied by the introduction of non-indigenous species and phosphorous abatement programs. The net result of these combined impacts has been, among other things, improvements in water quality since the mid-1990's, coincident with the establishment of dreissenid mussels in the system. Recently, multiple lines of evidence support a shift in production from an offshore to a nearshore-dominated system. However, the effects of this shift on the fish community are not well understood. Here, we report changes in the acquisition and allocation of energy in one nearshore fish species (yellow perch) and two offshore species (lake whitefish and lake herring) between the early 1980's to 2009. Shifts in energy dynamics will be interpreted with reference to changes in relative abundance and distribution of these species, and help inform the emerging picture of how anthropogenic stressors, especially invasion of Dreissenid mussels, have altered the ecology of the lake and its fishes.

Oral CCFFR (Environmental Stressors)

MIGRATION AND SURVIVAL OF ATLANTIC SALMON (SALMO SALAR) SMOLTS AND KELTS IN THE BAY D'ESPOIR FIORD, SOUTH COAST NEWFOUNDLAND

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Atlantic salmon (*Salmo salar*) smolts (n = 181) and kelts (n = 54) were surgically implanted with acoustic transmitters and released to determine migration route, residency time, and survival in a 50 km long estuarine fiord located on the south coast of Newfoundland. Data obtained from automated receivers placed throughout Bay d'Espoir indicated that migrating smolts and kelts used different routes to reach the outer areas of the fiord. The duration of time that smolts spent in the immediate river estuary zone differed between two populations (7 and 17 d), although the total time smolts were resident in the fiord was similar, and extensive (40 d). Many smolts were resident for periods of 4 to 8 weeks in the outer part of the fiord where maximum water depths range from 300 – 700 m. Overall smolt survival to the fiord exit was moderately high (54 to 85%), indicating that the initial phase of migration did not coincide with a period of unusually high mortality. Kelt residency times, survival, and swimming depths will also be determined and discussed. Knowledge gained from this study may be applied to mitigate potential impacts from the expanding salmonid aquaculture industry on wild Atlantic salmon populations within the fiord.

Oral CCFFR (General Session)

N_2O EMISSIONS FROM AN IMPACTED RIVER IN SOUTHERN ONTARIO: IMPLICATIONS FOR N-CYCLING PROCESSES AND GLOBAL BUGDETS

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N_2O is a powerful greenhouse gas primarily produced by microbial N cycling. Although rivers and estuaries are understood to be significant anthropogenic sources to the atmosphere, emissions to the atmosphere from these sites are poorly quantified. We measured N_2O emissions from the Grand River, Ontario, Canada, a seventh-order temperate river impacted by agriculture and wastewater treatment plant (WWTP) effluent. Two measurement scales were used: fluxes were quantified from the whole river during spring, early and late summer, and were also quantified from the middle reaches every two to three weeks over two consecutive years. Emissions were almost always positive, and were compared to previous river studies. Emissions were highest downstream of WWTPs and in summer when water temperature was high and dissolved oxygen (DO) was low. N_2O emissions were lower than IPCC estimations and correlated strongly with DO, and not NO_3^-, in contrast to empirical N_2O flux estimations used by the UN IPCC. This suggests that we may currently overestimate N_2O emissions from impacted rivers and that DO is an important, previously overlooked, control on N_2O production.

Poster SCL (General Session)

ABRUPT CHANGES IN HUDSON BAY LOWLAND LAKES, NORTHERN ONTARIO: WARMING-RELATED SIGNALS FROM DIATOMS AND OTHER PALEOINDICATORS

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The Sutton River region of the Hudson Bay Lowlands (HBL) has remained cool relative to the surrounding area largely because this is the last portion of Hudson and James Bay to become free of sea ice in the spring. However, unusually high air temperatures (daily maximum >30ºC), mass mortality of anadromous brook charr on the Sutton River, and uncharacteristic thermal stratification in an upland lake (Hawley Lake) was noted by fish ecologists working in the area in 2001. To examine whether this very recent and extreme warming event is exceptional at both regional and temporal scales, we examine diatoms together with additional paleolimnological proxies preserved in dated sediment cores from several lakes in the HBL region of northern Ontario.

We found that diatoms were scarce in our study lakes prior to the ca. mid-20th century, at which time diatom assemblage composition underwent notable changes and the relative abundances of siliceous phytoliths decreased. Concurrent with these changes, anomalies in sedimentation rates and magnetic susceptibility were recorded. The most prominent changes in the biological proxies occurred in the last ca. two decades, when planktonic diatoms and scaled chrysophytes increased in relative abundances together with sedimentary chlorophyll *a*, whereas benthic fragilarioid diatoms declined further. We explore possible links between these biological shifts, recent changes in air temperature and Hudson Bay ice cover, and very rapid isostatic rebound in the region.

Oral SCL (Effects of Recent Climate Change)

FISHING PRESSURE AND BASELINES IN CORAL REEF FISH COMMUNITIES IN THE EASTERN INDIAN OCEAN

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Top predators, such as sharks in coral reef ecosystems are experiencing rapid worldwide declines. Recent studies suggest that high abundances of top predators promote healthy and resilient reefs (e.g. inverted trophic biomass pyramid in the fish community) compared to those with few or no top predators. Unfortunately, evidence for such an association is very limited in temporal and spatial scope meaning that it is difficult to establish fishing activities as the main driver of ecosystem differences. Here we investigate the effects of a fishery that targets reef sharks and other tertiary consumers on coral reef atolls off the coast of north-western Australia. We compare the structure of reef fish communities at fished (Scott reef) and unfished (Rowley shoals) reefs using a 16-year data set of benthic habitat information and underwater visual counts of species abundance. Baited Remote Underwater Video Stations (BRUVS) were used in conjunction with visual surveys to attain species abundances of large bodied predators. The time span in combination with habitat information allows for the effect of the removal of top predators on fish communities to be examined with minimal confounding historical effects (e.g. coral bleaching). Fished reefs showed significantly fewer top predators, but significantly more tertiary consumers and herbivores in comparison to unfished reefs. Further, territorial species such as damselfish (*Pomacentridae*) were significantly higher in abundance at reefs subjected to fishing activity. Thus, declines in top-predator species due to fishing activities is likely a main driver of changes in the community structure of these reef fish communities.

Oral CCFFR (Capture Fisheries)

NEW CURRENTS IN MARINE-DERIVED NUTRIENTS DELIVERED TO ATLANTIC RIVERS: TRACKING INCORPORATION WITHIN STREAMS

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Returns of anadromous fish have declined dramatically in the past century throughout Atlantic Canada, reducing the delivery of marine-derived nutrients (MDN) to the rivers in which they spawn. These marine fish are important for anglers and commercial fisheries. The loss of these fishes could have profound effects on stream nutrient dynamics and aquatic production, particularly in nutrient-poor systems. The role of MDN transport in coastal rivers is a function of net nutrients transferred by all anadromous fish. Although many Atlantic anadromous fish, such as salmon, smelt, and alewives, do not die after spawning, collectively their release of excretory by-products and gametes may result in marine nutrient subsidies equivalent to those delivered by Pacific salmon and, therefore, are important to the productivity of Atlantic Canada streams. The objective of this study is to identify the pathway of incorporation and transfer of MDN to biofilm, invertebrate and fish communities, using stable isotope analysis of nitrogen and carbon in Atlantic rivers. When productivity is enhanced by the delivery of MDN, streams can support more primary and secondary production. Thus, having more anadromous fish spawning in streams can produce a positive-feedback system, where these streams support more insect and fish production. During a time when marine fisheries conservation is critical and ecosystem-based management is a goal for provincial and federal agencies, the aim of this project is to extend our understanding of the impacts of anadromous fish freshwater ecosystems.

Oral CCFFR (Environmental Stressors)

THE EFFECTS OF SEASONS AND GRAZING ON THE AMBOSELI WETLANDS, SOUTHERN KENYA

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The palustrine wetlands of the semi-arid Amboseli ecosystem are critical dry-season refugia for diverse wildlife, livestock and humans. As with most wetlands in Africa, Amboseli's wetlands have had little formal study. Our four-year study (2002-05) was conducted on wetlands within the National Park to (1) document the seasonal dynamics of wetland vegetation and use by herbivores; (2) decipher the hitherto suspected impact of the increasingly compressed elephant population, using a wetland exclosure, on plant biomass production and species composition, and use by other herbivores; and (3) study the impact of herbivory, using simulated grazing experiments, on plant production and species composition. Rainfall caused an increase in biomass and height of the vegetation, whereas grazing during dry seasons caused a decrease in both. Under simulated grazing, above-ground biomass and growth rates were higher than the control, especially during the dry season when most herbivores use the wetlands. However, elephants used the wetlands year-round, which appeared to decrease the response of the vegetation to rainfall and change the vegetation community structure, but not the species composition. The dense vegetation that develops when elephants are excluded does not deter other herbivores from using the wetlands. The wetlands are critical for wildlife during dry seasons and drought, though their ability to sustain an increasingly compressed population of elephants may be diminishing in spite of the ability of the plants to tolerate occasional defoliation. It is recommended that elephants be excluded from the wetlands on a cyclical basis to maintain plant heterogeneity and overall biodiversity.

Oral SWS/SCL (Wetlands)

LINKING O_2, P AND N IN A LARGE IMPACTED RIVER IN S. CANADA: ISOTOPIC INSIGHTS FOR ECOLOGY AND BIOGEOCHEMISTRY

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Population growth in Canada is increasing the pressure on freshwater systems for two essential but diametrically opposed services: the provision of drinking water and the assimilation of wastes. In many cities, wastewater treatment plants (WWTPs) discharge effluent directly into rivers. The Grand River watershed is home to 950,000 people. Projected population increase is over 40% within 20 years. Currently, more than 500,000 people rely on the Grand River for drinking water while there are 26 WWTPs along the river. Non point source nutrient loads are also extremely high, as agriculture (including large livestock operations) is the dominant land use. To accommodate this new growth, billion dollar decisions for wastewater and drinking water treatment and agricultural land management have been taken. Aquatic diel cycles of N, P and O_2 are linked through biological demands and redox chemistry. Here we examine the concomitant use of isotopes, $\delta^{18}O$ in O_2, $\delta^{18}O$ and $\delta^{15}N$ in NO_3^- and N_2O, $\delta^{15}N$ in NH_4^+, $\delta^{13}C$ and $\delta^{15}N$ in DOM, POM, macrophytes and benthic invertebrates, $\delta^{34}S$ and $\delta^{18}O$ in SO_4, with stoichiometric ratios to tease apart the sources and cycling of O_2, N, and P in various reaches of this 7th order river from the headwaters to the mouth at Lake Erie. Five approaches with differing spatial and temporal resolution are used: longitudinal surveys conducted at several times on the same day from headwaters to mouth (300 km), diel sampling (sampling every 2 hours over 28 hours), WWTP plume chasing surveys, year-round biweekly sampling at selected sites, and manipulation experiments with chambers installed on the river bed.

Poster SCL (General Session)

WHAT DOES BENTHIC ALGAL PRODUCTION CONTRIBUTE TO THE TOTAL SYSTEM?

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In oligotrophic lakes, primary production can be dominated by the benthos. Yet little work has been done on benthic primary production responses to key environmental factors and hence how that production might vary. Without knowing these responses it is challenging to evaluate total benthic primary production and hence its contribution to the system. We looked at primary production on soft sediments in Lake Opeongo, a typical Canadian Shield lake. We estimated *in situ* primary production using a full photosynthesis vs. irradiance curve at 34 sites. In addition, we recorded a suite of environmental factors implicated as influencing primary production: sediment type, wind disturbance, light, and temperature, along with algal pigments and biomass. An RDA of the above suggested that *in situ* photosynthesis increased throughout the summer, and was higher at sites with higher algal biomass. In addition, the full photosynthesis vs. irradiance curve allowed us to evaluate physiological responses of the cells. For example, we were able to show that cells are able to increase both their efficiency (pigments) and maximum rate of photosynthesis (enzymes) under lower light levels. Disturbance was also important. Disturbance was calculated using Pareto-Zipf plots of wind-weighted fetch thresholds against time. We have shown relatively easily obtained environmental factors, such as fetch, algal biomass, or time of summer, can significantly improve estimates of primary production derived only from light.

Oral SCL (Energy and Mass Flux)

CLIMATE CHANGE MODULATES STRUCTURAL AND FUNCTIONAL LAKE ECOSYSTEM RESPONSES TO INTRODUCED ANADROMOUS SALMON

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Global-scale climate warming has occurred for at least the past two centuries, undoubtedly modifying the development of modern aquatic ecosystems. We integrated limnological and paleolimnological analyses with fisheries modeling in Tuya Lake, a large mesotrophic system in northern British Columbia to explore our hypothesis that long-term climate change can influence lake ecosystems (i.e. ecosystem "climate conditioning") in ways that dictate the impacts of subsequent stressors (non-native sockeye salmon stocking). Our study revealed millennially-unprecedented changes in lake physics, nutrient cycling, and lake productivity that were strongly correlated to multi-centennial regional and pan-Arctic temperature trends, and culminated in the development of seasonal lake nitrogen deficiencies. Salmon biomass accumulation was strongly and negatively correlated to modern lake nutrient availability (TP; $r^2 = 0.87$), most likely regulating seasonal algal abundance (chl *a*; $r^2 = 0.87$) through salmon-enhanced climate-induced N-limitation (e.g. euphotic sedimentation losses). Our results highlight unforeseen complexity in ecosystem responses to stressors that vary on different timescales, and the importance of understanding long-term "climate conditioning" of northern lake ecosystems, as the climatic history of lakes may shape their ecological responses to subsequent stresses.

Oral CCFFR (Effects of Recent Climate Change)

EMPIRICAL MODELS FOR PREDICTING THE EXCRETION OF NUTRIENTS (N AND P) BY AQUATIC METAZOANS: TAXONOMIC DIFFERENCES IN RATES AND ELEMENT RATIOS

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The relative significance of nutrients supplied by different groups of metazoans (i.e. zooplankton versus mussels versus fish, or benthic versus pelagic organisms) in supporting bacteria and algal productivity is expected to vary. However, taxonomic differences in rates and ratios of nutrients excreted have not been thoroughly investigated. We developed empirical models for predicting the release of nutrients (N and P) by aquatic metazoans (zooplankton, mussels, benthic macroinvertebrates and fish). The number of species represented in each model ranged from 9 to 74. Rates and ratios of nutrient excretion were modeled and intertaxon differences in excretion were examined. Detritivorous fish excreted both N and P at rates greater than all other taxa; whereas mussels excreted N and P generally at rates less than other taxa. There were no significant differences in the rate of N and P excretion between zooplankton and fish (i.e. the allometry of N and P excretion was similar between zooplankton and fish). Molar N : P ratios of nutrients excreted increased with increasing organism dry mass for each group of metazoans, except for zooplankton and detritivorous fish (where N : P ratios declined with increasing organism dry mass). Molar N: P ratios in the excretions of aquatic metazoans were generally below the Redfield ratio of 16:1. These models provide the ability to compare simultaneously the internal regenerative pathways of nutrients by mixed assemblages of aquatic metazoans with other nutrient sources (e.g. internal loading from the sediments and external loading from the catchment) in both marine and freshwater ecosystems.

Oral SCL (General Session)

INTER-ANNUAL VARIABILITY IN ICE BREAK-UP DATES BETWEEN 1900 AND 2004 IN LAKE MENDOTA, WISCONSIN

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Changes in ice conditions, such as earlier ice break-up around the Northern Hemisphere are evident over the past 150 years. The overall objective of this study is to determine whether the temporal variability in ice break-up dates in Lake Mendota, Wisconsin between 1900 and 2004 resulted from local weather or global climate patterns. Two approaches were used to model temporal variability in ice break-up dates: i) a time-domain approach, specifically an autoregressive moving average (ARMA) model to predict the behaviour of ice break-up dates; and ii) a time-frequency approach, using a variation partitioning method in combination with a novel spectral analysis approach called Moran Eigenvector Maps (MEM) to disentangle the relative contribution of weather and climate on ice break-up dates and to identify the time-scales on which these processes are operating on ice conditions. A combination of global climate, broad-scale, and fine-scale weather patterns is explaining the variation in ice break-up dates through time. Interestingly, memory of an ice break-up date from the previous year is not apparent. Rather, variation in ice break-up dates appears to be acting cyclically from fine to broad temporal scales as revealed by the MEM analysis. Changes in regional and global meteorological patterns could result in continued earlier ice break-up dates potentially leading to changes in aquatic ecosystems, such as changes in water quality, community composition, and fish spawning success.

Oral CCFFR (Recent Effects of Climate Change)

DISTRIBUTION AND GENETIC DIFFERENTIATION OF HYBRIDIZING BLUE MUSSELS (*MYTILUS*) IN THE CANADIAN ATLANTIC PROVINCES

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Marine mussels of the genus *Mytilus* are partially reproductively isolated, maintaining genetic distinctiveness despite hybridization and considerable larval dispersal potential. A zone of sympatry exists between sibling species *Mytilus edulis* and *Mytilus trossulus* in the Canadian Atlantic Provinces, ranging from nearly pure *M. trossulus* populations in Northern Newfoundland to nearly pure *M. edulis* populations on the east coast of Nova Scotia with hybrid genotypes scattered among sites. In this study, population genetic analyses combined with data on the distribution of parental and hybrid genotypes of *Mytilus* in the Canadian Atlantic Provinces were used to determine large and small-scale genetic patterns within this hybrid zone. In the absence of any obvious physical barriers to dispersal within discrete bays, a bimodal genotype frequency distribution was found, with high proportions of the parental genotypes and low levels of hybridization. On a larger spatial scale, dispersal between the northern and the cooler southern waters appears to be limited, resulting in a genotype frequency gradient of parental *M. edulis* and *M. trossulus*. This hybrid zone appears to be maintained by reproductive isolating mechanisms acting against hybridization and ecological assortment leading to the coexistence of the two species.

Oral CCFFR (General Session)

THE DEEP ALGAL BLOOM: SEASONAL EVOLUTION AND PRODUCTION OF DEEP CHLOROPHYLL MAXIMA IN THE LAURENTIAN GREAT LAKES

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In thermally stratified lakes and oceans the highest concentrations of algal biomass often occur beneath the surface mixed layer. While the community composition and vertical structure of deep chlorophyll maxima (DCMs) has been well characterized in aquatic ecosystems, the contribution of this deep algal bloom to whole water column phytoplankton photosynthesis (PP) remains equivocal. In lakes, most estimates of DCM PP are based on *in vitro* incubations using artificial light which poorly replicates *in situ* light spectra at depth. This study begins by examining the quantitative importance of this spectral mismatch. By demonstrating how chromatic adaptation shapes DCM community composition we show why PP in the DCM is routinely underestimated. Bio-optical models that scale *in situ* measurements of photosynthetic pigment absorption and quantum efficiency to rates of photosynthetic electron transport are an emerging alternative to *in vitro* based photosynthetic techniques. Here we introduce a vertically and spectrally resolved bio-optical model validated against concurrent ^{14}C assimilation rates in Lake Erie. Finally, using a large dataset of bio-optical profiles from the Laurentian Great Lakes, the vertical structure of PP is compared across trophic and mixing depth gradients. These analyses demonstrate that PP beneath the epilimnion, at times, dominates whole water column PP. Furthermore, we show the quantitative importance of DCMs is largely driven by the optical depth of the metalimnion.

Oral SCL (Algal Blooms)

LANDSCAPE-SCALE INFLUENCES ON LEAST BITTERN (*IXOBRYCHUS EXILIS*) HABITAT USE IN SOUTHERN ONTARIO COASTAL MARSHES

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Least Bittern (*Ixobrychus exilis*) populations have declined in Canada, and this has led to the species being listed as threatened under the Species-at-risk Act. Wetland loss and degradation has been extreme in southern Ontario (> 90% loss in some areas) and this loss has been identified as a potential contributor to population declines. The objective of this study was to determine the influence of land-use surrounding wetlands, wetland size, isolation and water quality in predicting the presence of the Least Bittern in southern Ontario coastal marshes. Between 2006 and 2008, we surveyed 20 coastal marshes for Least Bitterns in southern Ontario. The proportion of urbanized land within 4,000m of the marsh was the most important variable in predicting their presence/absence. Least Bitterns were more likely to be found in wetlands surrounded by low levels of urbanization and high levels of rural land-uses. We also found that sites with higher levels of urbanization and poorer water quality, as indicated by the Water Quality Index (WQI), were less likely to support Least Bitterns. Water quality may impact the ability of this species to forage successfully and may be one potential route through which the Least Bittern is impacted by urbanization. Based on these results, urbanization should be limited within 4,000m of the wetland edge to protect existing rural marshes from degradation. Further research is needed to identify the impact that small-scale patterns of urbanization may have on habitat of Least Bitterns in Great Lakes coastal marshes.

Oral SWS (Wetlands)

RISK ASSESSMENT OF FISH PASSAGE OPTIONS FOR THE DAM ON THE BLACK STURGEON RIVER

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Simulation models were used to quantify ecological and social trade-offs associated with fish passage decisions for the aging dam near the mouth of the Black Sturgeon River, Lake Superior, Canada. The dam is used to control invasive sea lamprey (*Petromyzon marinus*) by denying maturing lamprey access to spawning habitat upstream. Local user groups and OMNR are pressing for dam removal to facilitate restoration of walleye (*Sanders vitreus*), a species of commercial and recreational value, and lake sturgeon (*Acipenser fulvescens*), a listed species, in Black Bay. Northern brook lamprey (*Ichthyomyzon fossor*), another listed species, is abundant above the dam and could be negatively affected by the chemical control methods needed if sea lampreys are allowed upstream of the current dam site. Our analysis considered the uncertainties and trade-offs across three management actions: a new dam with no fish passage at the current site, a new dam with selective fish passage at the current site, a new dam without fish passage relocated 65 km upstream of the current site and above potential walleye and lake sturgeon spawning habitat. Our risk assessment revealed clear tradeoffs between sea lamprey control, restoration of walleye and lake sturgeon, and protection of northern brook lamprey. A trap and sort fishway at the current dam site could ease these tradeoffs if passage of adult native fishes upstream of the dam and survival of juvenile fishes moving downstream of the dam are high. The other options sacrifice sea lamprey control and northern brook lamprey in favour of walleye and lake sturgeon, or vice versa. Our analysis could help stakeholders and managers reach a scientifically defensible decision for the Black Sturgeon dam by explicitly quantifying the trade-offs and uncertainties associated with the management options.

Oral CCFFR (Aquatic Habitats and Fishes)

DO TERRESTRIAL INPUTS SUBSIDIZE, SUBSTITUTE FOR, OR SUBTRACT FROM CONSUMER PRODUCTION IN LAKE FOOD WEBS?

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Terrestrially-derived organic matter makes up a substantial portion of the biomass of fishes, zoobenthos, and zooplankton in many lake food webs. This allochthonous support of consumers is generally assumed to subsidize their production, but evidence to support this assumption is limited. Some lines of reasoning and recent comparative studies suggest that terrestrial inputs may actually substitute for, or even subtract from, consumer production that would otherwise be supported by autochthonous inputs. We present natural-abundance H, C, and N stable isotope data showing that consumer allochthony (reliance on terrestrial organic matter) increases across a natural gradient of terrestrially-derived DOC (t-DOC). We then use a model of basal resource availability (terrestrial inputs plus benthic and pelagic primary production) and a dynamic food web model to explore the implications of changing t-DOC loads for consumer production. Our results suggest that trophic preferences and efficiencies can mediate the food web effects of terrestrial loads to lakes.

Oral SCL/CCFFR (Energy and Mass Flux)

PALEOLIMNOLOGICAL INVESTIGATION OF RESPONSES IN FOOD WEB DYNAMICS BEFORE AND AFTER A PISCIVORE MANIPULATION IN MOUSE AND RANGER LAKE, ONTARIO

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The Dorset Food Web Piscivore Manipulation Project (1991-1997) investigated trophic interactions of whole-lake pelagic communities in response to strong, top-down manipulations of the piscivore community. The project selected Mouse and Ranger Lake in the Muskoka-Haliburton region of south-central Ontario based on their similar morphological and chemical characteristics, but dissimilar piscivore populations. Immediately prior to the manipulation, Ranger Lake supported substantial populations of smallmouth and largemouth bass whereas Mouse Lake had only planktivorous fish (i.e. yellow perch, white sucker, pumpkinseeds, and golden shiners). The manipulation transferred all the piscivorous fish from Ranger to Mouse Lake. Results from the four year post-manipulation period did not demonstrate a consistent linear cascade from the piscivores to the phytoplankton implicit to the trophic cascade model (TCM). Expected changes in species composition were evident whereas changes in total biomass were not observed for certain species. This suggests that top-down interactions are complex and that extrinsic factors can influence community dynamics, such as climate change. To address these additional confounding factors, long-term data are necessary to better understand the pre-manipulation conditions of Mouse and Ranger Lake and how conditions have changed over longer time periods (e.g., the past ~ 150 years). Here we examine changes in sedimentary assemblages of algae (i.e., diatoms), *Chaoborus* and crustacean zooplankton using ^{210}Pb-dated sediment cores. High-resolution data are used to garner insights into the strength of top-down food web interactions over decadal scales, and to offer evidence for the influence extrinsic factors may have on pelagic communities. Collectively these data can also highlight the response lag that communities may experience following a food web manipulation.

Poster SCL (General Session)

THE NEARSHORE SHUNT: THREE DIMENSIONAL MODELING OF DREISSENID MUSSEL EFFECTS IN NEARSHORE AND OFFSHORE WATERS OF LAKE ERIE

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The nearshore shunt hypothesis predicts that invasive dreissenid mussels should increase detention of external and offshore inputs in the nearshore while redirecting nutrients and energy from the water column to the nearshore benthos. Characterizing the hypothesized processes, and mussel impacts on large lakes generally, has been difficult because of the strong influence of hydrodynamics on water mass distributions and on mussel access to the water column. Here we present a three dimensional hydrodynamic and ecological model for Lake Erie (ELCOM-CAEDYM) that includes routines to describe nutrient cycling, phytoplankton dynamics, mussel energetics and the physical-biological processes controlling food particle availability proximate to the mussels. With zero mussel biomass, the model gave reasonable predictions of nutrient and chlorophyll concentrations compared to observations for the year of simulation (2002) but tended to overestimate chlorophyll and nutrient concentrations in some nearshore areas. Setting mussel biomass distribution to match the best estimates for 2002 produced very similar model results over most of the lake but considerably altered results in nearshore areas with high mussel biomass. The insights into the nearshore shunt hypothesis afforded by the model will be discussed.

Oral SCL (Nearshore Ecosystems)

EFFECTS OF WATER CURRENTS AND SMALL-SCALE MIXING ON SPATIAL ZOOPLANKTON DISTRIBUTIONS IN THE NEAR SHORE OF A LAKE

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Wind-driven water circulation may cause resuspension of sediments and nutrients in near shore zones of lakes. These nutrient pulses could enhance algal productivity that enters the food web through grazing by zooplankton that are spatially concentrated by the same circulation patterns. As part of a collaborative study on these processes, we used an Optical Plankton Counter, a moored Acoustic Doppler Current Profiler, and high response rate thermistor chains to simultaneously measure spatial features of zooplankton, water currents, and fine-scale temperature stratification respectively at meter scales in the mixed layer of Lake Opeongo, Ontario. Analyses of these data were used to test the conjecture that increasing current speed and decreasing vertical stability of the mixed layer will progressively erode small-scale spatial pattern in zooplankton.

Oral SCL (Nearshore Ecosystems)

THE CREATION OF A HABITAT BANK IN THE TORONTO REGION

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Aquatic Habitat Toronto, a consensus-based partnership between Environment Canada, Fisheries and Oceans Canada, Ontario Ministry of Natural Resources, Toronto and Region Conservation Authority, The City of Toronto, and Waterfront Toronto is in the process of developing a functional 'habitat bank'. In accordance with the Fisheries and Oceans Canada's policy of 'no net loss' of productive capacity of fish habitat the habitat bank will be drawn on for compensation in the event that there has been harmful alteration, disruption, or destruction (HADD) of fish habitat at a waterfront site where the potential for on-site compensation is limited. The habitat bank will improve on the current approach of creation or restoration of adjacent habitats, with uncertainty about its success, after the HADD occurs. The habitats will be added to the bank as they have been created or restored and will have to be of proven value. The habitat bank can be composed of created or restored areas of the predominant fish habitat types along the Toronto waterfront (open coast, embayment, estuary and wetland) with the initial emphasis being on wetland habitats as they are currently a key limiting habitat feature in this area.

Oral CCFFR (Aquatic Habitats and Fishes)

AN APPROACH TO QUANTITATIVELY LINK FOOD WEB DYNAMNICS TO ENVIRONMENTAL VARIATION USING STABLE ISOTOPES

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Here we present an approach for combining several previously developed statistical methods to quantify how diet may contribute to changes in trophic niche structure across environmental gradients or through time using stable isotopes ($\delta^{15}N$, $\delta^{13}C$), and provide an example from boreal fish populations. Variance based metrics of niche width dimensions calculated from $\delta^{15}N$ vs. $\delta^{13}C$ bi-plots were combined with circular statistics to quantify directional change in trophic structure of lake trout and walleye populations across a lake size gradient and to identify when these changes may be partially explained by differences in the degree of isotopic diet specialization within a population. Despite recent advances in quantitative measures of trophic structure, many measurements when used alone only address one aspect of niche change and they have not yet been used in concert. The example presented here illustrates how this approach may be used to address more comprehensive questions regarding the link between food web dynamics and environmental variation across space or time.

Poster CCFFR (Introduced Aquatic Species)

OVERVIEW OF THE NSERC CANADIAN CAPTURE FISHERIES RESEARCH NETWORK

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The NSERC Canadian Capture Fisheries Research network is a unique collaboration among Canada's academic researchers, fishing industry and government. The vision of this network is to re-shape fisheries research in Canada, bringing together industry, the academic community and governmental research on priority research questions, and linking existing work/research so that it is useful. The research of the new network is aimed at increasing knowledge that will enhance ecological sustainability, viability, and improved management of Canadian fisheries. It includes research to overcome information gaps in relation to important fisheries, improve the use of industry information in assessment and management, enhance ecological sustainability while achieving operational efficiency, and improve the basis for the ecosystem-based approach to fisheries management. The network involves 33 academic co-applicants from 11 universities working in ongoing close collaboration with many collaborators from the fishing industry of Canada, researchers and managers from the Department of Fisheries and Oceans and other federal and provincial departments. The network is unique in that it is industry driven, and is focused on projects that have the active collaboration of industry with academic and departmental researchers. The network will increase research and training and provide information, knowledge and technology that will assist the capture fisheries industry to improve sustainability and viability.

Oral CCFFR (Capture Fisheries)

FATE OF ATLANTIC BLUEFIN TUNA IN AN EXPERIMENTAL RECREATIONAL CATCH-AND-RELEASE FISHERY

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Atlantic bluefin tuna are highly migratory marine pelagic fishes that can grow to a mass in excess of 650 kg. In the North Atlantic Ocean, bluefin tuna are fished commercially by more than 40 countries. Abundance of bluefin tuna has been severely reduced since the advent of industrial fishing and they have recently been evaluated for listing under the Convention on International Trade in Endangered Species (CITES). A recreational catch-and-release (C&R) fishery is currently being developed to target bluefin tuna off the coast of Prince Edward Island (PEI) and Nova Scotia. To evaluate the sustainability of a recreational C&R fishery, it is necessary to quantify mortality and sub-lethal consequences of C&R for use in management models. Here we report preliminary results including estimates of mortality from the deployment of pop-up archival satellite tags on 59 bluefin tuna captured and released off the coast of PEI in fall 2010.

Oral CCFFR (Capture Fisheries)

CONTROLS ON PHYTOPLANKTON BIOMASS IN SUBARTIC LAKES: NUTRIENT LIMITATION AND ZOOPLANKTON GRAZING

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Understanding how ecosystems will respond to environmental change is particularly important in northern regions, as climate change is predicted to have profound effects in this area. In the subarctic, melting permafrost is expected to affect lake chemistry through changes in the cycling of nutrients and organic matter. In an effort to understand how aquatic ecosystems in subarctic regions will respond to future climate change, we assessed the bottom-up and top-down control of phytoplankton biomass using nutrient enrichment bioassays and a zooplankton community grazing experiment. Although 38% of lakes' phytoplankton communities did not respond to N or P additions, the remaining 62% were limited by nitrogen, phosphorus or co-limited by both nutrients, suggesting that phytoplankton biomass may increase as more nutrients are available. Zooplankton grazing can control phytoplankton biomass; however, the results from the grazing experiment suggest that zooplankton community grazing rates are low (mean of 2.8% phytoplankton biomass grazed per day) compared average community grazing rates in temperate locations. Together, cladoceran biomass, lake chlorophyll concentration and average cladoceran size were important in explaining the grazing rates, and accounted for 59% of variation in community grazing rates between lakes. Overall, the bottom-up and minor top-down control on phytoplankton biomass suggests that climate change will likely have a large impact on lake productivity in this region.

Oral SCL (General Session)

INTERNAL PROCESSING OF NUTRIENTS AND METALS IN WETLANDS AND ASSOCIATED FLUXES: IMPORTANCE TO EARLY SUCCESSIONAL AQUATIC COMMUNITIES IN RECOVERING WATERSHEDS

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Allochthonous inputs of nutrients play an important role in structuring lake communities, and terrestrially-derived carbon has been shown to be particularly important in lakes in the early stages of recovery and succession. Lowland wetlands are the sites of many biogeochemical transformations, and can retain and/or be sources of mobilized metals, carbon, and other nutrients to downstream lakes. In cases where the vegetation and soils of terrestrial systems are recovering in concordance with aquatic systems, the biogeochemical processes occurring in these wetlands plays an even more important role in structuring the delivery of allochthonous materials. The objectives of this study are to determine how biogeochemical cycling of nutrients and metals differs across six wetlands of recovering watersheds, and to investigate differences in the loads of these allochthonous materials across their outflow streams. One of the catchments will be fitted with ISCO automated high-frequency samplers to assess the impact of short-term pulses of nutrients and metals from uplands and wetlands during flash events that may be common in these highly-impacted catchments. Specific attention is paid to structural properties of carbon exports related to lability and availability to aquatic communities. The spatial patterns in littoral communities are explored in one watershed, in relation to large gradients in allochthonous carbon and other nutrients. This research provides a better understanding of the concordance between terrestrial and aquatic succession in recovering watersheds, opening up the potential for management practices to accelerate the succession of whole ecosystems.

Poster SCL (Wetlands)

CANADIAN ARCTIC FISHERIES – PAST, PRESENT AND FUTURE

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We present an overview of the development and possible future of Canadian Arctic fisheries. These fisheries are heavily influenced by the long duration of ice cover and historical cultural fishing practices of the aboriginal peoples of the Canadian northern communities. Subsistence harvest for fish and marine mammals has, is and will be important to northern communities Freshwater fisheries for Coregonidae and coastal fisheries for Arctic charr, *Salvelinus alpinus* were the first commercial ventures. More recently, fisheries for Greenland halibut, *Reinhardtius hippoglossoides*, in NAFO area 0 and northern shrimp, *Pandalus borealis* and *P. montagui* off the southeast of Baffin Island and in Hudson Strait have developed. Changing attitudes of the Inuit towards offshore marine fishing and the possibility of climate warming could eventually result in the development of other commercial marine fisheries.

Oral CCFFR (Capture Fisheries)

TEMPORAL TRENDS IN MERCURY CONCENTRATIONS OF LARGE-BODIED FISHES IN NORTHERN ONTARIO LAKES

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Bioaccumulation of mercury in fish is an environmental concern responsible for most fish consumption advisories on lakes of northern Ontario. Atmospheric deposition is believed to be the primary source of inorganic mercury to undisturbed boreal lakes. The Ontario Ministry of Environment (OMOE) has been monitoring fish mercury concentrations in Ontario waters for over 30 years. Using historic fish mercury data from the OMOE long-term monitoring database and current fish mercury data from a new sampling program we examined changes in mercury bioaccumulation by seven fish species in lakes from across northern Ontario following a paired-comparisons approach. We predicted that mercury concentrations of most species would have declined over the last 30 years. Mercury concentration vs body size slopes did not change appreciably from historic to current sampling periods. Mean predicted mercury concentrations (standardized to a 1-kg fish) increased slightly over the last 30 years in all species. However, this change was not statistically significant for any of the study species and there was no indication that the nature of the temporal change varied geographically. The potential for future changes in fish mercury concentrations will be discussed in relation to changing atmospheric mercury deposition and climate-mediated changes in methylation rates and fish growth rates.

Oral CCFFR (Environmental Stressors)

NUTRIENT AND TEMPERATURE: SYNERGISTIC DRIVERS OF CONTEMPORARY CYANOBACTERIA DYNAMICS

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At large spatial scales, empirical models have clearly demonstrated significant relationships between nutrient concentrations and cyanobacteria biomass, where biomass increases with elevated phosphorus concentrations. Recently, it has been proposed that climate warming, in addition to higher nutrient concentrations, can increase cyanobacteria growth and dominance, both at the regional and global scales. Changes in temperature could have both direct and indirect effects on the growth of cyanobacteria. For example, the rate of cyanobacterial reproduction is directly influenced by water temperature; and increases in water temperature can affect lake stratification and the degree of profundal anoxia, so that warming could indirectly result in the mixing of internally loaded nutrients. To define the relative strength of nutrient and temperature and interactions between these variables, we are conducting analyses of long-term monitoring data (ca. 1985-2007) from four Alberta lakes. Average nutrient concentrations of our study lakes range from meso- to hypereutrophic conditions, but several lakes have also varied substantially in nutrient concentrations over the past 25 years. To model changes in the relationship between the response (i.e. cyanobacteria biomass) and predictors (i.e. nutrient concentrations and water temperature), we will conduct Additive Model (AM) analyses. These models allow parameters to vary through time, instead of estimating one fixed parameter, which will allow us to define whether interactions between these two variables are context-dependent. The overall goal of this project is to define temporal dynamics in cyanobacteria biomass at the regional scale, and quantify how cyanobacteria biomass responds to changes in temperature and nutrients.

Oral SCL (General Session)

HYDROLOGIC CORRELATES OF ACTIVITY IN LOTIC BULL TROUT

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Recent meta-analyses have determined that changes in river flow regimes negatively impact fish communities. Mitigating these effects is difficult due to the lack of empirical knowledge on the relationship between water flow and ecological response. We estimated swim speeds of bull trout in a large hydropeaking river using electromyograms (EMGs) remotely recorded from their swimming muscles. The following hypotheses were tested: 1) Bull trout must counteract the drag force of flowing water and therefore, locomotor activity is significantly correlated to river discharge 2) Rapid changes in river discharge alter the spatial arrangement of flow and result in peaks in activity as fish attempt to re-align themselves with optimal focal point velocities 3) Bull trout are particularly adapted to life in fast flowing waters and consequently maintain lower swim speeds than their reported critical velocities. The effect of water velocity on activity has been well documented using laboratory apparatus. However, very few studies have shown an effect of river flow on activity directly measured from free-swimming fish. Bull trout activity was significant related to hourly average river discharge. However, river discharge had only a small effect on swim speeds suggesting that these fish use velocity refuge or other strategies for energy economy. Within-hour changes in river flow did not elicit a hyperactive response in bull trout. Most often, hourly mean swim speeds were lower than values reported from laboratory critical velocity tests. However, there was significant individual variation in preferred swim speeds that could not be explained by either fish size or sex. Findings are discussed in the context of river management.

Oral CCFFR (General Session)

DISSOLVED ORGANIC P IN EPLIMENTIC WATER: FACT OR ARTIFACT?

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A recent publication presented experimental data suggesting that dissolved P regenerated by plankton is mostly PO4, in concordance with earlier work on P released by specific zooplankton. However, P in lakewater filtrates, i.e., dissolved P (DP), is typically several times greater than soluble reactive P (SRP). The difference between DP and SRP is defined as dissolved organic P (DOP). In ^{32}P-labelled lakewater, DOP can be fractionated using gel chromatography into a high molecular weight fraction, called colloidal P (>5000 MW), and a low molecular weight fraction, or XP (about 300 MW). It is possible that DOP is greater than SRP because it persists longer, but the limited information available suggests that it turns over fairly rapidly. Gentler methods of filtration yield lower estimates of DP, and in this study I use gel filtration to examine DP created by gentle filtration and dialysis. The results suggest that with gentle separation of dissolved and particulate P, DP decreases and the decrease is mostly due to DOP which then becomes very little and, when detectable, similar in concentration to PO_4. The colloidal DOP in these filtrates is not stable, but spontaneously degrades to PO_4 via XP. I conclude that DOP, as measured routinely in the epilimnia of P-limited lakes, is mostly an artifact of damage to cells. "Real" DOP is probably also created by cell damage via grazing and viral attack, but its concentration is too low to be detected by usual spectrophotometric analyses.

Oral SCL (General Session)

BEHAVIOUR AND PASSAGE SUCCESS OF UPSTREAM MIGRATING LAKE STURGEON IN A VERTICAL SLOT FISHWAY

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Spawning migrations of sturgeon have been influenced by the development dams which create barriers to migration. Although fish passage devices have been installed to facilitate passage of barriers, they have been generally unsuccessful. We examined fine scale movements of lake sturgeon (*Acipenser fulvescens*) during passage through a vertical slot fishway located on the Richelieu River in Quebec, Canada to determine passage success, passage rates and inter-individual differences in fishway use. Migratory lake sturgeon (n=107, 939–1625 mm TL) were captured immediately downstream of the fishway in May 2010, tagged with passive integrated transponder (PIT) tags and released into the fishway entrance basin over a period of two weeks (water temperature 11–20^{0}C). The fishway entrance was blocked to prevent escape and an array of PIT antennas installed on each vertical slot (n=15) and the fishway exit (n=1) acted as gates to enable quantification of movement rates within the fishway. Upstream movement was initiated by most individuals (96%), however, only 30% successfully ascended the entire fishway, with passage decreasing linearly as a function of distance. Sturgeon exhibited an ability to traverse the fishway quickly (minimum passage rate of 1.2 hrs), however, successful passage rates were variable (6.2–75.4 hrs from release) and maximum distance of ascent was not associated with fish size or water temperature. Passage rates through the two turning basins in the fishway were disproportionately longer compared with other basins, however, the activity of individuals within these and other locations remain unknown and represent an important knowledge gap.

Oral CCFFR (Aquatic Habitats and Fishes)

DETERMINING THE IMPACT OF PERMAFROST DEGRADATION ON LAKES FROM THE WESTERN CANADIAN SUB-ARCTIC USING LAKE SEDIMENTS

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Permafrost regions are particularly vulnerable to the impacts of recent warming. Retrogressive thaw slumps are amongst the most spectacular form of permafrost degradation. In the Mackenzie Delta, retrogressive thaw slumps have increased in size and number over the last ~60 years, a trend strongly correlated to temperature increases. Despite this, little is known about the impact of this form of degradation on freshwater ecosystems. Although limnological sampling has shown significant differences in specific conductivity, pH and DOC between lakes impacted by permafrost slumps and undisturbed lakes, the impact of slumping on the biota of these lakes remains unknown. We present the results of a diatom-based paleolimnological analysis of lakes from the Mackenzie Delta uplands. The diatom assemblages of slump-impacted lakes show major changes consistent with the timing of thaw slump events in these systems. Our results suggest that these retrogressive thaw slump events result in changes to both diatom habitat and lakewater chemistry. In contrast, lakes that have no history of permafrost thaw slumping record stable diatom assemblages over time. However, the appearance of planktonic diatom taxa as well as scaled chrysophytes in the most recent decades of our lake records suggest a warming-induced regional response to decreased ice cover and/or increased thermal stability. Because of a fire event that occurred in 1968, the difference between fire- and warming-induced thaw slumping will be explored. The timing of thermokarst activity will be useful in determining other impacts of permafrost degradation on lakes, including the release of contaminants from frozen ground.

Oral SCL (Effects of Recent Climate Change)

EVALUATING THE IMPACT OF METAL MINING ON BENTHIC ALGAL COMMUNITIES IN ARCTIC RIVERS USING A REFERENCE CONDITION APPROACH: A CASE STUDY IN THE SOUTH NAHANNI RIVER WATERSHED, NWT.

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Climate change and industrial activities increasingly threaten the ecological integrity of Northern aquatic ecosystems. Environmental assessments of Canadian rivers typically rely on describing differences in the taxonomic structure of benthic algal or macroinvertebrate communities at sites exposed to industrial activity. While effective assessments using taxonomy-based community descriptors are time consuming, require high levels of taxonomic expertise and are costly, by contrast, assessments using algal pigments can be completed at substantially lower costs and may be equally sensitive in detecting impairment.
The objective of this project is to evaluate benthic algal biomonitoring protocols, with an emphasis on the use of algal pigments as a biological monitoring tool. To do this, we sampled rivers in the South Nahanni River watershed (2008, 2009), including 58 reference sites (i.e., sites not exposed to industrial activities), and 23 sites located downstream of two metal mines (i.e., exposed sites). Samples were collected for the quantification of algal communities using standard measures of Chl-a, ash-free dry mass, rapid visual assessment methods, taxonomic community compositions, and a novel approach of quantifying pigment abundances using high-performance liquid chromatography. We also collected water samples, to quantify select nutrients and metal concentrations, and benthic macroinvertebrate samples at each site. Using these data we compared and contrasted biological assessments of the exposed sites using algal community pigments, with taxonomic descriptions of algal and macroinvertebrate community structure. We present preliminary results of these comparisons using a reference condition approach as an initial assessment of the utility of algal pigments as a biomonitoring tool.

Oral SCL (Environmental Stressors)

RESPONSE OF THE ZOOPLANKTON COMMUNITY TO MICROHABITAT VARIATIONS IN LONG POINT MARSH, LAKE ERIE

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Long Point Marsh is a very large wetland complex within the Long Point Biosphere Reserve of Lake Erie, with large areas of open water, rimmed by vegetation that vary from very sparse emergent cover to dense assemblages of emergent, submergent and floating plants. Within this complex, there is also a large variation in physical turbulence, water clarity, nutrient concentrations and water chemistry, which combine to form distinct microhabitats for aquatic biota. Increased human activities and lower water levels in recent decades are threatening the integrity of the marsh, and it is important to document the natural variation in these microhabitats while Long Point is still in a relatively healthy state. In this study, we focus on the zooplankton community because of their importance in nutrient cycling and as food for larval fish. Over a 10-day period in August, we visited 102 sites in Long Point Marsh and sampled them for zooplankton, macrophyte and a suite of physical and water-quality parameters. We used ordination techniques to identify the key microhabitat types and determined how zooplankton assorted among them. The zooplankton community appears to be largely driven by wind-generated turbulence and associated changes in pH and water conductivity. There is high spatial variation with respect to both the microhabitat and zooplankton assemblages and this must be taken into consideration in future remedial efforts.

Oral SWS (Wetlands)

WHOLE-SYSTEM HABITAT REMOVALS – ARE THEY HARMFUL ALTERATIONS OF FISH HABITAT?

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The Policy for the Management of Fish Habitat, states that there shall be no net loss of the productive capacity of fish habitat, where productive capacity is defined as 'the maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend'. Our experiment was designed as part of a framework of habitat manipulations intended to test hypotheses about lake productive capacity and fish community response to habitat change. A before after control impact (BACI) design was used. The chosen treatment was to remove wood from 50% of the nearshore areas of three small (< 25 ha) lakes to provide a coarse-scale empirical test of the relationship between fish habitat and productive capacity. The whole fish community in the three treatment lakes and two control lakes were sampled annually between 1998 and 2003, and then again in 2005 and 2008. These data were used to calculate abundance, biomass, production and CPUE before (1998-1999) and after (2000 onward) the treatment. In addition, visual transects were conducted and the locations of observed fish were overlaid on a habitat map. Abundance, biomass and production were highly variable for all lakes which, combined with low statistical power, reduced our ability to detect any changes that may have resulted from the treatment, even with the addition of the long term data (2005 and 2008). Visual surveys, however, indicated a clear, positive relationship between fish abundance and habitat complexity within lakes.

Oral CCFFR (Environmental Stressors)

THE EFFECT OF FOOD ABUNDANCE ON AGGRESSIVENESS AND TERRITORY SIZE OF JUVENILE RAINBOW TROUT, *ONCORHYNCHUS MYKISS*

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Describing the exact relationship between territory size and important environmental variables, such as food abundance, is crucial to understanding the role that territoriality plays in regulating population size of stream-dwelling salmonids. Models of optimal territory size predict that territory size should decrease with an increase in food abundance, whereas resource defence theory predicts that the intensity of territorial defence should peak at intermediate levels of food abundance. Several studies have now verified the first prediction. However, food abundance is typically manipulated at only two or three levels, making it difficult to describe the quantitative relationship between territory size and food abundance. To quantify this relationship and to test the prediction of resource defence theory, I manipulated food abundance over a broad range of values (0.62%, 1.25%, 2.5%, 5%, 10%, and 20% of the fish body weight; 5% is roughly equivalent to the maximum ration in a natural stream) in artificial stream channels (1.47 m^2) while monitoring the territorial behavior of juvenile rainbow trout (*Oncorhynchus mykiss*). Preliminary results indicate that the territories of dominant fish decreased with increasing food abundance, consistent with the prediction of optimal territory size models. Moreover, there was a dome- shaped relationship between the frequency of territorial aggression and food abundance which is consistent with the prediction of recourse defence theory. The implications of these results for population dynamics will be discussed.

Poster CCFFR (General Session)

THE CHIPPEWAS OF GEORGINA ISLAND FIRST NATION TAKES ACTION TO PROTECT AND RESTORE FISH HABITAT BY FORMING A FISH HABITAT MANAGEMENT PLAN AND BY ENGAGING THE COMMUNITY

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First Nation communities are faced with the challenge of managing their lands and waters with limited resources. The Chippewas of Georgina Island First Nation is located on Lake Simcoe Ontario. Its land consists of three islands and property at Virginia Beach and Island Grove, on the mainland. Surrounded by water, the community recognized the importance of taking an ecosystem approach when developing their fish habitat management plan. In 2008, the First Nation collaborated with the Anishinabek/Ontario Fisheries Resource Centre on a three year project to develop a fish habitat management plan aimed at protecting natural, social, and cultural values. This plan incorporates cultural and biological criteria to establish goals to protect fish habitat along the shores of Georgina Island. One of the main issues on Georgina Island is the rapid shoreline development. Key components of the management plan included recommendations for public education and involvement. Thus, a shoreline habitat report card was created with input from the local Department of Fisheries and Oceans and the local Ontario Ministry of Natural Resources. Anishinabek/Ontario Resource Centre staff along with employees of the First Nation conducted site visits on shoreline properties and provided recommendations to land owners. These recommendations included measures to protect and naturalize the shoreline, and to prevent erosion and the loss of fish habitat. This project is an example of successful coordination and sharing of resources from a variety of agencies. Moreover, the First Nation's ability to engage the community was vital when encouraging proper stewardship practices.

Poster CCFFR (Aquatic Habitats and Fishes)

SPATIAL DYNAMICS IN FISHERIES STOCK ASSESSMENT

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Stock assessment models help managers make decisions by characterizing the population dynamics of a marine species using biological and fishery information. Most models, however, lack an explicit description of the spatial distribution of fishing activity; harvester effort is assumed to be homogeneous across the fish stock. In most cases this assumption is violated because marine species tend to congregate in favorable habitats, where they are followed by the harvesters. This research aims to describe the spatial distribution of fishing effort and identify the consequences of violating the homogeneous effort assumption. The US sea scallop fishery, the most valuable fishery in the United States in recent years, is used as a case study.

A framework for this project is presented and the following major topics are introduced: (1) predicting the spatial distribution of the fishing fleet; (2) simulating the dynamics of the US scallop population and scallop fishery; and (3) determining the consequences of spatial heterogeneity of fishing to stock assessment. Progress on components (1) and (2) are presented and the implications of this project to management are discussed.

Oral CCFFR (Capture Fisheries Session)

CHARACTERIZING PATTERNS OF NEARSHORE AND WHOLE-LAKE WATER TEMPERATURES IN THE GREAT LAKES

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Nearshore waters are among the most biological productive and anthropogenically developed in the Great Lakes. Water temperatures at nearshore sites affect both biological processes and human uses. Empirically linking nearshore and whole-lake temperatures assists in understanding and predicting the impacts of stressors such as climate change on Great Lakes water temperatures. Daily water temperatures from 34 nearshore sites in Lakes Superior, Michigan, Huron, Erie, and Ontario were compared with whole-lake average surface water temperatures predicted by a previously developed model linking water temperatures to regional air temperatures. Nearshore datasets ranged in length from 4 to 58 years. Inshore – whole lake water temperature differences could be grouped into a small number of distinctly different seasonal patterns, which were characterized using quantile regression. Statistical associations linking these patterns to the physical characteristics of each site, such as intake depth and effective fetch, were explored.

Oral CCFFR (Nearshore Ecosystems)

SPILLOVER IN AN EXPERIMENTAL MODEL FISHERY: INFLUENCE OF DENSITY, HABITAT QUALITY AND FUNCTIONAL CONNECTIVITY ON IMMIGRATION FROM PROTECTED TO HARVESTED AREAS

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Immigration from protected to harvested areas influences the effectiveness of marine protected areas as both management and conservation tools but little information is available on factors that limit immigration in fish or other vertebrate populations. We developed a model, consisting in alternative scenarios predicting compensatory immigration with cumulative removal and differing in limiting factors (density, habitat quality and functional connectivity). To test our model, we carried out an experimental reduction of damselfish populations on seven sites in naturally fragmented habitat and monitored two control populations. Immigration occurred in response to removals. Scenarios that included replacement of a constant proportion of removed individuals fit better than models that included either no or complete replacement. In three sites, the best scenario also included density dependence that changed in direction and magnitude over the removal sequence. Total catch and the replacement rate of removed individuals were correlated strongly with a combined effect of relative habitat quality and connectivity measures. In damselfish populations, immigration to harvested areas is influenced by the ability to detect and move to vacated territories and by the improvement in territory quality they could achieve by moving. In addition, immigration can be modulated by social interactions in both the harvested and protected areas. This study illustrates how concepts of density-dependence and limiting factors from recruitment and survival studies can be applied to immigration, suggests the need for more complex transfer functions incorporating density dependence, and provides one of the first analyses of multiple factors affecting immigration in a natural population.

Poster CCFFR (General Session)

INFLUENCE OF DISPERSAL AND SPECIES INTERACTIONS ON ZOOPLANKTON COMMUNITY STRUCTURE

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Understanding factors that control community structure has become more important with the increasing rate of biodiversity loss. There is evidence that both dispersal and biotic interactions are important in shaping communities. We experimentally tested the effect of dispersal on different measures of community structure, including one that is believed to be driven primarily by biotic interactions. We established zooplankton communities in 60 350L mesocosms which received four different levels of dispersal; 0.01, 1.7, 3.0, and 12.5% of ambient zooplankton densities. Dispersers were collected from five lakes in the Killarney/Sudbury, Ontario area, mixed, and added to the mesocosms every 11 days for 12 weeks. Several community metrics were not significantly influenced by dispersal treatment; richness, diversity and total abundance were similar across treatments. However, negative species co-occurrence patterns increased with increasing dispersal indicating that co-occurrence patterns are influenced by more than just species interactions.

Poster SCL (General Session)

DEVELOPMENT OF AN UNDERWATER CAMERA SYSTEM TO OBSERVE THE HARVESTING TECHNIQUES OF COMMERCIAL SPECIES

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The commercial fishery is an expensive industry and requires a multitude of resources to move the product from the ocean to the consumer. Fuel costs and unintentional species caught in harvesting gear have come under considerable scrutiny in recent years, encouraging harvesting gear to become more efficient and species selective. However, prior to any gear modifications, a better understanding of the species behaviour and interaction to the harvesting gear is required. The use of an underwater camera system to quantify species behaviour in relation to capture gear is a relatively new application to the fishery, and has only recently been developed to incorporate high definition (HD 1080i/720p) digital technology. Inspired by cameras used in remotely operated vehicles (ROVs), the system designed for this research was developed to observe fish behaviour, and is ideal for capturing objects in motion as they relate to operating trawls. This type of research has previously led to new gear designs that have reduced the quantity of non-targeted and undersized species often caught in commercial fisheries. The camera system developed is not limited to trawl research but can be applied to stationary gear, such as pots or traps, and other forms of mobile gear.

Poster CCFFR (Capture Fisheries)

BEHAVIOURAL INTERACTIONS BETWEEN FLATFISH AND COMMERCIAL GROUND GEAR ON THE NEWFOUNDLAND GRAND BANK

Underwood*, Melanie J., Paul D. Winger, George Legge, and Stephen J. Walsh (Melanie.Underwood@mi.mun.ca)

The yellowtail flounder (*Limanda ferruginea*) fishery on the Newfoundland Grand Bank is currently limited by bycatch restrictions, in particular non-recovering American plaice (*Hippoglossoides platessoides*). In recent years, behavioral research of target species and their interactions to the harvesting gear have led to gear modifications that reduce bycatch. In preparation for gear modifications, *in situ* camera work was conducted on the Grand Bank, during June and October, 2010, to observe and quantify the relationship between flatfish behavior and harvesting gear. A high definition (HD 1080i/720p), digital camera system developed for this research was secured onto the headline of a commercial flatfish trawl. Individuals of different size classes were observed entering the mouth of the trawl, then analyzed using Observer XT 10. It is anticipated that behavioral differences between species and sizes will lead to a trawl designed to reduce American plaice bycatch and undersized yellowtail flounder.

Oral CCFFR (Capture Fisheries)

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Poster CCFFR (General Session)

SAMPLING AND ENVIRONMENT RELATED MORTALITY IN SHORTNOSE STURGEON LARVAE

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The shortnose sturgeon (*Acipenser brevirostrum*) is protected in the US and in Canada. The species' only known habitat in Canada is the Saint John River, where the fish spawn immediately below the Mactaquac Dam. The dam's vicinity to the spawning site creates potential hazards to larvae from fluctuating flows and water levels. Sturgeon larvae are typically sampled using anchored drift nets. However, we recorded a high number of mortalities, which required determining the source of mortality. We ran an experiment, deploying live larvae in sampling nets and monitoring their survival. We also modeled mortality rates vs. environmental factors, such as temperature, dam discharge, night / day sampling, deployment duration and net's debris load. In addition, we examined larval decomposition rates and applied our findings to larval collections from 2008-2010. Only 60% of live larvae deployed in nets were recovered, suggesting that larval catches should be corrected by the net's retaining ability. Out of those recovered, only up to 18% of the larvae survived 12 hours inside the net. Larval mortality depended on night / daytime sampling, net debris and number of sturgeon larvae captured. Discharge and length of net deployment were significant predictors of debris weight, therefore also influencing mortality. Analysis of decomposition rates supported these findings, estimating that 70-90% of mortality cases in 2008-2010 died while in the net. Our findings provide the first estimates of rates of larval escape and mortality from anchored drift nets, as well as the potential role of dams on larval morality.

Oral CCFFR (Environmental Stressors)

FEEDING ECOLOGY OF THE SHORTNOSE STURGEON IN THE SAINT JOHN RIVER, NB, CANADA

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The shortnose sturgeon is a protected species found in the US and Canada. The Saint John River (NB, Canada) harbours the species' only known Canadian population. The general foraging ecology of the shortnose sturgeon was studied in the 1970's. However, the specific effects of spatial, temporal and environmental parameters on shortnose sturgeon feeding habits are not fully understood. We used redundancy analysis to study shortnose sturgeon foraging at five sites, sampled in summer, early and late fall. Season, location, salinity, fish length, prey number, species richness and prey volume were used in the analysis. We recovered gut contents using colonic flushing. Over 60 families of prey items were identified in 166 colonic flushing samples. In samples from freshwater sites the main prey items were Gastropoda, Bivalvia, Chironomidae and Gammaridae; season, fish length, species richness and prey number were significant variables. In samples from saline locations the main prey taxa were Isopoda, Chironomidae, Gammaridae, Corophiidae and *Mya arenaria*; location and season, as well as species richness and fish length were found to be significant variables. We also found that freshwater gastropods were poorly digested, therefore providing little nutritional value. Overall, freshwater fish digested only 6% of the ingested volume, while saltwater sturgeon digested 77%. This study provides in-depth analysis of foraging behaviour in the species, as well as an estimate of digestion efficiency in the wild.

Poster CCFFR (General Session)

"FISHING THE LINE" AROUND REGULATORY CLOSURES: AN EXAMINATION OF FISHING EFFORT AROUND THE BROWN'S BANK SPAWNING CLOSURE ON THE SCOTIAN SHELF

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One possible consequence of the introduction of regulatory closures to a fishery is a concentration of fishing effort at the boundary of the closure, termed "fishing the line". Some studies have found the result of intensive line fishing is a 'prey depression' near the closure boundary where catch rates become reduced relative to neighbouring areas. In this study we investigate the relationship between catch (summarized as value) and effort around the Brown's Bank spawning closure, which seasonally protects spawning and juvenile haddock (*Melanogrammus aegelfinus*). We investigate the occurrence of "fishing the line" by trawlers, through their catch rates, movement patterns, and aggregations. Two primary aggregations near the line occur in all years examined: one along the east boundary predominantly catching haddock, and a second on the west boundary targeting primarily red fish (*Sebastes spp.*). In addition to target species, these areas differ in fishing strategies, including the length of set and the distance between sets. Generally, fishing near the east boundary occurs with higher vessel density and more common catch rate depressions than at the west boundary.

Oral CCFFR (General Session)

EVALUATION OF TWO NON-CHEMICAL ANESTHETICS FOR INTRACOELOMIC IMPLANTATION OF ELECTRONIC TAGS IN WALLEYE

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Anesthetics are valuable tools used to immobilize fish and reduce physical damage and stress during aquaculture practices and experimental procedures. Although there are many factors to consider when selecting an appropriate anesthetic (e.g., cost, availability, induction and recovery times, ease of use, and human safety), local regulations and legislation may limit the choices. Currently no chemical anesthetics are approved for use on food fish in Canada, and only tricaine methanesulfonate (MS-222) is approved for use in the United States so long as fish are held for 21 days before release. Holding fish is not practical in many situations, and as such the efficacy of non-chemical anesthetics requires further investigation. Electroanesthesisa and carbon dioxide (via sodium bicarbonate) were evaluated on adult walleye to determine their suitability for use prior to intracoelomic implantation of electronic tags. Walleye were subjected to one of four treatment groups (constant direct current, pulsed direct current, carbon dioxide, or control). Fish subjected to one of the three anesthetic treatments were monitored for induction and recovery times (where appropriate), and whether they met a surgery threshold range of 250-350 s (i.e, sufficient time for implantation of electronic tags). All fish were monitored for survival for five days post-trial, and radiographs were compared for electroanesthesia treatments versus the carbon dioxide treatment to determine if any vertebral damage occurred. While all anesthetic treatments were successful at immobilizing fish for surgical procedures, PDC electroanesthesia is recommended due to immediate induction times, quick recovery, high survival, and ease of use of equipment.

Poster CCFFR (General Session)

RELATIONSHIPS BETWEEN ZOOPLANKTON COMMUNITY STRUCTURE AND PHOSPHATE TURNOVER TIMES IN LAKE FOODWEBS

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Zooplankton are important herbivores in freshwater systems and considerable research has focused on how they affect nutrient availability for bacteria and algae. Stoichiometric theory predicts that cladocerans retain relatively more P and regenerate relatively more N than copepods, leading to increased P limitation when cladocerans are dominant. We compared zooplankton community structure and dissolved phosphate turnover times (TT) in a diverse set of Canadian lakes, ranging in total phosphorus (TP) concentrations from 2 to 298 µg L^{-1}. TT ranged from 0.9 to 35,174 min, however only 9 of 77 lakes had TT>15 min. In lakes with TT<15 min, TT was negatively, but weakly correlated with TP. Total zooplankton biomass ranged from 1.3 to 1632 mg m^{-3}. Zooplankton biomass increased with TP, but the proportion of cladocerans and copepods was not related to TP. Phosphate turnover times were not related to total zooplankton biomass, or to the biomass of cladocerans or copepods. In lakes with TT<15 minutes, TT was positively correlated to the percentage of zooplankton biomass consisting of cladocerans ($r^2 = 0.18$, $p = 0.0003$) and to cladoceran biomass standardized by total particulate phosphorus concentrations ($r^2 = 0.16$, $p = 0.002$). Overall, the results suggest a weak trend of increasing P availability in systems where cladocerans are dominant, in contrast to stoichiometric theory which predicts increased P limitation when cladocerans are dominant.

Oral SCL (General Session)

ADAPTIVE TRADEOFFS IN GROWTH AND METABOLISM BETWEEN JUVENILE COHO AND STEELHEAD

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Based on measured correlations between growth and metabolism, it is widely assumed that differences in growth between individuals and populations are mediated by differences in Standard Metabolic Rate (SMR). It is also hypothesized that there is a tradeoff between SMR and capacity for growth, such that elevated SMR bears a cost when resources are scarce. To test these ideas, we examined growth, standard metabolism, and swimming ability of juvenile coho and steelhead, species that co-exist in streams but differ in maximum growth rate, body morphology, and habitat use (steelhead grow faster, are more streamlined, and user higher velocity habitat than coho). Experimental manipulations show that SMR varies with ration in both coho and steelhead (independent of specific dynamic action), and indicate that elevated SMR is a consequence of increased consumption and growth, rather than a cause of it. Although inter-population differences in growth (e.g. counter-gradient variation) often involve a trade-off between growth and swimming ability, juvenile steelhead demonstrate both higher growth and swimming capacity than coho, but do not differ in SMR. This research suggests that adaptive tradeoffs underlying juvenile salmonid growth strategies may have more to do with differences in maximum ration and digestion efficiencies than variation in SMR.

Oral CCFFR (General Session)

SEASONAL RESPONSE OF AQUATIC COMMUNITY METABOLISM TO MUNICIPAL EFFLUENTS IN RIVERS

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Changing aquatic metabolism is a major ecological consequence of the addition of municipal effluent to rivers. However, changes to aquatic metabolism are also influenced by seasonal patterns of temperature, precipitation, and water level regulation. The effect of season on changes to aquatic metabolism was assessed using data from three Canadian rivers, Bow River in Alberta, South Saskatchewan River in Saskatchewan, and Grand River in Ontario. Diel sampling events of O_2 and $\delta^{18}O$-O_2 were conducted over 2 to 3 years to in an upstream (control) and downstream (effect) comparison. The magnitude of diel cycles was both greater downstream of effluent discharge and apparently greatest in spring. Isotopic mass balance modelling indicated that effects on photosynthesis were greatest in spring and on respiration were greatest in the summer; in both cases responses were two- to three-fold increases in metabolic rates. In all rivers studied, the enhanced metabolic footprint extended beyond 50 km downstream of the effluent discharge.

Poster SCL (General Session)

DETERMINATION OF THE CAUSES OF CYANOBACTERIA BLOOMS THROUGH WATER QUALITY MONITORING AND ASSESSMENT OF PHOSPHORUS AND NITROGEN INPUTS FROM THE WATERSHED AND BOTTOM SEDIMENTS IN DESBARATS LAKE, JOHNSTON TOWNSHIP, ONTARIO

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Desbarats Lake is a eutrophic, polymictic lake on the Canadian Shield in Northern Ontario (3.6 km^2, 10 m max. depth, 40 µg/L summer epilimnetic average total phosphorus, TP) with a history of summer and fall phytoplankton blooms and turbid water. A recently initiated remediation study attempts to determine the main source of nutrients. The watershed includes upstream lakes and wetlands with beavers, but does not include much agricultural land. Lake shore development likely contributes some nutrients as only 19 of 65 lake shore residents have a sewage disposal permit. Further, occasional incidences of hypoxia and elevated TP in the bottom water indicate the potential of internal phosphorus loading from anoxic lake bottom sediments.
There was no cyanobacterial bloom in 2010 although the lake did not appear to be nutrient limited and TP and inorganic nitrogen concentrations were high. Instead, a consistently low Secchi transparency of 0.60 m indicated light limitation. Remediation studies of such small and remote lakes are difficult and sparse, since funding sources are limited. Here, the Johnston Township provided funds and the Central Algoma Freshwater Coalition provided staff for a study to monitor water quality of the lake and its inflows as the first step towards potential remediation. Remediation seems to be especially important in the context of Desbarats Lake's location. Its outlet drains into the Desbarats (or Walker) River and from there into the St. Josef Channel of Lake Huron, where deteriorating water quality and cyanobacteria blooms have become a notorious issue.

Oral SCL (General Session)

TEMPORAL PATTERNS OF HYPOLIMNETIC DISSOLVED OXYGEN, PHOSPHORUS, SULFIDE AND IRON IN FOUR SMALL LAKES IN CENTRAL ONTARIO AND HAMILTON HARBOUR

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Cyanobacterial blooms are a seasonal phenomenon in freshwaters, and can present significant health, ecological, and aesthetic problems. Recently, there has been an increase in the number, severity, and distribution of such blooms in southern Ontario and Quebec. A number of mechanisms have been brought forward to explain cyanobacterial dominance, but one that receives less attention yet may be more significant in mesotrophic and oligotrophic systems is the ability of iron to act as a limiting nutrient. Because cyanobacteria are limited by iron more than eukaryotic algae are, biogeochemical processes that increase the supply of iron, in particular ferrous iron, may shift the phytoplankton community towards cyanobacterial dominance. A study of temporal relationships between hypolimnetic anoxia and internal loading of Fe and TP in several eutrophic and oligotrophic lakes in 2008-2010 suggest that increased ferrous iron levels adjacent to the metalimnion may trigger the onset of cyanobacterial blooms.

Poster SCL (Algal Blooms)

CAN WE PREDICT THE OCCURRENCE OF NUISANCE ALGAL BLOOMS BASED ON WATERSHED AND LIMNOLOGICAL FEATURES OF LAKES AND RIVERS?

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In 2010, organizations representing various levels of government (federal, provincial, and municipal) and university researchers started the Eastern Ontario Algal Partnership in an attempt to understand the apparent increase in nuisance algae in the Rideau Canal and its watershed. As part of this program, participants would collect algae whenever they observed a bloom. A total of 48 samples were collected during the summer of 2010 from 34 locations in Eastern Ontario (30 lakes, 18 rivers/streams). Sixteen genera were observed, with the majority of samples dominated by chlorophytes (62%), followed by cyanobacteria (30%) and other algae and plants groups (8%). This study examines if the occurrence of algal blooms can be predicted using only landuse and limnological characteristics of the lake and its watershed. Further, the advantages and disadvantages of citizen science based monitoring are discussed.

Oral SCL (Algal Blooms)

PATTERNS AND CAUSES OF LANDSCAPE SYNCHRONY OF PHYSICAL, CHEMICAL, AND ECOLOGICAL CHARACTERISTICS OF LAKES

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Interannual variation of 45 annually-resolved time series of environmental, limnological, and biotic parameters was quantified (1994-2009) in six lakes within 52,000 km^2 to test the hypothesis that interannual variation in the influx of energy (E; irradiance, heat) is synchronous over large spatial scales, whereas mass influx (m; water, solutes, particles) reduces synchrony when catchments act as local climate filters. Influx of E was more synchronous (*S*) than influx of *m*, owing to climatic factors (e.g. North Atlantic Oscillation, Pacific Decadal Oscillation) that interact to regulate spring and summer jet-stream position, storm tracks, and temperatures. Limnological parameters known to be regulated by E influx (ice melt, gas solubility) were up to two fold more synchronous than those regulated by *m* inputs (nutrient concentrations). Pairs of variables linked by simple direct mechanisms exhibited similar *S* values (air temperature and ice melt, nutrients and algae), whereas the coherence of other parameters (water temperature, mixing) was intermediate to that of multiple regulatory agents. In addition, even though planktonic populations were mostly less synchronous than many abiotic parameters, measures of aggregated plankton density varied more coherently among lakes than did constituent taxa, suggesting that compensatory dynamics associated with patterns of seasonal succession ensured stability in total plankton biomass despite relative asynchrony of individual taxa. These findings suggest that the effects of environmental variability in regulating aquatic community structure depend on whether E or *m* fluxes predominate, the intrinsic coherence of each forcing mechanism, and the strength of linkages between exogenous forcing and lake response.

Oral SCL (Energy and Mass Flux)

NATURAL AND HUMAN-MEDIATED GENE FLOW AMONG ONTARIO'S INLAND LAKE POPULATIONS OF WALLEYE (*SANDER VITREUS*)

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Gene flow among native and hatchery-supplemented individuals has the potential to reduce genetic structure and diversity of natural populations. Using 11 microsatellite loci, we characterized the genetic structure of 46 geographically dispersed inland lake walleye populations from five major drainage basins within the province of Ontario. Bayesian cluster-based assignment tests coupled with population genetic analyses allowed us to 1) characterize population divergence among Ontario walleye populations; and 2) determine if the observed population divergence is primarily due to natural / historic processes or recent anthropogenic events. The genetic structure of walleye populations consisted of two major clusters, corresponding to northern and southern population groups. Hierarchical analyses of genetic variation unexpectedly revealed higher genetic divergence among populations within drainage basins, rather than among drainage basins. Admixture analyses allowed us to identify patterns of gene flow between some lakes that are not consistent with natural processes, but more likely due to hatchery supplementations and human-mediated transfers. This study has implications for the management of inland walleye populations as supplementation of natural populations with hatchery-reared individuals may alter genetic structure, potentially influencing long-term population persistence.

Oral CCFFR (General Session)

MODELING THE ESTABLISHMENT OF INVASIVE SPEICES: HABITAT AND BIOTIC INTERACTIONS INFLUENCING THE ESTABLISHMENT OF *BYTHOTREPHES LONGIMANUS*

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Bythotrephes longimanus is an invasive pelagic crustacean, which first arrived in North America from Europe in early 1980s and can now be found throughout the Great Lakes and in many inland lakes and waterways. Determining the suitability of lakes to *Bythotrephes* establishment is an important step in quantifying its potential habitat range and environmental risk. Lake environmental conditions, planktivorous fishes, sport fishes and *Bythotrephes* occurrence data from 179 south-central Ontario lakes were used in this study to model lake characteristics suitable for its establishment. The performance of principal component analysis and different predictive models were used to determine the habitats that are suitable for the survival of *Bythotrephes* and the factors that may regulate its spread. Four modeling approaches were employed: linear discriminant analysis; multiple logistic regression; random forests; and, artificial neural networks. Ensemble prediction based on the four modeling approaches was also used as an indicator for predicting *Bythotrephes* occurrence. *Bythotrephes* appears to establish more readily in larger, deeper lakes with lower elevation, that have more sport fishes. *Bythotrephes* occurrence can be best predicted by artificial neural networks when including the measures of fish data, in addition to lake environmental data. Lake elevation, surface area and sport fish occurrence were ranked as the most important predictors of *Bythotrephes* invasion. The inclusion of biotic variables (occurrence or richness of sport or planktivorous fishes) enhanced cross-validated models relative to analyses based only on environmental data.

Oral CCFFR (Introduced Aquatic Species)

EFFECTS OF SAMPLE SIZE AND SPECIES DISTRIBUTION PATTERNS ON THE PERFORMANCE OF SPECIES DISTRIBUTION MODELS

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Knowledge of species' ecological and geographic distributions is increasingly important for investigating the habitat requirements of native or introduced species, planning conservation and management programs, and understanding the essential determinants of biodiversity patterns. Detailed information on species distributions is often unavailable for some taxa or regions, and collecting such data may be costly and time-consuming. Therefore, to determine the effects of sample size on model performance is important for making reliable predictions. It is difficult for ecologists to evaluate modeling approaches for predicting species distributions using field data because the true situation is unknown. Predictive models should be able to recover the truth if ecologists want to take them as reliable tools. In our study, simulated data derived from explicit theory were used as the truth for evaluating the performance of different modeling approaches. The generalized beta function was used for describing different shapes of species responses, and the true dataset was generated based on that. Data with different sample size were randomly drew from the true dataset and then used for developing models. Modeling approaches including linear discriminant analysis, multiple logistic regression, random forests and artificial neural networks were developed on the sampled datasets. The performance of model predictions was evaluated using the area under the receiver operating characteristic curve (AUC) and several other performance metrics. With increasing sample size, model accuracy increased and variability decreased across species response shapes and among models.

Poster CCFFR (Introduced Aquatic Species)

HARMFUL BLOOMS IN RECOVERING SYSTEMS: ARE OUR MANAGEMENT MODELS MISSING THE TARGETS? BAY OF QUINTE REVISITED

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Many Great Lakes Areas of Concern are increasingly demonstrating erratic and severe inshore blooms of cyanobacteria, some of which produce toxins and taste-odour. ***C***onventional remedial targets fail to predict or address these impairments, demonstrating a critical need for detailed, long term data to conduct a risk assessment and revaluate current management models. This paper presents a synthesis of comprehensive study of blooms, toxins and taste-odour carried out since 2004 in the Bay of Quinte to assess the temporal and spatial range of these impairments. Along with long-term open water monitoring sites, sampling and analyses were designed to evaluate inshore and beach areas that have not been previously investigated, and where there is a far higher risk of human contact. The results of this study show annual episodes of significant impairment from harmful blooms at beach and inshore sites, where toxin and taste odour can exceed guidelines and odour threshold levels by several orders of magnitude. Taxonomic and fluorescence data indicate that both planktonic and benthic biota may contribute to levels of impairment or represent seeding areas for blooms. These events are intermittent, and possibly moderated by climatic, hydrologic and shoreline effects such as urban wastewater discharge. A generally poor relationship between water quality at open water monitoring sites and shoreline events may be related to episodes of extremely high particulate nutrients in windblown shoreline scums. These and other biological nutrient transport vectors may significantly modify the distribution and sequesterment of nutrients predicted by conventional 'mixed reactor' models.

Oral SCL (Algal Blooms)

TEMPO AND MODE OF EVOLUTIONARY CHANGE IN SECONDARY SEXUAL CHARACTERISTICS IN RICEFISH (FAMILY ADRIANICHTHYIDAE)

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Diversification and speciation can be attributed to differences in sexual selection that contribute to reproductive isolation. Understanding the tempo and mode of changes in sexual characters can help determine whether these changes are speciational or continuous. Traits that change continuously through time between speciation events can be contrasted with traits that arise during speciation events to inform us about the mechanisms driving speciation. We investigated the tempo and mode of evolutionary change in ricefish (*Oryzias* and *Xenopoecilus* species) secondary sexual characteristics to determine whether changes in these traits are due to continuous processes such as sexual conflict or sexual selection, or whether they are due to other factors influencing speciation such as habitat shifts. Within this clade, there is a remarkable diversity of male anal fin size and shape across species, and anal fins play an important role mating. We measured morphological characteristics associated with body and fin size and shape to determine the evolutionary forces that underlie these changes in twelve species of ricefish, and compared and contrasted these characters across species and between sexes. In addition, we collected data regarding mating behaviour in some species, in an effort to link morphology and behaviour in a phylogenetic context to determine the drivers of the evolution of sexual characters in the group. Species varied in their reproductive behaviour, suggesting that the relative influence of different mechanisms of sexual selection varies across species. We discuss our results in the context of possible evolutionary change in sexual characteristics in ricefish.

Poster CCFFR (General Session)

FINE SCALE POPULATION STRUCTURE AND DISPERSAL OF JUVENILE STEELHEAD IN THE BULKLEY RIVER, BRITISH COLUMBIA

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Knowledge of fine scale population genetic structure is an essential component of any action to conserve genetic diversity and maintain population viability. We genotyped 430 juvenile steelhead trout from the Bulkley River, BC at 13 microsatellite loci to assess fine scale population structure and the effect of juvenile mixing on genetic diversity of steelhead populations. We detected significant genetic structuring among juveniles from nine tributary populations (pairwise F_{ST}: 0.02 – 0.34), and found significant isolation by distance among the tributary populations ($p = 0.015$, $R^2 = 0.289$). These results reflect highly specific homing behavior of spawning adults as well as temporal stability of those populations. Genotype assignment showed that rates of juvenile straying varied among tributaries and assignment of juveniles sampled from the mainstem of the river to source tributary populations suggested two things: 1) that long distant movement in juvenile steelhead is common and, 2) that groups of juveniles are well mixed in the mainstem. Therefore, actions to conserve Bulkley River steelhead must strive to maintain the genetic diversity of tributary populations.

Oral CCFFR (General Session)

AUTUMN WATER VELOCITY DISTURBANCE THRESHOLD DETERMINES CHANGE IN BENTHIC MAROINVERTEBRATE COMMUNITY STURCUTRE

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Water is the medium for the existence of aquatic life, yet we know surprisingly little about how the quantity and movement of natural water flow structures aquatic communities. Our lack of knowledge is largely due to the periodicity and frequency of natural hydrologic inputs, which span time frames from seconds to millennia, and the fact that very few studies last longer than 2 to 3 years. Using a long-term benthic macroinvertebrate (BMI) dataset, we demonstrate how change in autumn water velocity (AWV) corresponds to shifts in BMI community structure through time (2004 - 2009). Across our seven cobble substratum study streams we found that a threshold of change in average AWV of 0.25 m/s is needed before a detectable shift in BMI community structure is evident. Interestingly, we found that change in AWV is a function of change in channel depth and discharge; however, site specific discharge and channel width did not change congruently through time suggesting that steam bed movement is the driver of change in AWV in our study streams. Further, we propose that altered stream bed morphology is likely a consequence of variation in the magnitude, frequency and nature of both precipitation inputs, and Beaver (*Castor Canadensis*) dam occurrence. In general, stream sites shifted from slow AWV Chironomidae dominated communities to communities with higher proportions of Plecoptera, Ephemoptera, and Trichpotera (EPT) at higher AWV. This evidence suggests that predicted alteration of hydrologic inputs due to climate change will affect BMI community structure independent of temperature rise.

Oral SCL (Effects of Recent Climate Change)

THE ROLE OF FLOODING ON LIMNOLOGICAL CONDITIONS OF FLOODPLAIN LAKES IN THE PEACE-ATHABASCA DELTA, NORTHERN ALBERTA, CANADA

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Repeated measurements over three years (2003-05) were made on a series of lakes along a hydrological gradient in the Peace-Athabasca Delta (PAD), Canada, to characterize the role of river flooding on limnological conditions of northern floodplain lakes and their evolution. Floods elevate concentrations of suspended sediment, total phosphorus (TP), SO_4 and dissolved Si (DSi) and reduce concentrations of total Kjeldahl nitrogen (TKN), DOC and most ions, leading to increased limnological homogeneity among lakes. After flooding, evolution of limnological conditions occurs at two distinct timescales. In the weeks to months after flooding, water clarity increases as suspended sediments and TP settle out of the water column. Over this time period, concentrations of DOC, SO_4, TKN and ions do not change appreciably. However, in the absence of flooding for many years to decades, evaporative concentration leads to an increase in most nutrients, DOC and ions. These results suggest that regular flooding is not required to maintain high nutrient concentrations. Chl *a* concentration was low in floodplain lakes of the PAD and significantly correlated with Kd-par, TP and DSi. However, most of the variation in Chl *a* concentration remains unexplained by these factors, suggesting that zooplankton grazing and competition with macrophytes exert important influence on phytoplankton standing crop. In light of anticipated declines in river discharge, we predict that limnological conditions in the southern Athabasca sector will become increasingly less dominated by the short-term effects of flooding, and resemble nutrient- and solute-rich lakes in the northern Peace sector that are infrequently flooded.

Oral SCL (Environmental Stressors)

RELATIONS BETWEEN GREAT LAKES WATER LEVELS AND WETLAND PLANT COMMUNITIES

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Water-level fluctuations are the driving force behind diversity of wetland habitats in the Great Lakes. Occasional high lake levels kill invading upland plants and large, canopy-dominating wetland emergent plants. Ensuing low lake levels expose sediments to the air and stimulate germination of buried seeds, thus restoring diversity and allowing replenishment of the seed bank. The cycle is then repeated. Recent low lake levels have caused much public concern, but they are part of a longer-term pattern. Global climate change research on the upper Great Lakes identified quasi-periodic cycles of high and low lake levels that occurred at approximately 30- and 160-year intervals over the past 3000 years. These cycles match known climatic patterns derived from many sources. The current low lake levels are an expected 30-year event that is critical to wetlands and many species of fish and wildlife that depend on them. However, lower levels or an extended duration could signal influence from anthropogenic warming. Lakes Superior and Ontario are now regulated reservoirs in which the natural fluctuation patterns have been altered. Recent studies of the effects of regulation on Lake Ontario wetlands showed that lack of low lake levels since regulation began has resulted in sedge/grass-dominated communities at upper elevations being displaced by cattails, which can now survive due to wetter conditions. Models were developed on a GIS platform for each of four wetland geomorphic types based on topographic/bathymetric data and field sampling of plant communities along transects with specific water-depth histories. The models provide predictions of the extent of future sedge/grass meadows for new regulation plans under consideration by the International Joint Commission and represent a major environmental influence on decision-making.

Oral SWS (Wetlands)

REGIONAL METAPOPULATION STRUCTURE OF BROOK TROUT IN NORTHERN LAKE SUPERIOR

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Despite Canada's wealth of freshwater resources, aquatic species in Canada face significant conservation challenges. Coaster brook trout are an unfortunate example of this, having declined from being historically ubiquitous in nearshore environments of Lake Superior to a few isolated remnants today. This study examined the geographic genetic structure and connectivity among lake-dwelling and tributary populations of brook trout in northern and eastern Lake Superior, using genetic analysis of microsatellite DNA genotypes to assess the hierarchical structure and diversity within and among remnant coaster populations in Ontario waters of Lake Superior. The genetic results detected several regional gene pools and showed evidence of both local and long-distance dispersal, and underscore the interdependence of 'coaster' and river-resident fish for maintaining a structured metapopulation of brook trout in the lake basin.

Poster CCFFR (General Session)

ALTERED DISSOLVED ORGANIC MATTER COMPOSITION IN RIVERS WITH AGRICULTURAL LAND USE

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Dissolved organic matter (DOM) represents important flux of energy and nutrients from terrestrial to stream systems. Here we examine the influence of agricultural land use on the composition and concentration of DOM in streams of contrasting land use. Watersheds in Ontario with fewer wetlands, increased cropland area, and increased nitrogen loading exhibit altered composition and decreased structural complexity of DOM. A variety of mechanisms may control these watershed patterns. Longitudinal changes in composition and character examined in detail within a single mixed land use watershed indicate that alterations in structure of DOM may relate to increased autochthonous loading of algal DOM over row-crop dominated reaches; however, diurnal patterns observed at a sub-set of additional sites indicate increased heterotrophic activity in cropland dominated streams. Experiments examining the lability of DOM leached from soils under a variety of crop rotations and management systems indicate that DOM from annual-crop dominated systems is initially more humified and less labile than perennial-crop systems. Aqueous incubations of this DOM show that the more humic components of these samples are preferentially microbially degraded. Preliminary results examining the relationship between DOM age (^{14}C) and composition in rivers draining a variety of landscapes within the continental United States indicate that simplified DOM structure may be more strongly related to increased processing (older signature expected) than to algal production (younger signature expected).

Oral SCL (Energy and Mass Flux)

ALGAL BLOOMS IN ONTARIO LAKES: REPORTS SINCE 1994

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The Ontario Ministry of the Environment provides an algal identification service as part of the Ministry's response to algal bloom events. We've been tracking the samples that have come in to our algal monitoring group since 1994. Over the period from 1994 to 2009, we noted a significant increase in the number of algal blooms reported each year ($P < 0.001$). There was also an increase in the number in which cyanobacteria were confirmed to be dominant ($P < 0.001$), with these making up approximately 50 % of the total during peak years. The most common taxa of cynobacteria identified were *Anabaena*, *Aphanizomenon*, *Microcystis*, *Gloeotrichia* and various Oscillatoriales. The remaining samples were dominated filamentous green algae, or occasionally by chrysophytes, dinoflagellates or diatoms. We also noted geographic and seasonal trends in the blooms reported. Most of the increase in the number of cyanobacterial blooms was accounted for by lakes in northern Ontario (located within the boundary of the Ministry's northern region, primarily in its southern range). Samples are now coming in for analysis later into the fall than they did during the 1990s; bloom identification requests extended well into November in recent years. We attributed these trends to: increases in nutrient inputs in some areas which promote the growth of algae; factors associated with climate warming which may exacerbate bloom conditions; and an increase in public awareness of algal blooms and associated issues.

Oral SCL (Algal Blooms)

GENETIC ASSESSMENT OF POPULATION STRUCTURE OF SISCOWET LAKE TROUT (*SALVELINUS NAMAYCUSH SISCOWET*) IN LAKE SUPERIOR

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Siscowet lake trout (*Salvelinus namaycush siscowet*) are a deepwater form of lake trout native to Lake Superior, and represent the only deepwater form of lake trout that has not been extirpated from the Great Lakes. Because of the vast amount of deepwater habitat present in Lake Superior, siscowet are the most substantial predator in the lake. Although there are no commercial fisheries that presently focus on siscowet lake trout, there is interest in targeting this species for a fish oil fishery. As reliable identification of stock structure is a cornerstone to sustainable fisheries, understanding the spatial structure of siscowet in Lake Superior is essential for their sustainable management. We used 17 microsatellite loci to examine the genetic diversity and population structuring of siscowet lake trout throughout Lake Superior. The results confirm that the siscowet morphotype is genetically distinct from lean lake trout, and showed no evidence of interbreeding between the two forms. Remarkably, we found no evidence of genetic pattern or stock / population structuring within siscowet despite a high degree of geographic distance between sampling sites. These results suggest that siscowet lake trout represent a single panmictic population throughout Lake Superior. Appropriate management and harvest strategies should therefore be developed to reflect shared harvests and management responsibilities for the single, multijurisdictional population of siscowet throughout the entire lake, rather than individual management strategies based on geographic location.

Poster CCFFR (General Session)

MODELING THE SEASONAL AND INTERANNUAL VARIABILITY OF PERUVIAN ANCHOVY POPULATION DYNAMICS: LINKING ENVIRONMENTAL CONDITIONS WITH FISH

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The coastal waters of Peru support the world's largest single-species fishery, the Peruvian anchovy. The Peruvian anchovy catch vary dramatically year-to-year in response to the El Niño events. This study uses a coupled physical-biological modeling approach to investigate the response of anchovy growth, survival, and distribution to seasonal and interannual climatic variability. An individual based model was developed for the Peruvian anchovy that simulated growth and survival from egg to age-1. The modeled monthly output from the Regional Ocean Model System (ROMS), coupled with the Carbon Silicate Nitrogen Ecosystem model (CoSINE), was used as input to the anchovy model to study growth and survival to recruitment length (5 cm). Anchovy cohorts showed faster growth in the early and the late parts of the year, and sensitivity analysis showed the importance of prey and that realistic distribution of monthly spawning yielded high recruitment. Simulation of monthly cohorts for the 1991-2007 period showed that anchovy grew extremely slowly and had low recruitment during 1997-1998 El Niño. Sensitivity analysis showed that both temperature and prey concentrations regulated anchovy growth during normal years, while temperature was critical during El Niño conditions. Coupling physical and ecological models offers a promising method for studying the complex responses of fish populations to environmental variation, which can be potentially used for ecological forecasting and fishery management.

Poster CCFFR (Environmental Stressors)

EVIDENCE FOR THE LOSS OF CALCIPHILIC DAPHNIA SPECIES IN ONTARIO SHIELD LAKES ASSOCIATED WITH CA DECLINE OF LAKE WATERS

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The ongoing calcium decline in eastern Canadian Shield lakes is problematic for biota that require relatively high Ca levels, i.e. calciphilic taxa. Paleolimnological records have detected reductions in the relative abundance of Daphnia associated with calcium decline, but there is as yet no corroborating evidence from ongoing zooplankton monitoring programs of Shield lakes. Recently, Cairns surveyed 300 Shield lakes along a Ca gradient, and detected different responses among native daphniids. D. ambigua and D. catawba did not respond to low Ca, while five other taxa (D. retrocurva, pulicaria, mendotae, dubia and longiremis) were calciphilic, their frequency of occurrence declining at Ca levels < 2 mg/L. Here we report long-term changes in the large Cladoceran fauna of Plastic Lake, Ontario, a lake with paleolimnogical evidence of daphniid losses associated with Ca, not pH decline. We split the large Cladocera into three groups – Holopedium gibberum, Cairns' 5 calciphilic taxa, and the two remaining non-calciphilic daphniids. There was clear evidence of temporal cycles in the relative abundance of these three groups of taxa, which we believe is climate related, but both the absolute and the relative abundance of the calciphilic taxa fell significantly over time. Indeed these five taxa have been virtually absent in the lake since 2004, the year when the lake water Ca concentration fell consistently below 1.5 mg/L, a threshold below which it has since remained. The data support a growing consensus that the majority, but not all Daphnia species are being damaged by ongoing Ca decline on the Shield.

Oral SCL (Environmental Stressors)

CONNECTING LAKE CALCIUM DECLINE TO CLIMATE VARIABILITY: FUTURE CALCIUM TRENDS PREDICTING FOR RED CHALK LAKE

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Calcium (Ca) decline in central Ontario threatens aquatic ecosystems. Following acid deposition over decades, Ca decline has resulted from decreases in soil Ca pools; however the influence of climate variability has not been addressed. A new analysis for Red Chalk Lake in Ontario with a long-term monitoring record is presented to illustrate the importance of both reduced Ca storage and climatic variability. The lake's future Ca trajectories are predicted using an empirical relationship and several models.

Lake Ca concentration in Red Chalk Lake is mainly determined by annual loads from catchment streams. The deposition from air onto the lake and inputs from ungauged nearshore areas are much smaller contributions to the annual mass balance. The annual stream load is significantly correlated with Ca storage in the catchment's soil and the stream discharge (which depends on weather). A regression formula of load = *f*(year, discharge) can explain the inter-annual variations that occurred between 1978 and 2007. Reductions in discharge and catchment Ca storage have reduced the Ca loads conveyed by tributary streams, and consequently the Ca concentration in the lake.

By assuming a continuous decline pattern in the soil pool and using a simulated climate for 2007 to 2100, future discharges are calculated with a hydrologic model, future Ca loads are estimated by the regression formula, and under this scenario Red Chalk Lake's Ca concentration is predicted to continue to decline. A biologically critical threshold of 1.5 mg/L will be reached in 2038.

Oral SCL (Effects of Recent Climate Change)

PHENOTYPIC PLASTICITY AND MORPHOLOGICAL DIFFERENTIATION IN NATIVE AND NON-NATIVE PUMPKINSEED UNDER VARYING WATER VELOCITIES

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Morphological adaptations can significantly affect the successful introduction and establishment of invasive species. If individuals exhibit high phenotypic plasticity, populations are able to readily adjust to new environments. Since its introduction over a century ago, the pumpkinseed (*Lepomis gibbosus*), a species native to North America, has spread throughout most of Europe, including the Iberian Peninsula. Previous studies have described how pumpkinseed morphology adapts to local habitats, geography and prey availability. We hypothesized that morphological traits which are functionally significant in fluvial and lacustrine environments, will differentiate based on the habitat of origin (river or lake) and population origin (North American or Iberian) of pumpkinseed. Using twenty-four flow-through laboratory raceways, we simultaneously reared young-of-year pumpkinseed from four populations (North American fluvial, North American lacustrine, Iberian fluvial, Iberian lacustrine) under three water velocities (0 cm/s, 10 cm/s, 20 cm/s). Morphometric measurements were recorded using digital photographs taken at regular intervals during the 90-day rearing period. Fin placements exhibited highly significant differentiation based on population origin (pre-dorsal length, pre-pectoral length, and pre-pelvic length), whereas pectoral fin length exhibited differentiation based on habitat of origin, regardless of water velocity. In most cases, divergence of morphological traits within each population increased with water velocity. Five other functionally significant traits (e.g. body width) differentiated based on native and non-native population ranges, indicating that these patterns may to be associated with underlying genetic rather environmental effects. These findings may help us to better understand why some species of fishes pose a higher invasion risk than others.

Oral CCFFR (Introduced Aquatic Species)

USING LIFE HISTORY TO PREDICT THE SENSITIVITY OF FRESHWATER UNIONID MUSSEL POPULATIONS TO HUMAN INDUCED PERTURBATIONS

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Roughly two thirds of freshwater mussels native to North America are considered imperilled. There is a strong need for modelling of these species to inform management and recovery of at-risk populations, but species-specific information to populate such models is scarce. Here we present an exploratory elasticity analysis of freshwater unionid mussels to assess the relative impacts of human induced perturbation of vital rates on population growth. Three distinct elasticity groups were identified: (i) species strongly sensitive to changes in juvenile survival; (ii) species most sensitive to changes in adult survival; and (iii) species more sensitive to changes in rates related to reproduction (fecundity, age at maturity, and glochidial survival). We find that an incomplete or generalized life history can predict which of these three sensitivity patterns will be realized, and that predictions are most accurate when at least fecundity and age at maturity are known.

Oral CCFFR (General Session)

HEMIMYSIS ANOMALA IN LAKE ONTARIO: IMPACTS ON THE NEARSHORE FOOD WEB

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In 2006 the Ponto-Caspian invader *Hemimysis anomala* was observed at two locations in the Great Lakes basin. Since 2007 a collaborative effort between the Ontario Ministry of Natural Resources and Fisheries and Oceans Canada has documented the distribution of *H. anomala* along the northern shore of Lake Ontario. The distribution work revealed a strong density gradient from west to east (high to low density respectively). Based on the established density gradient, four sites were selected (Bronte, Cobourg, Waupoos and Bay of Quinte) and sampled each season (spring, summer and fall) encompassing a breadth of biota (seston to top predators) describing the respective food webs. Four species (rock bass, round goby, yellow perch and alewife), each representing different trophic guilds, were selected to assess the impact of *H. anomala* on fish condition and health as well as its impact on the nearshore Lake Ontario food web. Gut content analysis of these fish confirm that *H. anomala* have been incorporated into the Lake Ontario food web. Preliminary stable isotope analyses suggest a high interaction between *H. anomala* and other resident near shore fish species. The incorporation of *H. anomala* into the food web could provoke shifts in food web energy flow as well as the trophic position of their predators.

Oral CCFFR (Introduced Aquatic Species)

DEGRADATION OF PARTICULATE AND DISSOLVED MICROCYSTIN-LA FROM A SENESCING *MICROCYSTIS* BLOOM *IN VITRO* AND *IN SITU*

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At least one third of the described genera of cyanobacteria have been reported to produce toxins that pose a serious risk to ecological and human health. These cyanobacterial blooms are quite often (>50%) toxic. The largest and most common group of cyanotoxins is the hepatotoxic microcystins, comprised of over 90 variants. Due to its widespread occurrence, the majority of degradation studies focus on microcystin-LR, however the composition of microcystins in surface waters appears to vary. We have observed microcystin-LA to be dominant in several recreational lakes in Ontario and Quebec. Following a spring bloom in a small shallow lake, we examined the degradation behaviour of the dominant microcystin-LA both *in situ* and under laboratory conditions. *In vitro*, the dissolved microcystin-LA was most susceptible to high light conditions while the microcystin-LA associated with particles/cells showed faster degradation in response to higher temperatures. A concurrent sampling of the lake showed a more rapid decline in microcystin-LA concentrations than under laboratory conditions, indicating the importance of other loss processes (eg. sorption, dispersion, UV radiation) in the natural environment. Furthermore, microcystin-LA levels exceeding recreational guidelines (10-20 ug/L) persisted in both lake and laboratory environments for 6 weeks and 6-25 weeks respectively. Notably, microcystin-LA was measured at these concentrations in the dissolved fraction in lake areas where cyanobacteria were no longer evident. Overall, microcystin-LA appears to degrade more slowly and persist longer than microcystin-LR, suggesting that the microcystin variant should be considered in public health and lake management responses (eg. period of beach closures/openings).

Oral SCL/CCFFR (Algal Blooms)

PREDICTED REPRODUCTIVE RESPONSES AND SUBSEQUENT DISPERSAL OF INTRODUCED PUMPKINSEED *LEPOMIS GIBBOSUS* UNDER CONDITIONS OF CLIMATE CHANGE IN ENGLAND

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The North American centrarchid, pumpkinseed *Lepomis gibbosus*, was introduced to European inland waters in the late 19th century and has established in at least 28 countries. Considered invasive in the warmer, southern parts of its European introduced range, but non-invasive in most northern locations, pumpkinseed is one of six non-native species predicted to benefit from the projected conditions of climate change in the U.K. (increased water temperature [2–5°C] and hydrological variability). Pumpkinseed have been predicted to increase the number of spawning bouts in warmer waters, which under climate change conditions could result in greater numbers of recruits becoming more widely dispersed – effectively a switch to 'invasive' status. To test this prediction, we used a passive integrated transducer (PIT) array system to monitor the frequency and duration of PIT-tagged female pumpkinseed visits to nests defended by PIT-tagged males. Subsequent dispersal of the species under the greater hydrological variability was modelled using data collected on stream discharge and corresponding drift and pipe net samples of escaping fish from water bodies that discharge into an adjacent stream.

Oral CCFFR (Introduced Aquatic Species)

Exhibitors – CCFFR/SCL/C-SWS 2011

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www.lakefish.net

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