

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

**Société Canadienne de Limnologie
Society of Canadian Limnologists**

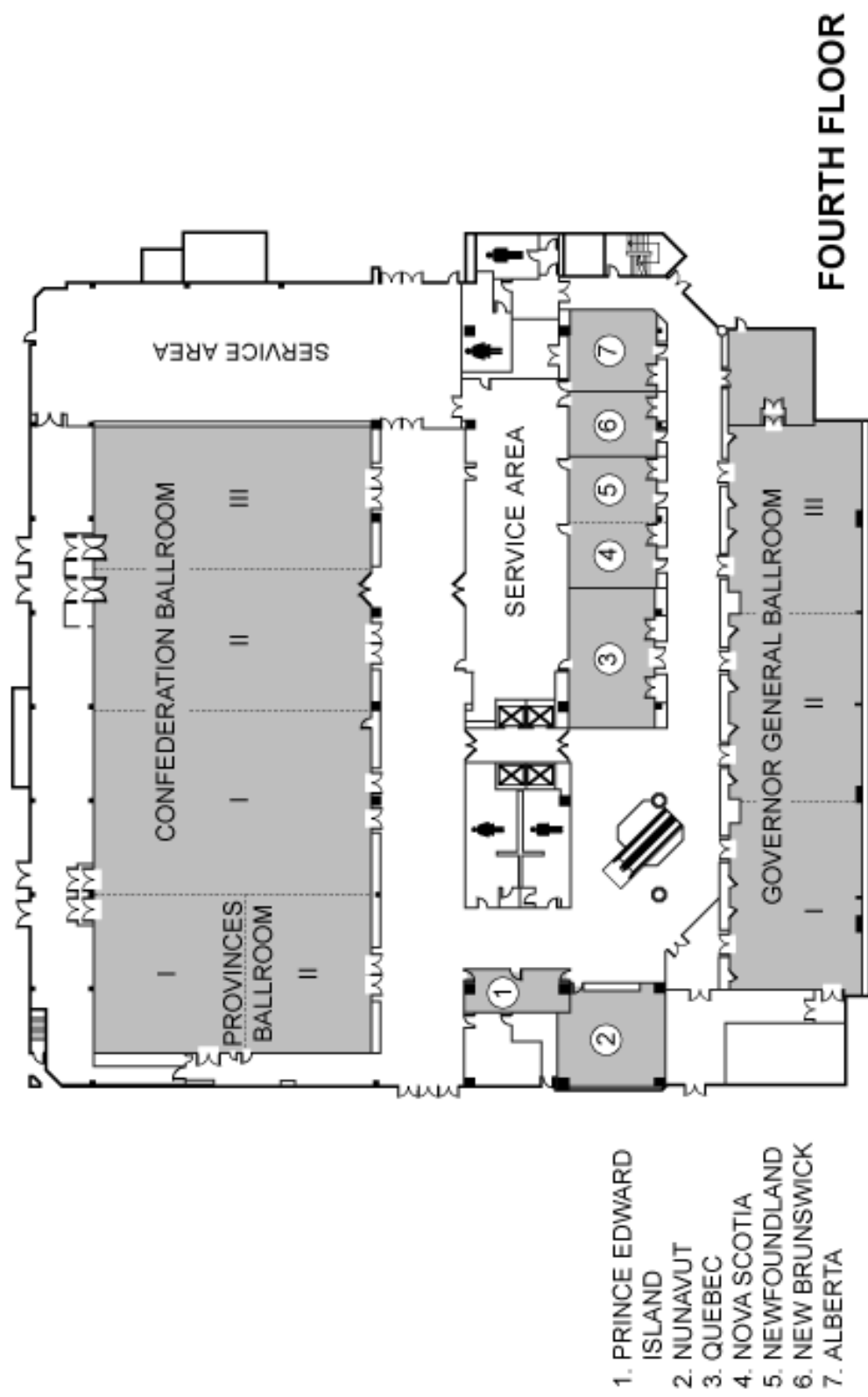


Ottawa, 9-11 January 2009

WESTIN HOTEL FLOOR PLAN

The Conference will take place in Confederation Ballroom I, II, III; Provinces Ballroom I, II; and Governor General Ballroom I

Posters will be on display in Confederation I on Friday night and in the Confederation Ballroom foyer on Saturday and Sunday



62nd Meeting of the
Canadian Conference for Fisheries Research
Conférence Canadienne de la Recherche sur les Pêches
and
Society of Canadian Limnologists
Société canadienne de limnologie

Westin Hotel
Ottawa
9-11 January 2009

Cover art: Images associated with the 2009 Plenary lectures

Front Cover:

Aerial photo of Lake Myvatn, Iceland. Myvatn is the location of ongoing research on benthic insect productivity and food web connections to the surrounding landscape.
Photo credit: Arni Einarsson.

J.C. Stevenson Memorial Lecture: Benthic production in lakes: cross-habitat and landscape linkages - M. Jake Vander Zanden

Rear Cover:

Whole ecosystem manipulation experiments at the Experimental Lakes Area, northwestern Ontario. A: Simulation of increased atmospheric mercury deposition by application of 200Hg to the uplands of Lake 658, using crop duster aircraft. B: Comparison of microbial consumption of sulfuric and nitric acids by experimental additions to the two divided basins of Lake 302. C: Experimental flooding of Wetland 979 demonstrating that decomposition of flooded vegetation and peat greatly increases flux of greenhouse gases and methyl mercury from peatland reservoirs.

F.H. Rigler Memorial Award Lecture: From Microbes to Whole Ecosystems - Carol A. Kelly and John W. M. Rudd

CCFFR/SCL 2009 Themes/Thèmes

- Advances in modelling and statistical analysis of aquatic ecosystems
- Des progrès dans la modélisation et l'analyse statistique des écosystèmes aquatiques.
- Effects of multiple stressors and their interactions on aquatic ecosystems
- Effets des stressors multiples et leurs interactions sur les écosystèmes aquatiques.
- Growth at the individual and population scales: measurement, modelling, and implications for production and population dynamics
- La croissance aux échelles de l'individu et de la population : quantification, modélisation et implications pour la production et la dynamique des populations.
- Impacts of climate change on the biodiversity of Canadian lakes, rivers, and oceans
- Les impacts des changements climatiques sur la biodiversité des lacs, rivières et océans canadiens.
- Measurement and analysis of connectivity in aquatic ecosystems
- Quantification et analyse de la connectivité des écosystèmes aquatiques.
- Size-selective exploitation of freshwater and marine fish populations
- Exploitation dépendante de la densité chez les populations de poissons d'eau douce et de poissons marins.
- Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott
- W.B. Scott, l'ichtyologie, les poissons et les pêcheries - une célébration !.

PROGRAM-AT-A-GLANCE

FRIDAY JANUARY 9

16:00 - 19:00 **Registration (Confederation I)**
19:00 **Mixer (Confederation I)**

SATURDAY JANUARY 10

Plenary session (Confederation I)
9:00 Opening Remarks
9:10 **J.C. Stevenson Memorial Lecture**
M. Jake Vander Zanden - Benthic production in lakes: cross-habitat and landscape linkages

9:55 **Break**

10:15 **F.H. Rigler Memorial Award Lecture**
Carol A. Kelly and John W. M. Rudd - From Microbes to Whole Ecosystems
11:00 Nicholas E. Mandrak - Overview of the changes in the composition of the Canadian freshwater fish fauna since 1973
11:30 Norman Yan - The emerging threat of Ca decline for soft-water lakes in Canada
11:50 Kim Hyatt - Clemens-Rigler Travel Fund

12:00 **Lunch**

12:00 - 13:00 Student Workshop: "The transition from grad school to a career" (Provinces I)
13:20 - 17:00 Concurrent Sessions
17:00 - 18:00 CCFFR Business Meeting (Governor General I)
17:00 - 18:00 SCL Business Meeting (Provinces I)
17:15 - 18:30 Poster Session (Confederation Ballroom Foyer)

18:30 **Pre-Banquet Cocktail and Banquet (Confederation I)**

SUNDAY JANUARY 11

9:00 - 12:00 Concurrent Sessions

12:00 **Lunch**

13:20 - 16:40 Concurrent Sessions

PLENARY ABSTRACTS

Stevenson Lecture

BENTHIC PRODUCTION IN LAKES: CROSS-HABITAT AND LANDSCAPE LINKAGES

M. Jake Vander Zanden

Center for Limnology, University of Wisconsin-Madison, 680 N. Park Street, Madison, WI 53706

Historically, the study of limnology has been synonymous with examination of pelagic (open-water) production and processes. The littoral zone has sometimes been viewed as separate from the pelagic, or as a refuge from predators, but rarely as a significant source of productivity at the whole-lake level. In contrast, stable carbon isotopes indicate that benthic-fixed carbon is an important, and sometimes dominant supporter of fish production in lakes, and that fishes integrate these two habitats and production pathways. Benthic production appears to be efficiently passed up the food chain to higher consumers, and generally supports more species diversity than an equivalent amount of pelagic production. In addition, benthic insect emergence can be a substantial flux of aquatic energy and nutrients to terrestrial ecosystems. I highlight these aquatic-terrestrial linkages with examples from ongoing research at Lake Myvatn, Iceland. In summary, littoral and pelagic zones each have unique properties, though both contribute in important ways to lakes. A growing understanding of these habitats and their interconnections is leading to a more holistic, ‘dual pathway’ paradigm of lake ecosystem function.

Rigler Lecture

FROM MICROBES TO WHOLE ECOSYSTEMS

Carol A. Kelly^{1,3} and John W. M. Rudd^{2,3}

¹Department of Microbiology, University of Manitoba; ²Experimental Lakes Area, Freshwater Institute, Winnipeg; ³R&K Research, Inc.

Understanding microbial processes in lakes is important because their activities affect the whole ecosystem - from water chemistry to entire food webs. The effects are sometimes positive, such as neutralization of acid rain, and sometimes negative, such as the microbial production of methyl mercury. We will discuss the concept of whole ecosystem impacts of microbial processes, using our work as examples of how the field of biogeochemistry has developed over the past few decades.

OVERVIEW OF THE CHANGES IN THE COMPOSITION OF THE CANADIAN FRESHWATER FISH FAUNA SINCE 1973

Nicholas E. Mandrak

Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON L7R 4A6 (nicholas.mandrak@dfo-mpo.gc.ca)

This is the 35th anniversary of the publication of the seminal *Freshwater Fishes of Canada* by Scott and Crossman. The freshwater fish fauna of Canada, and our understanding of it, has changed substantially since 1973. In 1973, 181 species were established in Canada; whereas, at least 209 species are currently known to be established. The composition of the fauna has changed as some species have become extinct (2 species) and some species have been only recently discovered (9 species), while others have invaded Canadian waters and become established (at least 8 species). As fish taxonomy has evolved, two species have been synonymised, and seven species have been split into 14 species. The greatest changes in the fish fauna have occurred geographically in the Great Lakes basin and taxonomically in the Cyprinidae. There is still much potential for further changes in our fish fauna as ongoing taxonomic uncertainties in many taxa, including Petromyzontidae, Cyprinidae, *Ictiobus*, *Coregonus*, Gasterosteidae and *Cottus*, are resolved and as invading species continue to become established.

THE EMERGING THREAT OF CA DECLINE IN CANADIAN SOFTWATER LAKES

Norman Yan^{*1,2}, Allegra Cairns¹, Dean Jeffries³, Tom Clair⁴, Shaun Watmough⁵, Julian Aherne⁵, Andrew Paterson^{2,6}, Adam Jeziorski⁶, and John Smol⁶

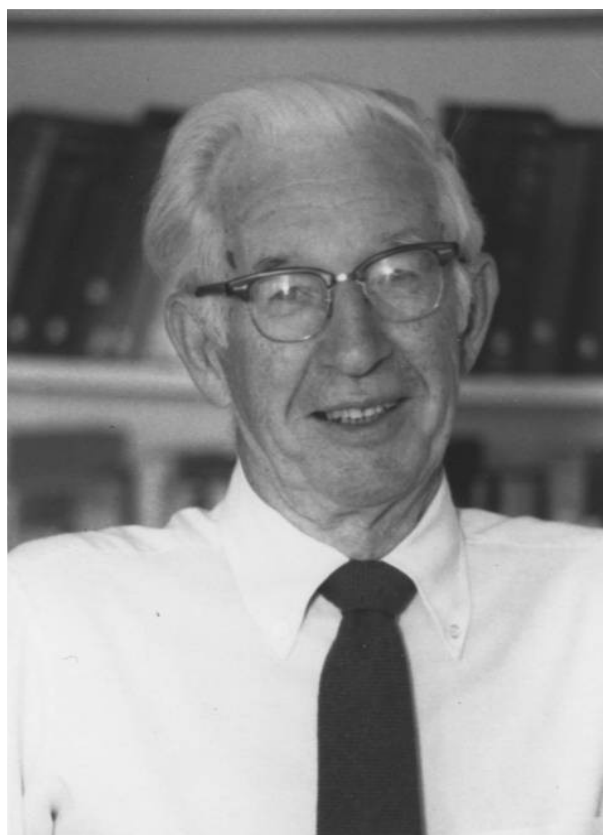
¹York University, Toronto, ON; ²Ontario Ministry of the Environment, Dorset, ON;

³Environment Canada, Burlington, ON; ⁴Environment Canada, Sackville, NB; ⁵Trent University, Peterborough, ON; ⁶Queen's University, Kingston, ON

There is a growing realization that recent, widespread decreases in calcium concentrations are posing a threat to biota in softwater lakes in central and eastern Canada. Ca concentrations in lakes fall if the exchangeable Ca pools in watershed soils are depleted; and such depletion may occur if additions of Ca to the soil from weathering and atmospheric input consistently fall below losses of Ca attributable to acid deposition and timber harvesting followed by forest re-growth. In this review, we will: 1) briefly review the causes of Ca decline in Canadian softwater lakes; 2) summarize Ca concentration thresholds that are problematic for a key group of freshwater biota, the Crustacea; 3) review the evidence that Ca decline is now widespread; and 4) that levels have now broached, or are approaching damaging thresholds in many lakes. There is an urgent need for Canadian ecologists to improve understanding of the unique effects of Ca decline on aquatic biota, and to understand the interactive effects of Ca decline with other environmental stressors, particular acidity and climate warming. Currently, those charged with the management of North America SO₂ emissions have not considered the separate effects of low Ca levels on aquatic resources, in addition to the effects of low pH and ANC. We suggest that this situation should change.

Oral Presentations
Afternoon of Saturday January 10
(Session 1 of 4)

Saturday	Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Casselman) Confederation I
13:20	Casselman - Introduction to the celebration: celebrating ichthyology, fish, and fisheries with W.B. (Bev) Scott
13:40	Beamish - Documentary film "Freshwater Fishes of Canada", a pre-release showing
14:00	Leggett - Celebrating my association with Bev
14:10	Watson - An editor's association and reminiscences
14:20	Hutchings - From 1988 to 2008: ecology and life history of non-commercial Atlantic marine fishes
14:40	Stephenson - Taxonomy in the grand scheme of things
15:00	Break
	Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Beamish) Confederation I
15:20	Nelson - History of the "Committee on Names of Fishes" and of the classification of the family Salmonidae and the names of its species
15:40	Reist - Progress in Char (<i>Salvelinus</i>) taxonomy since 1973
16:00	Anderson - W. B. Scott and the Huntsman Marine Science Centre
16:20	Powles - Return of an icon!
16:30	Mandrak - The importance of historical museum records in understanding biodiversity changes in the Great Lakes
16:40	Smith: Bev Scott: a view from south of the border
16:50	Watson-Wright - Reminiscences
17:00	Beamish - Wrap-up to the celebration: celebrating ichthyology, fish, and fisheries with W.B. (Bev) Scott
17:00	CCFFR Business Meeting – Governor General I SCL Business Meeting – Provinces I
17:15	Poster Session – Confederation Ballroom Foyer



**Celebrating Ichthyology, Fish, and Fisheries
with W.B. Scott**

W.B. (Bev) Scott is the dean of Canadian ichthyologists. Come and celebrate his longstanding interest and association with ichthyology, fish, and fisheries. Probably best known for the seminal work "Freshwater Fishes of Canada" that he and his late colleague, Ed Crossman, published, he also published "Atlantic Fishes of Canada" with his cherished wife and professional companion Milly. His colleagues, friends, and acquaintances will meet to experience the past and present and consider the future of Canadian ichthyology. Participate with Dr. Scott and his colleagues in exploring ichthyology, marine and freshwater fishes and fisheries and in celebrating with this acclaimed ichthyologist his lasting contribution. As Bev would say, it should be fun!

Oral Presentations
Afternoon of Saturday January 10
(Sessions 2-4 of 4)

Saturday	Stressors (Linley) Confederation II	Modelling (Jonsen) Confederation III	Growth (Post) Governor General I
13:20	Jeziorski - The widespread threat of calcium decline in fresh waters: A paleolimnological perspective	Jonsen - Statistical models for linking marine predator movements to oceanography	Morgan - Size doesn't always matter - yellow perch (<i>Perca flavescens</i>) growth varies with density and predation risk in Sudbury area lakes
13:40	Linley - Calcium concentrations at which south-central Ontario daphniid species are damaged by calcium decline: Potential implications for Canadian lakes recovering from acid deposition	Davies - A Bayesian state-space model to combine multiple indices and identify index non-proportionality for the assessment of 4X cusk (<i>Brosme brosme</i>)	Blanchfield - The influence of growth rate on mercury levels in fish: insights from whole-lake experiments
14:00	Korosi - Long-term trends in <i>Bosmina</i> and <i>Daphnia</i> size structure from soft-water Ontario lakes	Rosenfeld - Habitat-specific hydraulic geometry and frequency distributions as a simple approach for modelling stream habitat properties	Páez - Differences between populations of Atlantic salmon in the adoption of alternative reproductive tactics
14:20	Finlay - Increased urea concentrations causes water quality degradation in the Northern Great Plains	Walker - Selecting ordination diagrams with information criteria	Elvidge - Juvenile Atlantic salmon show different behavioural responses to visual threat cues in weakly acidic versus neutral streams
14:40	Bogard - Spatial and predictive patterns of urea occurrence in lakes of the Northern Great Plains	Sharma - Predicting fish densities at different spatial scales: Evaluating predictive success of univariate and multivariate statistical approaches	
15:00	Break		
	Stressors (Yan) Confederation II	Connectivity (Bradbury) Confederation III	Climate Change (Minns) Governor General I
15:20	Winter - Changes in phytoplankton community composition in Lake Simcoe over three decades: Relationships with decreases in phosphorus loading and the effects of other stressors	Bradbury - A re-evaluation of the spatial genetic connectivity of Atlantic cod using EST-derived microsatellites and single nucleotide polymorphisms	Arnott - The influence of climate change on zooplankton communities in Boreal Shield lakes
15:40	Ginn - Distribution of aquatic plants in relation to nutrients, substrate type, invasive species, and other environmental variables in Lake Simcoe (Ontario)	Coppaway - Movements of stream "resident" brook charr (<i>Salvelinus fontinalis</i>) within and among Lake Superior tributaries	Ogbebo - Phytoplankton taxonomic composition in lakes of the lower Mackenzie River Basin, Northwest Territories (Canada)
16:00	Evans - Resolving the effects of multiple stressors on the cold-water fish community of Lake Simcoe	Edelsparre - Is there a general movement syndrome in young of the year brook charr, <i>Salvelinus fontinalis</i> ?	Rennie - Changes in fish condition and mercury vary by region rather than food chain length: a result of climate change?
16:20	Yan - Evidence for global, regional, landscape, and in-lake influences on the recovery of Sudbury lakes from historical disturbances	Cote - Applying a measure of longitudinal connectivity to restoration decision making	Boily - Effects of ultraviolet radiation on yellow perch larvae (<i>Perca flavescens</i>)
17:00	CCFFR Business Meeting – Governor General I SCL Business Meeting – Provinces I		
17:15	Poster Session – Confederation Ballroom Foyer		

Oral Presentations
Morning of Sunday January 11
(Sessions 1-3 of 6)

Sunday	Contributed (Purchase) Confederation I	Contributed (McPhee) Confederation II	Stressors (Gunn) Confederation III
9:00	Purchase - Spatial/temporal patterns in the spawning densities of brook trout	Christie - A pool approach to allocating underutilized individual quotas	Gunn - Artificial deepening of a lake thermocline: A simulation of the impacts of changing surface winds
9:20	Warner - Anadromy and residency life histories in sympatric salmonids	Barnucz - Monitoring the expansion of round goby (<i>Neogobius melanostomus</i>) into Great Lakes tributaries; closing the knowledge gap for fisheries managers	Cantin - Artificial deepening of a lake thermocline: effects on the plankton
9:40	Weir - The influence of anadromous males on monopolization and variance in fertilization success among mature male Atlantic salmon parr	Colotelo - Forensic evaluation of common sources of physical injury to popular warmwater sportfish during recreational angling	Ouellet - Temperature duration frequency analysis on the St. Lawrence River - A tool for quantifying adverse conditions during the 2001 massive fish kill
10:00	Break		
	Connectivity (Bradbury) Confederation I	Modelling (Jonsen) Confederation II	Stressors (Vinebrooke) Confederation III
10:20	Cruz-Font - Telemetry data as a descriptor of lake trout behaviour in two lake ecotypes	Laursen - Modeling gas-evolving nitrogen and carbon biogeochemical processes in small lakes	Vinebrooke - Synergistic effect of nitrogen and phosphorus on primary production: Now you see it, now you don't
10:40	Hogan - Connectivity among populations of a demersal marine fish	Blukacz - A mass-balance remediation approach towards reaching delisting targets in areas of concern	Kowarzyk - N ₂ and N ₂ O concentrations and fluxes from estuarine sediments: Evidence of a tight nitrification denitrification couple
11:00	Comte - Predicting changes or predicting outcomes in aquatic microbial successions	Wang - Assessing the establishment success of <i>Bythotrephes longimanus</i> in relation to environmental conditions in south-central Ontario lakes	Tall - Spatial and temporal variability in N ₂ O emissions and N budget for Lake Saint Pierre a large fluvial lake of the St. Lawrence River, Canada
11:20	Derry - Ecological linkages between community and genetic diversity in zooplankton among Boreal Shield lakes	Winship - Assessment of the impact of bycatch on harbour porpoise in the North Sea	Marty - Linking terrestrial and aquatic ecosystems in a regulated river: Does flow alteration explain patterns of carbon flow?
11:40	McCracken - Measuring lacustrine influence on composition and function in a stream community	Bertolo - Space Oddity, or about asymmetrical distributional patterns of organisms at multiple scales	Laursen - Protecting Canada's drinking water: developing real-time, early-warning biomonitoring technology
12:00	Lunch		

Oral Presentations
Morning of Sunday January 11
(Sessions 4-6 of 6)

Sunday	Growth (Trudel) Governor General I	Contributed (Guy) Provinces I	Contributed (Paszkowski) Provinces II
9:00	Gutowsky - Population dynamics of the round goby (<i>Apollonia melanostoma</i>) in the Trent River, Ontario: An examination of an expanding population of invasive fish	Scott - How do we scale up measurements of benthic photosynthesis to the whole lake?	Tonn - Effects of stocked trout on communities in small boreal foothills lakes
9:20	Trudel - Prey quality affect the production of wild Pacific salmon in the northern California Current ecosystem	McCabe - Can a fluorometric probe be used to measure <i>in situ</i> phytoplankton pigments in coloured waters?	Paszkowski - Trophic relationships of western and red-necked grebes in the food web of Lake Wabamun, Alberta
9:40	Luek - The importance of benthic invertebrates for food web complexity of recovering lakes	McCarthy - Water column ammonium dynamics and phytoplankton community structure in Missisquoi Bay, Lake Champlain (Québec) in summer 2007	Chételat - Terrestrial carbon subsidies to aquatic food webs of the High Arctic: Evidence from chironomid diet
10:00	Break		
	Growth (Dodson) Governor General I	Contributed (Winter) Provinces I	Contributed (Tonn) Provinces II
10:20	Poos - Effects of urbanization on stream fish populations using an endangered indicator species	Bentzen - Hypotheses relating to long term declining trends in lake total phosphorus concentrations	Drake - Quantifying the dispersal potential of aquatic invasive species using vector-based risk models
10:40	Couillard - Changement ontogénique de niche : la biologie du poulamon atlantique (<i>Microgadus tomcod</i>) dans une zone de transition estuarienne	Chu - The feasibility of artificial nutrient fertilization within Inner Bay of Fundy streams	Delta - Genetic origin and dispersal of invasive <i>Lepomis gibbosus</i> in the Iberian Peninsula
11:00	Godbout - Développement ontogénique de deux populations d'éperlans arc-en-ciel (<i>Osmerus mordax</i>) de l'estuaire moyen du Fleuve St-Laurent	Vermaire - Quantifying changes in total phosphorus and whole-lake macrophyte biomass between pre-disturbance and present day conditions in the Eastern Townships of Quebec using paleolimnological approaches	Thibault - Origine de la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>) dans l'est du Québec
11:20	Maltais - La reproduction de l'aloise savoureuse (<i>Alosa sapidissima</i>) dans le Fleuve Saint-Laurent	Thienpont - Tracking the timing of permafrost thaw using diatoms in sediment cores from lakes near Inuvik, NWT	Bourque - Are temporal replicates useful in fish habitat use surveys?
11:40		Baulch - Nitrous oxide emissions from low order streams: Contrasting measured and modelled emissions	Rusak - Sampling requirements for the estimation of annual zooplankton abundance and community dynamics in north temperate lakes
12:00	Lunch		

Oral Presentations
Afternoon of Sunday January 11
(Sessions 1-3 of 6)

Sunday	Contributed (Rosenfeld) Confederation I	Stressors (Guy) Confederation II	Contributed (McLaughlin) Confederation III
13:20	Neff - Changes in biological communities across a geological transistion: Examining the impact of the Precambrian Shield on small-order lotic systems	Venkiteswaran - Applying $\delta^{18}\text{O}$ - O_2 to ecological questions in impacted rivers (2009 Peters Award Winner)	McLaughlin - FishMaP: A web application supporting science-based decisions concerning fish movement and passage
13:40	Ward-Campbell - Short-term effects of drain maintenance on aquatic assemblages inhabiting agricultural drains in southwestern Ontario	Williams - Influence of land use on bacterial activity and organic matter characteristics in Southern Ontario streams	Dolinsek - Ecological implications of inter-stream movements of pit tagged fishes
14:00	Lecraw - Sources of small-scale variation in benthic macroinvertebrate communities and primary production in small streams	Quesnelle - Productive capacity of semi-alluvial streams in Ontario: The importance of alluvial material for fish, benthic invertebrates, periphyton and organic material	Zeyl - Locomotor and perceptual bases of individual differences in activity exhibited by young-of-the-year brook charr
14:20	Rosenfeld - Contrasting landscape influences on sediment supply and stream restoration priorities in northern Fennoscandia (Sweden and Norway) and coastal British Columbia	Puckrin - The role of land-use context and nutrient excretion on algal and invertebrate colonization of mussel shells	Wood - Population density and territory size in juvenile rainbow trout, <i>Oncorhynchus mykiss</i> : Implications for population regulation
14:40	Cyr - Individual, environmental and seasonal variability in the isotopic signature of the primary consumer <i>Elliptio complanata</i>	Spooner - Land-use context governs the performance of freshwater mussels to nutrient cycling and trophic provisioning	McKee - The influence of lateral contributions to thermal and flow variation and the distribution of fish in small streams
15:00	Break		
	Contributed (Paterson) Confederation I	Stressors (Poos) Confederation II	Contributed (Harpur) Confederation III
15:20	McCabe - The potential influence of iron on freshwater algal blooms	Poos - Developing a generalized framework for species recovery from multiple stressors?	Harpur - Examining natural variation in the inland lake fish communities in Bruce Peninsula National Park, Ontario
15:40	Leblanc-Renaud - The relationship between microcystin gene copy number and microcystin concentrations in a shallow mesotrophic lake	Granados - Assessing the application of the Index of Biological Integrity in areas of concern	Kim - Effects of perceived predation risk on territorial behaviour and population density in wild juvenile Atlantic salmon
16:00	Guindon - Probing deeper into cyanobacterial community dynamics	Szkokan-Emilson - The importance of exported catchment products in shaping littoral benthic invertebrate communities	Tremblay - The role of lake sturgeon in a remote First Nation community, Namaygoosisagagun First Nation, highlighting results from a three year spawning survey in Smoothrock Lake, Ontario
16:20	Nguyen - New data on microbial community respiration in sea-ice	Wesolek - Use of multiple methods to detect spacial differences in littoral benthic invertebrate communities: A site specific investigation	

Oral Presentations
Afternoon of Sunday January 11
(Sessions 4-6 of 6)

Sunday	Exploitation (Hanson) Governor General I	Contributed (Gillis) Provinces I	Contributed (Bertolo) Provinces II
13:20	Hanson - Demographic effects of size-selective exploitation of clams, cod, and lobster - the role of refuges	Gillis - Movement analysis with fixed gear: VMS records in the Gulf of St. Lawrence snow crab fishery	Mills - Mercury concentrations in smallmouth bass (<i>Micropterus dolomieu</i>) in south-central Ontario lakes in relation to lake sediment
13:40	Adams - Adaptive life history variation in experimentally exploited brook trout (<i>Salvelinus fontinalis</i>)	Keefe - A comparison of two methodologies for estimating catch rate using the winter brook trout fishery in Newfoundland and Labrador, Canada	Misener - Impacts of disturbance on mercury levels and bioaccumulation in small stream environments of Northwestern, Ontario
14:00	Tucker - Using DNA-based stock identification to elucidate coastal migration of juvenile sockeye salmon (<i>Oncorhynchus nerka</i>)	Demille - Examining the role and effectiveness of year-round fish sanctuaries in the protection of black bass in Lake Opinicon, ON	Fathi - Measuring the flux of mercury between contaminated sediments and overlying water in St. Lawrence River, near Cornwall, Ontario
14:20	Vilimek - Long-term life history trends in Newfoundland northern sand lance	Bobrowski - Comparative survival and fitness of stocked juvenile life stages of Atlantic salmon in Lake Ontario streams	Inglis - Comparison of kairomone induced morphological defenses of <i>Daphnia pulicaria</i> clones from metal-contaminated and non-metal contaminated lakes in the presence of copper
14:40		Koops - Do length-based indices of condition work?	Al-Ansari - 17-alpha-ethynylestradiol (EE2) bioaccumulates in shorthorn redhorse sucker (<i>Moxostoma macrolepidotum</i>) from the St. Clair River
15:00	Break		
	Contributed (Cyr) Governor General I	Stressors (Brimble) Provinces I	Contributed (Blais) Provinces II
15:20	Tremblay - GHG fluxes (CO ₂ , CH ₄ , N ₂ O) and pCO ₂ monitoring before and during the first three years of the Eastmain-1 reservoir (Quebec, Canada)	Brimble - Impact of a large northern fulmar (<i>Fulmarus glacialis</i>) colony on the sediment quality of a series of freshwater ponds at Cape Vera, Devon Island	Foster - The role of seabirds in contaminant delivery to high Arctic ponds: A source apportionment study on Devon Island, NU
15:40	Demarty - Use of automated systems to measure greenhouse gas emissions from reservoirs	Edwards - Investigating crayfish community ecology and the influence of multiple stressors in crayfish decline	Blais - Contaminant biovector transport near a seabird colony on Devon Island, Arctic Canada
16:00	Ducharme Riel - The relative contribution of winter and summer hypolimnia in annual CO ₂ production of lakes		Mazumder - Shifting warm-water to cold-water conditions and foodweb dynamics of juvenile Pacific salmon in the Eastern Bering Sea ecosystem
16:20			Schein - Effects of agriculturally-derived nitrate on the estuarine food web structure and fish communities of Prince Edward Island

POSTERS-AT-A-GLANCE
Confederation Ballroom Foyer
Saturday, 10 January, 17:15 – 18:30

Session: Effects of multiple stressors and their interactions on aquatic ecosystems		
P1	Balthasar	CONCENTRATION AND FRACTIONATION OF METALS IN STREAMS ALONG A GRADIENT OF AGRICULTURAL LAND USE
P2	Boudreau	DETECTING ECOSYSTEM CHANGES THROUGH LOBSTER FISHERS' LOCAL ECOLOGICAL KNOWLEDGE
P3	Dalton	COMPARISON OF MACROPHYTE COMMUNITIES ALONG A GRADIENT OF AGRICULTURAL INTENSITY IN THE SOUTH NATION RIVER WATERSHED
P4	DeSellas	LONG-TERM CHANGES IN CLADOCERAN SIZE AND ASSEMBLAGE COMPOSITION IN LAKE OF THE WOODS, ONTARIO, CANADA
P5	Guillemette	CARBON SOURCES RESPIRED BY BACTERIA ON SHORT- AND LONG-TERM IN FRESHWATER ECOSYSTEMS
P6	McFeeters	LAND USE EFFECTS ON THE BASAL METABOLISM OF STREAM CRAYFISH
P7	Randall	LONG-TERM TRENDS IN AN INDEX OF BIOTIC INTEGRITY FOR NEAR SHORE FISHES IN HAMILTON HARBOUR, LAKE ONTARIO: THE CONFOUNDED EFFECTS OF MULTIPLE STRESSORS
P8	Rodé	A PALEOLIMNOLOGICAL RECONSTRUCTION OF LAKE SIMCOE'S HISTORICAL COLD-WATER FISH HABITAT
P9	Shin	PROTOTYPE VIBRATING WAVE GENERATOR FOR MEASURING GROWTH CHANGE OF FISH EXPOSED INDUSTRIAL NOISE AND VIBRATION STIMULI
P10	Verschoor	LONG-TERM CHANGE IN THE RELATIONSHIP BETWEEN OXYGEN AND THERMAL STRUCTURE IN LAKES IN THE DORSET REGION OF ONTARIO
Session: Growth at the individual and population scales: measurement, modelling, and implications for production and population dynamics		
P11	Tibble	MOVEMENT AND HABITAT USE OF A LACUSTRINE POPULATION OF BROOK CHARR (<i>SALVELINUS FONTINALIS</i>) IN THE INDIAN BAY WATERSHED, NEWFOUNDLAND
Session: Impacts of climate change on the biodiversity of Canadian lakes, rivers, and oceans		
P12	Chute	AN EVALUATION OF STREAM ECOSYSTEM STRUCTURE AND FUNCTION IN THE TORNGAT MOUNTAINS NATIONAL PARK RESERVE, LABRADOR

P13	Jourdain	THE ROLE OF CYANOBACTERIA RECRUITMENT AND PHOTOSYNTHETIC ACTIVITY ON INTERMITTENT BLOOM FORMATION
Session: Measurement and analysis of connectivity in aquatic ecosystems		
P14	Buchar	FISHY BUSINESS IN AN ARCTIC YUKON STREAM ECOSYSTEM: NUTRIENT AND CONTAMINANT SUBSIDIES BY SPAWNING CHUM SALMON (<i>ONCORHYNCHUS KETA</i>)
P15	Lyons	THE INFLUENCE OF FLOODING ON AQUATIC FOODWEBS OF THE PEACE-ATHABASCA DELTA
Session: Contributed Papers		
P16	Brown	GROWTH RATE INFLUENCES RETENTION OF LEARNED PREDATOR RECOGNITION IN JUVENILE RAINBOW TROUT: THE ADAPTIVE VALUE OF FORGETTING
P17	Day	SYNCHRONOUS RECRUITMENT AMONG GEOGRAPHIC POPULATIONS OF CANADIAN LAKE WHITEFISH (<i>COREGONUS CLUPEAFORMIS</i>) AND ARCTIC CHAR (<i>SALVELINUS ALPINUS</i>)
P18	Ferland	CARBON STORAGE IN BOREAL AND TEMPERATE QUÉBEC LAKES
P19	Gray	FOSSIL MIDGES AND HYPOLIMNETIC OXYGEN AT CLEAR LAKE, RIDING MOUNTAIN NATIONAL PARK, MANITOBA
P20	Hargan	A PRELIMINARY PHOSPHORUS BUDGET FOR THE LAKE OF THE WOODS
P21	Jayaraman	ROLE OF MICROFINANCE IN SOCIO-ECONOMIC DEVELOPMENT OF FISHERFOLK IN THOOTHUKUDI DISTRICT, TAMIL NADU (INDIA)
P22	Johnston	EGG QUALITY VARIATION IN WILD AND HATCHERY STOCKS OF LAKE TROUT
P23	Low	ARE REFLEX IMPAIRMENTS INDICATIVE OF ACUTE STRESS AND SHORT TERM MORTALITY IN BLUEGILL
P24	Moos	CLIMATE-RELATED EUTROPHICATION OF A SMALL BOREAL LAKE, EXPERIMENTAL LAKES AREA, NW ONTARIO: A PALEOLIMNOLOGICAL PERSPECTIVE
P25	Quinlan	VOLUME-WEIGHTED HYPOLIMNETIC OXYGEN (VWHO) AND EXTENT OF ANOXIA & HYPOXIA IN LAKES: HOW DO THESE METRICS OF HYPOLIMNETIC OXYGEN CONDITIONS COMPARE?
P26	Rowe	REAPPEARANCE OF A LARGE, WIDELY DISTRIBUTED FISH
P27	Vandergucht	A COMPARISON OF TECHNIQUES FOR DETERMINING P-LIMITATION IN LAKES

STUDENT WORKSHOP

Saturday January 10, 12:00-13:00, Provinces I Ballroom

Lunchtime discussion panel: “The transition from grad school to a career”

Welcome to the student workshop at the CCFFR-SCL joint meeting. The theme of the workshop is “**The transition from grad school to a career**” and will be a lunch hour discussion about a subject that concerns most graduate students; your future career after you complete your degree. A panel of experts from Academia, Industry, Government, and the NGO sectors will be on hand to share their experience about their career paths. We want this forum to be an interactive discussion so please be ready to ask questions. This is a great opportunity to get advice and find out how others have successfully navigated the transition from grad school to a career. So bring your lunch and join us for this discussion panel.

FORUM ÉTUDIANT

Samedi le 10 janvier, 12:00-13:00, salle Provinces I

Sujet de la discussion : « Des études graduées au marché du travail »

Une activité de discussion aura lieu sur l’heure du dîner dans le cadre du congrès joint CCFFR/SCL pour échanger sur vos interrogations quant à la transition entre la fin de vos études graduées et votre future carrière sur le marché du travail. Une panoplie d’experts issue des milieux universitaires, industriels, gouvernementaux ou encore, d’organisations à but non-lucratif seront disponibles pour partager leur expérience respective et pour répondre à vos interrogations. Nous voulons que ce forum soit très interactif, alors n’oubliez pas de préparer quelques questions! Si vous êtes intéressés par cette discussion sur vos options de carrière, amenez votre lunch et rejoignez-nous samedi le 10 janvier!

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ABSTRACTS

62nd Meeting of the

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

and

Society of Canadian Limnologists
Société canadienne de limnologie

Ottawa, Ontario

9-11 January 2009

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

ADAPTIVE LIFE HISTORY VARIATION IN EXPERIMENTALLY EXPLOITED BROOK TROUT (*SALVELINUS FONTINALIS*)

Adams*, B., Cote, D. and I. Fleming. Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook (blairadams@gov.nl.ca)

We examined life history responses to experimental manipulations and angler exploitation in brook trout populations from insular Newfoundland and New Brunswick. Thirteen populations of brook trout were sampled annually from 2005 to 2008, representing a broad range of the life history variation reported for this species. Variation in life history characters, including juvenile survival, growth rate, age at maturity, fecundity and egg size were tested for responses to changes in adult survival and density. Within populations, growth rate and age at maturity showed a significant response to increased adult survival and reduced density. Across populations age at maturity was relatively stable despite substantial variation in growth rate. Reproductive effort and egg size did not show a significant phenotypic response to changes in adult survival; however variation in reproductive effort and egg size appear to be related to environmental variability. Fitness modeling suggests that these phenotypic responses to exploitation represent an adaptive response that may mitigate the probability of population decline.

Size-Selective Exploitation of Freshwater and Marine Fish Populations (Oral CCFFR)

17-ALPHA-ETHYNYLESTRADIOL (EE2) BIOACCUMULATES IN SHORthead REDHORSE SUCKER (*MOXOSTOMA MACROLEPIDOTUM*) FROM THE ST CLAIR RIVER

Al-Ansari* AM¹, Saleem A¹, Kimpe L¹, Sherry JP², McMaster M², Trudeau VL¹, and Blais JM¹. ¹Centre for Advanced Research in Environmental Genomics, Department of Biology, University of Ottawa, Ottawa, ON, Canada. ²Environment Canada, Burlington, ON, Canada (aalan072@uottawa.ca)

17 α -ethynylestradiol (EE2) is a synthetic estrogen prescribed as an oral contraceptive. EE2 and the natural estrogens estrone (E1), 17 β -estradiol (E2) and estriol (E3) have been frequently detected as low ng/L or ng/g in wastewater treatment plant effluents, rivers, and sediments. Such low levels of environmental estrogens have been strongly correlated with endocrine disruption in aquatic species. The aim of this study is to determine whether EE2 bioaccumulates in whole fish tissues of Shorthead Redhorse Sucker (*Moxostoma macrolepidotum*) using high performance liquid chromatography coupled with mass spectrometry HPLC-APCI-MSD in selected ion monitoring mode. Thirty six wild fish were sampled from the St. Clair River, Stag Island, Ontario in 2002. Whole fish tissue samples were prepared by grinding each fish followed by extracting 20g of fish homogenates by accelerated solvent extraction for fat removal by preparative scale gel permeation chromatography. EE2 in fish tissues were detected at biologically active concentrations, ranging from 0.47 to 2.30ng/g fish body mass. To our knowledge, this study is the first to show EE2 bioaccumulation in wild fish.

Contributed Paper (Oral CCFFR) (GS)

W. B. SCOTT AND THE HUNTSMAN MARINE SCIENCE CENTRE

Anderson, John M.*, Huntsman Marine Science Centre, 1 Lower Campus Rd., St. Andrews, NB E5B 2L7 (atlsal@nbnet.nb.ca)

Beginning in the 1950s, Dr. Bev Scott has had a long association with St. Andrews, New Brunswick, and its federal government Biological Station. The association became permanent when he accepted the position of Executive Director of the Huntsman Marine Laboratory (later renamed the Huntsman Marine Science Centre). He oversaw the development of the Huntsman during its critical formative years. The paper chronicles his administrative achievements during his 1976-82 tenure at the Huntsman, one of which was a pioneering program in the identification of fish eggs and larvae, which eventually evolved into the now internationally known Atlantic Reference Centre. In 1998 he and his wife, Milly, moved to Kingston, Ontario.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

THE INFLUENCE OF CLIMATE CHANGE ON ZOOPLANKTON COMMUNITIES IN BOREAL SHIELD LAKES

Arnott*, S. E., S. MacPhee, and M. McLennan. Department of Biology, Queen's University, Kingston, ON (arnotts@queensu.ca)

Climate change is expected to have complex effects on lake ecosystems, resulting in changes in water temperatures, mixing depth, and water chemistry. Surface temperature is expected to increase, but the amount of cold water habitat will depend on dissolved organic carbon concentrations in individual lakes. Longer periods of thermal stratification are expected for some lakes, but other lakes may become isothermal. These changes in lake characteristics (among others) are expected to have implications for zooplankton communities. We used three approaches to assess zooplankton response to climate change. We compared mid-summer thermal structure and zooplankton composition in a warm versus cold year for 20 small lakes in Killarney Park, ON. We compared successional change in zooplankton composition in 5 Sudbury lakes for a year where thermal stratification set up soon after ice-off compared to a year where thermal stratification was delayed. Finally, we conducted a series of mesocosm experiments to assess how thermal stratification and temperature influence predator-prey interactions. Our results indicated that, across a range of lake-types, zooplankton abundance was higher and calanoid copepod length was shorter in the warm year than the cool year. This was surprising because other studies have predicted the opposite effect. We also found that *Chaoborus* exerted stronger predation on zooplankton during a field experiment when the water column was warm and isothermal compared to hot, isothermal conditions and cool, stratified conditions. This suggests that trophic interactions may have important indirect influences on zooplankton communities in a changing climate.

Impacts of Climate Change on the Biodiversity of Canadian Lakes, Rivers, and Oceans (Oral SCL)

CONCENTRATION AND FRACTIONATION OF METALS IN STREAMS ALONG A GRADIENT OF AGRICULTURAL LAND USE

Balthasar*, A.R.¹, M.A. Xenopoulos², D.E. Spooner² and R.D. Evans³. *¹Environmental and Life Sciences Graduate Program, Trent University, Peterborough, ON. ²Department of Biology, Trent University, Peterborough, ON. ³Environmental Resource Studies, Trent University, Peterborough, ON (rbalthasar@gmail.com)

Agriculture is a dominant component of the landscape of South and Central Ontario. Metal accumulation in aquatic organisms may be facilitated by nutrient loading and landscape changes associated with agriculture. Here we will use high precision isotopic analyses by ICP-MS to measure and trace the potential accumulation and fractionation of five metals (Zn, Cu, Ni, Cd and Cr) in an indicator species Unionoida (freshwater mussels) along a gradient of agriculture. Preliminary analysis, using ICP-MS on water samples, shows that water column zinc and nickel are highly variable across sites whereas cadmium and chromium vary less. Several metals were highly correlated with agricultural land use in particular; ⁶⁶Zn isotopes increased with the proportion of rural land use in the watershed. We also found higher concentrations of Cr, Ni, and Cd in areas dominated by monoculture, an intensive form of agriculture compared to other land uses. These results show that land use can affect the rate that metals leech from soils into streams and that agriculture practices may also affect water column metal concentrations. Verification of these initial findings will be obtained through water nutrient analysis and mussel tissue analysis.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL) (GS)

MONITORING THE EXPANSION OF ROUND GOBY (*NEOGOBIOUS MELANOSTOMUS*) INTO GREAT LAKES TRIBUTARIES; CLOSING THE KNOWLEDGE GAP FOR FISHERIES MANAGERS

Barnucz*, Jason, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, Ontario (jason.barnucz@dfo-mpo.gc.ca) and Jeff McNeice, Central Lake Ontario Conservation Authority, Oshawa, Ontario (jmcneice@cloca.com)

Since its introduction the round goby (*Neogobius melanostomus*) has rapidly spread throughout the Great Lakes basin. Recent fisheries surveys in Ontario have documented the spread of this species into many tributaries of the Great Lakes. Within Ontario, watershed planning agencies have prepared Fisheries Management Plans developed to manage fisheries and fish habitat in Great Lakes tributaries. A recommendation common to all of these plans is controlling the spread invasive species into tributaries of the Great Lakes. However, implementation of such a recommendation has proven challenging. Currently there are no initiatives in Ontario to evaluate the extent of the round goby invasion into Great Lakes tributaries. Sampling was conducted during 2007 and 2008 to determine the extent of the round goby invasion into four Lake Ontario tributaries, and to develop a standardized electrofishing method to detect round goby in wadeable streams. Of the four tributaries sampled, two had barriers to fish migration in close proximity to Lake Ontario. Sites were sampled with backpack electrofishing units using a combination of single-pass and triple-pass sampling methods. The sampling indicated that the round goby has successfully invaded all sampled tributaries. Sampling also indicated that single-pass backpack electrofishing methods were very effective at detecting round goby in wadeable streams. Additional sampling is required to evaluate the influence of round goby on native fishes in these tributaries. Preliminary information suggests lamprey barriers have been successful in mitigating the spread of round goby in Great Lakes tributaries.

Contributed Paper (Oral CCFFR)

NITROUS OXIDE EMISSIONS FROM LOW ORDER STREAMS: CONTRASTING MEASURED AND MODELLED EMISSIONS

Baulch*, H.M., P.J. Dillon, and R. Maranger. Trent University and Université de Montreal
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Human alterations of the nitrogen cycle have led to increased atmospheric concentrations of the potent greenhouse gas nitrous oxide (N₂O). Much work has been dedicated to quantifying N₂O fluxes from soils, but fluxes from aquatic sources are still poorly characterized. This is despite the 2-20 fold increase in riverine nitrogen concentrations in numerous regions, the finding that nitrate concentrations and nitrous oxide emissions are positively related, and models of the global N₂O budget that suggest rivers and estuaries are large emissions sources, particularly in the northern hemisphere. Diffusive N₂O fluxes from four of our study streams in southern Ontario indicate that these nitrogen enriched streams function as small N₂O sources; however emissions are far lower than predicted using current emissions models. A fifth stream with low nitrogen concentrations frequently functions as an N₂O sink. We extend our analysis to explore error terms associated with diffusive budgets by assessing the importance of diurnal variation in N₂O emissions and the importance of bubble-mediated fluxes. While exclusion of these terms has likely contributed to an underestimation of fluxes in many study systems, inclusion of these terms still results in emissions budgets from our nitrogen-enriched study streams that are well below predictions of global models.

Contributed Paper (Oral SCL) (GS)

DOCUMENTARY FILM “FRESHWATER FISHES OF CANADA”, A PRE-RELEASE SHOWING

Beamish, Fisheries and Oceans Canada, 3190 Hammond Bay Rd., Nanaimo, BC V9T 6N7
(Richard.Beamish@dfo-mpo.gc.ca)

Scott and Crossman video: “The Freshwater Fishes of Canada” documents the lives of Dr. W.B. Scott and Dr. E.J. Crossman and their extensive, 920-page book, “Freshwater Fishes of Canada”. This monumental work, researched and written by these two men, took thirteen years of arduous fieldwork and careful preparation to complete. On publication in 1973, it won the prestigious Wildlife Society Publication of the Year award! Nothing like it has been produced on this scale anywhere in North American – before or since. But this is not just the story of a book; it’s also the story of what needs to be achieved to protect Canada’s freshwater fishes.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

WRAP-UP TO THE CELEBRATION: CELEBRATING ICHTHYOLOGY, FISH, AND FISHERIES WITH W.B. (BEV) SCOTT

Beamish, Richard J.*, Fisheries and Oceans Canada, 3190 Hammond Bay Rd., Nanaimo, BC V9T 6N7
(Richard.Beamish@dfo-mpo.gc.ca), John M. Casselman*, Queen's University, Department of Biology, 2406 Biosciences Complex, 116 Barrie St., Kingston, ON K7L 3N6, (casselmj@queensu.ca)

Final Words, Wrap-up to the Celebration, and Thoughts from Others. Time is allowed here for special salutations, messages from afar, and general discussion open all. The general discussion could be wide-ranging, whatever suits your fancy. Possibly we could discuss such timely topics as blue walleye, Atlantic whitefish, Lake Erie lake herring, the barren-grounds study, and even registration costs at CCFFR for retirees!

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

HYPOTHESES RELATING TO LONG TERM DECLINING TRENDS IN LAKE TOTAL PHOSPHORUS CONCENTRATIONS

Bentzen*, E., M. C. Eimers¹, S. Watmough², A.M. Paterson³, and R. Weeber⁴. *¹Geography Department and ²Environmental & Resource Studies, Trent University, Peterborough, ON; ³Ontario Ministry of the Environment, Dorset Environmental Science Centre, Dorset, ON; ⁴Canadian Wildlife Service, Nepean, ON (ebentzen@trentu.ca)

Various biogeochemical changes have been reported in recent decades in Central Ontario Precambrian Shield lakes, including a 30% decline in total phosphorus (TP) concentrations. Biotic consequences of reduced TP have been observed in some intensely studied Dorset lakes but future implications cannot be predicted without determining what is driving TP levels. There are several hypotheses which may account for these changes but currently it is unknown if the main drivers behind declining TP are due to shifts in in-lake processes or external loading factors. Evidence for the role of altered catchment biogeochemistry includes declining lake Ca concentrations potentially due to soil acidification and climatic effects. This study reports an analysis of > 600 lakes collected by the Canadian Wildlife Service variably sampled between 2 to 15 times each from 1981 to 2003 for TP and other chemical parameters and that extend to a broader geographical distribution than the Dorset study lakes. TP ranges from 2 to > 30 µg/L although most lakes are oligotrophic with overall mean TP = 9 µg/L. The water bodies range from relatively small, shallow ponds to deep lakes that stratify during summer months. TP has not declined ubiquitously in all lakes but the overall trend for this large dataset supports an approximate net decline of 30%. Other parameters including lake morphometric features, catchment characteristics and the potential role of long-term soil acidification (Ca concentrations used to proxy watershed soil acidity) will be examined to help identify potential factors behind TP decline in Ontario lakes.

Contributed Paper (Oral SCL)

SPACE ODDITY, OU DE L'ASYMÉTRIE DES PATRONS DE DISTRIBUTION DES ORGANISMES À DIFFÉRENTES ÉCHELLES SPATIALES

Bertolo¹, Andrea, F. Guillaume Blanchet², Pierre Legendre³, Pierre Magnan¹, Marc Mingelbier⁴ et Philippe Brodeur⁵; ¹Canada Research Chair in Freshwater Ecology, Département de chimie-biologie, Université du Québec à Trois-Rivières, Trois-Rivières, Québec; ²Department of Renewable Resources, University of Alberta, Edmonton, Alberta; ³Département de sciences biologiques, Université de Montréal, Montréal, Québec; ⁴Ressources naturelles et Faune Québec, Direction de la recherche sur la faune, Québec, Québec; ⁵Ministère des ressources naturelles et de la faune, Direction de l'aménagement de la Mauricie et Centre-du-Québec, Trois-Rivières, Québec

Des développements récents dans le domaine de la modélisation spatiale ont permis d'ajouter des instruments dans le coffre d'outils des écologistes. Le premier est connu sous le nom de cartes de vecteurs propres de Moran (Moran eigenvector maps, MEM), une méthode de décomposition spectrale qui peut être utilisée pour construire une série de variables orthogonales spatialement explicites, basées sur le réseau de connections entre les points d'échantillonnage distribués dans l'espace. Les variables ainsi construites sont symétriques et caractérisées par différentes valeurs d'autocorrélation, permettant de modéliser des patrons symétriques à différentes échelles spatiales. Une méthode plus récente, les cartes de vecteurs propres asymétriques (Asymmetric eigenvector maps, AEM), est comparable en plusieurs points à la MEM, à cette différence près qu'elle permet de modéliser des patrons asymétriques résultant de processus spatiaux directionnels. Par le biais de l'analyse des patrons de distribution des larves de perchaude dans le lac St-Pierre (un lac fluvial du Saint-Laurent, Québec), nous montrons comment la combinaison des deux méthodes permet d'extraire plus d'information des données et aide dans la formulation d'hypothèses relatives aux mécanismes sous-jacents aux patrons observés. Notre analyse suggère que des facteurs symétriques (ex. les patrons de distribution des sites de ponte) et asymétriques (ex. la force du courant) opèrent à différentes échelles dans notre système. La complémentarité des MEM et AEM semble prometteuse pour la modélisation des patrons reliés à différents facteurs et caractérisés par différents degrés de symétrie.

Des progrès dans la modélisation et l'analyse statistique des écosystèmes aquatiques (Oral CCFFR)

SPACE ODDITY, OR ON ASYMMETRICAL DISTRIBUTION PATTERNS OF ORGANISMS AT MULTIPLE SPATIAL SCALES

Bertolo¹, Andrea, F. Guillaume Blanchet², Pierre Legendre³, Pierre Magnan¹, Marc Mingelbier⁴ et Philippe Brodeur⁵; ¹Canada Research Chair in Freshwater Ecology, Département de chimie-biologie, Université du Québec à Trois-Rivières, Trois-Rivières, Québec; ²Department of Renewable Resources, University of Alberta, Edmonton, Alberta; ³Département de sciences biologiques, Université de Montréal, Montréal, Québec; ⁴Ressources naturelles et Faune Québec, Direction de la recherche sur la faune, Québec, Québec; ⁵Ministère des ressources naturelles et de la faune, Direction de l'aménagement de la Mauricie et Centre-du-Québec, Trois-Rivières, Québec

Recent developments in spatial modelling have enriched the ecologist's statistical toolbox with two eigenvector-based methods. The first one is the Moran eigenvector maps (MEM) approach, a spectral decomposition tool which can be used to construct a series of spatially-explicit orthogonal variables based on a network of connexions among sampling points distributed through space. Such variables are symmetrical, and characterized by different values of autocorrelation, allowing to model symmetrical patterns at multiple spatial scales. A more recent approach, similar to MEM in some respect, allows to model asymmetrical patterns resulting from directional spatial processes. By analysing the distribution patterns of yellow perch larvae in Lake St. Pierre (a fluvial lake of the St. Lawrence river, Québec), we show how combining the two methods extracts more information from the data and helps in formulating hypotheses about the mechanisms behind the observed patterns. Our analysis suggests that symmetrical (e.g. patterns in spawning ground distribution) and asymmetrical (e.g. downstream flow) factors operate at different scales in our system. The complementarities of MEM and AEM seem promising in modelling multi-factor patterns characterized by different degrees of symmetry.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFR)

CONTAMINANT BIOVECTOR TRANSPORT NEAR A SEABIRD COLONY ON DEVON ISLAND, ARCTIC CANADA

Blais* JM¹, K Foster¹, E Choy¹, S Brimble¹, LE Kimpe¹, RW Macdonald², N Michelluti³, M Mallory⁴, MSV Douglas⁵, JP Smol³; ¹Department of Biology, University of Ottawa, Ottawa, ON, K1N 6N5, Canada, Institute of Ocean Sciences, ²Department of Fisheries and Oceans, Sidney, British Columbia, Canada, ³Department of Biology, Queen's University, Kingston, ON Canada ⁴Environment Canada, Iqaluit, NU, Canada, ⁵Department of Earth and Atmospheric Science, University of Alberta, Edmonton, AB, T6G 2E9 (Jules.Blais@uottawa.ca)

Industrial contaminants reaching the Arctic can have a profound impact on people and ecosystems. The prevailing view is that long range transport of semivolatile contaminants to the Arctic is primarily conducted by the physical system (e.g. winds, currents). Although this view may be correct in terms of bulk budgets and fluxes, it neglects the potential of animal behavior to focus contaminants into foodwebs due to their behaviors and lifecycles. In particular, gregarious animals that biomagnify and bioaccumulate certain contaminants and then migrate and congregate can become the predominant pathway for contaminants in many circumstances. Anadromous fish, like sockeye salmon, and colonial seabirds provide prominent examples for such behavior in the Arctic. Here we examine the potential for biovector transport in the Arctic to expose an arctic coastal ecosystem to contaminants near a seabird colony on Devon Island, High Arctic Canada. Approximately 10,000 breeding pairs of northern fulmars (*Fulmaris glacialis*) at Cape Vera supports a coastal arctic ecosystem consisting of freshwater ponds, plankton, plants, lichens, mosses, insects, lemmings, ermines, and foxes. Results indicate a strong tendency for enrichment of organic and metallic contaminants adjacent to the seabird colony, suggesting that biovector transport of contaminants is a major factor contributing to contaminants at this site.

Contributed Paper (Oral SCL)

THE INFLUENCE OF GROWTH RATE ON MERCURY LEVELS IN FISH: INSIGHTS FROM WHOLE-LAKE EXPERIMENTS

Blanchfield*, P.J.¹, Orihel, D.M.² and Biro P.A.³ ¹Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, MB (Paul.Blanchfield@dfo-mpo.gc.ca). ²Department of Biological Sciences, University of Alberta, Edmonton, AB. ³Department of Environmental Sciences, University of Technology, Sydney, NSW, Australia

Individual- and population-level variation in fish growth can influence contaminant concentrations. Fast-growing fish have lower mercury levels compared to slow-growing conspecifics because tissue is added with proportionally less food and mercury intake; known as growth dilution. We conducted a replicated, whole-lake study to explicitly examine the relationship between fish growth rate and mercury concentrations under natural conditions. We stocked hatchery-raised, age-0 rainbow trout (*Oncorhynchus mykiss*) into two small, fishless lakes. In each lake, we stocked equal densities of two strains of rainbow trout: a fast-growing domestic strain and a slow-growing wild strain. Study lakes were free of predators, so trout were able to access naturally-occurring prey, primarily zooplankton, in both littoral and pelagic zones. Wild and domestic trout were the same size when added to the study lakes in early August 2004. By late October 2004, trout in both lakes had roughly tripled in length and showed a 25 to 63-fold increase in body mass. Both strain and study lake influenced fish growth. In each lake, domestic strain trout were twice the weight of wild strain; fish in one lake were, on average, 1.3x the mass of trout in the other lake. Growth rate could not fully explain the variation in mercury concentrations between strains. The greater accumulation of mercury by domestic strain fish was likely due to higher consumption rates and activity levels. Growth rate explained most of the variation in mercury levels between lakes for a given strain. Thus, factors influencing mercury uptake and accumulation were similar between lakes.

Growth at the Individual and Population Scales (Oral CCFFR)

A MASS-BALANCE REMEDIATION APPROACH TOWARDS REACHING DELISTING TARGETS IN AREAS OF CONCERN

Blukacz*, E.A. and M.A. Koops, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada (Agnes.Richards@dfo-mpo.gc.ca)

In 1985, the International Joint Commission (IJC) identified the Bay of Quinte as an Area of Concern (AOC) due to its degraded ecosystem. A Remediation Action Plan (RAP) was established with delisting targets including the goals of decreasing phosphorous loading and restoring the upper (fish and wildlife) and lower (phytoplankton, zooplankton, and benthic invertebrates) trophic levels. The ultimate goal is to delist the Bay of Quinte as an AOC by 2015. To date, phosphorous control efforts have reduced phytoplankton abundance, however invasion by non-native species (e.g., zebra mussels, cormorants) has led to further disruption of the trophic dynamics. We use a mass-balanced ecosystem modelling approach to examine the feasibility of reaching the current delisting targets for the upper Bay of Quinte. We modified an Ecopath model representing the post-zebra mussel invasion period (1995-2002). The balanced model has 42 functional groups: cormorants, 23 fish groups, 6 benthic groups, 5 zooplankton groups, 4 primary producers, and 3 detrital pools. To address specific delisting targets, we modified the functional groups in the original balanced model to examine how readily we can rebalance the model under the current remediation plan. Specifically, we separated phytoplankton biomass into nuisance (e.g. *Anabaena*) and preferred species, to demonstrate a positive change in species composition. Similar modifications were made to examine changes in the zooplankton, benthic, and fish communities. The rebalanced model will help determine whether the current targets are feasible and help revise targets if necessary.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR)

COMPARATIVE SURVIVAL AND FITNESS OF STOCKED JUVENILE LIFE STAGES OF ATLANTIC SALMON IN LAKE ONTARIO STREAMS

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Collaborative efforts are underway to re-establish self-sustaining populations of Atlantic salmon (*Salmo salar*) in Lake Ontario and reverse their 19th century extirpation. We assessed the comparative survival, growth, and timing of emigration of three stocked juvenile life stages of Atlantic salmon in Lake Ontario tributaries, to determine their comparative ecology and suitability for re-establishing wild populations under modern conditions in the altered lake ecosystem. During the spring and summer of 2007 and 2008, emigrating smolts were captured with a stationary fyke net, using stratified mark-recapture methods to estimate numbers of emigrants. Abundance, size and distribution of stocked life stages were also assessed in the fall of 2007 and 2008 by backpack electrofishing in lotic habitats. Captured Atlantic salmon juveniles were identified to stocked life stage by scale pattern and genetic parentage analysis, which were validated using fin clips and tags. Atlantic salmon originally stocked as parr and yearlings demonstrated differences in distribution, growth, and timing of emigration. Stocked parr mostly emigrated after one season of stream residence during increasing stream temperature and discharge following the spring freshet. By contrast, most stocked yearlings emigrated within 10 weeks after stocking during variable stream temperature and discharge regimes. Differing stream residence and environmental conditions during emigration of stocked life stages indicate that stocked parr exhibit superior growth, survival and ecological adaptation than salmon stocked as yearlings.

Contributed Paper (Oral CCFFR) (GS)

SPATIAL AND PREDICTIVE PATTERNS OF UREA OCCURRENCE IN LAKES OF THE NORTHERN GREAT PLAINS

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The impacts of agricultural fertilizers on aquatic ecosystems in the Great Plains Region of North America are poorly understood. Saskatchewan alone accounts for 29% of Canadian annual fertilizer consumption, and 87% of N use is as urea. Unfortunately, little is known of whether this compound is carried into aquatic ecosystems via runoff. In this study, we surveyed 19 prairie lakes of varying salinity (0.3-50 ppt salinity) to determine the effect of land use and fertilizer application on both aquatic nutrient concentrations and algal biomass. Urea concentrations were highly correlated with lake water salinity and conductivity ($R^2 = 0.31$, $p = 0.013$; $R^2 = 0.29$, $p = 0.018$ respectively) and were weakly correlated with farming intensity within the region ($R^2 = 0.39$, $p = 0.14$). Overall, urea concentrations were greater in lakes with elevated TKN ($R^2 = 0.58$; $p = 0.00013$). TDP was weakly correlated with salinity ($R^2 = 0.12$; $p = 0.14$). These results suggest that agriculturally-derived nutrients accumulate rapidly in lakes of higher salinity, possibly due to the nature of the drainage basin (i.e. closed basins may trap more nutrients) or because elevated salinity suppresses microbial breakdown of organic nutrients. In a global context, urea concentrations in Great Plains lakes were moderate (30-550 $\mu\text{g L}^{-1}$); however this analysis suggests that urea levels may rapidly increase with agricultural intensity.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

EFFECTS OF ULTRAVIOLET RADIATION ON YELLOW PERCH LARVAE (*PERCA FLAVESCENS*)

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The penetration of ultraviolet radiation (UVR) in the water column varies with different factors including dissolved organic carbon (DOC). A recent study showed that yellow perch recruitment was related to DOC variation in 22 Canadian Shield lakes, suggesting a potential link between UVR penetration and larval survival. The objectives of this study are to experimentally determine the effect of UVR (UVB and UVA) on (1) the survival rate and (2) the cellular stress of yellow perch larvae. Perch larvae (< 2 days) were incubated under different UVR protection levels that were produced by a combination of both selective (UVA or UVA+UVB opaque) and non-selective filters, and exposed to solar radiation. At the end of each experiment, the surviving larvae were counted, sacrificed and preserved at -80°C. The UVR exposure level was measured over the whole experiment with a radiometer. Cellular stress was measured by the activity of a stress protein, superoxide dismutase (SOD). Raw DNA dosimeters placed in each incubator allowed us to estimate the maximum potential damage to DNA and to establish a relationship with larval survival. Preliminary results show that the UVR level (UVA and UVB) has an effect on larval survival and on the photo-induced damage to DNA.

Impacts of Climate Change on the Biodiversity of Canadian Lakes, Rivers, and Oceans (Oral CCFFR) (GS)

LES EFFETS DU RAYONNEMENT ULTRAVIOLET SUR LES LARVES DE PERCHAUDS (*PERCA FLAVESCENS*)

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La pénétration du rayonnement ultraviolet (RUV) dans la colonne d'eau varie en fonction de différents facteurs comme le carbone organique dissous (COD). Une étude récente a montré que le recrutement de la perchaude était en relation avec les variations de COD dans 22 lacs du bouclier canadien, suggérant un lien potentiel entre la pénétration du RUV et la survie des larves. Les objectifs de la présente étude sont de déterminer expérimentalement l'effet du RUV (UVB et UVA) sur (1) le taux de survie et (2) sur le stress cellulaire des larves de perchaudes. Des larves de perchaudes (< 2 jours) ont été placées dans des incubateurs offrant différents niveaux de protection au RUV par une combinaison de filtres sélectifs (opaques aux UVA ou aux UVA+UVB) et non sélectifs, et exposés à la radiation solaire. À la fin de chaque expérience, les larves vivantes ont été dénombrées, sacrifiées et conservées à - 80°C. Le stress cellulaire a été mesuré par l'activité d'une protéine de stress, la superoxyde dismutase (SOD). Le niveau d'exposition aux RUV a été mesuré pendant toute la durée de l'expérience à l'aide d'un radiomètre. Des dosimètres à ADN brut placés dans les incubateurs nous ont permis d'estimer le niveau potentiel maximal de dommages induits à l'ADN et de le mettre en relation avec la survie des larves. Les premiers résultats montrent que le niveau de RUV (tant les UVA que les UVB) a un effet sur la survie des larves et sur la quantité de photodommages induits à l'ADN.

Les impacts des changements climatiques sur la biodiversité des lacs, rivières et océans canadiens (Oral CCFFR) (GS)

DETECTING ECOSYSTEM CHANGES THROUGH LOBSTER FISHERS' LOCAL ECOLOGICAL KNOWLEDGE

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Lobster fishing area 34 (LFA 34) in southwest Nova Scotia is one of the most productive lobster areas in the world. The population in the Gulf of Maine has increased steadily since the 1980s for reasons that are not well understood. Lobster is traditionally fished in the inshore region where it is difficult to sample with research trawls. In order to try and fill in some of the gaps in the inshore data, a local ecological knowledge survey was designed for the lobster fishers of LFA 34. Forty-two fishers were interviewed using a semi-structured format. The interviews revealed consistent trends about the depletion of large fish, the occurrence of lobster in new habitats and at different depths, and about water temperature staying colder in the spring and warmer in the fall. The majority of fishers were concerned that the lobster population will suffer a large decline as a result of the high fishing effort they are currently sustaining. A comparison with inshore trawl survey data from Maine suggests that fishers' knowledge adequately represented important aspects of ecosystem change. We suggest that local ecological knowledge surveys can help researchers understand long-term changes in data-poor situations.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster CCFFR) (GS)

ARE TEMPORAL REPLICATES USEFUL IN FISH HABITAT USE SURVEYS?

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Habitat use models are relationships between species presence or abundance and environmental characteristics. When developing such models, the number of sites is often maximized to cover a large spatial extent and represent the complete range of environmental conditions found in the area. As sampling effort is often very limited in terms of budget, man-power and/or favorable weather conditions, each site is often sampled only once. However, fish distribution and habitat requirements may vary over time. Among-day variations in habitat use may decrease models explanatory power and affect variable selection; hence, some gains might be made by increasing temporal replication. To investigate how sampling effort should be assigned (number of sites and replicates per sites) in our system, a simulation study was conducted to compare the gains and losses of several scenarios. The number of sites and replicates per site, given a constant sampling effort, that optimize habitat use models adj-R² and variable selection accuracy were studied for five fish species covering the full observed gradient of fish densities coefficients of temporal variation (based on real data from a field survey in the Laurentian region of Québec). Species differed in the optimal assignment of the sampling effort, but overall, most species gained by increasing to some extent the number of temporal replicates. Future studies should be aware that maximizing the number of sites at the expense of temporal replication is not always the best option.

Contributed Paper (Oral CCFFR) (GS)

A RE-EVALUATION OF THE SPATIAL GENETIC CONNECTIVITY OF ATLANTIC COD USING EST-DERIVED MICROSATELLITES AND SINGLE NUCLEOTIDE POLYMORPHISMS

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From a molecular genetic perspective, Atlantic cod, *Gadus morhua*, is perhaps one of the best studied marine fish species. Though a variety of markers have been used to resolve the scale of ecological and evolutionary connectivity, significant discrepancies exist among markers and studies. We re-evaluate the spatial genetic connectivity of cod in the north Atlantic using a novel suite of markers developed from expressed sequence tags comprising approximately two orders of magnitude more genetic markers than previously employed in this species. We examined genetic variation at 72 (63 EST loci, 9 previously used) microsatellite loci and 1644 single nucleotide polymorphisms in cod from 9 and 13 geographic locations respectively from throughout the North Atlantic. Mean estimates of genetic divergence were similar for the three marker types (previously used microsatellites, EST microsatellites, EST SNPs), supporting the validity of inference made across loci. Bayesian clustering supports the presence of a large division between the eastern and western Atlantic, and at least four discrete subpopulations in Canadian waters. Principle Components Analysis (PCA) identified genetic clusters mirroring geographic structure associated with the first axis separating the eastern and western Atlantic population. Euclidean distance from the PCA was significantly associated with geographic distance ($R \sim 0.87$). Ogac Lake, from the Canadian Arctic, displayed PCA scores intermediate between the west and east Atlantic consistent with a hypothesis of historical trans-Atlantic gene flow during previous periods of range expansions. We conclude that the larger number of loci now available will be invaluable in examinations of both historic and contemporary marine connectivity.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFR)

IMPACT OF A LARGE NORTHERN FULMAR (*FULMARUS GLACIALIS*) COLONY ON THE SEDIMENT QUALITY OF A SERIES OF FRESHWATER PONDS AT CAPE VERA, DEVON ISLAND

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Seabirds are an important link between their marine feeding areas and their terrestrial breeding environments, transporting both marine-derived nutrients and contaminants to land via their excreta, feathers and carcasses. While providing the nutrient subsidies that shape the terrestrial ecosystem of many Arctic sites, seabirds may focus contaminants into their nesting sites at potentially toxic levels. The impact of a large northern fulmar (*Fulmarus glacialis*) colony on nearby ponds was investigated at Cape Vera, Devon Island. Ponds receiving seabird-subsidies were characterized by high nutrient and dissolved organic carbon concentrations and elevated primary productivity. The ponds closest to the cliffs, and thus receiving the highest seabird-subsidies, were the most contaminated, and in some cases exceeded Canadian Sediment Quality Guidelines for the Protection of Aquatic Life for As, Cd and Zn. This study demonstrates that seabirds can transport contaminants bioaccumulated from the ocean and funnel them into receptor sites to potentially toxic levels thousands of kilometers from industrial centers.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (GS) (Oral SCL)

GROWTH RATE INFLUENCES RETENTION OF LEARNED PREDATOR RECOGNITION IN JUVENILE RAINBOW TROUT: THE ADAPTIVE VALUE OF FORGETTING

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The ability to acquire context-specific information regarding local predation threats allows prey species, such as juvenile salmonids, to better balance the conflicting demands of successful predator avoidance and other fitness related activities such as foraging and territorial defence. An unexplored aspect of this model would predict that retention of learned predator recognition should also be shaped by these threat-sensitive trade-offs. Faster growing prey would presumably have lower risks of predation, compared to slower growing conspecifics, due to their potential to outgrow gape limited predators. Thus, the potential benefits associated with longer-term retention of predator recognition would be reduced compared to slower growing conspecifics. We tested this prediction in a series of laboratory experiments with predator naïve juvenile rainbow trout (*Onchorhynchus mykiss*). Trout were fed either a high food (HF) or low food (LF) ration for one week and conditioned to recognize the odour of a novel predator (Pumpkinseed, *Lepomis gibbosus*). When tested for the recognition of the predator cue two days post-conditioning, both HF and LF trout exhibited strong antipredator responses to pumpkinseed odour. However, when tested seven days post-conditioning, only LF trout showed evidence of recognition. HF trout did not exhibit any recognition (not different from non-conditioned controls). Subsequent experiments suggest that individual growth rates at the time of conditioning and not growth after conditioning shapes the retention of learned predator recognition. Thus, both the intensity and retention of acquired recognition appear to be shaped by threat-sensitive trade-offs, allowing prey to ‘fine-tune’ their behavioural response to immediate predation threats.

Contributed Paper (Poster CCFFR)

FISHY BUSINESS IN AN ARCTIC YUKON STREAM ECOSYSTEM: NUTRIENT AND CONTAMINANT SUBSIDIES BY SPAWNING CHUM SALMON (*ONCORHYNCHUS KETA*)

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The Fishing Branch River located in northcentral Yukon is a unique arctic waterway: its headwaters remain open year-round due to the underlying karstic bedrock that channels and discharges unusually large volumes of warm water. Every year chum salmon (*Oncorhynchus keta*) leave the Bering Sea to return to these ice-free waters to spawn and, as semelparous organisms (die after spawning), represent an important flux of nutrients from the ocean to their natal grounds. Unfortunately, recent studies have demonstrated that pollutants can accompany this nutrient transfer. Spawning habitats thus become loading grounds for biologically-delivered contaminants. As such, the novelty of the work presented here lies in evaluating chum spawning as biovectors of marine-derived nutrients and contaminants to the Fishing Branch River using the BACI (Before-After-Control-Impact) design. This design incorporates sample collection before and after spawning in the Fishing Branch River and in a nearby control stream (where anadromous spawning is absent). Biotic and abiotic samples that may act as chum-based nutrient and contaminant sinks include the arctic grayling (*Thymallus arcticus*) food web (periphyton, plankton, benthic macroinvertebrates, and arctic grayling), as well as water and sediment cores. Samples will be analyzed for N and C stable isotope enrichment, which are good indicators of salmon nutrient incorporation in freshwater food webs. Total polychlorinated biphenyls (PCBs) congener patterns as well as total mercury concentrations will be investigated. This study highlights the connectivity of marine and freshwater ecosystems mediated by migrating species such as chum salmon, a Fishing Branch keystone species.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Poster CCFFR)

ARTIFICIAL DEEPENING OF A LAKE THERMOCLINE: EFFECTS ON THE PLANKTON

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Plankton are heterogeneously distributed in water columns of lakes and one of the most important factors affecting their vertical distribution is thermal stratification. The depth of the thermocline in turn is strongly influenced by wind, which can act to deepen the position of the epilimnetic mixed layer. A change in the wind activity reaching lake surfaces can result from the removal of wind breaks through deforestation or via the effects of climate change. We examined experimentally the effects of a deepening of a lake thermocline on the vertical distribution of plankton and on various measures of their community structure (abundance and diversity). After a pre-experimental year of study (2007), we divided a three-basin lake into one experimental basin and two controls using a curtain. In the first part of the following summer (2008), the experimental basin was then subject to prolonged mixing using a SolarBee during thermocline establishment. The goal was to deepen the thermocline in the experimental basin by 3m relative to the controls. Time series on biotic and a suite of physico-chemical variables were collected from May to October in each year. A significant difference in thermal stratification was observed between the lake basins after mixing. Phytoplankton taxonomic composition in the experimental basin changed from dominance by cyanobacteria in 2007 to diatoms in 2008. Other analyses revealed how added turbulence and deepening of the thermocline affected the plankton community composition and distribution, as well as their relationships with physico-chemical factors.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

INTRODUCTION TO THE CELEBRATION: CELEBRATING ICHTHYOLOGY, FISH, AND FISHERIES WITH W.B. (BEV) SCOTT

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Introduction to Celebration: John M. Casselman (Celebrating with Bev), Margaret Crossman (Family Associations, Scotts and Crossmans) Richard J. Beamish (Celebrating with Bev, An Introduction to the Documentary Film “Freshwater Fisheries of Canada” — to be shown in next celebration slot)

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFR)

TERRESTRIAL CARBON SUBSIDIES TO AQUATIC FOOD WEBS OF THE HIGH ARCTIC: EVIDENCE FROM CHIRONOMID DIET

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Lakes in the Canadian High Arctic have very low biological production due to extreme climatic conditions and low watershed inputs of nutrients and organic matter (OM). We investigated the role of algal and terrestrial carbon in supporting these aquatic food webs by determining the diet of the dominant primary consumer, aquatic chironomids. In 2005 and 2006, chironomids were collected from 17 lakes on 3 islands of the Arctic Archipelago (~74-76°N) in polar desert and polar oasis watersheds. Additional sampling of 5 ponds and 3 inflow streams in the study area provided further contrasts in chironomid diet. Using a combination of carbon stable isotope and stomach content analyses, we determined that chironomids primarily consumed benthic algae and/or OM of terrestrial origin. The relative importance of these 2 carbon sources to chironomid diet was estimated for 2 lakes and a large pond using an isotope mixing model, and terrestrial carbon was an important energy subsidy for 2 of the ecosystems. Small-scale observations also revealed the dominant role of allochthonous energy subsidies in near-shore areas of some lakes. We suggest that terrestrial carbon may be a significant resource supporting aquatic food webs of the High Arctic, particularly in more productive polar oases where greater accumulation of OM-rich soil occurs.

Contributed Paper (Oral SCL) (GS)

A POOL APPROACH TO ALLOCATING UNDERUTILIZED INDIVIDUAL QUOTAS

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Ecological change, economic pressures, and demographics have reduced active participation in the commercial fishery in Lake Ontario. Inactive fishers have maintained their licences and the option to fish in the future. Quota assigned to these inactive or limited activity licences went unused and the allocated quota was larger than the harvest. This situation made management difficult because changes in the total allowable catch were disconnected from total harvest and reductions could constrain active fishers while portions of the total allowable catch remained unused. A pool of unallocated quota was established by allocating a portion (50%) of the individual quota previously assigned to inactive licences. A licence was deemed to be inactive if less than 50% of its total assigned quota was harvested in the previous year. Active fishers were allocated 100% of their assigned quota and, once they harvested 75% of that total, they were eligible to make a draw from the pool. Draws were allocated on a first-come, first-serve basis. This approach has allowed active fishers to pursue harvests within the total allowable catch for individual species and management units. The approach has improved the relationship between total allowable catch and harvest. This pool system has support among most fishers but some remain concerned about how the has affected the value of their licences and transferable quotas.

Contributed Paper (Oral CCFFR)

THE FEASIBILITY OF ARTIFICIAL NUTRIENT FERTILIZATION WITHIN INNER BAY OF FUNDY STREAMS

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Some streams within the Inner Bay of Fundy are presently experiencing a low level of productivity. Looking to the Pacific coast, artificial nutrient fertilization studies have been used successfully to increase productivity levels of the algal, benthic macroinvertebrate and fish communities. The objective of our study was to determine whether this restoration strategy was a feasible method in Inner Bay of Fundy streams. Using a controlled-release fertilizer (Multicote, 9-44-0), two phosphorous-limited streams within Fundy National Park were fertilized from June to August of 2007. Target concentrations increased phosphorous levels by 1, 2 and 3 µg/L at three sites within both study streams. We found that fertilized sites experienced up to a three-fold increase of algal standing stock in relation to control sites. In addition, stable isotopes were used to illustrate the food web response to artificial nutrient fertilization. We predicted that stream fertilization would cause a shift in the ¹³C/¹²C isotopic signature reflecting an enhanced autochthonous food source. There was some evidence of such a shift but interpretation was complicated by other environmental variables. For instance, chl-a levels at treatment sites indicated a rapid uptake of fertilizer suggesting locally restricted fertilization effects. Therefore, the expected downstream cumulative effect and the target phosphorus concentrations were not achieved. These findings would have strong implications for the feasibility of similar fertilization projects. For large-scale enrichment studies, our results imply that more complicated logistics and a greater commitment of financial resources are required for increasing productivity in Inner Bay of Fundy stream communities.

Contributed Paper (Oral CCFFR) (GS)

AN EVALUATION OF STREAM ECOSYSTEM STRUCTURE AND FUNCTION IN THE TORNGAT MOUNTAINS NATIONAL PARK RESERVE, LABRADOR

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The eastern Canadian subarctic had a relatively stable climate for several thousand years until the mid-1990s. Climate change impacts are less advanced in the east than in other circumpolar regions, where a warming trend has been evident since the 1960s, but climate models predict that temperatures will continue to increase in the future. The subarctic landscape of the Torngat Mountains National Park Reserve in Northern Labrador is dominated by streams, lakes and wetlands which are at risk of experiencing climate-induced changes in their biotic structure and function, which could ultimately threaten ecological integrity. To date, there has been little freshwater research conducted in the eastern subarctic. Our research aims to develop increased understanding of stream ecosystem structure and function within and around the Park, specifically across a habitat gradient of glacial-fed, snowmelt-fed and lake-fed streams. Structural investigations include the diversity and abundance of algae and benthic macroinvertebrates, and food web structure. We are particularly interested in understanding the trophic position of young of the year and juvenile Arctic char (*Salvelinus alpinus*), a culturally and economically valuable species, within the food web. Functional investigations include cellulose decomposition rates as well as growth rates and functional traits composition of benthic macroinvertebrates. These studies will contribute to the development of an effective and comprehensive biomonitoring program for the Torngat Mountains National Park Reserve.

Impacts of Climate Change on the Biodiversity of Canadian Lakes, Rivers, and Oceans (Poster CCFFR) (GS)

FORENSIC EVALUATION OF COMMON SOURCES OF PHYSICAL INJURY TO POPULAR WARMWATER SPORTFISH DURING RECREATIONAL ANGLING

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Fish that are angled and released can experience a number of potentially negative effects such as physiological disturbance, behavioural changes, and injury. Of late, much effort has been devoted to understanding physiological and behavioural impairments, with comparatively little detailed work on physical injury. Fishing gear and handling can cause physical injury to the fish including mucous and scale loss and fin fraying. Such injuries are vulnerable to infection from a variety of pathogens. One reason for little work on injury is that there have been few tools available to quantify the location and severity of injury. This study investigated the potential source of injury from common handling practices used in recreational angling of sportfish using fluorescein, a non-toxic dye solution which has been previously been used to detect latent injuries to fish epithelium. Digital photographs taken of the fish treated with fluorescein under UV light can be analyzed using computer software to visualize and quantify the extent of injury. Our model species for this study were largemouth bass and northern pike, two popular sportfish which are often handled in catch-and-release situations. The handling methods investigated included interaction with different surfaces, holding by the gills for hook removal, line rolling, landing net material, weigh in procedures and other tournament procedures. The results of this study will be helpful in a variety of fisheries management and research contexts, including suggestions for gear types and handling methods which are optimal for reducing fish injury and thus maintaining fish welfare and maximizing post-release survival.

Contributed Paper (Oral CCFFR) (GS)

PREDICTING CHANGES OR PREDICTING OUTCOMES IN AQUATIC MICROBIAL SUCCESSIONS

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Bacterioplankton community metabolism (BCM) is known to be strongly reactive to changes in the environment, but the processes underlying this response remain unclear. There is evidence that the overall BCM response to environmental change is mediated by shifts in different aspects of community structure (e.g. community composition or function), as bacterial abundance itself can seldom explain such variations. Yet the links between the environment, bacterial community structure and metabolism are not well understood. In this study, we examine the connections that exist between the environment, BCM and different component of community structure (function, composition, physiological structure and single-cell characteristics) across a range of aquatic systems in a complex watershed but also along the environmental transition that occur between all these interconnected systems. We compare both the absolute patterns in these different components of bacterial community structure, and also the rate of change of these components along environmental gradients. Collectively our results show that while it is possible to predict the magnitude of change of various aspects of bacterioplankton structure and metabolism from each other or from the environment, the actual outcome is much more difficult to constrain. The links that connect the various aspects of bacterioplankton community structure do not appear to be deterministic but rather dynamic, and vary with the type and intensity of environmental gradients experienced by bacteria. These results in turn point to the limits of our capacity to predict aspects of the structure and functioning of bacterial communities in aquatic ecosystems.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral SCL) (GS)

MOVEMENTS OF STREAM “RESIDENT” BROOK CHARR (*SALVELINUS FONTINALIS*) WITHIN AND AMONG LAKE SUPERIOR TRIBUTARIES

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This study investigated the nature of stream residency in migratory populations of brook charr (*Salvelinus fontinalis*) from Lake Superior. Migratory systems can be complex, with individuals differing in their propensity to migrate and the form and timing of their migratory movements. Some populations of Lake Superior brook charr have two ecotypes: a small form that purportedly remains in the stream environment throughout its life and a large ecotype that migrates from the stream to the lake (partial migration). We used electro-fishing surveys and passive integrated transponder tags to test whether individuals captured in a tributary remained in that tributary (resident), made diel foraging migrations from the tributary to the lake, or moved from tributary to tributary (vagrant stream specialist). Data analysis for the first summer's data from a two year study suggests most tagged individuals remained in the same tributary some moved from the tributary to the lake and returned to the tributary, with few moving between tributaries. This data indicates that the movement ecology of purported stream residents may be more complex and important to the management of Lake Superior brook charr than was previously appreciated.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFFR) (GS)

APPLYING A MEASURE OF LONGITUDINAL CONNECTIVITY TO RESTORATION DECISION MAKING

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Stream networks, like many terrestrial landscapes, are becoming increasingly fragmented by human activities. While this connectivity loss has been acknowledged for its potential negative impacts on aquatic species, there was formerly no satisfactory method to measure fragmentation in these linear systems. We utilize a new method, the Dendritic Connectivity Index (DCI), to assess watershed-scale stream connectivity and prioritize restoration efforts in watersheds of Terra Nova National Park. Hydrological conditions were modeled, based on barrier attributes, and compared with swimming/jumping physiology of Brook trout (*Salvelinus fontinalis*) to determine barrier passability and cumulative impacts of barriers within watersheds. Simulations were then utilized to determine the most favourable restoration scenarios for anadromous and nonanadromous life histories.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFFR)

CHANGEMENT ONTOGÉNIQUE DE NICHE : LA BIOLOGIE DU POULAMON ATLANTIQUE (*MICROGADUS TOMCOD*) DANS UNE ZONE DE TRANSITION ESTUARIENNE

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Le poulamon atlantique est un gadidé très abondant dans l'estuaire moyen du St-Laurent. Après l'éclosion, ils occupent les eaux estuariennes pendant 2 à 3 ans avant de se reproduire en eau douce. L'objectif principal de cette étude est de comprendre comment cette espèce exploite les différents habitats compris dans la zone de transition estuarienne. Suite à trois périodes d'échantillonnage, nous avons regroupé les différentes stations en 3 groupes physiques basés principalement sur la température et la salinité. Nous avons ensuite analysé la distribution du poulamon pour chaque classe d'âge jusqu'à 2 ans en fonction des caractéristiques physiques de l'estuaire. Les jeunes de 1 an semblent se regrouper en majorité dans la partie plus douce de l'estuaire, tandis que vers l'âge de 2 ans, on les retrouve de façon plus uniforme dans les 3 groupes de stations. Nous utiliserons les isotopes de soufre ($\delta_{34}\text{S}$) pour confirmer la présence à moyen terme des différents individus de 0, 1 et 2 ans dans chacune des 3 niches estuariennes. Nous présenterons également les conséquences de la résidence estuarienne dans les différents habitats en termes de croissance et de condition.

Growth at the Individual and Population Scales (Oral CCFR) (GS)

TELEMETRY DATA AS A DESCRIPTOR OF LAKE TROUT BEHAVIOUR IN TWO LAKE ECOTYPES

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Lake trout (*Salvelinus namaycush*) is a cold water fish species with high variation in selection of habitat characteristics such as temperature and depth occupancy. It is also highly variable with respect to the use of littoral and pelagic habitats as a result of the availability of prey. Therefore, it is hypothesized that depending on the food web of the lake, the incursions of lake trout into shallower and warmer waters seeking their prey will vary in frequency and duration. Acoustic telemetry was used to constantly monitor individual lake trout from two lakes: Louisa and Opeongo, both in Algonquin Park, Ontario. These lakes represent two distinct habitats and prey availability. Lake Louisa lacks preferred pelagic fish prey (e.g. cisco, *Coregonus artedii*) and *Mysis*, so it sustains a population that feeds on littoral fish and invertebrates. Lake Opeongo has abundant pelagic cisco, but also lacks *Mysis*. Five receivers were deployed in Lake Louisa and 14 receivers were deployed in Lake Opeongo with a spatial distribution that allowed the complete lake to be in range. In total, 21 adult lake trout fish were surgically implanted with ultrasonic tags during 2005, and their occupancy depths were recorded every 50 to 150 seconds. This study presents a description of the spatial movements of lake trout and a comparison between Lake Opeongo and Louisa. The seasonal behaviour is also presented and a regional scale is used to describe the lake areas visited by lake trout.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFR) (GS)

INDIVIDUAL, ENVIRONMENTAL AND SEASONAL VARIABILITY IN THE ISOTOPIC SIGNATURE OF THE PRIMARY CONSUMER *ELLIPTIO COMPLANATA*

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Stable isotopes provide a powerful tool to compare foodwebs in different ecosystems. These comparisons use long-lived primary consumers to account for differences in isotopic baselines between foodwebs, but there is currently no guideline on when and where to sample these organisms. In this study, I compare the isotopic signatures of the commonly used *Elliptio complanata* between habitats, seasonally and between individuals of different sizes. $\delta^{13}\text{C}$ signatures provide evidence that *E. complanata* is a plankton-feeder even during juvenile stages that spend most of their time buried in the sediments. $\delta^{15}\text{N}$ signatures were depleted in small endobenthic mussels, but changed rapidly upon emergence from the sediments. The isotopic signature of *E. complanata* did not change seasonally. $\delta^{15}\text{N}$ signatures increased with increasing body size in one lake basin, but not in another, a relationship that was attributed to differences in individual growth rates. *Elliptio* can be sampled at any time of the year, but it would be prudent to sample mid-sized (60 – 75 mm) adults to determine the isotopic baseline of lake and stream foodwebs.

Contributed Paper (Oral SCL)

COMPARISON OF MACROPHYTE COMMUNITIES ALONG A GRADIENT OF AGRICULTURAL INTENSITY IN THE SOUTH NATION RIVER WATERSHED

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In agricultural watersheds, water bodies such as ditches, streams, wetlands and rivers are intimately associated with croplands and may be inadvertently exposed to agrochemicals, such as herbicides and fertilizers through run-off and leaching. Macrophytes may potentially be affected by agrochemicals due to their immobility and taxonomic similarity to the intended targets. The South Nation River watershed in Ontario comprises 3919 km² and is predominantly agricultural. The macrophyte community was identified at twenty-six sites located throughout the watershed and characterized by level of agricultural impact. A total of 216 species were identified along stream banks and within the channels. Sites with higher levels of agricultural impact tended to have fewer species with a higher percentage of non-native species. A number of species common in low impact sites were uncommon in high impact sites (e.g. *Eupatorium maculatum*, *Ludwigia palustris*, *Potamogeton natans*). Results of multivariate analysis of species composition and environmental variables will be discussed.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL) (GS)

A BAYESIAN STATE-SPACE MODEL TO COMBINE MULTIPLE INDICES AND IDENTIFY INDEX NON-PROPORTIONALITY FOR THE ASSESSMENT OF 4X CUSK (*BROSME BROSME*)

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Cusk was listed as Threatened in 2003 based on fishery-independent trawl data that estimated a >90% decline since 1970. This designation has been contested due to perceived disproportionality of the index to biomass. Here, we combine a fishery-dependent CPUE longline index and a fishery-independent trawl index in a surplus production Bayesian state-space model to estimate population parameters, to test the hypotheses that each index is proportional to biomass, and assess recovery potential for cusk in the 4X NAFO division. We estimate a shape parameter via a power curve in the observation component of the model, thus allowing disproportionality between the indices and exploitable biomass to be estimated. The model estimating shape parameters for both indices suggests slight hyperstability in the longline and moderate hyperdepletion in the trawl index. The model that assumed direct proportionality of the longline index estimated even greater hyperdepletion in the trawl index. Biomass is estimated to have declined by 64% from 1970 to 2007, though credible limits were large. Biomass projections suggest that the 2003 landing limit of 750 t should have increased stock biomass; yet this has not occurred. This suggests: (1) ineffectiveness of the landing limit due to high bycatch mortality; (2) predicted recovery is an artifact of the model assumptions; and/or (3) poor recruitment over the last decade. The Bayesian state-space modelling approach for stock assessment is useful for incorporating diverse sources of information and minimizing bias in population projections when assessing poorly understood/sampled populations.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFR) (GS)

SYNCHRONOUS RECRUITMENT AMONG GEOGRAPHIC POPULATIONS OF CANADIAN LAKE WHITEFISH (*COREGONUS CLUPEAFORMIS*) AND ARCTIC CHAR (*SALVELINUS ALPINUS*)

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Evidence for large scale geographic synchrony can be seen in the commercial gillnet fisheries of Great Slave Lake, Northwest Territories, (lake whitefish) and Wellington Bay, Nunavut, and the Labrador coast (arctic char). Annual samples dating to the early 1970's have been collected from 3 geographic stock complexes along the Labrador coast, 4 geographic stock complexes in Wellington Bay and 6 commercial management areas of Great Slave Lake. As a preliminary indicator, recruitment of a single age class of these species into their respective fisheries was estimated as the number of fish harvested of that age class during each year of the fishery. Age class was converted to birth year by subtracting sample year from fish age. Recruitment trends for estimated birth year harvests spanned a period from the early 1960's to early 1990's. Autocorrelation analysis indicated that birth year trends of all stocks of arctic char and lake whitefish were non random. A state space model, the Kalman filter, was used to predict "best estimates" of birth year harvest abundances. Cross correlation analysis of smoothed filter estimates indicated that recruitment has been synchronous among lake whitefish populations of 6 management areas of Great Slave Lake and between Wellington Bay and Labrador coast char populations. Recruitment trends of arctic char were asynchronous with those of lake whitefish. Future work will investigate potential explanatory variables linking synchrony with climate and life history stage using reconstructed population age distributions.

Contributed Paper (Poster CCFR) (GS)

USE OF AUTOMATED SYSTEMS TO MEASURE GREENHOUSE GAS EMISSIONS FROM RESERVOIRS

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The growing concern to determine the contribution of freshwater reservoirs to the increase of GHGs in the atmosphere and the relevance of long term continuous measurements to ensure better comparison of energy production methods, for CO₂ credits evaluation and for National Greenhouse Gas Inventories, has lead us to develop continuous GHG monitor. We have installed automated systems in 3 generating stations of one temperate (Rivière des Prairies) and two boreal (Eastmain-1 and Robert-Bourassa) reservoirs in Quebec, Canada. Continuous water $p\text{CO}_2$, $p\text{CH}_4$ and $p\text{O}_2$ measurements allowed us to estimate gas fluxes. Comparison of results obtained at Eastmain-1 either with the automated system, or from summertime and wintertime field campaign demonstrate that continuous GHG monitor at a single sampling station provide representative and robust results for CO₂. These systems are very interesting for hydro facilities as they measure temporal variations of gas concentrations in reservoirs on long period of time for a minimum cost of operation.

Contributed Paper (Oral SCL)

EXAMINING THE ROLE AND EFFECTIVENESS OF YEAR-ROUND FISH SANCTUARIES IN THE PROTECTION OF BLACK BASS IN LAKE OPINICON, ON

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Over 10% of Lake Opinicon, ON has been closed to angling for more than sixty years. These closed waters were established as year-round fish sanctuaries by the Fish and Wildlife Division of the Ontario Department of Lands and Forests. Despite the long history of bass sanctuaries in Ontario, little research has been done to determine their role in bass management. In recent years, the Ontario Ministry of Natural Resources (OMNR) suggested that year-round fish sanctuaries for bass are “overly restrictive” and should have a “standardized date from May 15th to June 30th.” In Ontario, season closures during this period are a common regulation used to protect nest-guarding bass. It is during this time when bass are most vulnerable to angling due to the aggressive nature of brood protection. Removal of a nest-guarding male bass by angling could reduce his ability to provide parental care, and subsequently lower his reproductive success. As suggested by the OMNR, a season-specific bass sanctuary could eliminate the incidental by-catch of nest-guarding males that occurs during traditional season closures. Current research objectives are focusing on the effectiveness of fish sanctuary regulations for Lake Opinicon. The initial stage of research quantifies the density of successful bass nests within the year-round fish sanctuaries in this lake. The ultimate goal of this research initiative is to provide important biological rationale necessary for future management decisions concerning bass sanctuaries in Ontario.

Contributed Paper (Oral CCFFR) (GS)

ECOLOGICAL LINKAGES BETWEEN COMMUNITY AND GENETIC DIVERSITY IN ZOOPLANKTON AMONG BOREAL SHIELD LAKES

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Ecological linkages between species diversity in communities and genetic diversity in populations have potential to influence the assembly of communities in habitats recovering from human disturbance, but few studies have attempted to synthesize relationships between these levels of biological organization, especially for locally-adapted species. No such studies have been done in freshwater ecosystems despite the plethora of environmental stressors plaguing aquatic communities around the world. We present the first study to test 1) if diversity and dissimilarity among communities and populations of a locally-adapted species are correlated, and 2) if communities and population haplotypes respond differently to environmental selection and spatial proximity of habitats. We used a fragment of mitochondrial DNA (mtDNA) belonging to the gene cytochrome oxidase subunit I (COI) as a neutral tag to discriminate among different population haplotype variants. In boreal lakes with different histories of exposure to anthropogenic acidification, diversity and dissimilarity metrics for crustacean zooplankton communities and locally-adapted populations of an abundant and broadly-distributed calanoid copepod species, *Leptodiantomus minutus*, were compared. Spatial proximity was the dominant driver of haplotype structure among *L. minutus* lake populations, but there were similarities in the types of environmental variables that influenced distributions of species in communities and haplotypes in populations. How haplotype diversity among populations relates to community diversity depends on the relative influence of spatial proximity of habitats and selection at each of these scales of biological organization.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral SCL)

LONG-TERM CHANGES IN CLADOCERAN SIZE AND ASSEMBLAGE COMPOSITION IN LAKE OF THE WOODS, ONTARIO, CANADA

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Lake of the Woods (LOW) is an international waterbody that extends into northwestern Ontario and eastern Manitoba, Canada, and northern Minnesota, U.S.A. LOW has experienced a range of environmental stressors in recent history, including historical over-fishing and subsequent recovery of some predatory fish species, shoreline erosion, watershed alterations and climatic changes. This lake has garnered much public attention in recent years due to a perceived increase in the frequency and intensity of late-summer blue-green algal blooms. The arrival of two invasive cladoceran zooplankton species in LOW, *Eubosmina coregoni* in 1990 and *Bythotrephes longimanus* in 2007, imparts another potential ecological stressor to this system. The chitinized remains of cladocerans have successfully been used in paleolimnological studies to track long-term environmental changes in lakes worldwide. In order to detect ecologically-important shifts in the cladoceran assemblages of LOW, we examine cladoceran microfossils in present-day (~2003) and preindustrial (pre-1850s) sediment samples from multiple sites across LOW. Differences in surface-sediment (~2003) cladoceran assemblages between sites are related to physical and chemical variables using multivariate techniques. This reconstruction of natural (i.e., pre-development) changes in the cladoceran communities of LOW will provide further knowledge of the effects of long-term environmental changes in LOW.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL)

GENETIC ORIGIN AND DISPERSAL OF INVASIVE *LEPOMIS GIBBOSUS* IN THE IBERIAN PENINSULA

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Pumpkinseed sunfish (*Lepomis gibbosus*) were introduced to western Europe from North America in the late 19th century and established successfully. Since this time they have become invasive and have spread rapidly through both natural and assisted dispersal. To assess their potential North American site(s) of origin and subsequent spread in Europe, genetic comparisons between naturalized invasive populations on the Iberian Peninsula and native North American populations were performed using mitochondrial and microsatellite DNA. Sequence analysis of several mitochondrial genes (cytochrome *b*, ND-1, and ATPase 6 and 8) was used to estimate the phylogeographic origin and large scale dispersal of the invasive populations. Fine-scale genetic structuring, dispersal and connectivity among European populations were estimated using five microsatellite loci (RB7, RB20, *Lma*29, *Lmar*9 and *Lmar*18). The mitochondrial DNA data from the Iberian populations suggests their origin from eastern (Atlantic) North America, but could not discriminate between hypotheses of single versus multiple source introductions for European populations. Multiple origins are suspected, however, because of the introduction of this species as a forage fish to multiple water bodies throughout the peninsula. Furthermore, microsatellite data from the Iberian populations show fine-scale structuring within and among watersheds, suggesting multiple origins and dispersal pathways across Iberia, by expansion through watersheds and human-assisted translocation.

Contributed Paper (Oral CCFFR) (GS)

ECOLOGICAL IMPLICATIONS OF INTER-STREAM MOVEMENTS OF PIT TAGGED FISHES

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Freshwater fishes exhibit a variety of movements over a wide range of spatial and temporal scales, from localized daily movements to long-distance movements between adjacent local populations that interact via movement. However, the degree of movement at this latter spatial extent is poorly understood, yet is expected to be important to ecological (e.g. metapopulation dynamics, responses to habitat fragmentation) and micro-evolutionary processes (e.g., gene flow). Despite a rich literature examining fish movement, our understanding regarding the movements of many freshwater stream fishes remains largely incomplete. This three year study quantified the degree to which 24 species of native fishes moved between six adjacent streams located on the north shore of Lake Ontario, both within and among reproductive seasons. Movements of net caught fishes moving naturally into the streams were monitored using PIT-tagging and tracking technology. Overall, 12 of 24 and 10 of 13 species had individuals that moved between tributaries via Lake Ontario, within and among reproductive seasons, respectively. The frequency of inter-stream movements was low overall (mean = 2.9 and 19.4%) and varied among species (range: 0.5 – 33.3% and 5.9-85.7%), within and among reproductive seasons, respectively. Most inter-stream movements were made between immediately adjacent streams. Reproductive homing and site fidelity partly explain the low frequency of inter-stream movements. Results from this study demonstrate that fish assemblages in these Lake Ontario catchments exchange individuals at rates likely to be important for metapopulation dynamics and gene flow, but unlikely to allow populations to behaviourally respond en masse to in-stream structures that block movement.

Contributed Paper (Oral CCFFR) (GS)

QUANTIFYING THE DISPERSAL POTENTIAL OF AQUATIC INVASIVE SPECIES USING VECTOR-BASED RISK MODELS

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Consistent with human population and economic growth, the relative importance of abiotic factors (e.g., dispersal pathways) contributing to the introduction and spread of aquatic invasive species (AIS) has increased. Modeling approaches that forecast the likelihood of human-mediated invasions often consider propagule pressure (e.g., the number of introduced migrants) as a primary determinant of invasion success. Therefore, forecasting risk (e.g., the likelihood of invasion) requires an understanding of the probability of vector movement to uninvaded locations. We used a production-constrained gravity model to quantify angler movement, a relatively unknown AIS pathway. The model determined relative frequency and magnitude of angler movement according to the propulsiveness of angler origins (e.g., angler populations) and attractiveness of destinations (e.g., lake and fish community characteristics), based on data ($n = 2947$) from an angler survey conducted between February 2006 and 2008. The results of our study allowed destination waterbodies to be categorized according to the relative risk of introduction, prioritizing management action (e.g., outreach materials; increased monitoring and enforcement) at risky endpoints, such as those receiving many vectors, from several origins. The results of this study imply that risk modeling approaches designed to forecast vector movement can identify the relative risk of introduction within a spatial network of endpoints, a vital first step to prevent future AIS introductions while using management resources efficiently.

Contributed Paper (Oral CCFR) (GS)

THE RELATIVE CONTRIBUTION OF WINTER AND SUMMER HYPOLIMNIA IN ANNUAL CO₂ PRODUCTION OF LAKES

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Most studies of CO₂ dynamics in lakes have been carried out in surface water during the open water period, but significant accumulation of CO₂ may occur in summer hypolimnia and under the ice cover. The CO₂ that has accumulated during these periods is emitted to the atmosphere upon fall mixing and at ice melt, and there is evidence that these periods may contribute significantly to the annual emission budget of northern lakes. Respiration is thought to be one of the major sources of CO₂ during these periods, but the links between lake metabolism and CO₂ dynamics during these periods are not well understood. In order to determine the relative importance of winter and summer hypolimnia to annual CO₂ emissions, we followed 13 boreal lakes in northern Quebec, two temperate lakes of the St-Lawrence Lowlands and two temperate lakes situated on the Canadian Shield from summer 2007 to autumn 2008. We carried out monthly $p\text{CO}_2$ profiles at the deepest point of each lake, and laboratory incubation at *in situ* temperature to measure planktonic respiration rates of the surface and bottom strata of the water column. In this talk, we assess the relative importance of winter and hypolimnion to annual CO₂ production and we examine the variables that can predict cross-lake differences in CO₂ emissions.

Contributed Paper (Oral SCL) (GS)

IS THERE A GENERAL MOVEMENT SYNDROME IN YOUNG OF THE YEAR BROOK CHARR, *SALVELINUS FONTINALIS*?

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We tested whether foraging behaviour, risk taking, and dispersal form part of a general movement syndrome in young of the year (YOY) brook charr (*Salvelinus fontinalis*). There is growing interest in linking statistical methods of characterizing dispersal with the underlying behavioural mechanisms involved. Yet there is surprisingly little known empirically about how dispersal and foraging behaviour are related, although it has been postulated that dispersal and migratory movements arise from routine daily activities. The proportion of time individual YOY brook charr spent moving while searching for prey was quantified using focal observations in the field. Afterward, a measure of risk taking was obtained by recording the time taken by each individual to exit from an opaque tube into a novel stream environment. Finally, each individual's propensity to disperse in a simple lab environment was measured over 24 h in a 4 m apparatus consisting of 15 equal sized, sequential compartments. Contrary to expectation, individuals that spent a greater proportion of time while searching for prey in the field did not exit into a novel environment sooner, or exhibit a greater net displacement after 2 h and 24 h in lab, than did individuals that spent a lower proportion of time spent searching for prey in the field. Instead, the total number of compartments traversed over 2h in the lab was highly variable for the individuals that moved the least in the field and small and less variable for those that moved the most in the field. Level of activity during prey search and propensity to disperse appear to represent independent types of movement.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFFR) (GS)

INVESTIGATING CRAYFISH COMMUNITY ECOLOGY AND THE INFLUENCE OF MULTIPLE STRESSORS IN CRAYFISH DECLINE

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Previous work on Shield lakes located in central Ontario has indicated that crayfish populations have experienced significant declines in their relative abundances over the past 18 years. The purpose of this study was to identify the important environmental factors relating to crayfish species distribution, abundance and community composition. Additionally, we were interested in identifying environmental changes that may be associated with the observed changes in crayfish relative abundance. For instance, it has been recently hypothesized that decreasing lake calcium could be contributing to population declines in zooplankton. In order to address these questions, one-hundred lakes were surveyed for crayfish abundance and a number of chemical and environmental parameters. Historical survey records from the early 1990s were then used to determine whether significant changes in crayfish ecology and/or environmental characteristics have occurred. Our results indicate that a number of abiotic and biotic factors are important in shaping crayfish abundance, distribution and community composition, and that the importance of these factors has changed over time. Furthermore, we have found that changes in a number of environmental characteristics may be negatively impacting the abundance and richness of these important biological indicators.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral CCFFR) (GS)

JUVENILE ATLANTIC SALMON SHOW DIFFERENT BEHAVIOURAL RESPONSES TO VISUAL THREAT CUES IN WEAKLY ACIDIC VERSUS NEUTRAL STREAMS

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Recent studies have demonstrated additive effects of visual and chemical cues on the short-term antipredator behaviour of juvenile salmonids, as well as an absence of response to damage-released chemical alarm cue under weakly acidic conditions ($\text{pH} < 6.4$) in both laboratory and field settings. However, little is known about the response to visual cues in the absence of chemical information. Wild Atlantic salmon juveniles were selected in two New Brunswick streams (Catamaran Brook, $\text{pH} \sim 7.2$; Devil's Brook, $\text{pH} \sim 6.0$) for 5 minute pre- and post-stimulus *in situ* behavioural observations. We presented the subject with one of four cues: two simulating the presence of novel, predatory fish (a ball and a realistic predator model), and two simulating the activity of piscivorous birds (a pebble breaking the water surface, and a shadow passing overhead). Salmon in the weakly acidic stream demonstrated significantly greater overall responses than did those under neutral conditions. The bird stimuli elicited threat-averse behaviour in salmon tested in the weakly acidic stream, with no response shown by fish in the neutral stream. Salmon in both streams responded to the fish stimuli, demonstrating similar magnitudes of response to both stimuli under weakly acidic conditions. Under neutral conditions, however, subjects responded significantly more to the ball than to the realistic predator model. Our results demonstrate a general pattern towards greater levels of threat-averse behaviour by prey fish under weakly acidic conditions, with potential consequences for individual growth rates and survivorship over the growth season.

Growth at the Individual and Population Scales (Oral CCFR) (GS)

RESOLVING THE EFFECTS OF MULTIPLE STRESSORS ON THE COLD-WATER FISH COMMUNITY OF LAKE SIMCOE

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The cold-water fish community of Lake Simcoe is subject to multiple stressors including eutrophication, exploitation, fish stocking, invading species and climate change. In some cases these stressors have direct effects through predation or physiological mechanisms and in others indirect effects through physical processes or food web interactions. Our objective was to develop a new conceptual model of the interactions and impacts of multiple stressors on the coldwater fish community of Lake Simcoe. We used a 30-yr record of monthly temperature and dissolved oxygen profiles to characterize baseline trends in seasonal and annual thermal structure. Similarly we evaluated trends in phosphorus loading, algal density, water clarity, and hypolimnetic DO and tracked the occurrence of exploitation, stocking and invasive species as well as parallel changes in the abundance of the cold water fishes. Coldwater fish habitat was progressively degraded with increased phosphorus loading, during the 1980s and 1990s but later improved as P loads declined with improved P controls. Changes in thermal structure, winter ice conditions and heat content revealed a significant climate effect. Improved water clarity and dissolved oxygen occurred with the invasion of zebra mussels and spiny water flea as a consequence of the near shore phosphorus shunt and food web restructuring, respectively. Despite this complex of aquatic ecosystem stressors successful natural recruitment of lake trout, lake whitefish, lake herring, slimy sculpin and spoonhead sculpin has been observed after nearly of two decades of failure.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral CCFR)

MEASURING THE FLUX OF MERCURY BETWEEN CONTAMINATED SEDIMENTS AND OVERLYING WATER IN ST.LAWRENCE RIVER, NEAR CORNWALL, ONTARIO

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The St. Lawrence River near Cornwall, Ontario was designated an Area of Concern by the IJC in 1985 because of its contamination with mercury and other metals by local industry. This study investigated mercury accumulation in sediments and benthic fluxes of mercury between contaminated sediments and overlying water. We measured concentrations of total Hg (THg) and methyl mercury (MeHg) in both the porewater and solid phase of the sediments, and in overlying water to determine whether these sediments are acting as a source or sink for Hg. We also compared THg and MeHg vertical profiles in sediments with complimentary redox-sensitive variables, including sulphate, sulphide and Fe²⁺ distributions. We calculated flux rates of THg and MeHg from sediments to water, and compared these with THg accumulation rates determined from radiometrically dated sediment cores. We observed little to no diffusion of total Hg and MeHg from sediments to overlying water, and sediments were a major sink for THg and MeHg. There was very little seasonal variation in MeHg and THg concentrations during summer 2007.

Contributed Paper (Oral SCL) (GS)

CARBON STORAGE IN BOREAL AND TEMPERATE QUÉBEC LAKES

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Here we present a large-scale study of sediment C stocks in lakes spanning a wide morphometric and trophic range in two different regions in Québec: 13 lakes were sampled in the boreal closed-forest region of Quebec, and 16 lakes were sampled in Southern Québec. We quantified total carbon stocks by combining sub-bottom profiling of the sediments with estimates of carbon content made from surface cores. Estimation of sediment thickness was performed with high resolution, three-frequency system that penetrates up to the bedrock, and Bedrock, inorganic, organic and water depth were mapped along transects covering the entire lake surface. In addition to bottom mapping, Glew cores were taken in the central point of each lakes. The overall carbon mass storage in the lake was calculated using carbon content of cores and interpolated to the complete sediment basin. These estimates of total C stocks, and the derived carbon accumulation rates, are compared within and between regions, and the variability in carbon storage is explored in relation to catchment and lake properties.

Contributed Paper (Poster SCL) (GS)

INCREASED UREA CONCENTRATIONS CAUSES WATER QUALITY DEGRADATION IN THE NORTHERN GREAT PLAINS

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Urea is currently the most common form of nitrogen used as fertilizer on agricultural fields in Canada (e.g., 87% in Saskatchewan), yet the impact of elevated urea influx to downstream aquatic ecosystems is unknown. To address this issue, we added urea to phosphorous-rich waters in 3000-L mesocosms (final N:P = 1.5:1) at ambient and reduced light conditions in hypereutrophic Wascana Lake. After one month, the mesocosms with added urea experienced reduced water quality, as chlorophyll *a* concentrations increased, and water clarity was reduced. Urea addition also altered the algal composition, with reduced abundance of nitrogen-fixing cyanobacteria and increased chlorophytes. Despite the decline in the relative abundance of cyanobacteria, urea addition also caused an increase in microcystin, a hepatotoxin produced by cyanobacteria. Contrary to our expectations, addition of urea under low light regimes did not increase urea uptake by algae, but instead favoured the development of heterotrophic bacteria that subsequently reduced oxygen, suppressed algal biomass, and increased water clarity. These results suggest that influx of urea from fertilizer may play an important role in regulating water quality, particularly in areas of intense agricultural activities, such as the Northern Great Plains.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

THE ROLE OF SEABIRDS IN CONTAMINANT DELIVERY TO HIGH ARCTIC PONDS: A SOURCE APPORTIONMENT STUDY ON DEVON ISLAND, NU

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Seabird colonies have been linked to 'hot spots' of contamination both in the high Arctic and Antarctic environments. They are thought to collect contaminants from prey items, transport them to their nesting sites, and deposit them in their excrement. In this way marine-derived contaminants from prey items found across the broad foraging range of the seabirds, can be efficiently focused into remote, terrestrial receptor sites. We are studying this phenomenon at a High Arctic field site, on Devon Island in Nunavut Canada (76°15'N, 89°14'W). In the summer months this site is host to a colony of 20,000 Northern Fulmars (*Fulmarus glacialis*), a tubenosed petrel. A series of freshwater ponds representing a gradient of seabird influence, including controls, are located below the nesting cliffs. Concentrations of mercury, hexachlorobenzene and DDT in pond surface sediments along this gradient were previously shown to be enriched by one to two orders of magnitude by the seabirds. Given the remoteness of this location, concentrations measured in the study ponds are likely the result of two competing sources; atmospheric and seabird. The objective of this work is to discern the contribution of the seabird colony, as distinct from the atmospheric contribution, to pond concentrations and exposures and ultimately quantify this contribution through the development of a model. To that end, concentrations of polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT have been measured in relevant environmental media over the past three years, including air, water, sediment and periphyton.

Contributed Paper (Oral SCL) (GS)

MOVEMENT ANALYSIS WITH FIXED GEAR: VMS RECORDS IN THE GULF OF ST. LAWRENCE SNOW CRAB FISHERY

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Automated vessel monitoring systems (VMS) are becoming increasingly common in the regulation of commercial fisheries. By combining GPS fixes and two-way satellite communications they can provide near real time information for the high resolution spatial management of fisheries. In addition, they also provide data on vessel movements that enable novel approaches to studies of fleet dynamics. Recently, these data have been used to examine movements in mobile gear fisheries in order to test hypotheses about foraging patterns that attempt to develop ecosystem level interpretations of vessel movements. In our work, we examine a variety of quantitative tools to study VMS data generated from the Gulf of St. Lawrence Snow Crab (*Chionoecetes opilio*) fishery. Our analyses range from graphical exploratory methods to specific hypotheses tests and incorporate methods developed from: Lévy flights, fractal dimensions, and generalized additive models. The outcome of vessel activities is quantified in the landings reported by fishers throughout the period that the automated VMS records are collected. The ultimate goal of this work is to compare fishing success to movement dynamics through time and among fleet components (experienced vessels, new vessels, and others). This will contribute to a mechanistic perspective of variation in fishing power among vessels that can be related to current and future fleet composition through changes in fishing behaviour.

Contributed Paper (Oral CCFR)

DISTRIBUTION OF AQUATIC PLANTS IN RELATION TO NUTRIENTS, SUBSTRATE TYPE, INVASIVE SPECIES, AND OTHER ENVIRONMENTAL VARIABLES IN LAKE SIMCOE (ONTARIO)

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Lake Simcoe, the largest inland lake in southern Ontario, has been the focus of much public and scientific attention primarily due to high nutrient loadings and a lack of coldwater fish habitat. While many studies have focused on trends in water chemistry and fish stocks in this lake, the nearshore zone (0-20 m depth) has been virtually ignored. This zone is an important terrestrial-aquatic linkage, serves as critical nursery habitat to fish, and is the part of the lake used by humans for recreation. In recent years, the nearshore zone of Lake Simcoe has experienced dramatic environmental changes due to shoreline alteration, changes in surface runoff, and phosphorus shunting by dreissenid mussels. In order to fully investigate these changes, and gauge the full extent of their impact, we are undertaking a multi-disciplinary limnological study which uses biomonitors to track environmental change in Lake Simcoe and find out (a) where changes are taking place; (b) what is the cause of these changes; and (c) are mitigation targets adequate to restore water quality. In this study, we collected samples of aquatic plants from 42 transects on Lake Simcoe in order to determine community assemblage, quantity, and distribution with respect to key environmental variables.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

DÉVELOPPEMENT ONTOGÉNIQUE DE DEUX POPULATIONS D'ÉPERLANS ARC-EN-CIEL (*OSMERUS MORDAX*) DE L'ESTUAIRE MOYEN DU FLEUVE ST-LAURENT

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Peu d'étude relate les variations éco-morphologiques intraspécifiques chez les espèces marines et très peu d'entre elle s'attarde sur les premiers stades de vie. Dans cette présente étude, la distribution spatiale de deux populations d'éperlans arc-en-ciel (*Osmerus mordax*) de l'estuaire moyen du fleuve St-Laurent a été déterminée et des comparaisons morphologiques à différents stades ontogéniques (0+, 1+, 1++, adultes) ont été effectuées. Des analyses discriminantes et allométriques ont été combinées pour déterminer le stade auxquels les deux populations divergent morphologiquement. Les résultats indiquent une distribution homogène des deux populations dans l'estuaire et ce même si des environnements très différents sont présents dans celui-ci. De plus, une ségrégation entre les deux populations basée sur les différences morphologiques est possible dès le stade post-métamorphique (0+). Des différences entre les relations allométriques des individus de même groupe d'âge mais de population différente sont également présente. Ces résultats suggèrent que les divergences morphologiques seraient d'origine génétique et non induit par l'exploitation d'environnements différents. Finalement, une comparaison entre les adultes capturés pour cette étude et ceux attrapés lors d'une étude antérieure indique que leurs traits morphologiques ne serait pas stable temporellement.

La croissance aux échelles de l'individu et de la population (Oral CCFFR) (GS)

ONTOGENETIC DEVELOPMENT OF TWO POPULATIONS OF RAINBOW SMELT (*OSMERUS MORDAX*) IN THE ST-LAWRENCE RIVER

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Intraspecific eco-morphological variations in marine species have retained less attention than fresh water species in past studies. Furthermore, few project focus on first ontogenetic life stages. Spatial distribution of two rainbow smelt (*Osmerus mordax*) populations in the St-Lawrence River was assessed in this study. Moreover, morphological comparison using discriminant and allometric analysis was performed at different ontogenetic stages (0+, 1+, 1++, adults) to determine when morphological divergences appear between both populations. Homogenous distribution was found between both populations even if the St-Lawrence middle estuary presents different environments. Others results show a post-metamorphic segregation between both populations based on morphological differences. In addition, allometric growth differs among same age individuals from both populations. Since exploitation of different environments seems to play a minor role in morphological divergence, these differences could only be explained by genetic differences. Finally, a comparison between adults captured for this project and adults coming from a past study demonstrates a non stable variation in morphological traits in time.

Growth at the Individual and Population Scales (Oral CCFFR) (GS)

ASSESSING THE APPLICATION OF THE INDEX OF BIOLOGICAL INTEGRITY IN AREAS OF CONCERN

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The Index of Biological Integrity (IBI) is a multimetric index for biological assessment. The 1972 US-Canada Water Quality Agreement requires the development of Remedial Action Plans (RAPs) to determine the causes and severity of environmental degradation, selection of remedial actions, implementation and assessment in designated Areas of Concern (AOCs). Assessment of the RAP is measured through a variety of indicators, including the IBI. The IBI was applied to fish assemblage data from AOCs. The results did not indicate a significant increase in IBI scores following the implementation of the RAP. Thus, the fish community is either not responding to the remedial actions or the IBI is not sensitive to changes in the fish. To determine which one of these hypotheses is supported, multivariate analyses was applied to the fish assemblage data. Three-dimensional Principal Coordinates Analysis (PCoA) ordinations were generated for IBI narrative rank. The ordinations indicate the IBI metrics do not summarize the community data. IBI narrative ranks were not consistent along site species composition. Sites with similar species composition were assigned different narrative ranks. Variability within a narrative rank and overlap between ranks along the first axis in the ordinations indicates the metrics do not integrate the variability in the community data. IBI analyses exclude species that assimilate site condition and indicate changes in the fish community. Thus multivariate analyses and the IBI can generate different interpretations of the community data.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral CCFFR) (GS)

FOSSIL MIDGES AND HYPOLIMNETIC OXYGEN AT CLEAR LAKE, RIDING MOUNTAIN NATIONAL PARK, MANITOBA

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Clear Lake is a popular resort lake in Riding Mountain National Park of Canada and is subjected to nutrient stress from recreational activities, and municipal and agricultural wastes. Despite extensive use, the lake is still regarded as oligotrophic. There is concern that if not properly managed Clear Lake may become eutrophic, making it undesirable for both recreation and wildlife. To preserve the ecological integrity of Clear Lake, a comprehensive study of the lake's nutrient cycles, water budget and nutrient history was recommended. Sediment cores for nutrient and paleolimnological analysis were collected in February 2008. These cores facilitate reconstruction of the past 130 years of the lake's history, beginning approximately at the time of European settlement. Using midge fossils (principally Chironomidae) as indicators, we test the hypothesis that the hypolimnetic oxygen regime of Clear Lake has not changed significantly over the post-settlement interval. Any future increases in trophic status would most likely be due to anthropogenic sources and would need to be controlled to preserve the integrity of the lake.

Contributed Paper (Poster SCL) (GS)

CARBON SOURCES RESPIRED BY BACTERIA ON SHORT- AND LONG-TERM IN FRESHWATER ECOSYSTEMS

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The sources of organic carbon being preferentially used by bacteria in freshwater ecosystems are still a matter of debate. It is now clear that algae are not the sole source of carbon supporting bacterioplankton metabolism, but the relative importance of other sources, such as terrestrial carbon, is still uncertain. We used the newly-developed ReCReS system that allows the recovery and subsequent isotopic analysis of CO₂ produced by aquatic bacterial respiration, to address two fundamental questions: 1) Is algal-derived carbon preferentially respired by lake bacteria, and 2) Do nutrients influence the patterns of C utilization? The experiments were carried out in several lakes in southern Québec, and followed the changes in respiratory CO₂ isotopic signature over time, with and without nutrient additions. Our results suggest that algal carbon is preferentially used by bacteria in the short-term, and that longer-term carbon consumption is supported by terrestrially-derived carbon. Nutrients appear not only to enhance bacterial respiration, but also to increase the range of sources being used in the short-term. This study points to a sequential utilization of dissolved organic carbon pools originating from different sources.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL) (GS)

PROBING DEEPER INTO CYANOBACTERIAL COMMUNITY DYNAMICS

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Cyanobacterial blooms and their associated toxicity are major environmental and public health concerns. It is still not possible to predict when and where phytoplanktonic communities, or even populations of a given species, will start producing toxins. Intra-specific genetic diversity is increasingly recognized as a major factor behind the unpredictability of toxicity. In five lakes from the Yamaska river basin of southern Quebec, varying in their level of eutrophic condition, we monitored specific and intra-specific diversity of the potentially toxic genus *Microcystis*. *Microcystis*-specific PCR amplification of the 16S region and separation with DGGE gels, combined with taxonomical work, emphasized the strong seasonal successions occurring in the study sites. At the same time, toxicity monitoring by ELISA detection of microcystin showed that several of these lakes present a significant risk to bathers and to water treatment facilities. We will present results of the successional and turnover dynamics of toxic and nontoxic strains of *Microcystis* in these different lakes, as well as the relationship of genus and genotype to plankton microcystin content.

Contributed Paper (Oral SCL) (GS)

ARTIFICIAL DEEPENING OF A LAKE THERMOCLINE: A SIMULATION OF THE IMPACTS OF CHANGING SURFACE WINDS

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Previous studies suggest that thermal structure in small Boreal lakes (< 500ha) is largely controlled by DOC concentration rather than the effect of mixing by surface winds. However, deforestation (fire, clearcut, severe air pollution) or climate change may extend the dominant role of wind to impact much smaller lakes. We used a solar powered lake mixer (Solar Bee®) to simulate the effect of wind mixing to create three treatment levels in a small (18ha) three basin lake. The lake supports a small population of native lake trout, but the hypolimnetic waters (5-12m) are anoxic throughout most of the open water season. The control (eastern) basin was separated from the central basin by a narrow 1m deep channel. A 6m x 120m curtain was used to separate the central and western basins. The mixing occurred from ice-out until Aug. 15 in 2008 in the western basin. Relative to the pretreatment year (2007) the end of season thermocline changed in the 3 basins by 3.0, 1.5 and 0 m and the total heat content increased greatly with the enhanced mixing in 2008. Depth stratified gillnetting and Eckman grab surveys were used to assess changes in fish and benthic invertebrate depth distribution. Selected species of fish (brown bullhead, white sucker, creek chub) and benthic invertebrates (mayflies) were also analyzed for changes in Hg concentrations.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

POPULATION DYNAMICS OF THE ROUND GOBY (*APOLLONIA MELANOSTOMA*) IN THE TRENT RIVER, ONTARIO: AN EXAMINATION OF AN EXPANDING POPULATION OF INVASIVE FISH

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The round goby is a small demersal fish from the Ponto-Caspian region. Discovered in Lake St. Claire in 1990, round goby have since invaded all of the Great Lakes and by 2003 were found in the upper Bay of Quinte, Lake Ontario. A series of locks and dams have slowed round goby upstream migration from the Bay of Quinte into the Trent River; however it is believed that accidental bait bucket releases are responsible for establishing a pioneer population approximately 90 km from the river mouth. This aggressive invader offers new challenges for the Trent River and elicits questions about round goby movement, growth and abundance during range expansion. To monitor round goby movement, individual fish were marked in the spring and summer of 2007. More than 840 round goby were marked with fewer than 4% of those recaptured. Fish were recaptured seven to 50 days after first capture and no fish were found more than 40 meters from the original marking site. Recaptured fish also yielded growth estimates, with an expectedly strong negative correlation between growth rate and length at first capture ($P < 0.01$). To further investigate the Trent River round goby population, angling was used in 2008 to produce estimates of abundance and total length at differing stages of the invasion, i.e. up- and downstream of the 2003 pioneer population. The study showed lower abundance and larger round gobies are found at the edges of their range in the Trent River.

Growth at the Individual and Population Scales (Oral CCFR)

DEMOGRAPHIC EFFECTS OF SIZE-SELECTIVE EXPLOITATION OF CLAMS, COD, AND LOBSTER – THE ROLE OF REFUGES

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That size-selective predation (which includes fishing) could affect the population structure of organisms that exhibit indeterminate growth has been recognized for over a century yet this phenomenon received remarkably little empirical study in aquatic systems until the late 1980s. Three case studies are presented and the effects of the selection on population demographics contrasted. (1) Size-selective predation by muskrats had two measurable effects on freshwater mussels: removal of the largest individuals at age with little likelihood of a genetic effect in the locations where muskrats were native (some species having a physical refuge based on depth and large adult size); while species-at-risk in Germany apparently were extirpated due the lack of a refuge (densities reduced to below the level at which reproduction could occur). (2) Changes in fishing technology and increased fishing efficiency since the early 1980s had the effect of removing the size refuge (dome-shaped selectivity curve) and imposing unsustainable harvest rates for Atlantic cod in the southern Gulf of Saint Lawrence. This has resulted in a genetically-dwarfed population in much the same manner as selective breeding was used to create toy poodles from early domesticated dogs. (3) Lastly, I argue that the major factor that explains the persistence of American Lobster populations in the face of high (~70% per year) exploitation is the rigidly enforced minimum size limit, a depth refuge in some jurisdictions, and a serendipitous upper size limit. Recent regulations that impose a maximum ring size and a maximum retention size should provide further protection because they allow the lobster to grow through the predatory window after only 3 or 4 moults. The surviving lobster may then live to reproduce for 30 to 40 additional years.

Size-Selective Exploitation of Freshwater and Marine Fish Populations (Oral CCFFR)

A PRELIMINARY PHOSPHORUS BUDGET FOR THE LAKE OF THE WOODS

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Lake of the Woods (LoW) is a large (385,000ha), freshwater lake, that is within the boundaries of the provinces of Ontario and Manitoba and the state of Minnesota. With the presence of toxin-producing cyanobacteria, and seasonally-elevated nutrient concentrations recorded, there are increasing concerns that LoW water quality has deteriorated in the recent years. In addition to local concerns in the three jurisdictions, the issue of LoW water quality has wider significance to Winnipeg. Nutrient loading to Lake Winnipeg via the Winnipeg River watershed is the second largest source of nutrients to Lake Winnipeg (after the Red River), with more than half of the Winnipeg River flow originating from LoW. Shoal Lake, also closely connected to LoW, is the main source of drinking water to Winnipeg. Thus, a clear understanding of the nutrient sources influencing LoW water quality is needed to not only provide lake management goals for LoW, but also Lake Winnipeg and Shoal Lake. A comprehensive review of both the natural and anthropogenic sources of phosphorus to LoW has been compiled using existing hydrology and nutrient data collected by various agencies. Mass balance measurements have been utilized to evaluate total phosphorus (TP) loading to the lake. Due to the size and hydrological complexity of LoW, there is a lack of TP monitoring data available. Thus, the use of nutrient flux models such as INCA that incorporate land-use and climate variables has been initiated to predict annual TP fluxes and address the role of anthropogenic phosphorus loading to LoW.

Contributed Paper (Poster SCL) (GS)

EXAMINING NATURAL VARIATION IN THE INLAND LAKE FISH COMMUNITIES IN BRUCE PENINSULA NATIONAL PARK, ONTARIO

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Studies often attribute observed changes in biological communities to direct anthropogenic perturbation, often based on limited knowledge of the range of natural variation in the community. The paucity of natural variation knowledge may lead to erroneous conclusions and consequent management actions. To determine the temporal variation of, and factors influencing, fish communities in Bruce Peninsula National Park, 25 small, shallow, remote inland lakes were sampled in 2007 using the same protocol as a study completed in 1973. The morphology and isolation of these lakes, and lack of direct human impacts, make them an ideal model system for studying natural variation in fish communities. Multivariate analyses were used to detect changes in the fish communities between study periods and to identify factors influencing these communities. Preliminary results indicate that some species (e.g. banded killifish) have expanded in distribution and abundance while others (e.g. white sucker) have declined, and that the morphology and connectivity of some lakes has changed substantially as a result of beaver activity and the dynamic karstic geomorphology of the Bruce Peninsula. Their affects on the fish communities in these lakes may have been, and continue to be, exacerbated by fluctuations in the climate. Results from this study will provide resource managers with a better understanding of the factors that influence natural community dynamics and provide a baseline of variation that supplies context for observed changes that may require management.

Contributed Paper (Oral CCFFR) (GS)

CONNECTIVITY AMONG POPULATIONS OF A DEMERSAL MARINE FISH

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The degree of connectivity among marine populations, connected via larval dispersal, has important implications for the persistence and resilience of populations in the face of natural and anthropogenic disturbances, and thus how these populations should be managed. However there are few empirical studies that have measured or estimated the extent of dispersal or the degree of connectivity among populations of marine fishes. Here we estimate the degree of connectivity among populations of a coral reef fish by estimating the larval dispersal movements of juvenile fishes among several sites in a ~6000 km² region of the Caribbean. We use genetic assignment tests to estimate the dispersal movement of individual fishes collected over three years. We found that approximately 50% of juveniles dispersed no more than 40km from their natal reef over the three years of sampling. Also, approximately 18% of juveniles were self-recruiting (settled to the natal reef) over the three years. Most interestingly, we found that dispersal-distance distributions (dispersal kernels), as well as the degree of self-recruitment, varied among years. These results have implications for the appropriate scaling of management and conservation efforts.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFFR)

FROM 1988 TO 2008: ECOLOGY AND LIFE HISTORY OF NON-COMMERCIAL ATLANTIC MARINE FISHES

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“Atlantic Fishes of Canada” (Scott and Scott 1988) served as the point of departure for a study of non-commercially exploited marine fishes about which little or nothing is known from an ecological or life-historical perspective. Based on samples obtained from Department of Fisheries and Oceans’ September groundfish surveys in the southern Gulf of St. Lawrence in 2000 and 2001, we quantified data on egg size, fecundity, growth, estimated age and size at maturity, spawning period, diet and parasites for seven species: Longhorn Sculpin, Shorthorn Sculpin, Arctic Hookear Sculpin, Mailed Sculpin, Alligatorfish, Atlantic Spiny Lumpsucker, and White Barracudina. These data can contribute to studies of natural history, marine fish biodiversity, and initiatives to implement an ecosystem-based approach to fisheries management.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFR)

COMPARISON OF KAIROMONE INDUCED MORPHOLOGICAL DEFENSES OF *DAPHNIA PULICARIA* CLONES FROM METAL-CONTAMINATED AND NON-METAL CONTAMINATED LAKES IN THE PRESENCE OF COPPER

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Daphnia defend against predation through predator-induced morphological defences. *Chaoborus* spp. that feed on *Daphnia* release an odour (also known as a kairomone) from their digestive tract to the water. *Daphnia* respond to kairomone by producing neonates that have induced morphological defences (e.g., enlarged bodies and neck teeth) which serve to enlarge the daphniid beyond the gape limit of the predator, increasing their probability of surviving a predator encounter. When lab-cultured *Daphnia* are exposed to environmentally-relevant metal concentrations, kairomone perception is inhibited, rendering them unable to respond to kairomone and increasing predation vulnerability. Considering *Daphnia* inhabit metal-contaminated lakes around Sudbury, it is likely the extant population have adapted to function under chronic metal exposure. The purpose of this study was to determine if multiple clones of *Daphnia pulicaria* from metal-contaminated and uncontaminated lakes respond differently to predator kairomone when exposed to copper. Several different clones from the Sudbury (metal-contaminated) and Dorset (non-metal contaminated) area lakes were exposed to increasing environmentally-relevant concentrations of copper and predator kairomone. Neonates were then collected and measured in order to assess predator-induced life history responses and morphological defenses. Preliminary results have shown that as copper concentrations increase *D. pulicaria* from metal-contaminated lakes are still able to perceive and respond to predator kairomone; however *D. pulicaria* clones from non-metal contaminated lakes do not respond to predator kairomone. This suggests that *D. pulicaria* may be able to adapt to environmental stressors, such as chronic metal stress.

Contributed Paper (Oral SCL) (GS)

ROLE OF MICROFINANCE IN SOCIO-ECONOMIC DEVELOPMENT OF FISHERFOLK IN THOOTHUKUDI DISTRICT, TAMIL NADU (INDIA)

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The study was taken up to analyse the role of microfinance in socio-economic development of fisherfolk in Thoothukudi district during the period 2004-05. The objective of the study was to study the role and performance of fisherwomen Self Help groups. The SHGs received loan for economic activities. About (47.1 %) invested in net, catamaran and boat, (10 %) invested in economic activities, 11 % invested in house alteration / construction, 8.5 % invested in education, 6.5 % invested in medical purpose, 5.9 % invested in old debt repayment and 4.4 % invested in gold. All the SHGs reported 100 % repayment except Punnakayal which reported a repayment rate of 99.6. The study showed that microcredit helped the poor coastal fisherwomen in their socio-economic empowerment and welfare development. The common problems observed in the study area were poor sanitation, inadequate hospital, drinking water, transport facilities and inadequate follow-up support by the NGOs and Government departments in microfinance delays in sanction of microcredit loans, insufficient cooperation for banks and varying rates of interest charged for loans sanctioned by the banks and financial institutions. The SHGs expressed their difficulties in expanding their economic activities due to difficulties in marketing their products.

Contributed Paper (Poster CCFR)

THE WIDESPREAD THREAT OF CALCIUM DECLINE IN FRESH WATERS: A PALEOLIMNOLOGICAL PERSPECTIVE

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For many softwater lakes recovery from acid deposition is occurring slowly if at all despite emission reductions; this is at least partially due to reductions in acid deposition being offset by reductions in aqueous calcium (Ca). As crustacean zooplankton are both highly dependent upon aqueous Ca and are the primary consumers in many affected softwater lakes, the impact of Ca decline on this community is of considerable interest. However, the implications of continued Ca reductions for crustacean zooplankton communities and their response to fluctuations in Ca since the onset of acid deposition remain largely unknown. This lack of knowledge regarding past responses to fluctuating Ca was addressed via an examination of sedimentary crustacean microfossils from three south-central Ontario lakes. The three lakes selected for this analysis (Blue Chalk, Harp and Plastic) are soft, headwater lakes located on the Canadian Shield in the Muskoka-Haliburton region of Ontario. Each has been monitored by the Ontario Ministry of the Environment since the mid-1970s for a variety of limnological and biological variables, and are broadly typical of lakes on the Canadian Shield. A comparison of the timing and nature of changes in the relative abundances of Ca-rich versus Ca-poor crustacean zooplankton species within these three lakes that differ widely in Ca and acidification history, despite experiencing similar regional acid deposition influences, has provided what may be the first evidence of direct biological damage due to Ca decline as well as insight into the potential effects upon zooplankton assemblages among systems of varying buffering capacity.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

EGG QUALITY VARIATION IN WILD AND HATCHERY STOCKS OF LAKE TROUT

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Organisms are predicted to produce higher quality offspring, at the expense of offspring quantity, in environments where conditions for offspring survival are poorer. In addition, egg quality (an index of offspring quality) has been shown to vary with maternal size or age within a particular environment for a variety of fish species. The relative contributions of environmental and maternal factors to variation in egg quality were examined in an iteroparous salmonid, lake trout. Egg size (dry mass) and lipid concentration (percent of dry mass) were measured for 19 wild populations and for 8 hatchery strains originating from these populations. Both egg traits showed very little interannual variation within lake trout populations. Egg size was positively related to maternal size and age in about 60% of wild and hatchery populations. Both the egg size vs female size relationship and mean egg size varied among strains, possibly in response to climate. Egg lipid concentration was a less variable trait than egg size, but also varied significantly among strains. Lake trout growth and egg size in hatcheries were related to growth and egg size in their source populations, but growth was faster and egg size was usually smaller in the hatchery broodstocks. Egg quality in lake trout varies among wild populations and responds to the environmental changes associated with transfer from a wild to a hatchery environment.

Contributed Paper (Poster CCFFR)

STATISTICAL MODELS FOR LINKING MARINE PREDATOR MOVEMENTS TO OCEANOGRAPHY

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The rapid advancement of electronic tracking and remote sensing technologies has yielded an impressive array of studies that link marine predator movements and behavior to the physical ocean environment. Such studies provide critical insight into the movements, habitat use, and spatio-temporal distribution of predators, but analyses are typically ad-hoc and rarely make full use of the rich behavioural information hidden within electronic tracking data. Using contrived and real examples, I will illustrate how work in our lab is coupling physical and electronic tracking data to build more informative models of marine predator behaviour. These tools can be used to make causal inference of drivers of foraging and migratory behaviours and project climate change impacts on the distribution of foraging and migratory animals.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR)

THE ROLE OF CYANOBACTERIA RECRUITMENT AND PHOTOSYNTHETIC ACTIVITY ON INTERMITTENT BLOOM FORMATION

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Enhanced predictability of intermittent cyanobacteria blooms will involve better understanding of how physical and chemical variables in the water column affect cyanobacteria growth and photosynthetic activity. Perhaps even more crucial however, will be to understand such influences at the sediment-water interface, where cyanobacteria recruitment can initially occur. We propose two hypotheses: first, cyanobacteria recruitment (cell abundance and diversity) are influenced by temperature and light exposure at the water-sediment interface along longitudinal littoral to pelagic gradient. Secondly, once cyanobacteria have recruited, we hypothesize that their position in the water column will be directly influenced by optimization of both nutrient acquisition and light exposure. We collected weekly time series data on a suite of physical and chemical variables, most in profile, in Lake Bromont, QC. Recruitment was evaluated using traps and photosynthetic activity measured with a WATER-PAM. The intermittent cyanobacteria blooms observed were caused by *Planktothrix agardhii* recruiting mainly from the deeper (5m) parts of the lake where less than 1% of incident light reaches the sediments and temperatures are lower than in the littoral zone. This species is known to alter its position in the water column, usually forming a large metalimnetic layer, but forming dense masses when ascending to the surface. The strong presence of cyanobacteria in the metalimnion of our lake was attributed to recruitment from the sediments, as well as to optimized biomass production at the interface of the nutrient-poor epilimnion and the light-limited hypolimnion.

Impacts of Climate Change on the Biodiversity of Canadian Lakes, Rivers, and Oceans (Poster SCL) (GS)

A COMPARISON OF TWO METHODOLOGIES FOR ESTIMATING CATCH RATE USING THE WINTER BROOK TROUT FISHERY IN NEWFOUNDLAND AND LABRADOR, CANADA

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On the island portion of Newfoundland and Labrador, Canada, the provincial government relies on roving creel surveys to assess the brook trout *Salvelinus fontinalis* fishery. Estimation of catch and harvest rates for these surveys require on-site interview methods which gather information from incomplete fishing trips. The mean of ratios estimator is the accepted method for deriving catch rate from incomplete trips. For completed trips the accepted method is the ratio of means estimator. We compared the two estimators, using incomplete and complete trip catch data, to determine if a bias existed. Our results show that catch and harvest rates determined by surveying anglers prior to trip completion, were significantly higher at the individual angler level. Catch rate was higher by 16%, while harvest rate was overestimated by 21%. When catch and harvest rates were calculated at the lake level using the mean of ratios estimator, the discrepancy increased to 32% and 39%, respectively. We provide a model to correct for this bias.

Contributed Paper (Oral CCFFR)

EFFECTS OF PERCEIVED PREDATION RISK ON TERRITORIAL BEHAVIOUR AND POPULATION DENSITY IN WILD JUVENILE ATLANTIC SALMON

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While a great deal is known regarding the short-term antipredator response of juvenile salmonids to increased risk of predation, less is known about the effects on territorial defence. In a series of field observations conducted at Catamaran Brook, New Brunswick, we quantified the territorial behaviour of wild juvenile Atlantic salmon in response to an increase in perceived predation threats. 0+ salmon did not change their territory area when exposed to a short-term increase in risk of predation (conspecific alarm cue) compared to a control (stream water). However, when exposed to a long term increase in risk of predation (over two weeks), individuals had smaller territories compared to control sites. Furthermore, juvenile density in high predation risk sites decreased, whereas the density in control sites increased. Our results suggest that reducing territory size may be too costly over the short term. However, when exposed to chronic increase in predation risk, juvenile salmon either detect and avoid habitats with a high risk of predation or modify their behaviour when using such sites.

Contributed Paper (Oral CCFFR) (GS)

DO LENGTH-BASED INDICES OF CONDITION WORK?

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Simple weight-at-length ratios, such as Fulton's K, relative condition factor or relative weight, are often used as indices of fish condition. The assumption is that these indices provide information about fish health or energetic status. However, simple condition indices have been criticized for their assumptions and performance, though most often based on single species studies. Here I review the research on simple weight-at-length ratios to determine if they are reliable indicators of condition. A search of the literature uncovered 32 studies on 23 fishes containing 77 tests of condition versus a weight-at-length index. In the majority of cases (68%), authors concluded that weight-at-length was a reliable indicator of condition. A meta-analysis of these studies showed that while weight-at-length ratios can act as condition indices, they explain less than half of the variance in condition. The performance of simple weight-at-length indices varied among species, among age classes, and with the weight-at-length index chosen. This meta-analysis suggests that the usefulness of weight-at-length indices is dependent on a number of variables that are not related to condition and their use should be limited to situations where they have been tested and verified.

Contributed Paper (Oral CCFFR)

LONG-TERM TRENDS IN *BOSMINA* AND *DAPHNIA* SIZE STRUCTURE FROM SOFT-WATER ONTARIO LAKES

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The size-structure of *Bosmina* and *Daphnia* microfossils was compared between present-day and pre-industrial sediment intervals in 44 Precambrian Shield lakes in south-central Ontario (Canada) in order to determine if any regional changes in body size were linked to anthropogenic stressors. No significant change in *Bosmina* carapace length has occurred since ~1850; however, significant decreases in *Bosmina* mucro and antennule lengths were detected. A significant decrease in *Daphnia* body length (as inferred by the length of the post-abdominal claw) since pre-industrial times was also observed. In addition, standard deviation values for *Bosmina* mucro and antennule lengths, and *Daphnia* post-abdominal claw length, were higher in the modern sediment intervals compared to the pre-industrial sediment intervals. This suggests that these size measures are much more variable today compared to ~1850. Potential causes of *Bosmina* and *Daphnia* size shifts include changes in water quality (specifically changes in pH, dissolved organic carbon, and temperature) and shifts in predation intensity by fish and other invertebrates. Overall, our results highlight the importance of pre-impact data for understanding how zooplankton populations have been influenced by anthropogenic stressors.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

N₂ AND N₂O CONCENTRATIONS AND FLUXES FROM ESTUARINE SEDIMENTS: EVIDENCE OF A TIGHT NITRIFICATION DENITRIFICATION COUPLE

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Sediments are important sites for nitrogen transformations since gradients in the availability of oxygen and nutrients favour coupled microbial processes such as nitrification and denitrification. In this study we measured dissolved N₂ and N₂O concentrations in pore waters from sediment cores collected at five stations of St Lawrence estuary. Pore water was extracted using whole core squeezing and N₂ concentration was measured using membrane inlet mass spectrometry. Nutrient concentrations (NO₃, NO₂) were also determined. N₂ profiles increased with depth (0-3 cm in the sediments), and was inversely proportional to NO₃ concentrations at each station. Indeed, N₂ concentration could be predicted from NO₃ concentration given the strong negative linear relationships between the two variables within and among cores with r² values varying from 0.62-0.95. N₂O profiles in the sediments suggest sediments were a sink for N in 2006, corresponding to decreased concentrations in water column profiles. However N₂O was shown to accumulate in the bottom waters on different sampling dates. Change in nitrate concentrations explained half to a quarter of the N₂ evolution, suggesting a strong but variable nitrification-denitrification couple. The latter will be verified using DGGE profiles of nitrogen transformation genes, amoA for nitrification and nosZ for denitrification.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

MODELING GAS-EVOLVING NITROGEN AND CARBON BIOGEOCHEMICAL PROCESSES IN SMALL LAKES

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A model based-approach originally developed for measuring riverine denitrification has been modified for use in small, thermally-stratified lakes. The approach is based on high precision measurement of dissolved gases ($N_2:Ar$, $O_2:Ar$, N_2O , CO_2 , and CH_4), and correcting for atmospheric re-equilibration and vertical mixing. Estimates of gas production (or consumption) from water column profiles are compared with dissolved gas fluxes across the sediment-water interface, measured using benthic chambers and sampled by SCUBA. Over the summer – autumn period, estimates of N_2O and CH_4 production at the whole-system scale were comparable to benthic flux measurements. Analysis of denitrification (based on $N_2:Ar$ measurements) and respiration (based on $O_2:Ar$ and CO_2 measurements) are ongoing. Open-system approaches to measuring gas evolving or consuming processes have significant advantages over chamber approaches, integrating larger sediment-surface area and integrating temporal variability. In addition, the use of SCUBA is more time intensive, limiting the number of sites where these processes can be measured by a research team.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral SCL) (GS)

PROTECTING CANADA'S DRINKING WATER: DEVELOPING REAL-TIME, EARLY-WARNING BIOMONITORING TECHNOLOGY

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Our research addresses the necessity of developing an early-warning strategy to detect potential threats to drinking water sources. Natural bodies of water that ultimately constitute some of Canada's drinking water supply can contain a variety of pollutants such as heavy metals, PAHs, halogenated organic molecules, pharmaceuticals, and pathogens. While the associated health risks of some of these components are already known, there remains an alarming lack of research in many other areas. We are developing a holistic, multi-organism-based system to measure stress reactions in the aquatic community and are monitoring these stress responses in real-time. We will also develop ecotoxicity models based on dose-responses of individual organisms to specific classes of stressors (chemical and biological). These models will aid in the interpretation of the data and will provide information for water-utilities managers about the nature of the stressor. The ultimate goal of our research is the development and implementation of an early-warning system in real-time for drinking-water facilities that would detect chemical contaminants and pathogens using biomonitoring organisms. Our study is/will: 1) measuring responses in aquatic plants and invertebrates to chemical stressors at environmentally-relevant concentrations, and to pathogens; 2) developing a microarray-based test that can be used to directly detect pathogenic organisms; 3) build and test a flow-through system in a drinking-water facility for stress-response determinations in real-time; and 4) develop methods of stereotyped responses for the whole suite of biomonitoring organisms to chemical contaminants and pathogens.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

THE RELATIONSHIP BETWEEN MICROCYSTIN GENE COPY NUMBER AND MICROCYSTIN CONCENTRATIONS IN A SHALLOW MESOTROPHIC LAKE

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Cyanobacterial blooms can cause taste and odour problems, are aesthetically displeasing, and can lead to fish and benthic invertebrate mortality. In addition, some cyanobacterial blooms produce toxic compounds of human health concern with the hepatotoxic microcystins being the most commonly encountered in freshwater. Using primers based on the genes encoding for algal toxins, it is possible to detect the presence of toxigenic algae *in situ* more rapidly than through chemical analyses of toxins. Molecular techniques also tend to be more sensitive allowing for the early detection of potentially toxic blooms. In theory, because the genes coding for microcystins are constitutive and not under environmental control, their presence in the environment is indicative of toxin production. We examined the relationship between microcystin gene copy number and microcystin concentrations in a shallow mesotrophic lake. Constance Lake, located just west of Ottawa, was sampled throughout May-October of 2006-2007 for standard limnological variables as well as microcystins (ELISA and HPLC methods) and microcystin gene copy numbers using Quantitative PCR. Overall we detected higher microcystin gene copy numbers and correspondingly higher microcystin values in the summer of 2006 than 2007. We found a significant positive relationship between *mycD* gene copy number and microcystin concentrations over both summers ($p < 0.05$), however, gene copy number explained less than half of the variation in microcystin concentrations ($r^2 = 0.47$). This indicates that while molecular tools provide good methods for detecting the presence of toxigenic cyanobacteria and thus the potential for cyanotoxin production, they may be of more limited value in predicting toxin levels in the environment.

Contributed Paper (Oral SCL) (GS)

SOURCES OF SMALL-SCALE VARIATION IN BENTHIC MACROINVERTEBRATE COMMUNITIES AND PRIMARY PRODUCTION IN SMALL STREAMS

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Benthic macroinvertebrate community assemblages can be influenced by large-scale longitudinal factors or reach-scale lateral factors. The “reach contributing area” (RCA) is a way of defining variability in lateral inputs as the area of land adjacent to a stream contributing directly to a specific reach. Differing RCAs in bedrock dominated watersheds can be associated with differences in groundwater inputs as well as surface runoff which can, in turn affect stream habitat attributes such as temperature, organic debris, and nutrient levels. The RCA is naturally variable at small scales on a stream and may be associated with differences in stream habitat and invertebrate community in a stream reach. The objective of this study is to measure invertebrate communities, stream habitat variables, and riparian characteristics and relate these to variation in the reach contributing area. Stream, biotic and riparian data were collected in reaches of two RCA sizes along small streams in the Nipigon Bay watershed. Additional sites were studied in areas harvested within 6 years to explore the association of RCA with the magnitude of disturbance effects. It was found that several habitat variables differed significantly between the RCA classes including dominant substrate, total nitrogen, and dissolved oxygen. These differences in habitat variables may be associated with richness, abundance or feeding guild composition of the related macroinvertebrate communities. In addition to improving our understanding of the extent and sources of natural variability in aquatic invertebrate communities, results from this study will contribute to the development of more ecologically based prescriptions for forest management activities in small stream watersheds.

Contributed Paper (Oral CCFFR) (GS)

CELEBRATING MY ASSOCIATION WITH BEV

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W.B. Scott has been an omnipresent, positive influence on my career in science from my fledgling days as an M.Sc. student to those of a seasoned retiree. Here, I highlight and acknowledge these contributions and express my everlasting gratitude for the guidance, support, and wisdom shared over 40+ years of scientific interaction and friendship.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFR)

CALCIUM CONCENTRATIONS AT WHICH SOUTH-CENTRAL ONTARIO DAPHNIIID SPECIES ARE DAMAGED BY CALCIUM DECLINE: POTENTIAL IMPLICATIONS FOR CANADIAN LAKES RECOVERING FROM ACID DEPOSITION

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For about 20,000 Ontario lakes, acid deposition rates exceeded the buffering capacity of soils and the lakes acidified but the Ca^{2+} levels of Canadian Shield lakes generally increased. What will happen to Ca^{2+} levels on the Shield as continental sulphur emission rates decline? A worrisome possibility is acid deposition and multiple logging cycles have so depleted exchangeable Ca^{2+} levels in soils that lake water Ca^{2+} levels will decline to levels below those recently experienced by Shield lake biota (below 1.0 mg L^{-1}). The implications of such a decline for aquatic biota are simply not known. Preliminary bioassay studies suggest a threshold of 1.5 mg L^{-1} for *Daphnia pulex*; though this work was performed in modified hard water media. Analysis of Dorset A-lake data produced evidence for an increase in daphniid abundance in recent years with falling Ca^{2+} , but no lakes in the dataset have fallen below the suggested 1.5 mg L^{-1} threshold. In this study we perform 21 day life table experiments on *D. magna*, *D. ambigua*, *D. pulex* and *D. pulicaria* in soft water media. Results suggest the 1.5 mg L^{-1} threshold is maintained when performed in a soft water media, and there maybe a daphniid failure in lakes which have dropped below 1.5 mg L^{-1} .

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

ARE REFLEX IMPAIRMENTS INDICATIVE OF ACUTE STRESS AND SHORT TERM MORTALITY IN BLUEGILL

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Current methods of monitoring fish mortality associated with interaction with fishing gear require holding fish for long periods of time in captivity or the use of telemetry. The reflex action mortality predictors (RAMP) method has shown that reflexes may be useful in predicting delayed mortality of released individuals as it serves as an integrated measure of the impact of multiple stressors that contribute to mortality. Reflexes are involuntary responses to a stimulus and absence of a reflex is a sign of stress that can decrease the chance of evading predation or to perform innate behaviours. The presence and impairment pattern of reflex impairment must be validated for individual species. Bluegill (*Lepomis macrochirus*) were the model species for this study because they are a common warmwater species often involved in catch-and-release angling. Bluegill were captured, using standard angling gear, and air exposed for 0, 60, 240, 480, 960 or 1200 seconds. Following treatment, each fish was measured for 8 different reflexes; five restrained and three free swimming. Free swimming reflexes included orientation, upright orientation and startle response. Restrained reflexes include body flex, dorsal fin erection, vestibular-ocular response, operculum closure and gag response. Although, no short-term (2hrs) mortality was observed, impairment was shown for some of the reflexes including body orientation, startle response, upright orientation, dorsal fin erection, and body flex. This study identified valid reflexes in bluegill and will aid in directing further research to understand the utility of RAMP for quantifying and predicting stress and mortality in warmwater fish.

Contributed Paper (Poster CCFR)

THE IMPORTANCE OF BENTHIC INVERTEBRATES FOR FOOD WEB COMPLEXITY OF RECOVERING LAKES

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Benthic invertebrates are strongly exploited by fish and form a crucial part in the food webs of freshwater lakes. In the Sudbury area, benthic invertebrates seem to have a reduced biomass and diversity, which may hamper biological recovery. This energetic bottleneck should be especially restricting in lakes with high levels of piscivory, within which yellow perch (*Perca flavescens*) primarily use the littoral zone. We studied perch in two lakes with low piscivore abundance and two with high piscivore abundance over a two year period. Additionally, in 2006 one of the high piscivore lakes was stocked with 184 smallmouth bass (*Micropterus dolomieu*). We measured perch use of pelagic and littoral habitats, determined diet and stable isotope signature, and compared these to resource availability (i.e., benthic invertebrate biomass). High piscivory reduced perch biomass and caused a shift in habitat use from the pelagic to the littoral that was reflected in the stable isotope signature. There was little variation in perch carbon signature in low piscivore lakes while in high piscivore lakes there was high variation and a greater use of littoral carbon sources. Chironomids were most abundant both in the environment and in littoral perch diets in all lakes. While total benthos abundance was similar in all lakes, larger benthic invertebrates (Odonata and Trichoptera) were more abundant in high piscivore lakes. A limited benthic community may hamper the development of a more diverse fish community when the arrival of piscivorous fish changes the population size structure and behavior of the perch but also affects the predation pressure on benthos.

Growth at the Individual and Population Scales (Oral CCFR) (GS)

THE INFLUENCE OF FLOODING ON AQUATIC FOODWEBS OF THE PEACE-ATHABASCA DELTA

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Ecological conditions within floodplain basins are strongly regulated by hydrologic processes such as river flooding, precipitation and evaporation. Floods provide lakes with horizontal transfer of material which has been characterized to enhance productivity. A predictable sequence of physical, chemical, and biotic changes occurs in floodplain lakes that experience annual flooding. Initially, the turbid flood waters reduce light penetration through the water column, yet there are sufficient nutrients to stimulate growth of phytoplankton. Once floodwaters recede, mineral turbidity decreases which leads to proliferation of phyto-benthos, macrophytes, and epiphytes. In the Peace-Athabasca Delta (PAD), floods exert a similar sequence of physio-chemical changes, but river connection varies amongst basins from continuous to very infrequent (> 2 decades between floods). The variability of flood frequency results in less predictable ecological responses in the PAD basins. Field studies were conducted in 2007 and 2008 to understand the role of flooding on seasonal food-web dynamics. Four lakes of varying flooding frequencies and two adjacent rivers were sampled to characterize water chemistry, and trophic interactions of the flora and fauna. Stable isotopic analysis was implemented to trace hydrological changes (H and O) and foodweb dynamics (C and N). The knowledge gained from this study will enhance understanding the effects of flooding on aquatic food-web dynamics of the PAD, and will help inform interpretations based on carbon and nitrogen stable isotopic records in paleolimnological records. Moreover, the study will contribute to the stewardship of this important delta in the face of climatic variability and river flow alteration.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Poster SCL) (GS)

LA REPRODUCTION DE L'ALOSE SAVOUREUSE (*ALOSA SAPIDISSIMA*) DANS LE FLEUVE SAINT-LAURENT

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Le statut de l'alose savoureuse (*Alosa sapidissima*) dans le fleuve Saint-Laurent est considéré comme étant vulnérable. Afin de mieux connaître l'état des populations de ce poisson dans le fleuve Saint-Laurent, des échantillonnages de larves et de juvéniles d'aloses ont été effectués. L'âge et la taille des poissons capturés ont été mesurés. L'objectif principal de cette étude est de déterminer si il y a des évidences de présence de frayères d'aloses savoureuses ailleurs qu'aux deux endroits déjà répertoriés (rivière des Outaouais et Rivière-Des-Prairies). Des larves d'aloses âgées de moins de 10 jours ont été capturés dans les secteurs de Trois-Rivières et de l'Île d'Orléans. Ceci nous suggère que la présence de frayères dans ces secteurs est fort probable. Ensuite, nous avons trouvés que les poissons capturés en amont étaient légèrement plus âgés et plus grands que ceux capturés plus en aval. Ce qui laisse croire que la ponte aurait lieu légèrement plus tôt dans les frayères plus en amont. Selon ces résultats, il est probable que les poissons fassent de la ponte multiple, c'est-à-dire que les géniteurs pondent plusieurs fois et dans des frayères différentes. Un autre objectif est d'approfondir les connaissances sur les jeunes stades de vie, nous avons trouvés que le taux de croissance des jeunes aloses suit une fonction exponentielle et que les poissons nés plus tôt dans la saison croissent moins rapidement que ceux nés plus tard.

Growth at the Individual and Population Scales (Oral CCFR) (GS)

THE IMPORTANCE OF HISTORICAL MUSEUM RECORDS IN UNDERSTANDING BIODIVERSITY CHANGES: EXAMPLES FROM THE GREAT LAKES

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The Ichthyology collection of the Royal Ontario Museum forms the basis for our understanding of spatial and temporal patterns in the biodiversity of freshwater fishes in many regions of Canada, particularly in the Great Lakes basin. Among its many uses, the Ichthyology collection has proved invaluable in determining temporal trends in rare species undergoing COSEWIC assessment, and in examining changes in fish assemblages over time as the result of environmental change. A key strength of any well-curated museum collection is the ability to refer back to a voucher to confirm identity; something that simply cannot be done with paper or electronic records. I will illustrate the uses of the Ichthyology collection in these ways using freshwater fish records collected by Bev Scott in the Great Lakes basin.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

LINKING TERRESTRIAL AND AQUATIC ECOSYSTEMS IN A REGULATED RIVER: DOES FLOW ALTERATION EXPLAIN PATTERNS OF CARBON FLOW?

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The alteration of flow regime is considered as one of the most common perturbations in lotic systems. Under altered flow regimes, a loss of diversity and changes in food web structure resulting from habitat loss and altered consumers-prey relationships are often reported. In this study, we studied carbon pathways supporting the food web in relation to the hydrological characteristics of two boreal rivers. We hypothesized that increasing terrestrial loading and facilitating movement of both food sources and consumers due to water level fluctuations would increase the proportion of terrestrial carbon supporting the aquatic food web. Carbon stable isotope signatures of aquatic vegetation, invertebrates and fish were measured during a 4 year period in an unregulated river (Batchawana River) and in a regulated river (Magpie River). In the MR, constraints on the operating flow regime were applied in 2003/2004 and lifted in 2005/2006. We compared the carbon signatures of autochthonous carbon (as periphyton, macro-algae and macrophytes) to that of consumers (macro-invertebrates and fish). Carbon signatures were significantly higher in the regulated river, likely as a result of the water velocity effect on primary producers and upstream reservoir processes. Periphyton signatures were strongly related to that of both invertebrates and fish taxa, with a relationship that did not differ significantly from the 1:1 line. Results from this study demonstrate the importance of autotrophic production supporting the food web of rivers where terrestrial carbon dominates.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

SHIFTING WARM-WATER TO COLD-WATER CONDITIONS AND FOODWEB DYNAMICS OF JUVENILE PACIFIC SALMON IN THE EASTERN BERING SEA ECOSYSTEM

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The Eastern Bering Sea (EBS) ecosystem is an important feeding ground for juvenile Pacific salmon. Shifts in the relative strength of Pacific Decadal Oscillation (PDO) and Arctic Oscillation (AO), and associated shifts in thermal regimes in the EBS have been suggested to have major implications for energy flow along foodweb and trophic interactions among forage fish and juvenile salmon. The EBS shifted from a warm-water condition during 2002-2005 to a relatively cold-water condition during 2006-2007. This shift seems to be linked to dramatic shifts in the abundance of the major forage fish species, the most common diet of juvenile Pacific salmon species. We evaluate if the reversal of ocean thermal regimes cause significant shifts in foodweb dynamics and trophic interactions among the juveniles of salmon species, ontogenetic niche shifts as a function of size within species, and diet overlaps among species. To test our objectives, we used N and C stable isotope signatures of over 10,000 samples of juvenile salmon, forage fish and zooplankton collected during six years along north-south and east-west transects of the EBS. We present results showing how the change from warm to cold years are associated with significant contrasts in diet overlaps and trophic interactions among salmon species, and onshore-offshore variability in trophic shifts within Pacific salmon species as a function of body size, and discuss the implications of the observed variability for growth, survival and productivity of Pacific salmon.

Contributed Paper (Oral SCL)

CAN A FLUOROMETRIC PROBE BE USED TO MEASURE *IN SITU* PHYTOPLANKTON PIGMENTS IN COLOURED WATERS?

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Measurement and monitoring of phytoplankton communities can be labour intensive, so oceanographers often use fluorometric probes to estimate the concentration of photosynthetic pigments as a proxy for the concentration of algae. Substances other than algae may interfere with pigment readings, however, if they are excited by similar wavelengths or if they create turbidity that deflects the light from the probe. To test whether fluorometric probes could be used in freshwater systems with high dissolved organic carbon (DOC), we measured *in situ* pigment profiles in five southern Ontario lakes with a range of DOC concentrations using a YSI 6600 sonde with probes for chlorophyll *a* (chl), phycocyanin (PC), and phycoerythrin (PE). Water samples collected at several depths were then filtered to remove particulates before using the sonde to measure background water colour. Chlorophyll samples were also collected and analysed to compare with *in situ* readings. Most of the PE measurement in all five lakes, and most of the chl measurement in one coloured lake was due to water colour. Filtered water in the lab sometimes fluoresced more than *in situ* readings, suggesting that turbidity may contribute to low pigment readings. Extracted chlorophyll profiles had peaks at approximately the same depth as *in situ* readings, but the extracted peaks were more pronounced. Caution needs to be exercised if using the probe to determine the depth of highest algal concentration in the field, as observed peaks may be due entirely to water colour, and high concentrations of algae may be obscured by turbidity.

Contributed Paper (Oral SCL) (GS)

THE POTENTIAL INFLUENCE OF IRON ON FRESHWATER ALGAL BLOOMS

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Despite three decades of phosphorus (P) control, cyanobacterial blooms are continuing to occur in many freshwater lakes. Most tests to determine limiting nutrients concentrate on whole algal communities, while blooms are often characterized not only by an increase in biomass, but also by a shift in community dominance from eukaryotes to cyanobacteria. This work explores that dominance shift. Cyanobacteria have a higher phosphorus (P) affinity than eukaryotes, yet they do not dominate in oligotrophic waters, indicating that their growth is limited by something else, such as iron (Fe), for which they have a higher requirement than eukaryotes. To test whether Fe contributes differentially to increased biomass of eukaryotic and prokaryotic algae, phytoplankton from three lakes were collected and incubated in a mesh and Plexiglas-shielded outdoor waterbath in 500mL microcosms. For each of four treatments (control, P, Fe, P plus Fe) three of six replicates contained ampicillin to suppress growth of cyanobacteria. After six days microcosm communities were filtered for chlorophyll, and samples were preserved for cell counts. The results were mixed: in some lakes, on some dates, algal communities responded to P alone, to Fe alone, or to P and Fe. In some cases the whole community responded, while in others only cyanobacteria or eukaryotes responded. The biomass and structure of communities at the start of the experiment influenced the outcome, as did the concentrations of iron and phosphorus in the water prior to nutrient additions. Thus, an increase in Fe can be a contributing factor to cyanobacterial population explosions.

Contributed Paper (Oral SCL) (GS)

WATER COLUMN AMMONIUM DYNAMICS AND PHYTOPLANKTON COMMUNITY STRUCTURE IN MISSISQUOI BAY, LAKE CHAMPLAIN (QUÉBEC) IN SUMMER 2007

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Water column ammonium (NH_4^+) regeneration and potential uptake rates were measured nearshore and offshore in Missisquoi Bay, Lake Champlain, in June and August 2007. Uptake rates nearshore were lower in August than June, with the opposite trend observed offshore. Uptake rates were lower offshore versus nearshore in June and higher in August. Light/dark differences (3:1) were significant in all cases, suggesting that autotrophic uptake comprised a larger proportion of total uptake than heterotrophic uptake. However, the light to dark uptake ratio decreased from June to August at both sites. Nearshore, this decrease is explained by lower light uptake. Offshore, both light and dark uptake increased from June to August, but the increase was larger in the dark, which suggests that heterotrophic uptake was accelerating more rapidly than autotrophic uptake. Despite not reaching bloom conditions, cyanobacteria biomass was 7-fold higher at both sites in August and cell counts accounted for up to 95% of total phytoplankton, but ambient NH_4^+ concentrations were lower. Ammonium regeneration rates decreased at both sites from June to August, which suggests that higher cyanobacteria biomass and/or reduced grazing pressure affects water column NH_4^+ regeneration. Nearshore sediments switched from a large NH_4^+ source in June to a NH_4^+ sink in August. Thus, despite the lower water column regeneration rates in August, it is likely that primary production in late summer was driven mostly by water column recycling processes and episodic external inputs. These results provide insights into relationships between internal nutrient recycling and phytoplankton community structure.

Contributed Paper (Oral SCL) (GS)

MEASURING LACUSTRINE INFLUENCE ON COMPOSITION AND FUNCTION IN A STREAM COMMUNITY

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Headwater lakes are common characteristics of river systems in the province of New Brunswick, especially within the Miramichi River basin. The role of lakes and their effects on downstream communities has been relatively unstudied. Our research aims to determine how a headwater lake may contribute energy and influence to the functional composition of a downstream riverine community using stable isotope analysis (SIA). SIA is a proven biogeochemical tool used to determine major pathways within a food web. During the spring and summer of 2008 samples from various trophic levels (i.e. 1° producers, 1° consumers etc.) were collected from 4 sites within Catamaran Lake, and from 3 sites (at 0.1km, 0.2km and 0.5km) within the outflow stream Catamaran Brook. Data were then analysed using a one isotope, two-source mixing model. It was predicted that the proximal downstream communities rely more so on nutrients derived from the headwater lake rather from the riparian borders of the brook that influence the distal sites. Results will be discussed in terms of the influences of season and various trophic levels.

Measurement and Analysis of Connectivity in Aquatic Ecosystems (Oral CCFR)

LAND USE EFFECTS ON THE BASAL METABOLISM OF STREAM CRAYFISH

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The effect of land development on stream ecosystems is often measured in terms of changes in primary productivity, contaminant concentrations, and community composition. In contrast, it remains largely unclear how human activities in the catchment alter physiological processes of key stream invertebrates. We assessed the field metabolic rate (FMR) of crayfish across seven southern Ontario streams ranging in agricultural land use. A log-log plot of respiration against mass revealed slopes (hereafter called the scaling exponent) that varied widely among streams. The scaling exponent for crayfish in individual streams ranged from 0.46 ($r^2 = 0.81$) to 0.78 ($r^2 = 0.60$) with the combined scaling exponent for all sampled individuals being 0.58 ($r^2 = 0.57$). Individuals of equal mass thus differed in FMR by several fold in different streams. This variation in the scaling exponent was strongly related to the proportion of agricultural land use in the watershed ($r^2 = 0.75$) and other catchment properties. Preliminary results also suggest a decrease in the variance of mass specific respiration in streams flowing through areas of high agricultural use. These findings suggest: 1) mass specific respiration rates can vary widely among crayfish in different streams and 2) land use by humans directly or indirectly alters stream properties that control crayfish FMR. Human activities thus appear to alter trophic transfer efficiencies of stream invertebrates and stream food webs.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL) (GS)

THE INFLUENCE OF LATERAL CONTRIBUTIONS TO THERMAL AND FLOW VARIATION AND THE DISTRIBUTION OF FISH IN SMALL STREAMS

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The Nipigon Bay watershed on the north shore of Lake Superior drains a high relief landscape dominated by thin soils over bedrock. The coldwater streams in the area provide habitat for several native fish species including migratory brook trout. There is concern that forest management activities planned in the area will result in detrimental hydrologic impacts, including increases peak flows and water temperatures. However, in order to evaluate such impacts we require a better description of the natural variability in stream discharge patterns and stream temperatures, at both the watershed and reach scale. The objectives of this study are to quantify spatial variability in stream water temperature at a reach scale and evaluate the association between this variability and the characteristics of the entire watershed and the landscape directly adjacent to the reach. Preliminary surveys indicate that stream temperature varies as much as 8.9 °C over a reach of 50 m due to variation in shading and groundwater inputs which in turn appear to be associated with differences in the structure and composition of the riparian zone. Further study will help clarify this association as well as evaluate the relationship between temperature differences and fish distribution and the influence of forest harvesting on stream temperature variability.

Contributed Paper (Oral CCFFR) (GS)

FISHMAP: A WEB APPLICATION SUPPORTING SCIENCE-BASED DECISIONS CONCERNING FISH MOVEMENT AND PASSAGE

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Dams represent one of the commonest human alterations of riverscapes and decisions regarding their construction, removal, and modification for fish passage are becoming increasingly prominent. This presentation will highlight the Fish Migration and Passage (FishMaP) knowledge base (<http://fishmap.uoguelph.ca/>)— an on-line tool summarizing the migration and passage biology of fishes in the Laurentian Great Lakes. Our presentation objectives are to (i) bring the knowledge base to the attention of a wider group of potential users, (ii) encourage data sharing, and (iii) solicit feedback on the content and design of the knowledge base. FishMaP allows users to obtain a fish species list by selecting a tertiary watershed, a tributary name, a fish faunal region with a lake, or a custom species list selected from a list of species inhabiting the Great Lakes basin. For species in the list, the knowledge base summarizes information on conservation designations, rarity, propensity to inhabit lotic environments, migratory tendencies, sensitivity to barriers and fast flows, use of fishways and culverts, and swimming performance. Users can select reports summarizing information about each species under a specific topic (e.g. migratory tendencies) or summarizing information about each topic for a given species. Within report types, information can be organized by common or scientific species names. Records summarized in each report topic are referenced back to literature sources. FishMaP has been made available to help stakeholders from management agencies, academia, consulting firms, and NGO's reach more informed decisions regarding dams and fishways.

Contributed Paper (Oral CCFFR)

MERCURY CONCENTRATIONS IN SMALLMOUTH BASS (*MICROPTERUS DOLOMIEU*) IN SOUTH-CENTRAL ONTARIO LAKES IN RELATION TO LAKE SEDIMENT

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Mercury (Hg) concentrations in smallmouth bass (*Micropterus dolomieu*) were analyzed in headwater lakes across a diverse landscape in Ontario and were found to be related to both present-day ($R = 0.92$, $p = 0.0002$) and pre-industrial lake sediment ($R = 0.76$, $p = 0.0107$) Hg concentrations. Land cover and geology was delineated for each watershed using GIS. Land cover was grouped by the proportion of coniferous and deciduous vegetation and density, anthropogenic disturbances such as; development, mine tailings, croplands, harvesting and burn sites were included before data reduction. Surficial and quaternary geology were classified into 12 and 9 classes, respectively, based upon structure and composition. Physico-chemical properties which enhanced Hg accumulation in both fish and sediment were; lake pH (component₁ score = -0.77), longitude (0.52), and the ratio of aluminum to dissolved organic carbon (DOC) (0.22). Properties which favored Hg accumulation in either smallmouth bass or lake sediment were; land cover (component₂ score = 0.72), longitude (0.58), and dissolved organic carbon (0.43). Land cover was more influential than geology and landscape features became more important when examining lakes regardless of order. Overall, lake pH and longitude were the dominant factors in Hg distribution in Ontario lakes (53 % and 27 % of Hg variance, respectively), far greater than other variables. This study incorporates landscape features and sediment Hg concentrations to determine the most influential factors for Hg concentrations in the dorsal muscle of smallmouth bass in Ontario.

Contributed Paper (Oral CCFFR) (GS)

IMPACTS OF DISTURBANCE ON MERCURY LEVELS AND BIOACCUMULATION IN SMALL STREAM ENVIRONMENTS OF NORTHWESTERN, ONTARIO

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In the Boreal forest, disturbance from forest fire and forest management are associated with increases in both the flux of mercury to aquatic systems and the concentrations of mercury in fish. However, the mechanisms by which mercury enters and bioaccumulates in the food chain with increased flux are poorly understood. We measured mercury concentrations in periphyton, macro-invertebrates (EPT) and fish (brook trout and dace species) sampled from small streams (draining 1, 3, 10 km² in a nested design) in 6 watersheds that differ in disturbance history. We also evaluated stream habitat and other watershed characteristics, including beaver impoundment and wetland area, to help account for natural variability in the mercury levels of stream biota. Preliminary analyses show that macro-invertebrates have relatively high, but extremely variable mercury levels (0.129 ug/g to 2.699 ug/g). Mercury levels in fish range from 0.005ug/g to 0.548ug/g, sometimes exceeding the Health Canada threshold for consumption (0.5ug/g). The results of this and several other studies are intended to improve our ability to predict and manage mercury inputs into aquatic systems during land-use planning.

Contributed Paper (Oral CCFFR) (GS)

CLIMATE-RELATED EUTROPHICATION OF A SMALL BOREAL LAKE, EXPERIMENTAL LAKES AREA, NW ONTARIO: A PALEOLIMNOLOGICAL PERSPECTIVE

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Paleolimnological investigation of changes in water quantity and quality in Lake 239, Experimental Lakes Area, in northwestern Ontario indicate marked changes in limnological conditions during the Holocene. Water-quantity changes are based on the analysis of diatoms and inferences of lake-level changes from a near-shore sediment core. Changes in water quality are based on the analysis of diatom assemblages and associated quantitative inferences of total phosphorus (TP) from a deep central core. Lake levels at least 8 m lower than today were inferred from the near-shore core and were concurrent with an increase in a nutrient rich diatom assemblage, an increase in diatom accumulation, and a decrease in the chrysophyte scales relative to diatoms in the central core. *Fragilaria crotonensis* and *Aulacoseira subarctica* were two of the dominant nutrient-rich taxa that contributed to an increase in diatom-inferred TP during the mid-Holocene. Results from this study provide strong empirical evidence that water levels much lower than today can dramatically change trophic status, as occurred during the dry mid-Holocene, and may provide a good analogue for understanding future impacts of climatic changes due to anthropogenic activities.

Contributed Paper (Poster SCL)

SIZE DOESN'T ALWAYS MATTER – YELLOW PERCH (*PERCA FLAVESCENS*) GROWTH VARIES WITH DENSITY AND PREDATION RISK IN SUDBURY AREA LAKES

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Yellow perch is indigenous to North America and its native range extends throughout much of Canada east of the Rocky Mountains. They are the dominate species in many Sudbury lakes during early stages of recovery from acidification (pH>5). With improvements in water quality predatory species have begun colonizing many perch-only lakes. We combined habitat use, life history, body shape, and stable isotope analyses to assess whether yellow perch growth varies with changes in predation risk. Detailed biological measurements were made on yellow perch collected across a predation risk gradient of eight lakes (three lakes with no piscivores, two lakes with low piscivore abundance, and three lakes with high piscivore abundance). Yellow perch abandoned the pelagic zone in lakes with high piscivore abundances or low adult yellow perch density. Stable isotope analysis revealed that yellow perch in the lakes with no piscivores or low piscivore abundance utilized food sources from both littoral and pelagic habitats while yellow perch in high piscivore abundance lakes utilized habitat specific food sources. δC increased with yellow perch size in high piscivore lakes in the littoral zone (feeding on more littoral prey). δN increased with yellow perch size in no and low piscivore lakes in the littoral zone (feeding at some kind of higher trophic level). Yellow perch responded to predation risk by increasing the dorsal spine length and body depth in the pelagic zone. Young-of-year and age 1 fish grew significantly slower in high piscivore lakes. Yellow perch appeared to invest more energy in defense than growth when exposed to increased predation risk.

Growth at the Individual and Population Scales (Oral CCFR)

CHANGES IN BIOLOGICAL COMMUNITIES ACROSS A GEOLOGICAL TRANSITION: EXAMINING THE IMPACT OF THE PRECAMBRIAN SHIELD ON SMALL-ORDER LOTIC SYSTEMS

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Low-order lotic systems of the Canadian Precambrian Shield include an extensive portion of Ontario's many waterways that remain relatively unstudied, particularly concerning fish species composition. The geology of the Precambrian Shield - namely, large outcroppings of ancient metamorphic and igneous rock that were exposed to the surface during the glacial period - has a large influence on the abiotic conditions of aquatic systems. These differences are especially striking in comparison to non-Shield areas, particularly in the transition zone in south-central Ontario. In this study, we used both historical and current fish and invertebrate data from small-order streams in central Ontario in order to assess both community composition and abiotic conditions of Shield lotic systems in this area. Multivariate methods were used to elucidate both biotic and abiotic patterns between sites. In addition, comparisons to sites in south-central Ontario are made in order to examine changes in abiotic conditions and fish species composition along the transition zone of the Shield. These analyses show interesting patterns between Shield and non-Shield sites in both biological composition as well as abiotic conditions.

Contributed Paper (Oral CCFFR) (GS)

HISTORY OF THE "COMMITTEE ON NAMES OF FISHES" AND OF THE CLASSIFICATION OF THE FAMILY SALMONIDAE AND THE NAMES OF ITS SPECIES

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Some aspects of the history of the "Committee on Names of Fishes", having its start as a result of an American Fisheries Society (AFS) resolution in 1933, a joint committee of the AFS and the ASIH, will be explored. Several Canadians have served on the committee and as authors of its Special Publication, namely W. A. Clemens, J. R. Dymond, C. C. Lindsey, W. B. Scott, E. J. Crossman, and J. S. Nelson. The history of some changes to the classification and names of salmonids and some current conflicts over membership will be discussed. The history of why we use the common names for the five Canadian Pacific salmon, in light of much earlier disagreement ranging from Alaska to California, will be summarized — such as the history of choosing Chinook (Salmon) over King and Spring for *Oncorhynchus tshawytscha* with key involvement from W. E. Ricker in 1952 (and input e.g., from J. R. Dymond).

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

NEW DATA ON MICROBIAL COMMUNITY RESPIRATION IN SEA-ICE

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Microbes play an important role in carbon cycling. Although bacteria convert an important amount of C into biomass through their production, significant amounts of C are used for bacterial respiration. Studies have already shown bacteria in sea-ice are highly productive, but to our knowledge, there are no direct estimates of respiration. Using melted ice core and seawater incubations, we developed a method to measure community respiration using optical fiber sensors (FIBOX) at several sites of Amundsen Gulf in the Canadian Arctic, as part of the CFL ecosystem study. When possible, we measured rates at the ice-water interface and for low and high snow covers, at each location. Microbial respiration has never been directly measured in sea-ice and rates are usually assumed to be low due to cold temperature. Our preliminary results show a measurable respiration rate that could be useful in carbon balance estimates for the gulf. Rates measured up to now show higher respiration in ice than water column. Additional data for bacterial production and abundance measures was taken at each site. With this data, we hope to gain a better understanding of possible consequences of arctic ice melt on carbon cycling by sea-ice microbial communities.

Contributed Paper (Oral SCL) (GS)

PHYTOPLANKTON TAXONOMIC COMPOSITION IN LAKES OF THE LOWER MACKENZIE RIVER BASIN, NORTHWEST TERRITORIES (CANADA)

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The lower Mackenzie River Basin is an area where global warming is relatively pronounced and where oil and gas exploration and extraction is poised to intensify. The degree to which these stressors may affect lake trophic status and algal species composition is currently unknown. Here, we present data on water chemistry and phytoplankton taxonomic composition from 2004-2007 sampling surveys conducted in lakes situated along the proposed Mackenzie Gas Project (MGP) pipeline route in the Canadian Northwest Territories. Most lakes sampled for this study were oligotrophic and at least four of the nine major phytoplankton taxonomic groups (Cyanophytes, Chlorophytes, Chrysophytes, Bacillariophytes, Cryptophytes, Dinophytes, Euglenophytes, Haptophytes, and Xanthophytes) were present. Phytoplankton group abundances were generally dominated by Cyanophytes and Chrysophytes, while Euglenophytes and Xanthophytes were absent in the Mackenzie River Delta flood plain lakes. Nonmetric multidimensional scaling (MDS) showed phytoplankton community composition, based on phytoplankton abundance, was best explained by water clarity (conductivity, turbidity, dissolved organic carbon) and nutrients (total phosphorus and total nitrogen). The potential adverse effects of human development and climate change on these relatively pristine high latitude lakes are discussed.

Impacts of Climate Change on the Biodiversity of Canadian Lakes, Rivers, and Oceans (Oral SCL)

TEMPERATURE DURATION FREQUENCY ANALYSIS ON THE ST. LAWRENCE RIVER – A TOOL FOR QUANTIFYING ADVERSE CONDITIONS DURING THE 2001 MASSIVE FISH KILL

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In 2001, the most important fish kill of the St. Lawrence River history occurred in summer 2001. More 25 000 carps (*Cyprinus carpio*) were found dead within a six week period. The exact number of dead fish remains unknown because the carcasses were only collected in inhabited areas. The analyses performed on dead body have shown that the death was ultimately caused by bacterial infections with *Aeromonas hydrophila* and *Flavobacterium sp.* These bacteria are not sufficiently strong themselves to affect healthy fishes; the fishes had to be already affected by other stress factors that will lead them to be immunosuppressant. In this case, it seems that the immunosuppression was physically (i.e., spawning) and environmentally (i.e., high temperatures and low water levels) induced. The objective of this study was to confirm the likelihood of environmental stress using hydrometeorological information and methods based on the analysis of extremes. The frequency analyses performed shown that water temperature were abnormal for this period of the year, with return period greater than 15 years. Early in May, water temperatures as high as 34°C were recorded in some shallow water areas, which is quite sufficient to stress fishes. Low water levels can explain the rapide heating of water, Return periods for water levels exceeded 13 years. Other frequencies analyses performed on air temperature series do not reveal any abnormal pattern in this variable. These results highlight the importance of water temperature for the aquatic ecosystems and the need for the development of modeling approaches such as 2D hydrodynamic models for studying all the characteristics of the ecosystem linked with the water temperature, including thermal refugia.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral CCFFR)

DIFFERENCES BETWEEN POPULATIONS OF ATLANTIC SALMON IN THE ADOPTION OF ALTERNATIVE REPRODUCTIVE TACTICS

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We designed a laboratory experiment to corroborate previous field results showing that the criteria for the adoption of reproductive tactics in male Atlantic salmon is different between populations of different altitudes. Young of the year were captured from upstream and downstream populations of the Sainte-Marguerite River in August 2005. These fish were reared up to sexual maturity under controlled environmental conditions. In early February 2006, all individuals were sufficiently large to be pit-tagged, allowing us to examine the effects of growth rate on future reproductive tactics (premature sexual maturation or smoltification). Although work is still in progress, our preliminary results suggest that 1) future smolts are the fastest growing individuals, and 2) the growth rate required to achieve smoltification and premature sexual maturation is smaller in upstream than downstream populations. The differences found under controlled conditions suggest that size and growth rate values for the adoption of reproductive tactics are genetically based and could thus be the result of selective processes.

Growth at the Individual and Population Scales (Oral CCFFR) (GS)

TROPHIC RELATIONSHIPS OF WESTERN AND RED-NECKED GREBES IN THE FOOD WEB OF LAKE WABAMUN, ALBERTA

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We used stable isotope analysis (SIA) to investigate trophic relationships of two species of grebes on a large lake in the Aspen Parkland. We collected feathers and pectoral muscles from 42 western grebes and 23 red-necked grebes that had died in a rehabilitation centre after an oil spill on Lake Wabamun in August 2005. We also collected representatives of eight fish species and nine macroinvertebrate taxa and performed SIA on their tissues to describe the food web of the lake. Isotopic signals for stable carbon showed a clear separation between limnetic and littoral webs. Western grebe muscle was more depleted in ^{13}C than red-necked grebe muscle, suggesting that the former species focused its foraging offshore. Values for ^{15}N were more enriched for western grebe than red-necked grebe muscle, indicating that the larger western grebe occupied a higher trophic position and was likely more piscivorous. Based on stable nitrogen isotopic signals, grebes were the top predators on Lake Wabamun, followed by large northern pike, lake whitefish, and yellow perch. Carbon and nitrogen signals of primary feathers of both species of grebes appeared effective in separating hatch-year birds (feathers formed on Lake Wabamun) from adults (feathers formed on marine wintering grounds).

Contributed Paper (Oral CCFFR)

EFFECTS OF URBANIZATION ON STREAM FISH POPULATIONS USING AN ENDANGERED INDICATOR SPECIES

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The endangered fish, the redbreasted dace (*Clinostomus elongatus*), is undergoing severe decline across its entire Canadian range. The predominant hypothesis linked to the decline of redbreasted dace has been the vast urban expansion of the Greater Toronto Area, where most of its range resides. As result the redbreasted dace is an excellent indicator of population affects of urbanization to stream fishes. The objective of this study was to determine differences in populations of redbreasted dace based on urbanization. For this a paired design was used separating currently urbanized and non-urbanized streams across the Greater Toronto Area, Ontario, Canada. Redbreasted dace were sampled across 70 sites in 2007-2008 and tagging with a color coded visual implant elastomer tag (VIE), weighed, and measured for size. We used the mark-recapture data from over forty connected patches to show marked decreases in movement (e.g. immigration/emigration) in relation to the non-urbanized streams. In addition, we obtained demographic data from scales and demonstrate that populations of redbreasted dace in urban settings had a significant decrease in young of the year and decreased population sizes. We provide novel insights into the biology of redbreasted dace and provide a cautionary note for the affect of urbanization to stream fishes.

Growth at the Individual and Population Scales (Oral CCFFR) (GS)

DEVELOPING A GENERALIZED FRAMEWORK FOR SPECIES RECOVERY FROM MULTIPLE STRESSORS?

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Science-based approaches for selecting among single-species, multi-species, and ecosystem-based recovery plans are needed to conserve the growing number of imperiled species. To date, most species at risk recovery plans have focused on a single species or single factor approaches, which manipulate individual habitat features or species in the hopes that it will aid in recovery. However it is uncertain how these actions may be effect aquatic communities, especially given that most communities are under the influence of multiple stressors. We developed a generalized framework for determining which recovery plan is most suited for ecological situations with many species undergoing multiple stressors. Using the Sydenham River, Ontario as a model system, we start by using habitat variables predicted to influence fish species at risk and testing if they were adequate predictors of the actual species at risk distributions. Three hypotheses of the response of species at risk communities to habitat gradients were used to fit the resulting models to an appropriate recovery plan. For fish species at risk in the Sydenham River, the habitat variables predicted to influence fish species at risk were generally related to their occurrences; however, species at risk were found in different habitats despite similar geographic distributions. Using the proposed framework, an ecosystem-based recovery plan was deemed most appropriate. To generalize our framework to other systems we developed decision criteria for interpreting multivariate models for given ecological contexts. We demonstrate the merits in considering multiple stressors for aquatic communities with species at risk.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral CCFFR) (GS)

RETURN OF AN ICON!

Powles, Perce, Trent University, 1600 West Bank Dr., Peterborough, ON K9J 7B8

The former Director of the Huntsman Marine Science Centre, Dr. W.B. Scott, accompanied my wife and me to a very auspicious reunion of fisheries researchers at St. Andrews Biological Station (SABS) in October 2008: the 100th anniversary of the Station. He was returning after 10 years in Kingston and, of course, was welcomed with open arms. Dr. Rob Stephenson, Director of SABS, and his committee had prepared four days of exciting activities, including a two-day historical conference highlighting contributors to the evolution of fishery science in Canada over the past 100 years. It is often taken for granted that grad students and teachers benefited from Bev's work, but this paper will also acknowledge his inspiration and contributions to my many honours students who used his 1973 bible as a basic research tool for their theses.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

THE ROLE OF LAND-USE CONTEXT AND NUTRIENT EXCRETION ON ALGAL AND INVERTEBRATE COLONIZATION OF MUSSEL SHELLS

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Recent work has demonstrated that nutrient excretion can subsidize benthic food webs by promoting algal growth and invertebrate grazing on mussel shells. Land-use in the watershed can confound this relationship by changing the relative amount of limiting nutrients in streams, potentially minimizing the effect of nutrient-cycling by organisms. We asked how land-use context affects the abundance and richness of algae and invertebrates colonizing mussel shells. We hypothesized that nutrient limitation would influence the importance of mussel excretion on algal and invertebrate colonization. We predicted that mussels excreting more ammonia under nitrogen limitation would have greater algae and invertebrate colonization. To test this hypothesis, we performed a field experiment using live mussels and sham shell agar-filled mussel shells (agar only control, high N:P agar, low N:P agar) to simulate mussel excretion. We placed five replicates of each treatment in a high and a low nutrient stream in Southern Ontario. After three weeks, we collected and scrubbed the mussels, quantifying invertebrate and algal abundance and richness. Our results to date suggest that nutrient excretion may be an important subsidy to benthic food webs. However, this relationship may be governed by the degree of nutrient limitation associated with land-use.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

SPATIAL/TEMPORAL PATTERNS IN THE SPAWNING DENSITIES OF BROOK TROUT

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We explore the causal basis for a temporally stable spatial pattern in the density of spawning individuals of a freshwater fish. Based on a comparatively long-term set of data spanning one decade, reproductively active brook trout (*Salvelinus fontinalis*) inhabiting a near-pristine river on Cape Race, southeastern Newfoundland, occupy areas of either high or low density. Compared to their low-density counterparts, high-density aggregations are typically more than 30 times denser despite occupying only 4% of the available habitat. High-density areas are characterized by slower flow and suspected ground- or bog-water seepage, attributes likely to increase the probability of offspring survival in Freshwater River. Disparity in density between high- and low-density aggregations declined as total population size increased, a pattern consistent with the predictions of the ideal free distribution. The larger body sizes of trout in the high-density aggregations may prevent others from occupying the most preferred spawning habitat. This spatial pattern in spawner density is consistent with that predicted by an ideal despotic distribution, although we cannot discount the influence that Allee effects might have on the distributional patterns of spawning individuals at low population sizes.

Contributed Paper (Oral CCFFR)

PRODUCTIVE CAPACITY OF SEMI-ALLUVIAL STREAMS IN ONTARIO: THE IMPORTANCE OF ALLUVIAL MATERIAL FOR FISH, BENTHIC INVERTEBRATES, PERIPHYTON AND ORGANIC MATERIAL

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The natural flow regime is a key component of creating and maintaining in-channel and floodplain conditions critical for aquatic and riparian life. Changes in land-use and climate (e.g., urbanization, agriculture, damming) are expected to result in modified flow regimes leading to flashier and more powerful and erosive flows. Armouring streambanks to reduce erosion and damming leads to lower recruitment of gravels into streams while larger peak flows increases transport capacity leading to a loss of gravels: critical habitat for aquatic biota. Semi-alluvial streams are characterized by having only a thin veneer of alluvium on top of a non-erodible base of bedrock or clays. Under this new flow and sediment regime we will see more sections of exposed clay or bedrock. What does this loss of gravel mean for benthic invertebrates, fish and productive capacity? We sampled streams with varying degrees of exposed clay and bedrock for fish, benthic invertebrates, periphyton and coarse particulate organic matter. Our results indicate that gravel substrates are more productive than clay, containing a higher biomass of benthic invertebrates, periphyton and coarse particulate organic matter. Bedrock substrates were more productive in some cases and less in others, relating to the nature of the flow regime, bed transport, and bed scour. Fish density and biomass were not different among sites. Our study shows the importance of substrate in the productive capacity of streams. Further research should focus on other substrate types and watershed-scale substrate modeling to allow quantification of gains and losses of fish habitat.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral CCFFR) (GS)

VOLUME-WEIGHTED HYPOLIMNETIC OXYGEN (VWHO) AND EXTENT OF ANOXIA & HYPOXIA IN LAKES: HOW DO THESE METRICS OF HYPOLIMNETIC OXYGEN CONDITIONS COMPARE?

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The Ontario Ministry of Natural Resources (OMNR) has enacted guidelines for management of lake trout (*Salvelinus namaycush*) habitat in Ontario lakes by demarcating a threshold volume-weighted hypolimnetic dissolved oxygen (VWHO) value of 7 mg/L for fish habitat preservation. The nature of this oxygen metric, which involves determining the oxygen mass of hypolimnetic strata and standardizing it to the volume of the hypolimnion, may be difficult for lake managers to interpret in terms of how much of a hypolimnion is experiencing anoxic (dissolved oxygen concentration (DO) < 1 mg/L) or hypoxic (DO < 4 mg/L) conditions. In this study, we determine VWHO-anoxic-hypoxia relationships from approximately 500 end-of-summer oxygen profiles from 80 shield lakes in south-central Ontario. Hypolimnia typically do not have anoxic strata when VWHO is greater than 6 mg/L, and typically do not have hypoxic strata when VWHO is greater than 7 mg/L. A VWHO of 4 mg/L generally corresponds to anoxia in <20% of the hypolimnion, and hypoxia in approximately 50% of the hypolimnion. With VWHO values less than 3 mg/L, the entire hypolimnion is typically hypoxic, while greater than 50% of the hypolimnion is anoxic when VWHO is less than 2 mg/L. Results suggest that VWHO-anoxia-hypoxia relationships agree with 'intuitive' expectations (e.g. a VWHO = 4 mg/L indicates a hypolimnion is hypoxic). Results also validate the OMNR's VWHO guideline of 7 mg/L, as VWHO values less than this typically contain hypoxic and/or anoxic bottom strata, which would impair recruitment of juvenile lake trout.

Contributed Paper (Poster CCFFR)

LONG-TERM TRENDS IN AN INDEX OF BIOTIC INTEGRITY FOR NEAR SHORE FISHES IN HAMILTON HARBOUR, LAKE ONTARIO: THE CONFOUNDED EFFECTS OF MULTIPLE STRESSORS

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As part of the Great Lakes Action Plan, the coastal fish community in Hamilton Harbour, an IJC designated degraded area, has been monitored by boat electrofishing since 1988. An Index of Biotic Integrity (IBI), which is based on community metrics from the fish catch data, increased significantly between 1988 and 2008. Changes in IBI were associated with increases in species diversity, increases in the occurrence of turbidity-intolerant species, and with decreases in the abundance of non-native species in the fish catches. During this 20-yr period, several ecosystem-level changes, both positive and negative, have occurred in the Harbour as a result of management actions (phosphorus control, habitat restoration, installation of a carp barrier) and introductions of invasive species (*Dreissena* mussels, round gobies, and cormorants). By design, the Great Lakes IBI integrates the effects of four main factors influencing the fish community: non-native fishes, water quality, physical habitat, and piscivore abundance. Understanding the reasons for the change in IBI in Hamilton Harbour is critical for future management, but it is challenging because of the confounded multiple stressors that have impacted fishes in the harbour. Work on understanding the effects and interactions of the multiple stressors is ongoing. Despite the increases in IBI in recent years, average IBI values for Hamilton Harbour continue to be lower than for other coastal areas of Lake Ontario.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster CCFFR)

PROGRESS IN CHAR (*SALVELINUS*) TAXONOMY SINCE 1973

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In 1973, Scott and Crossman established much of the taxonomy for freshwater Canadian fishes and listed four species within *Salvelinus* as present in Canada – Arctic char (ARCH, *S. alpinus*), brook trout (BKTR, *S. fontinalis*), Dolly Varden (DVCH, *S. malma*), and lake trout (LKTR, *S. namaycush*). Work in the intervening 35 years has increased our understanding as follows: 1) Species-level taxonomy has been revised to recognize one additional species in the Canadian fauna – bull trout (BUTR, *S. confluentus*); 2) Realignment of the composition and distribution of ARCH, DVCH, and BUTR have all occurred, resulting in better understanding of allopatry, sympatry, contact zones and possible hybridization and introgression events; and 3) increased understanding of taxonomy of the species has laid the foundation for resolving complexities of intraspecific taxonomy and diversity. This new knowledge enables new efforts to resolve emerging issues for chars, particularly in more northern areas of the country, including: a) resolution of distributional disjunctions for DVCH, b) subspecific complexity in both DVCH and ARCH, c) life history and eco-phenotypic diversity in ARCH, BUTR, DVCH and LKTR, and d) improved understanding of anthropogenic effects on northern char diversity, which may profoundly affect northern aquatic ecosystems. Accordingly, although much progress has occurred, our understanding of char taxonomy and diversity is still very much a work in progress. However, thanks to the legacy of Bev Scott and Ed Crossman and “Freshwater Fishes of Canada”, we have an excellent foundation upon which to build new concepts of fish taxonomy for Canada.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

CHANGES IN FISH CONDITION AND MERCURY VARY BY REGION RATHER THAN FOOD CHAIN LENGTH: A RESULT OF CLIMATE CHANGE?

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We compared changes in mercury concentration ([Hg]) and body condition (relative weight) in Ontario coregonid fish populations between 1967-2006. Temporal comparisons among lakes were made to determine whether (1) the successful establishment of *Bythotrephes* had affected coregonid populations; (2) populations with longer food chains (*Mysis* present) were more stable over time, and (3) changes in [Hg] or condition depended on geography. Lake herring [Hg] in northwestern populations decreased more than those from northeastern or southern Ontario. Declines in body condition of both species were greater among northwestern populations compared with those from southern Ontario. Climate data from northwestern and southern Ontario showed a general warming trend over the period of study, but greater temporal changes in climate were observed at northern latitudes. In northwestern Ontario, growing degree days >5°C (GDD) increased and precipitation declined over the study period, whereas GDD and precipitation showed no significant trend in southern Ontario. We propose that the observed changes in fish [Hg] and condition are climate induced, with greater declines in fish condition and [Hg] in the northwestern region where climate change was most pronounced. Because fish condition affects both reproductive success and overwinter survival, observed condition declines of the magnitude reported here may have profound implications for the structure of future aquatic ecosystems in a warming climate.

Impacts of Climate Change on the Biodiversity of Canadian Lakes, Rivers, and Oceans (Oral SCL) (GS)

A PALEOLIMNOLOGICAL RECONSTRUCTION OF LAKE SIMCOE'S HISTORICAL COLD-WATER FISH HABITAT

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Since the start of European settlement (circa. 1800) in the Lake Simcoe watershed, phosphorus loading has increased 3-fold. Concurrently, Lake Simcoe populations of lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*) have declined. This decline is the result of poor population recruitment, attributed to eutrophication, causing a reduction in volume-weighted hypolimnetic oxygen (VWHO) concentrations. Recent phosphorus abatement efforts have succeeded in decreasing phosphorus inputs, and VWHO levels have recovered to a target value of 5 mg/L. However, cold-water fish populations continue to experience recruitment failure, possibly because an Ontario Ministry of Natural Resources (MNR) guideline of maintaining a VWHO of 7 mg/L better reflects the necessary habitat conditions of juvenile fish. This work aims to reconstruct historic VWHO values to determine how the cold-water fish habitat of Lake Simcoe has fluctuated since the onset of European settlement. VWHO values will be inferred using a Chironomidae (Insecta:Diptera) VWHO model. Fish abundances will be inferred using a *Daphnia ephippia* model. The major goals of these paleolimnological analyses are: 1) to determine if pre-disturbance characteristics of the lake include VWHO concentrations as high as 7 mg/L; 2) to determine how fish abundance has fluctuated; 3) to compare inferred changes in VWHO and fish abundance with variability in anthropogenic P inputs.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL)

CONTRASTING LANDSCAPE INFLUENCES ON SEDIMENT SUPPLY AND STREAM RESTORATION PRIORITIES IN NORTHERN FENNOSCANDIA (SWEDEN AND NORWAY) AND COASTAL BRITISH COLUMBIA

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The rate and calibre of sediment supply is a master variable determining channel structure. Steep topography, high precipitation, and erodible bedrock in geologically young landscapes with high sediment yields (e.g. coastal B.C.) results in streams with significant quantities of sediment and wood. Landscapes with low sediment supplies (e.g. northern Sweden, Finland, and the Canadian Shield) are characterized by low relief, resistant bedrock, and abundant mainstem lakes that act as sediment traps. Dominant landuse impact to streams in northern Sweden has been extensive channel narrowing, removal of obstructions, and bank armoring with boulders to facilitate timber floating, thereby reducing sediment supply from bank erosion and increasing export through higher channel velocities. In contrast, dominant landuse impacts in B.C. have increased sediment inputs from bank erosion, logging roads, hillslopes and gullies. Stream restoration in northern Fennoscandia has focused on channel widening and removal of bank-armoring boulders to increase sediment supply and retention. In contrast, restoration in coastal B.C. has focused on reducing sediment yields (through bank and hillslope stabilization) and restoring wood inputs. These contrasting impacts and restoration trajectories demonstrate the importance of understanding the roles of historic landuse on sediment supply and channel structure.

Contributed Paper (Oral CCFFR)

HABITAT-SPECIFIC HYDRAULIC GEOMETRY AND FREQUENCY DISTRIBUTIONS AS A SIMPLE APPROACH FOR MODELLING STREAM HABITAT PROPERTIES

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Accurately characterizing and modelling instream habitat in a cost-effective way is an ongoing challenge for stream ecologists. We applied frequency distributions (gamma probability functions fit to point velocity and depth data) to evaluate their ability to characterize variation in hydraulic conditions at the channel unit scale among contrasting habitat types (pools, glides, riffles, and runs) at different flows in a small trout stream. Velocity and depth distributions differed systematically between habitat types, with linear regression explaining 65 and 72 %, respectively, of variation in gamma distribution parameters related to skewness and kurtosis. Modelling variance in mean velocity and depth using gamma distributions provided accurate estimates of reach average habitat suitability for trout. Frequency distributions provide a simple method to characterize and model hydraulic conditions in streams, but their transferability across systems requires further study, and their widespread application depends on developing clear relationships between distribution parameters and easily measured stream characteristics, like habitat type, channel size, gradient, and substrate calibre.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR)

REAPPEARANCE OF A LARGE, WIDELY DISTRIBUTED FISH

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Casey and Myers (1998) published a paper entitled 'Near Extinction of a Large, Widely Distributed Fish' which described the collapse of barndoor skate (*Raja laevis*) throughout its range in the northwest Atlantic. This widely cited paper was instrumental in drawing attention to the extinction risk faced by incidentally harvested marine species through overfishing although subsequent research questioned the degree to which barndoor skate numbers truly declined. In the present study, we updated and expanded upon the datasets used by Casey and Myers (1998) to reassess the status of barndoor skate. We found that although the species remains at low levels of abundance in much of the northern part of its range, it has rebounded to historic levels in southern areas. The initial decline of barndoor skate on Georges Bank was coincident with a large increase in groundfish landings and the recent increase in abundance followed a period of low fishing activity in this area. Recent life history information suggests that the species may be more resilient to exploitation than previously thought and these life history characteristics, coupled with the reduction in fishing effort on Georges Bank, may have allowed barndoor skate to rebound in less time than may have been anticipated. Although barndoor skate numbers have increased considerably in some areas, there is continued concern for their status in the face of high fishing pressure. This study, in conjunction with that of Casey and Myers (1998), highlights the importance of assessing the abundance and life history of non-commercial marine species.

Contributed Paper (Poster CCFFR)

SAMPLING REQUIREMENTS FOR THE ESTIMATION OF ANNUAL ZOOPLANKTON ABUNDANCE AND COMMUNITY DYNAMICS IN NORTH TEMPERATE LAKES

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Detecting and understanding long-term changes in zooplankton populations and communities requires sound sampling strategies and reliable estimates of annual abundance. We use a long-term, highly-resolved dataset from four north-temperate lakes to investigate the sampling requirements necessary to precisely quantify common zooplankton species and taxonomic aggregates as well as the influence that a reduced sampling regime has on our ability to investigate changes in community structure. Sample sizes required for estimating mean annual abundance (with a precision of 20%) ranged from 8-11 samples per year for all zooplankton taxa to as many as 34-86 samples per year for individual rotifer species, depending on the lake. Despite these often onerous sampling requirements for some taxa, patterns of population abundance were fairly similar when compared using reduced (five samples per year) and extended (14 samples per year on average) datasets. The same three-fold reduction in sampling produced shifts in community structure ranging between 6-20% for two-dimensional solutions and between 9-21% in three dimensions, depending on the lake. Although individual investigators need to determine acceptable boundaries of sampling precision based on the objectives of their study, it appears that enumerating 5-10 sample events per year may adequately document long-term changes in populations and communities on an annual basis in many lakes.

Contributed Paper (Oral SCL)

EFFECTS OF AGRICULTURALLY-DERIVED NITRATE ON THE ESTUARINE FOOD WEB STRUCTURE AND FISH COMMUNITIES OF PRINCE EDWARD ISLAND

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Agriculture is a major industry on Prince Edward Island (PEI), covering approximately 45% of the land area. Large quantities of nitrate from artificial fertilizers are entering surface and groundwaters that feed estuaries and bays, displacing sea grass (*Zostera*) plant cover with dense blooms of sea lettuce (*Ulva lactuca*) and resulting in anoxic events. Better understanding of how this eutrophication problem affects the food webs and fish communities can enable more effective mitigation strategies. Using carbon and nitrogen stable isotope analysis the estuarine food webs were described at five stations in the Stanley River estuary on PEI where habitat varied from complete eelgrass coverage to complete sea lettuce cover. Stable isotope signatures did not differ between fish caught at high and low sea lettuce stations. This indicated little or no shift from a pelagic to a benthic-driven food web. In addition, the fish community at these five stations was sampled monthly from May to August by beach seining. Differences in the fish community were found between stations with high and low sea lettuce cover. In general, stations with large quantities of sea lettuce had more mummichogs and fewer threespine and fourspine sticklebacks than those with less sea lettuce. The fish community also varied temporally throughout the summer, with diversity being greatest in May and June, while mummichogs, fourspine sticklebacks, young-of-the-year (YOY) *Gasterosteus*, and YOY mummichogs dominated in July and August. It appears the fish community changes with sea lettuce impact, but fish diets do not.

Contributed Paper (Oral CCFR) (GS)

HOW DO WE SCALE UP MEASUREMENTS OF BENTHIC PHOTOSYNTHESIS TO THE WHOLE LAKE?

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Recent studies of benthic primary production have indicated that it can be as important to the total ecosystem production as pelagic primary production. These studies have used very few measurements to scale up to the full lake, taking into consideration only light. There are, however, several other environmental factors that are known to affect primary productivity, including nutrient concentrations, community composition and disturbance. In this study, we test the effect of date, depth, algal community composition, algal biomass, sediment type, and disturbance on the primary production of soft sediments in a Canadian Shield lake. Previous studies have measured benthic primary production under in situ light conditions; however variable cloudiness can create problems when extrapolating these measurements. Therefore, we measured benthic primary production as full photosynthesis vs. irradiance curves at each site. A multiple regression analysis showed that the rate of benthic primary production was related to date and algal biomass as well as interactions with sediment type and algal community composition ($p < 0.0001$, adjusted $R^2 = 0.67$, $n = 34$). Everything else being equal, primary production was higher at the end of the summer, but lower at sites with higher chlorophyll. These results indicate that it is important to consider how benthic primary production will change throughout the season as well as how it varies across sites. A final test will be conducted to determine if this model predicts a significantly different overall contribution of benthic primary production to the whole lake than the simpler model of light only.

Contributed Paper (Oral SCL) (GS)

PREDICTING FISH DENSITIES AT DIFFERENT SPATIAL SCALES: EVALUATING PREDICTIVE SUCCESS OF UNIVARIATE AND MULTIVARIATE STATISTICAL APPROACHES

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Modelling species distributions and community composition with high predictive ability from small to large spatial scales is essential to understanding species-habitat relationships. The objectives of our study were to determine: i) how the size of analytical units influence fish-habitat relationships, ii) how predictive success varies for species and community models, and iii) how linear vs. tree-based models perform in predicting fish-habitat relationships. Fish density and local and landscape environmental data were collected for Purvis Lake, a Laurentian lake on the Canadian Shield, in July 2005. There were four fish species found in the lake: pumpkinseed, rock bass, smallmouth bass, and yellow perch. We developed and evaluated the predictive success of species and community models at small (20m) and large (100m) sampling units using multiple regression, regression trees, redundancy analysis, and multivariate regression trees. At the 20 metre sampling unit, regression trees on average explained the most variation (33%) in quantifying fish-habitat relationships. At the 100 metre sampling unit, multivariate regression trees explained approximately 73% of the variation in fish community density. At both spatial scales, regression trees and multivariate regression trees explained more variation than their linear univariate and multivariate counterparts. This suggests that the fish density data in Purvis Lake are exhibiting a non-linear response with respect to environmental variables. This study demonstrates the importance of evaluating a suite of statistical approaches to select the best statistical approach to use on a dataset, which can then be used to identify key determinants of habitat quality for species and communities.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR)

PROTOTYPE VIBRATING WAVE GENERATOR FOR MEASURING GROWTH CHANGE OF FISH EXPOSED INDUSTRIAL NOISE AND VIBRATION STIMULI

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A prototype vibrating wave generator designed to measure the growth change of fish exposed industrial noise and vibration stimuli was developed and some experiments were conducted to confirm its practical use. The vibrating wave generator is composed of a programmable logic controller with a D/A converter, an inverter to control the rpm of the vibration motor and a vertical vibration motor attached on a water tank. At the results, the underwater sound wave similar to the one recorded in the field during the bulldozer operation was regenerated successfully in the water tank using the vibrating wave generator. The rpm of the vibration motor was controlled 2.5 to 5.0 seconds to make the vibrating wave pattern. The growth rate of the 20 individuals of eel (*Anguilla japonica*) exposed noise and vibration in the test water tank was reduced 30% approximately than the one in the control water tank during 48 days experiments. The underwater noise level in the test water tank as a stimuli source was about 30 dB higher than the background underwater noise level. The operation interval of the vibration motor was 4 minutes OFF and 2 minutes ON from 8h 00m to 12h 00m, 13h 00m to 17h 00m in everyday for 48 days.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster CCFFR)

BEV SCOTT: A VIEW FROM SOUTH OF THE BORDER

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Bev Scott has had a long and distinguished association with ichthyology and ichthyologists in the United States. Largely through his membership in and contributions to the American Society of Ichthyologists and Herpetologists (ASIH), Bev has many friends in Canada's neighbor to the south. Smith and Collette share some reminiscences about Bev.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFR)

LAND-USE CONTEXT GOVERNS THE PERFORMANCE OF FRESHWATER MUSSELS TO NUTRIENT CYCLING AND TROPHIC PROVISIONING

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The extent to which humans alter landscapes will have profound implications on how energy and nutrients move through ecosystems. These should be most pronounced in streams, which serve as conduits of material transport and ultimate buffer to lake and coastal ecosystems. Freshwater mussels are native filter-feeding bivalves that occur in large, speciose aggregations known as mussel beds. Through their filtering abilities they can have large effects on ecosystems by moving materials from the water column to the benthos, which in turn, benefits local algal and invertebrate communities. We asked how the trophic importance of these subsidies changes relative to local nutrient limiting conditions associated with an agricultural land-use gradient. We selected 14 mussel beds in streams with varying agricultural land use (10-90% crop monoculture) and quantified variables relevant to ecosystem (nutrients, leaf bag community respiration) and mussel (oxygen, consumption, nutrient excretion) performance. Overall, freshwater mussel performance varied as a function of land-use with increased rates of oxygen consumption and ($r^2 = 0.81$, $P < 0.05$) excretion ($r^2 = 0.23$, $P < 0.05$) associated with high crop monoculture. Our results show that shifts in land-use may have cascading effects on the physiology and performance of freshwater mussels. Consequently these shifts may alter the nature of foodweb subsidies at adjacent and higher trophic levels.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

TAXONOMY IN THE GRAND SCHEME OF THINGS

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While the attention to, and appreciation of, taxonomy has been punctuated in the century of history of fisheries research in Canada, W.B. Scott has been a consistent contributor and champion of this field for many decades. Bev's three taxonomic syntheses and his persistent support of Canadian collections represent a great legacy. In this paper we look back at some aspects of the pivotal role Bev has played in Atlantic fisheries work, including his Atlantic taxonomic syntheses and the establishment of the Atlantic Reference Centre. We also look forward to discuss the increasing importance of taxonomy to the evolving interest in biodiversity objectives and to the challenges of the spatial, temporal and taxonomic scope of future monitoring.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFR)

THE IMPORTANCE OF EXPORTED CATCHMENT PRODUCTS IN SHAPING LITTORAL BENTHIC INVERTEBRATE COMMUNITIES

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Relationships between exported catchment materials and near-shore benthic invertebrate communities were investigated using a gradient of forest denudation from smelter-related aerial deposition on the Sudbury landscape. Catchments and associated streams running into Daisy Lake were used as sites that provide a gradient of doses of allochthonous products to near-shore habitats and communities. Leaf-packs and kick and sweep surveys characterized the benthic invertebrate community, and environmental surveys included stream water samples, sediment traps and riparian forest point-surveys. Latent PCA variables (factors) of community assemblage gradients correlated to inputs of inorganic and organic materials. Highest diversities were observed at sites with the most export of organic materials from wetlands and densely forested catchments. This study reveals the importance of allochthonous inputs to oligotrophic lakes and suggests remediation options to restore damaged terrestrial and aquatic communities simultaneously.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

SPATIAL AND TEMPORAL VARIABILITY IN N₂O EMISSIONS AND N BUDGET FOR LAKE SAINT-PIERRE A LARGE FLUVIAL LAKE OF THE ST. LAWRENCE RIVER, CANADA

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Aquatic ecosystems, per unit area are considered to be hotspots on the landscape for denitrification. One of the by-products of denitrification, nitrous oxide (N₂O) is a potent greenhouse gas and with anthropogenic N loading on the rise to aquatic ecosystems this should result in increased N₂O emission from rivers and lakes. Direct measurements of N₂O flux in large rivers are still rare and factors regulating the relative production of N₂O to N₂ are poorly understood in freshwaters. Here we measured N₂O concentrations at 25 sites over the summer, in Lake Saint-Pierre (LSP) a broadening of the St Lawrence River. Overall LSP is a net atmospheric source of N₂O with fluxes averaging 3.9 $\mu\text{mol-N m}^{-2} \text{day}^{-1}$. Emissions were spatially and temporally highly variable ranging from -4.2 $\mu\text{mol-N m}^{-2} \text{day}^{-1}$ to 50.9 $\mu\text{mol-N m}^{-2} \text{day}^{-1}$. TN concentrations alone explained 62% of the variance in N₂O fluxes and both were highest in the early summer. Although the overall rate of emissions varied greatly among sampling dates, the site of highest N₂O emissions shifted from downstream to upstream sites over the summer. LSP retained approximately 36% of its N-NO₃⁻ load with N₂ production accounting for 46% of this retention. When we compared our annual flux estimate with those of other systems in a literature survey, two classes of rivers apparently emerged. Systems with a lower average hydraulic load (mean depth: water residence time) emitted more N₂O per unit NO₃⁻. Our results also suggest a variable N₂O: N₂ ratio in LSP and other aquatic systems.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

ORIGINE DE LA TRUITE ARC-EN-CIEL (*ONCORHYNCHUS MYKISS*) DANS L'EST DU QUÉBEC

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La truite arc-en-ciel est une espèce de salmonidé exotique qui a été introduite au Québec dès la fin du XIXe siècle. Bien que son ensemencement et son élevage soient restreints aux régions situées en amont du Fleuve St-Laurent, on note depuis quelques années la capture de truites arc-en-ciel dans les rivières à saumon de la Gaspésie, de la Côte Nord, de Charlevoix et du Bas-St-Laurent. On s'inquiète désormais de son impact potentiel sur les salmonidés indigènes, comme le saumon atlantique et l'omble de fontaine, puisque les risques de compétition pour la nourriture et l'habitat sont élevés, particulièrement au stade juvénile. Afin de mieux comprendre le processus de colonisation de cette espèce au Québec, nous avons tenté de déterminer l'origine génétique des spécimens que l'on retrouve désormais dans l'est de la province. S'agit-il d'individus issus des lignées piscicoles utilisées pour les ensemencements? Ou encore de migrants provenant des populations établies en amont du Fleuve et dans les provinces Maritimes? Une analyse de réassignation populationnelle basée sur des microsatellites a été réalisée à partir de onze populations sources : six populations naturalisées du Québec, de l'Ontario, de l'Île-du-Prince-Édouard et des États-Unis et cinq lignées piscicoles du Québec et des Maritimes. Les résultats obtenus mettent en lumière l'importante contribution des populations naturalisées du Québec et de l'Ontario au processus d'invasion de la truite arc-en-ciel dans l'Est du Québec, alors que les lignées piscicoles et les populations des Maritimes semblent n'avoir qu'un rôle négligeable.

Contributed Paper (Oral CCFFR) (GS)

RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) ORIGIN IN EASTERN QUEBEC

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Rainbow trout is an exotic salmonid introduced in Quebec since the end of XIX century. Even if its stocking and rearing are restricted to regions located in the upper part of the St. Lawrence River, captures have been recorded in salmon rivers of Gaspésie, Côte Nord, Charlevoix and Bas-St-Laurent regions in recent years. Concerns have been raised about its potential impact on native salmonids, such as Atlantic salmon and brook charr, because of the high risks of competition for food and habitat, especially at the juvenile stage. To understand the colonization process of this species in Quebec, we determined the genetic origin of specimens now found in the eastern part of the province to answer the following questions. Do these individuals come from farmed strains used for stockings? Or are they migrants from established populations located upstream or in the Maritimes provinces? We conducted a population assignment analysis based on microsatellites with eleven source populations: six naturalized populations from Quebec, Ontario, Prince-Edward-Island and USA, and five aquaculture strains from Quebec and Maritimes. The colonization process of rainbow trout in Eastern Quebec is primarily derived from naturalized populations in Quebec and Ontario, whereas farmed strains and Maritimes populations seem to play a negligible role.

Contributed Paper (Oral CCFFR) (GS)

TRACKING THE TIMING OF PERMAFROST THAW USING DIATOMS IN SEDIMENT CORES FROM LAKES NEAR INUVIK, NWT

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Despite predictions of major changes in northern hemisphere permafrost extent, little information exists regarding the impact this loss will have on freshwater ecosystems. In the western Canadian Arctic, permafrost thawing often leads to retrogressive thaw subsidence. Based on water chemistry analyses it is known that systems with histories of thaw slumping have altered chemical characteristics; however, the timing of this change is not known. Using paleolimnological techniques our aim was to track permafrost thaw by comparing diatom assemblages from lakes currently impacted by permafrost slumping, with those that lack visible slump scars. In Lake INV-2a, an undisturbed lake, small benthic taxa have dominated the diatom assemblage for the period represented by this 32 cm sediment core. In the uppermost portion of the core planktonic *Cyclotella pseudostelligera* have increased in relative abundance, a signal shown regionally to be an indication of climate warming. Nearby Lake INV-2b, has a stable slump scar on its margin, which is believed to have formed in the early 20th century, and is known to have been accelerated by an intense fire that burned the Inuvik area in 1968. A decrease in the relative abundance of periphytic diatoms corresponding to the timing of slump development suggests that slumping results in changes in diatom habitats. In sediment intervals since the fire-induced acceleration, there has been a major increase in *Cyclostephanos* taxa, which may be tracking an increase in conductivity and nutrients released by the slump. Future analyses will focus on other impacted sites, including those with active slumps.

Contributed Paper (Oral SCL) (GS)

MOVEMENT AND HABITAT USE OF A LACUSTRINE POPULATION OF BROOK CHARR (*SALVELINUS FONTINALIS*) IN THE INDIAN BAY WATERSHED, NEWFOUNDLAND

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Most current studies on movement and habitat use of brook charr (*Salvelinus fontinalis*) have concentrated on streams and rivers, or the open water seasons in lakes. At this time, no studies have examined variations in movement rates and habitat associations of lacustrine brook charr on an individual basis throughout the year. The purpose of this study is to examine changes in the activity of individual brook charr in a lake throughout the year and identify possible triggers for these changes. This study will examine a lacustrine population of brook charr in Little Bear Cave Pond, an approximately 225 ha lake located in the Indian Bay watershed east of Gander, Newfoundland from September 2008 to November 2009. Twenty brook charr were tagged with Vemco V9TP-2L acoustic tags which transmit the ambient water temperature and pressure. Lake-wide fish movement will be monitored using Vemco VR2W acoustic receivers arranged in an equilateral triangle grid throughout the lake. This grid system will allow the vertical and horizontal positioning of tagged individuals to within 2-5m accuracy. In addition to the acoustic tags, 300 brook charr were tagged with PIT tags. Movement of PIT-tagged individuals in the littoral zone will be monitored using near-shore RFID antenna arrays. Year round weather data, water temperature profiles and light penetration, as well as seasonal water quality and fish diet, will be monitored and compared with the results of the tracking study to identify fish-activity triggers.

Growth at the Individual and Population Scales (Poster CCFFR) (GS)

EFFECTS OF STOCKED TROUT ON COMMUNITIES IN SMALL BOREAL FOOTHILLS LAKES

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The stocking of lakes with non-native trout is an established management activity that creates recreational fisheries. However, significant ecological impacts of trout are documented, particularly in naturally fishless, oligotrophic and/or alpine lakes. Trout are currently being stocked into small Boreal Foothills lakes in Alberta. In contrast to alpine lakes, however, these Foothills lakes are warmer, more productive, and contain dense populations of macrophytes and hardy forage fishes. Since small-bodied fishes can themselves affect macroinvertebrates and amphibians, and ecosystem resistance to disturbance can be related to productivity and availability of refuges, we hypothesized that effects of stocked trout would be muted in these boreal-foothills lakes. We found no evidence that wood frog differed in abundance, body size, or metamorphosis patterns between fish-bearing stocked and unstocked lakes. In a naturally fishless unstocked lake, however, wood frogs were both more abundant and larger than in unstocked lakes containing forage fish. Densities of forage fishes (fathead minnow, brook stickleback, dace spp.) were variable among lakes and years, but there was no overall difference between stocked and unstocked lakes. Trends in size structures of minnows in stocked vs. unstocked suggest predation may be altering size distributions and forage fishes were more benthic, more concentrated inshore and/or less diurnal in stocked vs. unstocked lakes. Trout did not affect the abundance or sizes of most invertebrate taxa. Our comparisons suggest that there were limited impacts on native communities of the lakes into which trout were stocked.

Contributed Paper (Oral CCFFR)

GHG FLUXES (CO₂, CH₄, N₂O) AND pCO₂ MONITORING BEFORE AND DURING THE FIRST THREE YEARS OF THE EASTMAIN-1 RESERVOIR (QUEBEC, CANADA)

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The recent flooding (November 2005) of Eastmain-1 (EM-1) reservoir is currently being monitored within a joint study (Hydro-Québec, Université du Québec à Montréal, McGill University, Environnement Illimité inc.). The main goal is to determine the GHG fluxes from various terrestrial and aquatic environments before and after flooding in order to establish the impacts, in terms of net GHG emissions, of creating reservoirs in northern environments. The results of GHG (CO₂, CH₄ and N₂O) fluxes and dissolved gases measurement campaigns carried out during the open-water period and under-ice in this newly created reservoir are presented, and compared to those obtained in the natural aquatic environments present before flooding. CO₂ fluxes ($8,059 \text{ mg CO}_2 \text{ m}^{-2} \text{ d}^{-1} \pm 58\%$; $n = 79$) measured in the EM-1 reservoir increased rapidly the first year after impoundment to reach values between 4 to 10 times higher, respectively, than those measured in the aquatic environments before flooding ($574 \pm 14\%$ ppm, $n = 17$ and $758 \text{ mg CO}_2 \text{ m}^{-2} \text{ d}^{-1} \pm 98\%$, $n = 188$). In 2008, 3 years after flooding, the CO₂ fluxes are only 2 times higher than natural lakes. CH₄ fluxes have returned to natural values 2 years after flooding.

Contributed Paper (Oral SCL)

THE ROLE OF LAKE STURGEON IN A REMOTE FIRST NATION COMMUNITY, NAMAYGOOSISAGAGUN FIRST NATION, HIGHLIGHTING RESULTS FROM A THREE YEAR SPAWNING SURVEY IN SMOOTHROCK LAKE, ONTARIO

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Through time immemorial the lake sturgeon has held an important role in First Nation communities. Namaygoosisagagun First Nation is unique, due to its remote location in Northern Ontario, so lake sturgeon continues to play an important role in this community. Lake sturgeon provides a reliable food source every spring through subsistence fishing; this relationship is changing with younger generations not wanting to pick up this harvesting tradition. The Anishinabek Ontario Fisheries Resource Centre (A/OFRC) along with the Namaygoosisagagun First Nation has completed three consecutive years of lake sturgeon spawning surveys. The use of traditional ecological knowledge from elders of Namaygoosisagagun First Nation was essential in the commencement of this project. Since this lake is remote, it has not had the development of dams and the creation of commercial fisheries. Consequently, the lake sturgeon population has been only minimally affected and provides an interesting comparison with other more negatively affected populations. A total of 146 lake sturgeon have been sampled, tagged and released. Lake sturgeon sampled in 2006, 2007 and 2008, had a total of 34 year classes and ranged from 8 – 51. This population dynamics of lake sturgeon in Smoothrock Lake are similar to two other lakes located in Northern Ontario: Lake of the Woods and Burntbush Lake. Preliminary genetic work has shown that Smoothrock Lake, lake sturgeon population originated from the Great Lakes gene pool.

Contributed Paper (Oral CCFR)

PREY QUALITY AFFECT THE PRODUCTION OF WILD PACIFIC SALMON IN THE NORTHERN CALIFORNIA CURRENT ECOSYSTEM

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The marine survival of salmon has been observed to covary with climate and ocean conditions at small and large spatial scales. Several competing hypotheses have been proposed to explain these patterns. Although the specific mechanisms affecting the marine survival of salmon differ among these hypotheses, all generally agree that lower marine survival of Pacific salmon is associated with lower marine growth during their first year at sea. In this study, we examined the effects of ocean conditions on the growth and survival of Pacific salmon in the northern California Current System (CCS) and Alaska Coastal Current (ACC), and developed forecasting models for the marine survival of Pacific salmon. Our work shows that, while plankton productivity and temperatures tend to be higher in the CCS, salmon are generally larger and fatter, and have higher growth in the ACC. The poorer growth and condition of salmon in the northern CCS appears to be related to a calorie-deficient diet rather than to lower rates of food consumption or to higher metabolic rates. This indicates that ocean conditions affect salmon production through changes in prey community composition and quality, which in turn are induced by the effects of climate on ocean circulation, and on the local success of different zooplankton life history strategies (year round activity vs seasonal dormancy and lipid accumulation).

Growth at the Individual and Population Scales (Oral CCFR)

USING DNA-BASED STOCK IDENTIFICATION TO ELUCIDATE COASTAL MIGRATION OF JUVENILE SOCKEYE SALMON (*ONCORHYNCHUS NERKA*)

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The ocean feeding grounds of juvenile salmon range over several thousand kilometres of highly variable physical ocean conditions, prey quality and abundance, and predator assemblages. Therefore, the fate of individual stocks may depend on where they migrate and how much time they spend in different regions. Using DNA stock identification techniques, we reconstructed migration patterns for juvenile sockeye salmon (n=4062) along the entire Pacific coast of North America. In spring and summer, the majority of fish were caught in close proximity to their respective rivers of origin. By fall, sockeye salmon were caught as far north and west as the Alaska Peninsula, with the majority of fish caught from Central British Columbia and SE Alaska. Juvenile sockeye salmon generally disappeared from the coast by winter, suggesting dispersion into the Gulf of Alaska. However, we also demonstrated stock-specific differences in migration patterns. For each stock identified, body size and energy density were higher at northern latitudes suggesting an environmental or food web influence on juvenile sockeye growth or alternatively, that faster growing fish initiated their northward migration earlier.

Size-Selective Exploitation of Freshwater and Marine Fish Populations (Oral CCFFR)

A COMPARISON OF TECHNIQUES FOR DETERMINING P-LIMITATION IN LAKES

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Phosphorus is known to be a limiting nutrient in many freshwater ecosystems. Measurement of P-limitation in lakes has been problematic and the validity of some commonly used techniques has been called into question. Here we examine soluble reactive phosphorus (SRP), total dissolved phosphorus (TDP), total phosphorus (TP) and alkaline phosphatase activity (APA) and compare these with the turnover time of the dissolved phosphate pool (TT, determined by radiobioassay), which has been considered a reliable indicator of P-limitation. Twenty lakes with TP concentrations ranging from 10.72 to 75.00 µg/L were sampled during the summer. TDP best predicted TT ($\log TT = -0.5292 \log TDP + 1.2079$, $R^2 = 0.3725$, $p = 0.004$). TP was also significantly related to TT ($p = 0.01$). SRP and APA were not significantly related to the TT. The usefulness of the different indicators for detecting P-limitation ranked as follows: TDP>TP>APA>SRP. The results suggest that TDP may be a good indicator of P-limitation in plankton, unlike APA and SRP which did not correlate with TT.

Contributed Paper (Poster SCL)

APPLYING $\delta^{18}\text{O}$ - O_2 TO ECOLOGICAL QUESTIONS IN IMPACTED RIVERS

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Understanding the effects of multiple agricultural and urban/suburban stressors on river ecology will be assessed by using a series of Canadian rivers with different upstream nutrient and metabolic histories. Diel changes in O_2 concentrations have previously been used to estimate biological rates but this approach has suffered from various assumptions such as gas exchange rates. By combining diel variation in O_2 with $\delta^{18}\text{O}$ - O_2 both metabolic and gas exchange rates can be better constrained than by O_2 concentrations alone. The PoRGy (photosynthesis–respiration–gas exchange) model will be used to examine how metabolic and gas exchange rates are changed by these cumulative stressors. Further, the duration of impacts, that is, for how long downstream do the impacts persist, will be addressed by linear transects of several hundred kilometers. Understanding the nature and duration of impacts in Canadian rivers is an important part of good river management. The ability to understand the results of future river diversion and nutrient additions requires better understanding of river ecology than is presently available.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

QUANTIFYING CHANGES IN TOTAL PHOSPHORUS AND WHOLE-LAKE MACROPHYTE BIOMASS BETWEEN PRE-DISTURBANCE AND PRESENT DAY CONDITIONS IN THE EASTERN TOWNSHIPS OF QUEBEC USING PALEOLIMNOLOGICAL APPROACHES

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Eutrophication of lakes can lead to a number of dramatic ecosystem shifts, including the dominance of toxic cyanobacteria, hypolimnetic anoxia, fish kills, and the collapse of macrophyte communities. With the relatively large number of recent closures or warnings of cyanobacteria blooms in Eastern Township lakes, residents have become increasingly concerned about eutrophication. In an effort to quantitatively determine the extent of water-quality deterioration in the Eastern Townships, we have undertaken a paleolimnological study of 41 lakes in the region. Surface sediment diatom assemblages were used to construct inference models for total phosphorus and whole-lake macrophyte biomass. These models will then be applied to the diatom assemblage in the bottom 1 cm of the sediment cores to infer pre-disturbance (before 1850) total phosphorus and whole-lake macrophyte biomass in the 41 lakes. This top-bottom paleolimnological approach has the advantage of providing quantitative data on water-quality change over a broad spatial area. The change in water-quality from pre-disturbance to present day will then be compared to human land-use in the catchment to determine if human land-use is a strong predictor of a decline in water-quality.

Contributed Paper (Oral SCL) (GS)

LONG-TERM CHANGE IN THE RELATIONSHIP BETWEEN OXYGEN AND THERMAL STRUCTURE IN LAKES IN THE DORSET REGION OF ONTARIO

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Climate change has been implicated in a number of undesirable outcomes such as hotter summer periods, often accompanied by drought. Climate change also promotes earlier ice-off and longer ice-free seasons, which in turn permit lakes to stratify earlier and remain that way longer, thus lengthening optimal growth periods for certain algal species like cyanobacteria and the period of hypolimnetic respiration. Analysis of a 20+ year data set of climate and lake water conditions from the Dorset region of Ontario indicates a small long-term change in the end-of-summer depth of the 1 mg/L oxygen isopleths in relation to the thermocline in some lakes. The biogeochemical consequences of this change may explain the recent occurrence of cyanobacterial blooms in the shallower, more eutrophic lakes of the Dorset region.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Poster SCL) (GS)

LONG-TERM LIFE HISTORY TRENDS IN NEWFOUNDLAND NORTHERN SAND LANCE

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Human exploitation may alter population structure of the targeted species through both environmental and genetic mechanisms. Commercial fisheries most often target the largest and oldest individuals of a population, which may lead to fishery-induced evolution. It is difficult, however, to distinguish such changes from those resulting due to phenotypic plasticity. Maturation age and size have decreased in Newfoundland stocks of herring and capelin. Data for herring suggests that this change is due to fishery-induced evolution. Sand lance, Newfoundland's other planktivorous pelagic fish, has never been fished commercially and thus can act as a pseudo-control. If maturation changes in herring and capelin are due to fishery-induced evolution, they should not have occurred in sand lance. Sand lance samples were collected between 1968 and 2006 during standardized annual surveys by Fisheries and Oceans Canada. We will investigate temporal trends in sand lance maturation and growth rates after fish ages have been determined. As an initial analysis, sand lance data have been examined for shifts in the ratio of gonad weight to body weight to determine whether gonadal investment has increased over time at smaller sizes.

Size-Selective Exploitation of Freshwater and Marine Fish Populations (Oral CCFFR) (GS)

SYNERGISTIC EFFECT OF NITROGEN AND PHOSPHORUS ON PRIMARY PRODUCTION: NOW YOU SEE IT, NOW YOU DON'T

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Anthropogenic nitrogen and phosphorus inputs are the primary stressors that drive cultural eutrophication of freshwater ecosystems. There often exists debate over the relative importance of the direct and indirect (i.e. co-limitation) effects of the two nutrients on primary production. Conflicting lines of evidence regarding nutrient limitation of freshwater ecosystems may stem from differences in study scale. We assessed nutrient limitation in alpine waterbodies by conducting surveys of water chemistry, nutrient bioassays, and a replicated whole-pond fertilization experiment. Lakes appeared phosphorus-limited while ponds were nitrogen-limited based on the common chemical index of nutrient limitation, namely total dissolved nitrogen:total phosphorus). In contrast, meta-analysis of our results from 60 in vitro bioassays indicated co-limitation was widespread – nitrogen significantly amplifying the driving positive effect of phosphorus on phytoplankton production. However, neither nitrogen nor phosphorus significantly increased phytoplankton or periphyton abundance in natural whole ponds, owing likely to the offsetting effect of observed high grazing pressure. Therefore, our findings clearly demonstrate the importance of scale when interpreting evidence of nutrient limitation from empirical studies.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

SELECTING ORDINATION DIAGRAMS WITH INFORMATION CRITERIA

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Graphing is one of the most important components of data analysis and presentation. Multivariate datasets are particularly difficult to graph, which is a problem as many questions in aquatic ecology are inherently multivariate. For example, in aquatic community ecology the number of variables of interest is usually greater than the number of species in the community under study. Ordination methods provide a powerful approach to graphing multivariate data. These methods summarize complex datasets with a few latent variables (i.e. axes). Unfortunately, conducting an ordination requires several methodological decisions to be made, including the choice of a distance measure, a scaling procedure, the number of axes and an appropriate response model for interpreting the abstract axes in terms of the original variables. These choices often have substantial effects on biological conclusions drawn from ordination diagrams and we are far from a consensus on how to make them. As our quantitative toolbox grows, new possibilities are emerging for addressing these methodological issues. Here I modify the newly popular AIC procedure to make these choices, in a manner that is similar to the familiar task of choosing among alternative regression models. This modified AIC procedure allows analysts to combine the information in the dataset being graphed with prior information about the system under study to help make methodological decisions. This is an advance over the standard approach of recommending ordination procedures based on their performance in simulation studies, which ignores much of the information contained in the data actually being graphed.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR) (GS)

ASSESSING THE ESTABLISHMENT SUCCESS OF *BYTHOTREPHER LONGIMANUS* IN RELATION TO ENVIRONMENTAL CONDITIONS IN SOUTH-CENTRAL ONTARIO LAKES

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Bythotrephes longimanus is an invasive planktonic crustacean that has arrived in North America from Europe and poses a leading threat to the biodiversity of Canadian lakes. Determining the suitability of a lake to *Bythotrephes* establishment is an important step in quantifying its potential habitat range and environmental risk. In this study lake environmental conditions and *Bythotrephes* occurrence data were collected from more than three hundred south-central Ontario lakes. Statistical models were developed and compared to predict *Bythotrephes* incidence using four modeling approaches: linear discriminant analysis, multiple logistic regression, classification trees and artificial neural networks. The performance of different modeling approaches offered a strategy to determine the environmental conditions that are suitable for the survival of *Bythotrephes* and the hidden factors that regulate its spread. Linear discriminant analysis and multiple logistic regression indicated that lake chemical variables are more important for predicting *Bythotrephes* occurrence whereas classification trees and artificial neural networks suggested that lake physical variables are more influential. All the four approaches ranked pH as a relative important predictor of *Bythotrephes* incidence. Multiple logistic regression performed better than the other three modeling approaches as demonstrated by several performance metrics. Resemblance analysis comparing each method's prediction for each lake was performed to determine how similar the four approaches were at predicting *Bythotrephes* occurrence, and the results indicated that predictions from multiple logistic regression had a relatively strong association with those from artificial neural networks.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR) (GS)

SHORT-TERM EFFECTS OF DRAIN MAINTENANCE ON AQUATIC ASSEMBLAGES INHABITING AGRICULTURAL DRAINS IN SOUTHWESTERN ONTARIO

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There is growing demand for ecologists to elucidate the effects of human actions on natural ecosystems and to restore nature-like ecosystem functions to heavily altered ecosystems. Our study focuses on the short-term responses of fish and invertebrate assemblages to the maintenance of agricultural drains, systems where the consequences of human actions are currently of significant ecological and policy concern. A recent survey in southwestern Ontario revealed no consistent long-term differences in the species richness, abundance, composition, and life stages of fishes found inhabiting drains and reference water courses of comparable size, suggesting that fish populations recover quickly after drain maintenance. Our hypothesis was that drain maintenance resulted in changes in aquatic assemblages. We predicted that following initial disturbance species richness, abundance and composition would be lowered and maintained drains would then move back to a pre-maintenance state. We used a Before-After-Control-Impact design that sample 8 pairs of reference (control) and drain (impact) water courses over 2 years to test whether drain maintenance alters fish assemblages and the time required for recovery. Responses by fish assemblages were variable across pairs. In pairs where fish assemblages changed following maintenance, the assemblages in drains tended to increase in similarity to assemblages in reference watercourses, contrary to expectation, and the time courses for changes were less than 18 months. Greater understanding of the nature and timing of recovery by fish assemblages will help drain superintendents and fish habitat managers develop drain maintenance practices that better balance the needs of agriculture with those of fishes.

Contributed Paper (Oral CCFFR) (GS)

ANADROMY AND RESIDENCY LIFE HISTORIES IN SYMPATRIC SALMONIDS

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A given population of freshwater fish may contain groups of individuals that exhibit both anadromous and resident life history strategies. Anadromous individuals may risk higher mortality for higher growth and fecundity. Although anadromy in salmonids is well studied, how factors such as inter- and intra-specific competition and habitat quality influence the relative benefit of each strategy is poorly understood. We are investigating these questions using three sympatric populations of salmonids from the Renew's River watershed, Newfoundland. Atlantic salmon and brook trout are native; whereas brown trout were introduced to the Avalon in the late 1800's and colonized Renew's River at an unknown date. For each species, it is hypothesised that individuals from anadromous mothers are larger at emergence than those from resident mothers, but this difference decreases with juvenile age. The proportion of juveniles from anadromous mothers is expected to decrease with distance from the sea, but increase with juvenile age. To test these hypotheses, the proportion of brown trout, brook trout and Atlantic salmon from anadromous mothers will be determined for different age-classes in different habitats using the strontium/calcium ratio of otolith cores. Initial data on movement of adult brown trout and distribution of each species within the Renew's River watershed will be summarized and presented.

Contributed Paper (Oral CCFFR) (GS)

AN EDITOR'S ASSOCIATION AND REMINISCENCES

Watson, Jeff, 6077 Wilderton Ave., Montréal, QC H3S 2K8 (jeff.watson@sympatico.ca)

Bev and Milly Scott's relationship with the then Scientific Information and Publications Branch (SIPB) of DFO was very close. Both "Freshwater Fisheries of Canada" and "Atlantic Fishes of Canada" were co-operative efforts from concept to publication. Bev and Milly, through the Huntsman Marine Laboratory, also worked closely with the SIPB to prepare Canada's input to the International database, Aquatic Sciences and Fisheries Abstracts.

Celebrating Ichthyology, Fish, and Fisheries with W.B. Scott (Oral CCFFR)

THE INFLUENCE OF ANADROMOUS MALES ON MONOPOLIZATION AND VARIANCE IN FERTILIZATION SUCCESS AMONG MATURE MALE ATLANTIC SALMON PARR

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Atlantic salmon (*Salmo salar*) males express markedly different alternative mating strategies. Large anadromous males typically fight for access to spawning females, whereas small mature male parr sneak fertilizations. Anadromous males can be an order of magnitude heavier than mature male parr, such that during the spawning season they may attack and kill mature male parr. The two male types may also compete indirectly via sperm competition, which occurs during external fertilization of eggs. Furthermore, competition within strategies may influence individual success with changing male density. We conducted an experiment in stream channels at the Margaree Fish Hatchery in Margaree, Nova Scotia, to assess the influence of the presence of anadromous males on the variance in male parr fertilization success when competing at low (three parr) or high (ten parr) densities. Females spawned with parr at either density in the presence or absence of an anadromous male. Eggs were left over winter in the stream channels to develop to the eyed-stage. Sections were excavated and a subsample of eyed eggs was used to conduct paternity analyses. There were no consistent differences in egg survival to the eyed stage with respect to anadromous male presence or parr density. Furthermore, microsatellite DNA analysis of paternity indicated that when parr were at low densities and in the absence of anadromous males, individual parr could monopolize spawning events. Variance among parr in fertilization success decreased when anadromous males were present as well as when there were more parr competing for access to females.

Contributed Paper (Oral CCFFR) (GS)

USE OF MULTIPLE METHODS TO DETECT SPACIAL DIFFERENCES IN LITTORAL BENTHIC INVERTEBRATE COMMUNITIES: A SITE SPECIFIC INVESTIGATION

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Multiple sampling methods for littoral benthic invertebrates, including white birch (*Betula papyrifera*) and speckled alder (*Alnus rugosa*) leaf packs, ten-minute traveling kick and sweep, and Ekman substrate grabs were used to detect spatial differences in community structure at nine inflow sites of an acid and metal damaged lake near Sudbury, Ontario. Randomized block analysis of variance demonstrated that invertebrate biological summary metrics like Simpson's diversity exhibited significant differences between sites. Principal component analyses also demonstrated differences in the ability of a sampling method to detect differences in invertebrate composition and environmental gradients. The results of this study show the sensitivity and strengths of four common sampling methods for littoral benthic invertebrates in detecting differences in community and environmental gradients. These results also provide insight in selecting the best sampling method when assessing objectives for a variety of ecological studies such as biological recovery of damaged lakes and their land-water linkages.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL) (GS)

INFLUENCE OF LAND USE ON BACTERIAL ACTIVITY AND ORGANIC MATTER CHARACTERISTICS IN SOUTHERN ONTARIO STREAMS

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Heterotrophic bacteria are important organic matter transformers and nutrient remineralizers in aquatic ecosystems where stream nutrient and organic matter characteristics are dictated largely by the type of land use in stream catchment and riparian zone areas. To determine the influence of land use on bacterial activity, we collected surface water from 53 Southern Ontario streams that have catchments ranging widely in their agricultural, urban, wetland, and forested land use. At each site, we measured bacterial abundance and production, extracellular enzyme activity, nutrient concentration and spectroscopy and fluorescence properties of dissolved organic matter. Bacterial abundance and production ranged from 0.02 to 1.04×10^9 cells l^{-1} and 0.8 to $429.3 \mu g C l^{-1} d^{-1}$, respectively. Preliminary regression analyses indicated that bacterial abundance and production were related positively to percent monoculture cropland in the catchment and riparian zone as well as percent total cropland in the riparian zone of streams but related negatively to percent woodland area in the catchment and percent wetland area in the streams riparian zone. Total and dissolved phosphorus concentrations were related positively to bacterial activity and percent monoculture. Our results suggest that riparian zone organic matter and nutrient inputs are more easily accessible to the bacterial community than organic matter and nutrients produced in the total catchment area of streams, where woodland catchment area was a notable exception.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

ASSESSMENT OF THE IMPACT OF BYCATCH ON HARBOUR PORPOISE IN THE NORTH SEA

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Bycatch of harbour porpoise (*Phocoena phocoena*) in set-net fisheries in the North Sea is an international conservation issue. While several datasets are available on harbour porpoise and fisheries in this area, these data have mainly been analysed separately. We used a population model to integrate these data and assess the impact of bycatch on the state and dynamics of harbour porpoise in the North Sea during 1987-2005. The model was fitted to data on abundance, age at sexual maturity, pregnancy rate, age at death, and bycatch rate (per unit fishing effort) with data on total fishing effort as input. A Bayesian statistical framework was used to explicitly account for uncertainty in parameter estimates. Several different scenarios were considered with respect to population dynamics, population structure and the data used to fit the model. Estimates of bycatch were higher than previous estimates, but were also highly uncertain. There was a high probability that this bycatch resulted in a decrease in the number of harbour porpoise during the study period, especially during the late 1980s and early 1990s. Estimated life history parameters suggested a limited scope for population growth, even in the absence of bycatch. The model highlighted an inconsistency between the observed pregnancy rate and observed age structure of natural mortality. The model was not informative about maximum population growth rate or carrying capacity. Scenarios with two subpopulations suggested that dispersal from the north to the south was the most plausible explanation for observed changes in distribution between 1994 and 2005.

Advances in Modelling and Statistical Analysis of Aquatic Ecosystems (Oral CCFFR)

CHANGES IN PHYTOPLANKTON COMMUNITY COMPOSITION IN LAKE SIMCOE OVER THREE DECADES: RELATIONSHIPS WITH DECREASES IN PHOSPHORUS LOADING AND THE EFFECTS OF OTHER STRESSORS

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Concern over declines in native coldwater fish species in Lake Simcoe led to the formation of a multi-agency partnership in 1990, working together towards reductions in phosphorus loads from the watershed. The whole lake volume-weighted spring total phosphorus concentration decreased significantly ($P < 0.01$) from 1980 to 2007. There was a significant ($P < 0.01$) increase in minimum volume-weighted hypolimnetic dissolved oxygen concentration from June to September over the same period, which now typically fluctuates around 5 mg/L. However, there were no corresponding decreases in phytoplankton biovolume or chlorophyll concentrations at open lake stations, although significant increases in water clarity have been observed since the establishment of zebra mussels in 1996. While consistent changes in overall phytoplankton biomass were not evident, high peaks in abundance recorded during the 1980s and early 1990s in certain years were not observed in later years, and the biovolumes of chlorophytes and cyanobacteria decreased significantly ($P < 0.05$). Diatoms generally dominated the phytoplankton counts at all stations in most years. Correspondence analysis (CA) of seasonal (May to October) composite samples revealed a distinct shift and less inter-annual variation in community composition at lower taxonomic levels (genus or species) along the first axis of the ordination, the timing of which also coincided with zebra mussel establishment. Determining the direct and indirect effects of multiple stressors, such as climatic variation and aquatic invasive species, on the water chemistry and aquatic biota of Lake Simcoe presents an ongoing challenge.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

POPULATION DENSITY AND TERRITORY SIZE IN JUVENILE RAINBOW TROUT, *ONCORHYNCHUS MYKISS*: IMPLICATIONS FOR POPULATION REGULATION

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Despite a wealth of research regarding territoriality and population regulation in stream dwelling salmonids, the effect of population density on territory size and individual behaviour of salmonids remains unclear. Studies to date which have investigated the effect of population density on territory size have either manipulated density in conjunction with food abundance, or have used densities far outside the range of densities typically found in nature. We manipulated population density of juvenile rainbow trout at five levels representing a range of more realistic densities, in artificial stream channels, while keeping per capita food supply constant. In a second experiment we manipulated density at three levels while keeping the total amount of food constant among density treatments. We tested the contrasting predictions that the territory size of dominant fish (1) is not affected by population density; (2) decreases with population density as $1/n$; or (3) decreases with population density but towards an asymptotic minimum size. Our results supported the prediction of an asymptotic minimum size; territories of dominant fish decreased with increasing population density before leveling off at the highest densities. At low densities dominant fish were despotic and defended most of the available space. However, as fish abundance increased, dominants defended less space, and subordinates assumed a larger proportion of the overall aggression. Our results suggest that territoriality plays a role in regulating populations of stream dwelling salmonids and may have practical applications for conservation management.

Contributed Paper (Oral CCFFR) (GS)

EVIDENCE FOR GLOBAL, REGIONAL, LANDSCAPE, AND IN-LAKE INFLUENCES ON THE RECOVERY OF SUDBURY LAKES FROM HISTORICAL DISTURBANCES

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A review of long-term studies of recovery of lakes in Sudbury demonstrates that recovery is best viewed as a phenomenon influenced not just by local reductions in SO₂ emissions, but also by multiple drivers at multiple scales. The massive reductions in local emissions are of course of critical importance. In addition, at the largest scale, El Nino events precipitate droughts which have been followed by re-acidification episodes which have temporarily derailed recovery. At a regional scale, massive reforestation efforts have lowered wind speeds, in part leading to the cooling of local lakes despite global warming. Landscape modification has also been critical. The trans-Canada highway bypass traverses the region, and winter de-icing operations have increased salt levels in lakes bordering the highway, apparently ameliorating metal toxicity. Spatial patchiness in recovery of plankton at a local scale can also be explained in part by local re-greening efforts which, via landscape liming, have further ameliorated metal toxicity. A complete picture of the regulators of recovery in Sudbury lakes must consider multiple interacting forces at multiple scales.

Effects of Multiple Stressors and their Interactions on Aquatic Ecosystems (Oral SCL)

LOCOMOTOR AND PERCEPTUAL BASES OF INDIVIDUAL DIFFERENCES IN ACTIVITY EXHIBITED BY YOUNG-OF-THE-YEAR BROOK CHARR

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In the field, some recently emerged brook charr (*Salvinus fontinalis*) are active, feeding on insect prey near the water surface away from the stream bank. Others are inactive, feeding on crustaceans at the substrate near the bank. We used a shelter-exit experiment under low and high light to test whether differences in the activity exhibited by foraging brook charr in the field were linked to differences in their propensity to move, or differences in how they perceive their environment. Young-of-the-year brook charr were captured in the field, transported to the laboratory, and placed singly into a translucent container that opened into a larger aquarium. For each individual, time to exit the container (exit time) and proportion of time spent moving in the open aquarium were measured in low and high light. Individuals differed in exit time and proportion of time spent moving across light treatments. Exit time was related to proportion of time spent moving in the aquarium and light treatment using time-to-event regression. Consistent with the propensity to move hypothesis, individuals that exited earliest from the container moved the most in the open aquarium. Contrary to the perception hypothesis, exit times did not vary with changes in light level. Elucidating the mechanistic bases for individual differences in activity is important for understanding origins of the alternative foraging tactics employed by brook charr in the field and, more broadly, the tendency for some fish populations to diverge into subpopulations differing in foraging behaviour and habitat use.

Contributed Paper (Oral CCFFR)

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