

**Canadian Conference for Fisheries Research  
CCFFR**

**Conférence Canadienne de la  
Recherche sur les Pêches  
CCRP**

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



**HALIFAX JANUARY 3-5, 2008**

## Ransom Aldrich Myers (1952-2007)



Ransom Aldrich Myers (Ram) was a mathematically-gifted, intellectually pugnacious and passionately humane scientist committed to the unconstrained communication of science to decision makers and to society. Author of more than 150 peer-reviewed publications, Ram undertook research in areas as varied as life history evolution, oceanography, stock-recruitment relationships, parameter estimation, conservation biology, and aspects of the general biology of sea turtles and Greenland sharks. Among his best-known papers are those dealing with reproductive strategies in Atlantic salmon, recruitment variability in marine fishes, maximum population growth rate ( $r_{max}$ ), the collapse of Atlantic cod, fishery-induced declines of large predatory fishes, and the consequences of these declines to the abundance of, and interactions between, other species.

One of the theme sessions at the 61<sup>st</sup> Canadian Conference For Fisheries Research (CCFFR) is in honour of Ram Myers. Organized by Jeff Hutchings and Boris Worm, the invited speakers include those with whom Ram collaborated throughout his 26-year research career, including fellow graduate students from his postgraduate studies at Dalhousie University, colleagues at the Department of Fisheries & Oceans and Memorial University of Newfoundland in St. John's, and graduate students and postdoctoral fellows under his supervision at Dalhousie.

In addition to this session, two memoriums to Ram will be presented in conjunction with the CCFFR meeting. One is a poster, to be displayed during the meeting, and the second is an obituary published in the January 2008 of *Canadian Journal of Fisheries and Aquatic Sciences*.

61<sup>st</sup> 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*

Marriott Harbourfront Hotel

HALIFAX

January 3-5, 2007

**Cover art: Images associated with the 2008 plenary lectures.**

**Front Cover:** The Paria River in northern Trinidad, one of the field sites for Andrew Hendry's research on adaptive diversification in guppies, *Poecilia reticulata*. The inset shows an example of male guppy colouration in a low predation environment. (J.C. Stevenson Memorial Lecture: Ecological speciation: Canadian fishes and the illusion of ubiquity).

Photo credits: Andrew Hendry

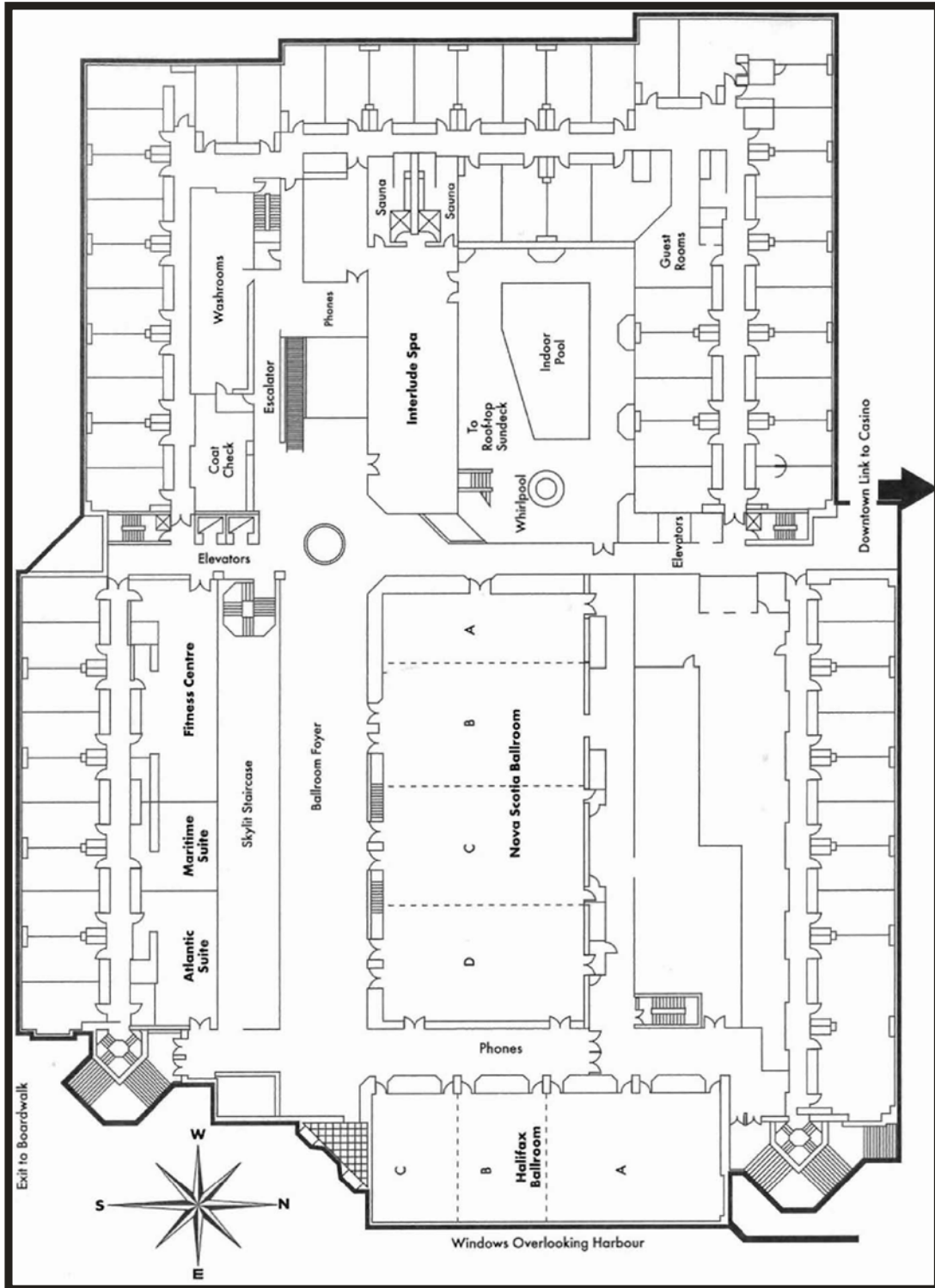
**Rear Cover:** Two views of Aurora Whitepine Lake, one of Bill Keller's long-term study sites for his study of lake acidification and recovery. Aurora Whitepine Lake is also notable as one of only two lakes that naturally supported the Aurora trout, *Salvelinus fontinalis timagamiensis*, shown in the third image. The Aurora trout was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1987 and 2000, and is currently listed as Endangered under the Species at Risk Act.

(F.H. Rigler Memorial Award Lecture: Limnology in North-eastern Ontario: From Acidification to Multiple Stressors; Jeff Hutchings – Canadian species at risk: assessment, listing and the communication of science).

Photo credits: Bill Keller (sunset), Brent Metcalfe (aircraft) and Ed Snucins (Aurora trout).

## Marriott Harbourfront Floor Plan (2<sup>nd</sup> floor)

The Conference will take place in Nova Scotia Ball Room A,B,C,D, Halifax A,B,C and the Nova Scotia Ball Room Foyer.



## CCFFR Officers 2007/8:

### President / *Président*

- **John Casselman**, Department of Biology, Queen's University, Kingston, Ontario
- (e-mail: [casselmj@queensu.ca](mailto:casselmj@queensu.ca) )

### Programme / *Responsable du programme*

- **Mark Ridgway**, Harkness Laboratory of Fisheries Research, Aquatic Research and Development Section, Ontario Ministry of Natural Resources, Trent University, 2140 East Bank Drive, Peterborough, ON, K9J 7B8
- [Mark.Ridgway@ontario.ca](mailto:Mark.Ridgway@ontario.ca)

### Local arrangements / *Responsable de l'organisation locale*

- **Paul Bentzen**, Department of Biology, Dalhousie University, 1355 Oxford Street, Halifax, NS, B3H 4J1
- [Paul.Bentzen@dal.ca](mailto:Paul.Bentzen@dal.ca)

### Secretary-treasurer / *Secrétaire-trésorier*

- **Julie Deault**, Fisheries and Oceans, Canada, 200 Kent Street, 12S033, Ottawa, ON K1A 0E6
- (613) 990-5384 phone, (613) 954-0807 fax
- [deaultJ@dfo-mpo.gc.ca](mailto:deaultJ@dfo-mpo.gc.ca)

### Nomination / *Responsable des nominations* (for 2009)

- **Eric Taylor**, Department of Zoology, University of British Columbia, #2370-6270 University Blvd., Vancouver, BC, V6T 1Z4
- [etaylor@zoology.ubc.ca](mailto:etaylor@zoology.ubc.ca)

## SCL Officers 2007/8:

### President / *Président*

- **Helene Cyr**, Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, ON, M5S 3G5
- [helene@zoo.utoronto.ca](mailto:helene@zoo.utoronto.ca)

### Programme / *Responsable du programme*

- **Norman Yan**, Department of Biology, York University, Toronto, ON M3J 1P3
- [nyan@yorku.ca](mailto:nyan@yorku.ca)

### Secretary-treasurer / *Secrétaire-trésorier*

- **Rolf Vinebrooke**, Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9
- [rolf@ualberta.ca](mailto:rolf@ualberta.ca)

### Programme / *Responsable du programme* (2009)

- **Martha Guy**, National Guidelines and Standards Office, Environment Canada, Ottawa, ON, K1A 0H3
- [martha.guy@ec.gc.ca](mailto:martha.guy@ec.gc.ca)

## **CCFFR/SCL 2008 Themes/Thèmes**

- Population processes at low abundance : recovery, rarity and invasives
- Procédés liés aux populations en faible abondance : reconstitution, rareté et envahissement
- Ecosystem-based management : science and policy
- Gestion écosystémique : sciences et politiques
- Waterbirds in marine and freshwater food webs
- Les oiseaux aquatiques dans les réseaux trophiques d'eau salée et d'eau douce
- Evolutionary Processes in Marine and Freshwater Ecosystems
- Écologie évolutive dans les écosystèmes d'eau salée et d'eau douce
- Complexities in Ecological Recovery
- Complexités liées à la reconstitution écologique
- Physical Limnology and Oceanography – Influences on Populations and Ecosystems
- Limnologie et océanographie physiques : influences sur les populations et les écosystèmes
- River and Estuary Ecosystems
- Écosystèmes des rivières et des estuaires
- A Special Session in Memory of Ram Myers
- Session spéciale à la mémoire de Ram Myers

## Program-at-a-Glance

**Friday January 4 PLENARY – Nova Scotia Ballroom BCD**

09:00	Opening Remarks
-------	-----------------

*J.C. Stevenson Memorial Lecture*

09:15 **Andrew Hendry**  
Ecological speciation: Canadian fishes and the illusion of ubiquity

10:00	<b>Break</b>
-------	--------------

*F.H. Rigler Memorial Award Lecture*

10:20 **Bill Keller**  
Limnology in North-eastern Ontario: From Acidification to Multiple Stressors

11:05 Jeff Hutchings – Canadian species at risk: assessment, listing and the communication of science

11:50 Don Jackson – Canadian Journal of Fisheries and Aquatic Science – Update

12:00      **Lunch**

13:20 Concurrent Sessions

17:10 Business Meeting – Nova Scotia A  
-18:00

17:30 Poster Session (Nova Scotia Ballroom Foyer)  
-19:00

19:00      **Banquet – Halifax ABC**

## Saturday January 5

08:20 Concurrent Sessions

12:00      **Lunch**

13:20 Concurrent Sessions

## **Plenary Abstracts:**

### **Stevenson Lecture**

#### **Ecological speciation: Canadian fishes and the illusion of ubiquity.**

Andrew Hendry, Redpath Museum & Department of Biology, McGill University, Montreal, Québec

Ecological speciation occurs when adaptation to different environments drives the evolution of reproductive isolation. This process is thought to have been very important in the evolution of biological diversity, and Canadian fishes have figured prominently in the theory's development and widespread acceptance. Indeed, ecological speciation seems so rampant in Canadian fishes (sticklebacks, coregonids, salmonids, osmerids, and centrarchids) that one can get the impression of ubiquity. Eager to ride on the coat-tails of this exciting work, I have used similar methods to investigate ecological speciation in lake/stream stickleback and in Trinidadian guppies. Much to my initial dismay, I have failed to find simple and strong signatures of ecological speciation. Setting aside the possibility of personal incompetence, my failure to duplicate previous results may simply reflect a positive bias in the reporting of ecological speciation. In retrospect, such a bias seems obvious given that essentially all published studies of ecological speciation are confirmatory, whereas many populations in different environments likely show little, if any, hint of incipient speciation. I argue for the merits of further work on populations that show little evidence of ecological speciation, thus enabling analyses along a continuum from zero to complete reproductive isolation. This comparative approach may help inform the conditions that promote and constrain ecological speciation. Of particular importance may be the nature of mating systems, the amount of dispersal, the role of competition, and the genetic basis for adaptation and reproductive isolation.

## **Rigler Lecture**

### **Limnology in North-eastern Ontario: From Acidification to Multiple Stressors**

Bill Keller, Ontario Ministry of the Environment, Laurentian University, Sudbury, ON

Monitoring programs on lakes near Sudbury, in northern Ontario, extend back to the 1970's. Historically, over 7000 lakes were acidified by sulphur deposition associated with emissions from the Sudbury metal smelters and more distant sulphur sources. The most severely damaged lakes were within 20 to 30 km of the Sudbury smelters, where acid conditions were combined with very high concentrations of some metals, including nickel and copper. However, much has changed after the implementation of large sulphur and metal emission reductions at the smelters in the 1970's and 1990's. Air pollution controls have led to widespread changes in damaged Sudbury lakes, including increased pH and decreased concentrations of sulphate and metals. While chemical improvements have often been large, some lakes are still acidified, although water quality recovery is continuing. Biological recovery has been observed in some lakes among various groups of organisms including fish, zooplankton, phytoplankton and zoobenthos. Sudbury studies are providing a very unique opportunity to begin to understand the processes of recovery in damaged aquatic ecosystems, in response to pollution controls. They are also showing that the recovery of acid-damaged lakes is closely linked to the effects of other major environmental stressors such as climate change, base cation depletion and UV-B irradiance. Future studies of the recovery of acid-damaged lakes around Sudbury, and in other regions, will need to determine the interactions of these and other stressors.

## **Canadian species at risk: assessment, listing and the communication of science**

**Jeff Hutchings**, Department of Biology, Dalhousie University, Halifax, NS B3H 4J1  
CANADA (Jeff.Hutchings@Dal.Ca)

In partial fulfilment of its international obligations under the Convention on Biological Diversity (1992), Canada's federal government passed the Species at Risk Act (SARA) in 2002. By June 2004, all sections of the Act had come into force. SARA provided legal recognition of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; established 1977), the independent arms-length science advisory body responsible for assessing the status of species that may be at risk of extinction. Receipt of COSEWIC's Annual Report by the Minister of the Environment triggers decision-making timelines that culminate with the government's decision either to: accept COSEWIC's assessment and add the species to the legal list; not add the species to the list; or refer the matter back to COSEWIC. Status assessments by COSEWIC are based solely on science and are not influenced by perceived socio-economic or political consequences associated with a legal listing. Importantly, COSEWIC's assessments are communicated to the public at the same time they are communicated to government. The same level of transparency is not evident in the role that science plays in legal listing decisions. With particular reference to fishes, the current Chair of COSEWIC will: 1) describe the species assessment and listing decision processes; 2) identify listing biases (notably for marine fishes); and 3) discuss strengths and weaknesses of the assessment and listing processes as they pertain to the communication of science to society and to government decision-makers.

**Oral Presentations Afternoon of Friday January 4**  
**(Sessions 1- 4 of 4)**

	Ram Myers Session (Hutchings) NS - CD	Complexities in Ecological Recovery (Keller) NS -B	River and Estuary Ecosystems (Curry) Halifax C	Physical Limnology and Oceanography Influence on Ecology (Campana) NS - A
13:20	Worm - Ecosystem effects of fishing marine predators	Rusak - Asymmetrical food web responses in trophic-level richness, biomass and function following lake acidification: implications for ecosystem recovery	Senay - Linking environment, spatial distribution and functional traits in stream fish communities	Dadswell - The North Atlantic Gyre and the ocean migration of Canadian Atlantic salmon ( <i>Salmo salar</i> )
13:40	Montevecchi - Winging it with Ram: seabird signals, salmon and shifts	Gunn - Confounding effects of drought on the recovery of benthic invertebrates in a mining impacted stream	Cote - Measuring habitat connectivity in riverine systems	Cairns - What controls the worldwide distribution of marine vertebrate communities? A temperature-dependent predation hypothesis
14:00	Hutchings - Alternative reproductive strategies then and now: 25 years of study of Atlantic salmon	Luek - Recovering benthic invertebrate communities: a bottleneck for whole lake biological recovery? - preliminary results from an extensive field study	Lanthier - Among-day variations in fish community structure: implications for the development of habitat quality models	Fisher - North Atlantic Oscillation variability influences latitudinal trends in marine fish species richness
14:20	Gibson - Statistical, life history-based assessment models for diadromous fish populations	Linley - It's a matter of time: duration of non-acidity promoting recovery of zooplankton species richness	Bedard - Interannual variations of habitat quality models for juvenile Atlantic salmon ( <i>Salmo salar</i> )	Purchase - Continued use of ancient submerged capelin spawning beaches 350 km from shore
14:40	Fuller - Inspirations from Ransom A. Myers: marine conservation from the bottom and the top down	Valois - Landscape-scale patterns of zooplankton community structure in lakes recovering from acidification and metal contamination	Bourque - Effects of cloud cover on river fish community structure estimates in the Laurentians, QC	Wilson - Nutrient recycling by stream fish assemblages
15:00	<b>Break</b>			
	Ram Myers Session (Hutchings) NS - CD	Complexities in Ecological Recovery (Keller) NS - B	River and Estuary Ecosystems (Curry/Munkittrick) Halifax C	Physical Limnology and Oceanography Influence on Ecology (Campana) NS - A
15:20	Jonsen - Inferring animal behaviour in the ocean from messy data	Ramcharan - Use of heat content to study long-term trends in lake thermal regimes	Munkittrick - Assessing health of fish populations in the Saint John River system	Finlay - Synchrony of CO <sub>2</sub> flux in hardwater lakes
15:40	Rosenberg - On being fortunate: knowing and working with Ram Myers from 1983-2007	McEachern - Water quality monitoring at abandoned mine sites - Silver Bear Mines, Northwest Territories	Noel - Community metabolism in the Saint John River	Ogbebo - Latitudinal gradients in nutrient concentrations and algal biomass in northern Canadian waters
16:00	Lotze - Historical catches and declines in large marine fishes	Warren - Density of juvenile Atlantic ( <i>Gadus morhua</i> ) and Greenland cod ( <i>G. ogac</i> ) with spatial expansion and recovery of eelgrass ( <i>Zostera marina</i> )	Arciszewski - The potential of invertebrate species and their life history characteristics for monitoring the impact of effluents	Mitchell - Streamflow, salmon and beaver dams - roles in the structuring of stream fish communities within an anadromous salmon dominated stream
16:20	Ford - Declining wild salmon populations in relation to parasites from farm salmon	Morris - Spawning distribution of Atlantic cod overwintering in Smith Sound: A potential mechanism of cod recovery along the north east coast of Newfoundland	Smedley - Stream and catchment scale effects on fish condition and community composition in an agricultural landscape	Lewis - Descriptive models of recruitment for white bass and walleye in irrigation reservoirs
16:40	Hutchings - Ransom Aldrich Myers (1952-2007): an appreciation	Morgan - Yellow perch ( <i>Perca flavescens</i> ) population responses to introduced piscivores		
17:10	Business Meeting			
17:30	Poster Session			

**Oral Presentations**  
**Morning of Saturday January 5**  
**(Sessions 1-3 of 6)**

Saturday	Contributed Papers (Dunlop) Halifax C	Population Processes at Low Abundance (Post) Nova Scotia C	River and Estuary Ecosystems (Cairns) Halifax B
8:20	Christie - Control of sea lamprey and their origins in Lake Ontario	Wilke - Populations in decline: early life history response of endangered Atlantic salmon to inadvertent selection during conservation breeding	Hanson - Reformulating empirical models from lakes for use in estuaries and lagoons: Why not?
8:40	Lukey - Consistency of COSEWIC species designations: freshwater fishes as a case study	Desjardins - The (art and) science of restoring Atlantic salmon to Lake Ontario	Chu, C - Classification and modelling of stream temperatures in Ontario
9:00	McDermid - Status and threats to freshwater fish communities in Ontario's northern boreal forest.	Fox - Life history strategy relevant to invasion success?	Maranger - Spatial and temporal variability in N <sub>2</sub> O emissions and N budget for Lake Saint-Pierre a large fluvial lake of the St. Lawrence River, Canada
9:20	Morris - Prevalence and recurrence of escaped farmed Atlantic salmon ( <i>Salmo salar</i> ) in eastern North American rivers	Velez-Espino - Invasion dynamics of round goby ( <i>Neogobius melanostomus</i> ) in Hamilton Harbour, Lake Ontario	Chu, D - Analyzing the effects of artificial fertilization on the productivity of inner Bay of Fundy streams
9:40	Paterson, J - Ecological response of Nile perch to environmental change in Lake Nabugabo, Uganda	Woolnough - Colonization of aquatic ecosystems after urban development	Hughes - Mosstaken identity: a story of aquatic food sources in two inner Bay of Fundy river systems
10:00	<b>Break</b>		
	Ecosystem-based Management (Dunlop) Halifax C	Population Processes at Low Abundance (Post) Nova Scotia C	River and Estuary Ecosystems (Cairns) Halifax B
10:20	Boudreau - Did the decline of groundfish stocks in the Gulf of Maine increase lobster landings?	Post - Dynamics at low density: thresholds for sustainability and conservation	Laliberte - Two-dimensional hydrodynamic flow models and mechanistic approach to fish habitat instream flow needs analysis
10:40	Bosman - Fish assemblages of the Northumberland Strait, temporal and explanatory variable patterns	Parkinson - The bioeconomic equilibrium in recreational fisheries	Reynolds - The effect of acidification on the survival of American eels elvers
11:00	Fu - Using population-based ecosystem indicators to assess the status of groundfish communities off British Columbia coast	Allen - Understanding reproduction at low abundance: Key indicators of reproductive development in lake sturgeon, <i>Acipenser fulvescens</i>	Hallett - Is the American eel primarily a marine species?
11:20	Harris - Estimating the unreported bycatch mortality: cusk ( <i>Brosme brosme</i> ) mortality in the lobster fishery of southwestern Nova Scotia	Gregory - Growth, mortality and behaviour of age 0 Atlantic cod at low population size	Cairns - Why has the American eel collapsed in the upper St. Lawrence River but not elsewhere?
11:40	Perry - A comparison of two methodologies for estimating catch rate using the winter brook trout fishery in Newfoundland and Labrador, Canada	Kelly - Isolated population dynamics as a potential consequence of low abundances for Atlantic cod	Casselman - Long-term American eel ( <i>Anguilla rostrata</i> ) dynamics in the St. Lawrence River - Lake Ontario system as indicated by recruitment age-based modelling
12:00	<b>Lunch</b>		

**Oral Presentations**  
**Morning of Saturday January 5**  
**(Sessions 4-6 of 6)**

Saturday	Evolutionary Ecology (Fraser) Nova Scotia D	Waterbirds In Food Webs (Ridgway) Nova Scotia A	Contributed Papers (Purchase) Nova Scotia B
8:20	Gauthier-Ouellet - A spatio-temporal mixed stock analysis of Atlantic salmon ( <i>Salmo salar</i> ) in the west Greenland fishery		Bachan - Maternal effects of egg quality on progeny morphology, survival and growth in larval Atlantic cod ( <i>Gadus morhua</i> )
8:40	Coulson - Heterogeneity in isolation by distance and spatial patterns of genetic differentiation among anadromous rainbow smelt ( <i>Osmerus mordax</i> )		Leadbeater - Comparison of the biochemical composition of shortnose sturgeon ( <i>Acipenser brevirostrum</i> ) eggs from wild and captive sources
9:00	Heath - Dispersal and population genetic structure in bicolor damselfish on the Mesoamerican barrier reef: local adaptation versus risk-spreading	Pink - The role of dissolved oxygen in aquatic predator-prey interactions: Do decreases in levels of oxygen result in increased presence of avian predators?	Litvak - Effects of spermatazoa density, longevity and duration of egg receptivity on fertilization success of winter flounder ( <i>Pseudopleuronectes americanus</i> L.)
9:20	Hasselman - Genetic structure of American shad populations across the native range of the species	Hamilton - Interactions between semipalmated sandpipers and intertidal mudflat communities in the upper Bay of Fundy	Mogensen - Modeling lipid allocation strategies in young of the year rainbow trout ( <i>Oncorhynchus mykiss</i> )
9:40	Blackie - Disentangling the evolutionary processes responsible for sympatric morphs of lake trout: evidence for sympatric divergence in Great Bear Lake	Murphy - Double-crested prey choice and availability during the chick rearing periods, Ontario, Canada	Peake - Gait transition as an alternate estimator of maximum aerobic capacity in fish
10:00	<b>Break</b>		
	Evolutionary Ecology (Fraser) Nova Scotia D	Waterbirds in Food Webs (Ridgway) Nova Scotia A	Contributed Papers (Yan) Nova Scotia B
10:20	Zanatta - Population structure and mantle display polymorphisms in the wavy-rayed lampmussel, <i>Lampsilis fasciola</i> (Bivalvia: Unionidae)	Burke - Capelin availability influences seabird foraging decisions	Kidd - Is the birth control pill an effective form of contraception for fishes?
10:40	Palstra - Consequences of life-history for estimating effective population size ( $N_e$ ) in salmonid fishes: an empirical evaluation in Atlantic salmon ( <i>Salmo salar</i> ) populations in Newfoundland and Labrador	Regular - Capelin, murrres and ocean climate: inter-annual associations across a decadal shift	Paterson - Exploring causes of increases in taste and odour-causing chrysophyte abundance in Canadian Shield lakes
11:00	Guenard - Differences in morphology, energy budget, and activity patterns between arctic charr from two contrasting populations	Hedd - Diets and distributions of Leach's Storm-Petrels before and after an ecosystem shift in the Northwest Atlantic	Hicks - Influence of residential development on aquatic macrophyte communities in lakes of the Kawartha region, Ontario
11:20	McLaughlin - Personality and foraging behaviour in young brook charr	Smol - Arctic seabirds as biovectors for the transport of marine-derived nutrients and contaminants to polar lakes and ponds: A paleolimnological perspective	Cyr - Littoral sediments: how much of a refuge do they offer against temperature variability?
11:40	Bhagat - Introduced pumpkinseed sunfish ( <i>Lepomis gibbosus</i> L.)	Ridgway - Response of fish and double-crested cormorants to a large-scale egg-oiling experiment in the coastal regions of Lake Huron	Young - Prey availability, not a refuge, regulates <i>Bythotrephes longimanus</i> abundance in Harp Lake, Ontario
12:00	<b>Lunch</b>		

**Oral Presentations**  
**Afternoon of Saturday January 5**  
**(Sessions 1-3 of 6)**

Saturday	Ecosystem-based Management (Yan) Halifax C	Population Processes at Low Abundance (Hutchings) NS C	River and Estuary Ecosystems (Peake) Halifax B
13:20	Ginn - Tracking water quality changes in Nova Scotia related to acidification, eutrophication, and climate change using paleolimnological techniques.	Weisz - Factors influencing the presence of an invading macroinvertebrate predator, <i>Bythotrephes longimanus</i> , in Canadian Shield lakes	Emerson - Have rock, won't travel: A study to enhance juvenile Atlantic salmon production
13:40	Hall - Does land use dictate methylmercury concentrations in Saskatchewan wetlands?	Bailey - Estimating probability of establishment for Cladocera introduced at low abundance: An assessment of the proposed IMO ballast water treatment standards	Wozney - Genetic assessment of population fragmentation of lake sturgeon ( <i>Acipenser fulvescens</i> ) in the Ottawa River
14:00	Guy - Interactions of total ammonia and nitrate toxicity in the environment	Finch - Exploring eastern sand darter ( <i>Ammocrypta pellucida</i> ) population dynamics on the lower Thames River	Reid - Species traits influence the genetic consequences of river fragmentation on two co-occurring redhorse species
14:20	Nordin - The Bowron River watershed: a landscape level assessment of the post-beetle change in stream and riparian function	Cook - A comparison of habitat use for captive and wild Atlantic whitefish: inferences from hydroacoustic tracking	Brinkmann - Mercury gradient in longnose dace ( <i>Rhinichthys cataractae</i> ) in the absence of point sources along the Oldman River continuum, upper south Saskatchewan River basin
14:40	Woolnough - Spatial predictions of unionid populations based on fish distribution in three southwestern Ontario rivers		
15:00	<b>Break</b>		
	Ecosystem-based Management (Ridgway) Halifax C	Contributed Papers (Dunlop) NS C	
15:20	McLaughlin - Effectiveness and non-target effects of in-stream barriers used to control sea lamprey in the Laurentian Great Lakes	Serada - General empirical models for predicting the release of nutrients from fish with a comparison between detritivores and non-detritivores	
15:40	Lea - Identifying temperature sensitivities of fish communities in British Columbian streams	Li - The relationship between otolith growth and somatic growth	
16:00	Wichert - Science and action: Windermere basin case study	Krimmer - Behavioural and physiological response of over-wintering brook trout ( <i>Salvelinus fontinalis</i> ) to instream flow manipulations from the Canadian Rocky Mountains	

**Oral Presentations**  
**Afternoon of Saturday January 5**  
**(Sessions 4-6 of 6)**

Saturday	Evolutionary Ecology (Fraser) Nova Scotia - D	Contributed Papers (Boisclair) Nova Scotia - A	Contributed Papers (Purchase) Nova Scotia - B
13:20	Fraser - Parental divergence predicts the degree of out-breeding depression between farmed and wild Atlantic salmon	Randall - Perspective on a habitat area-production approach for assessing the productive capacity of fish habitat	Campana - Estimation of discard mortality in blue sharks using archival satellite pop-up tags, with implications for the status of the North Atlantic population
13:40	Moreau - The interaction of transgenic and non-transgenic Atlantic salmon siblings across multiple environments	Stewart - Seasonal spatial distribution, habitat partitioning, and temperature of occupancy of Lake Ontario chinook salmon and rainbow trout	Hruska - Relationships between spawning ground arrival timing, spawning ground longevity, and spawning success in female sockeye salmon ( <i>Oncorhynchus nerka</i> ): an investigation of pre-spawning mortality
14:00	Bezanson - Behavioural change due to domestication selection in a captive breeding program of endangered Atlantic salmon	Murphy - Factors limiting warmwater fish habitat suitability in an embayment in Tommy Thompson Park, Toronto, Ontario	Morrison - Exploring fisheries options during periods of ecological change
14:20	Poole - Lacustrine habitat use and its influence on Atlantic salmon parr populations in southern Labrador	Naumann - Habitat selection by shortjaw cisco ( <i>Coregonus zenithicus</i> ) in Lake Huron	Obushenko - Risk assessment of alternative initial allocations of Lake Erie walleye using catch at age simulation and a Bayesian approach to uncertain stock-recruit dynamics
14:40	Cooper - Biogeography of right-eyed flounders (Pleuronectidae): phylogeny and fossils reveal an historical response to arctic climate change	Barth - Abundance, movement and habitat use of juvenile lake sturgeon in the Winnipeg River, Manitoba	van Poorten - Exploitative competition between angler groups limits potential catch of visiting anglers
15:00	<b>Break</b>		
	Evolutionary Ecology (Fraser) NS - D	Contributed Papers (Bentzen) NS - A	Contributed Papers (Purchase) NS - B
15:20	Westley - Toward unraveling the invasion paradox: evolutionary ecology of introduced brown trout in Newfoundland	Brown - Learning about danger: chemically mediated predator recognition learning in juvenile salmonids and the effects of ambient pH	Hoyle - Response of freshwater drum to a disease outbreak in Lake Ontario
15:40	Adams - A stochastic life history-based population model for brook trout ( <i>Salvelinus fontinalis</i> ): predicted population responses to exploitation	Bradbury - Of genetic isolation-by-distance	Klassen - Evaluating the use of hatchery-reared yoy lake sturgeon in stocking programs: from the lab to the field
16:00		DeMille - The physiological impacts of decompression and fizzing in smallmouth bass <i>Micropterus dolomieu</i>	Ross - The effects of competition on the growth of three cohabiting juvenile gadids: <i>Gadus morhua</i> , <i>G. ogac</i> , and <i>Urophycis tenuis</i>

**Posters at-a-glance  
Nova Scotia Ballroom Foyer**

<b>Session: Population Processes at Low Abundance</b>		
<b>P1</b>	Ings	A META-ANALYSIS OF SPATIAL AND TEMPORAL SCALES OF BROWN TROUT INTERACTIONS WITH ATLANTIC SALMON
<b>P2</b>	Desjardins	SURVIVAL, GROWTH AND EMIGRATION OF STOCKED ATLANTIC SALMON IN LAKE ONTARIO STREAMS
<b>Session: Ecosystem-based Management</b>		
<b>P3</b>	Cooper	FIELD GUIDE TO SKATES (FAMILY RAJIDAE) OF THE CANADIAN ATLANTIC AND ADJACENT REGIONS
<b>P4</b>	O'Connor	SELECTING MARINE PROTECTED AREAS IN NOVA SCOTIA'S COASTAL ZONE
<b>P5</b>	Waters	IS THERE PROGRESS TOWARD ECOSYSTEM-BASED MANAGEMENT
<b>P11</b>	Soliman	MODELING PHOSPHORUS CONCENTRATION IN NOVA SCOTIA LAKES USING THE ONTARIO LAKESHORE CAPACITY MODEL: TRACKING CHANGES IN TROPHIC STATUS AND IDENTIFYING SHORELINE DEVELOPMENT CAPACITIES
<b>Session: Waterbirds in Marine and Freshwater Food Webs</b>		
<b>P6</b>	Montevecchi	SEABIRDS HELP DETECT ARCTIC ECOSYSTEM CHANGE: A CANADIAN INTERNATIONAL POLAR YEAR (IPY) INITIATIVE
<b>Session: Evolutionary Ecology in Marine and Freshwater Ecosystems</b>		
<b>P7</b>	Avery	USING SHAPE ANALYSIS TO IDENTIFY MORPHOLOGICAL DIFFERENCES IN CARDINAL FISH ( <i>ASTRAPOGON STELLATUS</i> ) FROM PEDRO BANK, JAMAICA AND MAN-O-WAR CAY, BAHAMAS
<b>P8</b>	Gomez-Uchida	ROLE OF MUTATION, MIGRATION, AND EFFECTIVE POPULATION SIZE IN THE DIVERSIFICATION OF TWO SYMPATRIC MORPHS OF ARCTIC CHARR ( <i>SALVELINUS ALPINUS</i> )
<b>P9</b>	Houde	ECOLOGICAL INTERACTIONS BETWEEN JUVENILES OF MULTI-GENERATIONAL CROSSES OF FARMED AND WILD ATLANTIC SALMON
<b>Session: Complexities in Ecological Recovery</b>		
<b>P10</b>	Bowron	DETERMINING THE RESPONSE OF WHITE SUCKER ( <i>CATOSTOMUS COMMERSONI</i> ) AFTER THE SHUTDOWN AND RESTART OF A LAKE SUPERIOUR PULP MILL
<b>P12</b>	Szkokan-Emilson	CONCORDANCE OF TERRESTRIAL AND AQUATIC RECOVERY: DOES FULL RECOVERY OF AQUATIC SYSTEMS HAVE TO AWAIT IMPROVEMENTS ON THE LAND?
<b>P13</b>	Wesolek	SPATIAL PATTERNS IN BENTHIC INVERTEBRATE RECOVERY: USE OF SITE SPECIFIC AND SUBCATCHMENT SCALE VARIABLES TO PREDICT CHANGE
<b>P14</b>	Wolniewicz	THE INFLUENCE OF EXCHANGEABLE BASE CATIONS OF CATCHMENT SOILS ON THEIR CORRESPONDING ION CONCENTRATIONS IN 34 HEADWATER LAKES IN NOVA SCOTIA
<b>Session: Physical Limnology and Oceanography Influences on Populations</b>		
<b>P15</b>	Evans	PLANTONIC AND BENTHIC COMMUNITY COMPOSITION IN LAKES OF THE LOWER MACKENZIE RIVER BASIN, NORTHERN CANADA
<b>Session: River and Estuary Ecosystems</b>		
<b>P16</b>	Blais	THE PERSISTENCE OF STEROIDAL ESTROGENS IN THE AQUATIC ENVIRONMENT, AND THEIR BIOCONCENTRATION IN FISH.
<b>P17</b>	Brinkmann	MERCURY LEVELS AND DAILY RATION IN NORTHERN PIKE ( <i>ESOX LUCIUS</i> ) OF A NEWLY CONSTRUCTED IRRIGATION RESERVOIR IN A

		FLOW-AUGMENTED STREAM SYSTEM
<b>P18</b>	Mackereth	WETLAND AND RIPARIAN HYDROLOGIC RESPONSE TO FOREST MANAGEMENT IN THE BOREAL FOREST
<b>P19</b>	Warnock	MULTILOCUS MICROSATELLITE DNA ANALYSIS AS A STOCK DELINEATOR IN MIGRATORY BULL TROUT
<b>Session: Contributed Papers</b>		
<b>P20</b>	Blanchfield	FATE OF ESCAPED FARMED RAINBOW TROUT
<b>P21</b>	Bouvier	RELATING SPECIES TRAITS TO HABITAT CHARACTERISTICS IN COASTAL WETLANDS OF THE LOWER GREAT LAKES
<b>P22</b>	Chiandret	PLANKTON COMMUNITIES IN URBAN STORMWATER PONDS: A LIMNOLOGICAL APPROACH
<b>P23</b>	Cooper	THE ST. ANDREWS BIOLOGICAL STATION— A CENTURY OF MARINE RESEARCH 1908-2008
<b>P24</b>	Coté	SHOULD I STAY OR SHOULD I GO NOW? BEHAVIOURAL RESPONSES OF ATLANTIC SALMON PARR TO THE FORMATION OF ANCHOR ICE AND FLOOD EVENTS
<b>P25</b>	Fleming	RECONSTRUCTION OF HOLOCENE ENVIRONMENTAL CHANGES IN NORTHERN BRITISH COLUMBIA USING FOSSIL MIDGES
<b>P26</b>	Gautreau	FISHES OF THE LOWER SAINT JOHN RIVER
<b>P27</b>	Greer	LONG-TERM CHANGES IN AGE, BODY SIZE, AND GROWTH OF AMERICAN EELS, <i>ANGUILLA ROSTRATA</i> , ASCENDING THE EEL LADDER AT THE MOSES-SAUNDERS GENERATING STATION, UPPER ST. LAWRENCE RIVER
<b>P28</b>	Klassen	BLACK FLY LARVAE: A NOVEL APPROACH TO LAKE STURGEON CONSERVATION AQUACULTURE
<b>P29</b>	LeBlanc	NESTING SUCCESS OF SMALLMOUTH BASS ( <i>MICROPTERUS DOLOMIEU</i> ) IN NOVA SCOTIA : PRELIMINARY ASSESSMENT OF FACTORS AFFECTING NEST SUCCESS RATES
<b>P30</b>	Litvak	THE EFFECT OF SPERM TO EGG RATIO AND GAMETE CONTACT TIME ON FERTILIZATION SUCCESS IN ATLANTIC COD
<b>P31</b>	Matsumoto	VISUAL SENSITIVITY IN JUVENILE PACIFIC BLUEFIN TUNA, <i>THUNNUS ORIENTALIS</i>
<b>P32</b>	Hicks	DETERMINANTS OF ZOOPLANKTON COMMUNITY STOICHIOMETRY IN CANADIAN SHIELD LAKES
<b>P33</b>	Nasmith	EFFECTS OF INTRODUCED TROUT ON FORAGE FISH BEHAVIOUR IN BOREAL FOOTHILLS LAKES
<b>P34</b>	Schaner	INVESTIGATION OF POTENTIAL FOR BIAS IN ACOUSTIC ESTIMATES OF ALEWIFE ( <i>ALOSA PSEUDOHARENGUS</i> ) IN LAKE ONTARIO
<b>P35</b>	Schank	DO INTRODUCED TROUT AFFECT THE ABUNDANCE AND PATTERNS OF METAMORPHOSIS OF NATIVE AMPHIBIANS?
<b>P36</b>	Suzuki/Ishibashi	MOLECULAR CLONING AND EXPRESSION OF OPSIN GENES DURING LARVAL AND JUVENILE DEVELOPMENT IN THE CHUB MACKEREL <i>SCOMBER JAPONICUS</i>
<b>P37</b>	Vermaire	AN EMPIRICAL EXAMINATION OF THE THEORY OF ALTERNATIVE STABLE STATES IN SHALLOW LAKES: THE IMPACT OF NUTRIENT ENRICHMENT ON ENVIRONMENTAL VARIABILITY

## **Abstracts**

61<sup>st</sup> 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*

Halifax, Nova Scotia  
January 3-5, 2008

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

A STOCHASTIC LIFE HISTORY-BASED POPULATION MODEL FOR BROOK TROUT  
(*SALVELINUS FONTINALIS*): PREDICTING POPULATION RESPONSES TO EXPLOITATION

**Adams\***, B., Cote, D., Fleming, I., Knight, T. and Caissie, A.

\*Ocean Science Centre, Memorial University of Newfoundland, Newfoundland and Labrador, Canada.  
bkadams@nf.sympatico.ca - (709) 424-7550

A stochastic life history model was developed and tested for brook trout (*Salvelinus fontinalis*) using data from 16 lakes in eastern Canada. Monte Carlo re-sampling was combined with a population matrix model to create probability distributions of intrinsic rates of increase ( $r$ ). These probability distributions were then used to assess the impact of environmental perturbations, primarily increased adult mortality as a consequence of recreational fishing. Simulated exploitation was used in 8 of the 16 lakes to test the predictive power of the model. Population rates of change in the exploited and control lakes were congruent with model predictions. Abundance, density, age and size structure, and growth rate responses were in qualitative agreement with model predictions. Simulations of alternate recreational fishing management regimes suggest that under moderate to high exploitation rates, a minimum size is the most effective method of ensuring long-term population persistence in short lived salmonids. This modeling approach appears to be a robust method, even in data poor scenarios, to assess population responses to exploitation at both the lake and regional scale.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

UNDERSTANDING REPRODUCTION AT LOW ABUNDANCE: KEY INDICATORS OF  
REPRODUCTIVE DEVELOPMENT IN LAKE STURGEON, *ACIPENSER FULVESCENS*

**Allen\***, P. J.<sup>1,2</sup>, Anderson, W. G.<sup>2</sup>, and S. J. Peake<sup>1</sup>.

<sup>1</sup>Canadian Rivers Institute, University of New Brunswick, Fredericton, <sup>2</sup>Department of Biological Sciences, University of Manitoba (allenp@cc.umanitoba.ca)

Rare or uncommon species pose problems for effective population management. Understanding population processes is essential to the management and recovery of these species, yet key components of these processes, such as reproduction, are difficult to determine. Lake sturgeon, *Acipenser fulvescens*, is a declining or endangered species in many Canadian ecosystems. Low abundance is coupled with late reproductive maturity, slow egg development, and long reproductive intervals. Assessing populations is also hindered by a lack of external sex characteristics. Population management and size estimates can be greatly improved with additional information on reproductive maturity. Understanding the annual size of the spawning population can benefit population status assessments and long-term population modeling for estimates of reproductive output. We sampled wild adult lake sturgeon from the Winnipeg River, Manitoba in order to determine indicators of reproductive development for use in population assessments. Adult lake sturgeon were sampled for blood indicators of sex and stage of maturity, and gonadal biopsies were collected for histological verification. Fish from both sexes and all reproductive stages were used to determine the best indicators of sex and reproductive development stage. Results will be discussed in the context of management and conservation of this species.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives)

## THE POTENTIAL OF INVERTEBRATE SPECIES AND THEIR LIFE HISTORY CHARACTERISTICS FOR MONITORING THE IMPACT OF EFFLUENTS

**Arciszewski T.\***, K. Munkittrick, and K. Kidd.

Canadian Rivers Institute, University of New Brunswick, Saint John, New Brunswick. (email: tim.a@unb.ca)

Typical monitoring programs in Canada (i.e. Environmental Effects Monitoring) use fish populations and invertebrate communities to assess impacts of point sources in rivers. However, appropriate fish sentinels may not be available and invertebrate community data can be expensive (and laborious) to obtain. We wanted to determine if invertebrate populations could be used as sentinel species in monitoring programs. We used a model reach of the Saint John River that has been eutrophied from sewage inputs and compared the responses of the slimy sculpin (*Cottus cognatus*) with stonefly growth, survival, and reproduction of two larval stoneflies, *Acroneuria* sp. and *Paragnetina* sp.. Both the sculpin and the stoneflies showed eutrophication responses downstream of sewage effluents. The stoneflies showed increased abundance, size, development, condition, and fecundity and the sculpin showed increased abundance, size, growth, and condition. Our findings support the further investigation of invertebrate populations as alternative sentinels in environmental monitoring programs. Some advantages include the speed and ease of the measurements, use of organisms which are present in both reference and exposure areas (not those that are absent at exposure sites), and the sedentary habits of invertebrates.

Oral SCL (River and Estuary Ecosystems) (GS)

## USING SHAPE ANALYSIS TO IDENTIFY MORPHOLOGICAL DIFFERENCES IN CARDINAL FISH (ASTRAPOGON STELLATUS) FROM PEDRO BANK, JAMAICA AND MAN-O-WAR CAY, BAHAMAS

**Avery\***, T.S., J.M. Reader, S. Winfield and M.J. Dadswell

The close association of the Caribbean conchfish, *Atropogon stellatus* (Cope, 1867), with the currently overfished and CITES-listed Queen Conch, *Strombus gigas*, place conchfish at risk. There is little evidence to suggest that adult conchfish will use hosts other than the Queen Conch. Conchfish have been rarely studied and there is a lack of information on conchfish in areas where conch are fished. Conchfish from Pedro Bank, Jamaica and Man-o-War Cay, Bahamas, were collected and stored in formalin then alcohol. Truss distance measurements were taken from 10 landmarks and converted to Cartesian coordinates prior to analysis. Significant differences in shape were shown using both Discriminant Analysis (Hotelling's  $T^2$ ) and two-group permutation with Mahalanobis distance. These results will be coupled with other morphological and meristic measures, age, and sex ratios to compare with historical records and broaden the baseline information for this species.

Poster CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## MATERNAL EFFECTS OF EGG QUALITY ON PROGENY MORPHOLOGY, SURVIVAL AND GROWTH IN LARVAL ATLANTIC COD (*GADUS MORHUA*)

**Bachan**<sup>1,2\*</sup>, M.M., Fleming<sup>1</sup>, I.A. & Trippel<sup>2</sup>, E.A.

<sup>1</sup>Memorial University of Newfoundland, St. John's, NL, <sup>2</sup>St. Andrews Biological Station, Fisheries and Oceans Canada, St. Andrews, NB \* (email: [michellebac@gmail.com](mailto:michellebac@gmail.com))

Maternal effects have been shown to influence offspring survival. However, for many marine serial spawners, such as Atlantic cod, questions exist about how the production of several distinct egg batches from a single female can affect egg quality and subsequent larval morphology, survival and growth rates. A paired mating system (controlled for male contribution) was used to obtain consecutive egg batches from individual females from which morphological measurements were obtained of 0 days post hatch (dph) and 5dph larvae. Measures of larval size and development were correlated to egg diameter and batch number. Surviving larvae were subjected to a feeding experiment and fed at one of two diet levels over a 15 day period. Specific growth rates and condition factor were greater for individuals exposed to the high food diet versus the low food diet, though survivorship was variable. Moreover, growth and condition varied as a function of batch number. Lipid analyses are being used to determine egg quality and to assess whether lipid classes or fatty acid composition differ between the successive egg batches and can account for differences in offspring growth and survival within or among females. Our results indicate that female allocation of resources to offspring varies across the breeding season with implications for environmental dependent offspring survival and growth.

Oral CCFFR (Contributed paper) (GS)

## ESTIMATING PROBABILITY OF ESTABLISHMENT FOR CLADOCERA INTRODUCED AT LOW ABUNDANCE: AN ASSESSMENT OF THE PROPOSED IMO BALLAST WATER TREATMENT STANDARDS

**Bailey**, S.A.<sup>1\*</sup>, A. Velez-Espino<sup>1</sup>, M. Koops<sup>1</sup>, O. Johannsson<sup>1</sup>, and C. Wiley<sup>2</sup>.

<sup>1</sup>Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Road, Box 5050, Burlington, ON, L7R 4A6. <sup>2</sup>Fisheries and Oceans Canada/Transport Canada Marine Safety, 100 Front Street South, Sarnia, ON, N7T 2M4. (email: [sarah.bailey@dfo-mpo.gc.ca](mailto:sarah.bailey@dfo-mpo.gc.ca))

A variety of technological treatment methods are being developed to reduce the invasion risk associated with ballast water discharge. The International Maritime Organization (IMO) has proposed minimum discharge standards for treatment technologies, comprised of maximum densities of viable organisms and indicator microbes. For example, a discharge density of 10 individuals·m<sup>-3</sup> has been proposed for organisms greater than 50 µm in minimum dimension, such as zooplankton. Theoretically, lowering inoculum density will reduce establishment probability due to density-dependent demographics and environmental stochasticity. To our knowledge, however, there has been no empirical testing of the efficacy of the proposed standards. We are particularly interested in the impact the proposed standards would have on parthenogenetic taxa that are not subjected to density-dependent demographics (i.e., cladocerans). Mesocosm experiments (5000 L) were conducted in Hamilton Harbour, Lake Ontario, to measure growth rates of six Cladocera given low inoculum density. We modified a diffusion approximation to estimate establishment probabilities based on four parameters: inoculum density, critical reproductive threshold density, and the mean and variance of the stochastic growth rate. Only one of the study species (*Daphnia retrocurva*) exhibited a low-moderate probability of establishment (~25%) at inoculum densities of 10 individuals·m<sup>-3</sup>. Two additional species (*Bosmina coregoni* and *Bosmina* spp.) exhibited very low probabilities of establishment (<1%), while the remaining species appear incapable of establishment given such low inocula. Our results indicate that the proposed discharge standard for zooplankton is highly precautionary but that the probability of establishment may not be insignificant for some species.

Oral SCL (Population Processes at Low Abundance – Recovery, Rarity & Invasives)

## ABUNDANCE, MOVEMENT AND HABITAT USE OF JUVENILE LAKE STURGEON IN THE WINNIPEG RIVER, MANITOBA.

**Barth\***, C.C.<sup>1,2</sup>, Peake, S.J.<sup>1</sup>, Anderson, W.G.<sup>2</sup>, and M. Abrahams<sup>2</sup>.

<sup>1</sup>Canadian Rivers Institute, University of New Brunswick, Fredericton; <sup>2</sup>Department of Biological Sciences, University of Manitoba. (Email: [umbarth0@cc.umanitoba.ca](mailto:umbarth0@cc.umanitoba.ca))

Information related to abundance, movement and habitat use of juvenile lake sturgeon (<60 cm long) in large impounded rivers is relatively scarce. As such, we studied a population of fish between the Slave Falls Generating Station (GS) and the Seven Sisters Falls GS on the Winnipeg River during the open-water seasons of 2005 and 2006. Gillnet catches indicated that large numbers of juvenile sturgeon congregated in deep water areas and these fish appeared to segregate themselves from other sympatric species. Furthermore, results suggest that water depth (or some correlate) is a key factor influencing habitat selection, while water velocity and substrate may act as contributing factors. Mark and recapture information suggests that juvenile sturgeon have relatively small home ranges. Data collected from acoustic-tagged fish confirms a high degree of site fidelity, and indicates that juvenile lake sturgeon are in almost constant motion during summer, presumably engaged in foraging activity. Individuals often showed a characteristic movement pattern, which was narrow and parallel to the river. Overall, our studies have shown that nursery areas for juvenile lake sturgeon can exist in impounded sections of a large river, if the appropriate habitat conditions exist.

Oral CCFFR (Contributed paper)

## INTERANNUAL VARIATIONS OF HABITAT QUALITY MODELS FOR JUVENILE ATLANTIC SALMON (*SALMO SALAR*)

**Bédard\***, M.E. and D. Boisclair. Département de sciences biologiques, Université de Montréal, Montréal, Québec ([me.bedard@umontreal.ca](mailto:me.bedard@umontreal.ca) ; [daniel.boisclair@umontreal.ca](mailto:daniel.boisclair@umontreal.ca))

Habitat quality models (HQM) are relationships between indices of habitat quality and abiotic and biotic conditions. They may be used to predict distribution patterns of organisms and to identify areas that should be protected for conservation purposes. HQM are often developed from data collected in one river over one particular year, or from data from several rivers each sampled over different years. However, inter-annual variations of fish density may affect habitat selection and hence the structure and the robustness of HQM. In addition, in years with high river discharge, environmental conditions such as water depth and velocity may be more homogeneous. This may homogenize fish distribution patterns, and consequently, the identity of the variables that explain variations of fish density. In contrast, in years with low river discharge, fish may be confined to river sections, like riffles, that offer shelter from predation. The purpose of our study was to assess the effect of inter-annual variation of fish density and river discharge on HQM of juvenile Atlantic salmon (JAS). Field work was performed along the Ste-Marguerite River (Saguenay, Québec) in 2003, 2004 and 2005. JAS density was estimated by underwater observations. Our results suggest that the inter-annual variation of fish density and river discharge do not affect the identity of the variables that explain most of the spatial variations of JAS density. The distribution of JAS relative to key features of rivers such as sedimentary links also remained constant.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## BEHAVIOURAL CHANGE DUE TO DOMESTICATION SELECTION IN A CAPTIVE BREEDING PROGRAM OF ENDANGERED ATLANTIC SALMON

**Bezanson**<sup>\*1</sup>, L., C. Herbing<sup>1</sup>, P.T. O'Reilly<sup>2</sup>. <sup>1</sup>Department of Biology, Dalhousie University, Halifax, NS.  
<sup>2</sup>Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, NS (email: [lbezanso@dal.ca](mailto:lbezanso@dal.ca))

Captive breeding and rearing is commonly used in efforts to conserve and restore salmonid populations around the world. However, due to the very different environmental conditions and thus selective pressures experienced by populations maintained in captivity and those in the wild, genetic change due to domestic selection can occur. Assessing to what extent, and how rapidly this genetic change can take place is vital in determining the efficacy of captive breeding programs as well as the long-term impact on the wild and captive components of targeted populations. Anti-predator response, the behavioural reaction to an avian predator, has been shown to be selected against in the hatchery environment. Behavioural trials determining anti-predator response were conducted on four groups of Atlantic salmon fry from a captive breeding program for endangered inner Bay of Fundy Atlantic salmon (*Salmo salar*). The groups tested included: first-generation, second-generation, and fully wild fry, as well as second-generation hatchery fish with wild exposure. This fourth group is offspring of first-generation captive-produced parents who were released into the wild as juveniles, recaptured, and spawned in captivity. This study has the potential to address whether genetic change can occur as rapidly as within one or two generations in the captive environment, and to what degree exposure to the wild can counteract this change.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## INTRODUCED PUMPKINSEED SUNFISH (*LEPOMIS GIBBOSUS* L.)

**Bhagat**<sup>\*1</sup>, Y., M.G. Fox<sup>2</sup>, and M.T. Ferreira<sup>3</sup> (e-mail: [yakutabhagat@trentu.ca](mailto:yakutabhagat@trentu.ca))  
<sup>1</sup>Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario, Canada; <sup>2</sup>Environmental & Resource Studies Program and Department of Biology, Trent University, Peterborough, Ontario, Canada; <sup>3</sup>Departamento de Engenharia Florestal, Instituto Superior de Agronomia, Tapada da Ajuda, Lisboa, Portugal

The pumpkinseed (*Lepomis gibbosus* L.) is a North American species that was introduced into Europe more than 100 years ago, and has since undergone rapid expansion in parts of its non-native range. This species has demonstrated a high degree of morphological and life history plasticity, including the ability to develop trophic morphotypes in favourable environments. Iberian reservoirs offer unique possibilities for morphological diversification of pumpkinseeds because of the range of habitats, the dearth of native predators and competitors and the possibilities for planktivory in these fluctuating environments. As part of an overall study to examine the effect of reservoir morphometry, productivity and food availability on morphological diversification, we sampled pumpkinseeds from four habitat zones (fluvial pelagic, fluvial littoral, lacustrine pelagic and lacustrine littoral) in five Portuguese reservoirs and tested the hypothesis that differences in habitat type and resource availability between different habitat zones will lead to differences in functional morphological characters. Our previous results showed that there were significant differences in external morphology in pumpkinseeds captured from the four habitat zones in all five reservoirs, the differences between littoral and pelagic zones being most pronounced. To test the prediction that differences in habitat types would translate to differences in resource availability, we performed stomach content analysis on pumpkinseeds captured from all four habitat zones, separating prey type into major taxonomic groups that have been previously hypothesized to generate adaptations in external and internal morphology. An internal morphological assessment involving gill rakers and pharyngeal dentition was also conducted to determine differences in feeding structures between habitat populations. The results from these analyses will be discussed in the context of the likely role of phenotypic plasticity in functional morphological differentiation among a highly potentially invasive species.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## DISENTANGLING THE EVOLUTIONARY PROCESSES RESPONSIBLE FOR SYMPATRIC MORPHS OF LAKE TROUT: EVIDENCE FOR SYMPATRIC DIVERGENCE IN GREAT BEAR LAKE

**Blackie, Craig \*** & Paul Bentzen

Gene Probe Laboratory, Biology Department, Dalhousie University, Halifax, NS, B3H 4J1, (902)494-1398, email: [cr616392@dal.ca](mailto:cr616392@dal.ca)

Contrasting patterns of gene flow on different spatial scales can offer insights into the evolutionary processes responsible for sympatric intraspecific morphs. Northern freshwater fishes have been used extensively as a model for contrasting historical (allopatric) and contemporary (sympatric) evolution given the young age of most populations, the well-understood post-glacial colonization and the consistent morphological patterns seen among broad taxonomic groups. Here we present results from an ongoing study on lake trout (*Salvelinus namaycush*) morphs from Great Bear Lake, Northwest Territories. We collected sexually mature lake trout from multiple spawning sites in each of three arms of the lake (Dease Arm, Smith Arm and McTavish Arm respectively) and applied morphological and genetic analyses. Using linear and geometric morphometric approaches we determined that lake trout found on respective spawning sites displayed specific morphological attributes related to body shape, fin size and gill raker number. Furthermore, the respective morphs spawned in multiple areas of the lake. Using nine microsatellite loci, we determined that fish from each of the spawning areas were differentiated from one another. A neighbor-joining phenogram grouped fish together based on geographic location rather than by morph. Assignment tests and model-based clustering methods corroborated this and revealed evidence for historical and contemporary gene flow among spawning sites within arms of the lake with lower gene flow estimates at larger spatial scales. These findings suggest that the lake trout morphs in Great Bear Lake are the result of sympatric divergence related to ecological factors, although mitochondrial DNA data also needs to be considered. The results also suggest that the lake trout in Great Bear Lake should be managed as separate morphs in each of the geographically distinct arms of the lake.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## THE PERSISTENCE OF STEROIDAL ESTROGENS IN THE AQUATIC ENVIRONMENT, AND THEIR BIOCONCENTRATION IN FISH.

Atkinson, S.K.<sup>1</sup>, V.L. Marlatt<sup>1</sup>, D.R.S. Lean<sup>1</sup>, J. Ridal<sup>2</sup>, V.L. Trudeau<sup>1</sup>, J.M. **Blais**<sup>1\*</sup>.

<sup>1</sup>Department of Biology, University of Ottawa, Ottawa, ON, Canada, K1N 6N5

<sup>2</sup>St. Lawrence River Institute of Environmental Studies, Cornwall, ON, Canada, K6H 4Z1

\* [Jules.Blais@uottawa.ca](mailto:Jules.Blais@uottawa.ca)

Concentrations of the natural estrogens estrone (E1), estradiol (E2) and ethinylestradiol (EE2), the synthetic estrogen used in the birth control pill, have been measured in the environment at levels which can alter the normal reproduction and development of fish. The initial purpose of this study was to determine the steroid estrogen concentrations in local sewage treatment plants (STP's) and their potential to bioconcentrate in fish. Estrogens were extracted from Ottawa and Cornwall sewage samples and analyzed by gas chromatography with negative-ionization mass spectrometry. These estrogens were persistent in both STP's; E1, E2 and EE2 enter rivers at concentrations equal to or slightly higher than those of untreated sewage. In all samples, steroidal estrogen concentrations in wastewater were found at biologically active concentrations. We also investigated the persistence of steroid estrogens in water under different exposures to UVB radiation in waters varying in dissolved organic carbon (DOC) concentration. The rate of E1 degradation was inversely related to DOC concentrations, and positively related to UVB intensity. In contrast, EE2 did not degrade significantly under any UV treatment. This suggests that EE2 is relatively resistant to photodegradation by ambient UV radiation. Finally, we determined a bioconcentration factor of ~150 for ethinyl estradiol in goldfish.

Poster SCL (River and Estuary Ecosystems)

## FATE OF ESCAPED FARMED RAINBOW TROUT

**Blanchfield\***, P.J. and L. Tate

Fisheries and Oceans Canada, Freshwater Institute, 501 University Crescent, Winnipeg, MB, R3T 2N6, Canada (email: BlanchfieldP@dfo-mpo.gc.ca)

Escapes of domesticated fish to the wild remains a major ecological concern associated with the open-pen aquaculture industry. Rainbow trout (*Oncorhynchus mykiss*) is the dominant species reared in the Canadian freshwater industry. In contrast to other farmed salmonids (i.e., Atlantic salmon, *Salmo salar*), the impacts of escaped rainbow trout have received relatively little attention. In general, the potential ecological impacts of escaped fish are difficult to quantify in the large water bodies where most of this industry occurs. We released rainbow trout from an experimental farm in a small boreal lake (ELA project) and monitored their survival, behaviour and habitat use with automated telemetry systems. Survival of farmed rainbow trout varied considerably among years, but was generally low with only 22% of tagged fish surviving for a period of 1 y. Rainbow trout spent most of their time in close proximity to the cage site while the farm was in operation; otherwise they were widely distributed around the lake. Rainbow trout consistently maintained a shallow (~2 m) depth distribution. Early results from this ongoing study suggest that only a small proportion of fish survive after an “escape event”, but these fish are able to maintain high growth rates by exploiting a variety of habitats, including dependence upon the cage site for waste food pellets.

Poster CCFFR (Contributed paper)

## FISH ASSEMBLAGES OF THE NORTHUMBERLAND STRAIT: SPATIAL, TEMPORAL AND EXPLANATORY VARIABLE PATTERNS

**Bosman**, S.H.,\* Methven, D.A., Hanson, J.M. and Courtenay, S.C.

Department of Biology, University of New Brunswick, Saint John (email: S.Bosman@unb.ca).

The focus of marine fisheries management is slowly shifting from single-species to an ecosystem approach. A first step towards ecosystem management is to identify species assemblages. Trawl survey data collected during summers of 2001 to 2006 were analyzed to identify fish assemblages in the Northumberland Strait. Multivariate techniques, including cluster analyses and non-metric multidimensional scaling ordinations, were used to characterize spatial and temporal trends in fish assemblages. In addition, abiotic (depth, bottom temperature, substrate type) and biotic (lobster and lady crab catches) explanatory variables were examined for correlation with assemblage structure. Two distinct fish assemblages occurred each year in the same geographic areas. The first, located off northwestern PEI, contained mostly demersal fishes (winter flounder, longhorn sculpin). The second, located in the center of the Northumberland Strait, contained a mixture of demersal and pelagic fishes (rainbow smelt, cunner). Although no explanatory variables correlated strongly with fish assemblage structure, bottom temperature contributed to the highest correlation each year ( $\rho_w = 0.104 - 0.191$ ) when examining only abiotic variables. Both bottom temperature and lady crab catches contributed to the highest correlation each year ( $\rho_w = 0.104 - 0.480$ ) when examining abiotic and biotic variables together. These results indicate that spatially and temporally persistent fish assemblages occur in the Northumberland Strait; however additional research is needed on environmental influences and species interactions in order to better understand the ecosystem as a whole.

Oral CCFFR (Ecosystem-based Management –Science and Policy) (GS)

## DID THE DECLINE OF GROUND FISH STOCKS IN THE GULF OF MAINE INCREASE LOBSTER LANDINGS?

**Boudreau\***, S.A. and Worm, B.

Department of Biology, Dalhousie University, Halifax, NS (sboud@mathstat.dal.ca)

The metric tonnage of American lobster (*Homarus americanus*) being landed in the Gulf of Maine (GOM) in the past 20 years is well above the historical average. Lobster fishing area (LFA) 34, in the Canadian portion of the GOM, lands approximately 40% of all Canadian lobster and in the 2004-05 fishing season, landings were ~5.5 times higher than in 1980-81. The increase in landings is unique to this region as there has been an observed decline of lobster landings progressing from lower to higher latitudes. It is hypothesized that the increase in lobster landings is partly linked to a rapid decline in predatory groundfish stocks in the northwest Atlantic. Local expert interviews in LFA 34 indicate that 83% of lobster fishers interviewed believe that the decline in fish stocks is the reason for the increased landings. Two of the species that the fishers observed as major predators of lobsters, cod (*Gadus morhua*) and wolffish (*Anarhichas lupus*), have experienced particularly severe declines since the early 1990s. This top-down mechanism is partly supported by evidence from trawl surveys suggesting that a loss of predator control has been favorable to lobster fishers in the GOM.

Oral CCFFR (Ecosystem-based Management – Science and Policy) (GS)

## EFFECTS OF CLOUD COVER ON RIVER FISH COMMUNITY STRUCTURE ESTIMATES IN THE LAURENTIANS, QC

**Bourque\***, G. and D. Boisclair.

Département de sciences biologiques, Université de Montréal, Montréal, QC  
(\*email: 074051b@acadiau.ca)

Habitat use modelling is increasingly used to assess impacts of human or natural perturbations (e.g., dam construction, climate change) on fish populations and communities. Quantifying the use and quality of a habitat implies obtaining accurate estimates of its use by the population or community of interest. Cloud cover has already been shown to impact Atlantic salmon habitat use in rivers, but knowledge about other species, or whole communities, is still sparse. In this study, we investigate the effects of cloud cover on river fish community structure estimates to assess its potential impacts on habitat use models performance. We surveyed 14 sections of 100 m in the Rivière Rouge and Rivière du Nord watersheds (Laurentian region of Québec). Between late-June and early-August 2007, a total of 20 visits at > 50 % cloud cover were paired within 48 hours with visits at < 50 % cloud cover. Density of fish species encountered and habitat variables were noted for each 10 m subsection. Data were collected by calibrated snorkellers swimming upstream in linear transects spread across the river width. Total fish density did not appear to differ between paired visits, suggesting that it might not be affected by cloud cover. On the other hand, individual species responses differ. In conclusion, researchers should be careful when combining sampling events from cloudy and sunny days, but could do so when considering overall fish community responses: sample size could be increased without decreasing habitat use models performance.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## RELATING SPECIES TRAITS TO HABITAT CHARACTERISTICS IN COASTAL WETLANDS OF THE LOWER GREAT LAKES

**Bouvier**, L.D. <sup>\*1</sup>, K. Cottenie<sup>2</sup>, and S.E. Doka<sup>1</sup>

<sup>1</sup> Great Lakes Lab for Fisheries and Aquatic Sciences, Fisheries & Oceans Canada, Burlington, Ontario, Canada L7R 4A6; <sup>2</sup> Department of Integrative Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1 (email: [bouvierld@dfo-mpo.gc.ca](mailto:bouvierld@dfo-mpo.gc.ca))

Habitat characteristics play a critical role in structuring fish assemblages. While species traits ultimately determine these habitat-species relationships, generally community ecologists determine relationships between species assemblages and habitat characteristics first and in some cases relate these relationships to certain key traits. However, a novel statistical technique, fourth-corner analysis, directly relates species traits to habitat characteristics. We tested associations between species traits and habitat characteristics in a novel wetland system. Fish and habitat surveys were conducted in 12 wetlands across the lower Great Lakes basin. Fish surveys were accomplished with the use of fyke nets and a boat electrofisher. An extensive literature search was completed to gather information on 42 life-history and biogeographical characteristics for 129 fishes. We predicted, a priori, specific species trait and habitat associations based on our literature search. The fourth-corner analysis was applied to five fish assemblage composition matrices: presence/absence matrices for all combinations of sampling methods; and, separate abundance matrices for electrofishing and fyke netting data to determine the effect (if any) of sampling method. Results indicated that the environmental variables with the greatest significant relationships to the life-history and biogeographical characteristics were the area of the tertiary watershed, macrophyte coverage (% of open water, % of floating macrophytes), and geographical positioning. These results were consistent across all species assemblage matrices. Of the 49 predicted species trait and habitat associations approximately half were correct for each of the five fish assemblage composition matrices (49-53% correct predictions). However, 72-83% of the predicted species trait and habitat associations related to vegetative coverage were correctly predicted. This method provides a very important, causal, framework which may be incorporated into risk assessments for invasive species, and may be used to predict the effect of climate change on species distributions.

Poster CCFFR (Contributed paper)

## DETERMINING THE RESPONSE OF WHITE SUCKER (*CATOSTOMUS COMMERSONI*) AFTER THE SHUTDOWN AND RESTART OF A LAKE SUPERIOUR PULP MILL.

**Bowron**<sup>\*</sup> L.<sup>1</sup>, K.R. Munkittrick<sup>1</sup>, M.E. McMaster<sup>2</sup>, G. Tetreault<sup>2</sup> and L.M. Hewitt<sup>2</sup>.

<sup>1</sup>Canadian Rivers Institute and Department of Biology, University of New Brunswick, 100 Tucker Park Road, Saint John, New Brunswick, Canada E2L 4L5 (email: [flg29@unb.ca](mailto:flg29@unb.ca)) <sup>2</sup>Environment Canada, Burlington, ON.

The impacts of pulp mills effluents on fish and fish habitat have been studied at Jackfish Bay, Lake Superior, Ontario, Canada since the late 1980's. Jackfish Bay has received the effluent from a large bleached kraft pulp mill (BKM) in Terrace Bay, ON since 1948. The site is isolated from other sources of contamination, industrial or municipal effluents. Ongoing studies conducted since 1988, showed that white suckers (*Catostomus commersoni*) had a number of reproductive alterations, including delayed maturity, decreased gonadal size, decreased expression of secondary sexual characteristics, and depressed levels of circulating steroids. Reductions in gonad size and steroid levels persisted until the pulp mill closed its hardwood line in the late fall of 2005, and ceased all effluent discharge from its softwood line from February 2006 to September 2006. Fish were collected in the spring and fall of 2006 during shutdown, and then again 8 months after the mill reopened. Relative to their performance as measured with the previous 17 years of data, males recovered quickly after mill closure, as did steroid hormone levels in females. Persistent whole- organism responses in females may be related to a time lag associated with recovery of their egg production. Continued studies will evaluate these questions.

Poster CCFFR (Complexities in Ecological Recovery) (GS)

## CONNECTIVITY AND DISPERSAL ESTIMATION IN AQUATIC ORGANISMS USING MODELS OF GENETIC ISOLATION-BY-DISTANCE

**Bradbury\***, I., Campana, S., and P. Bentzen

<sup>1</sup>Marine Gene Probe Laboratory, Biology Department, Life Sciences Centre, Dalhousie University, Halifax, Nova Scotia, Canada, Bedford Institute of Oceanography, PO Box 1006, Dartmouth, NS, Canada \* Author to whom correspondence should be addressed. Tel: (902) 494-1398, fax: (902) 494-3736, email: [ibradbur@dal.ca](mailto:ibradbur@dal.ca).

Dispersal and connectivity in fragmented habitats is a key factor promoting the stability and persistence of metapopulations. Genetic approaches such as those based on isolation by distance (IBD) may provide one of the best means of estimating dispersal in marine systems where divergence is typically low. We evaluate the accuracy of this approach through a simulation experiment and application to rainbow smelt, *Osmerus mordax*. Simulated IBD relationships ( $F_{ST} / (1 - F_{ST})$  and geographic distance) were generated for combinations of dispersal distance and number of generations. IBD linearity increased with time since colonization and dispersal distance, though the effect of dispersal distance predominated after initial colonization. IBD-based estimates of dispersal display close agreement with actual values though the presence of non-equilibrium may bias estimates. This approach was applied to anadromous rainbow smelt sampled at 22 spawning locations in coastal Newfoundland using eight tetranucleotide microsatellite loci. The observed IBD relationship indicates a lack of equilibrium at large scales and the average dispersal distance was estimated as <1.5 km per generation. This estimate was evaluated using direct estimates of dispersal during the larval, juvenile and adult stages. Across all stages dispersal was limited to local estuaries and rates of annual spawning site fidelity ranged from 90-99%. We conclude that IBD patterns may reflect dispersal phenotype, yet non-linearity in IBD pattern is probably the norm in aquatic. Accordingly, approximations of demographic parameters based on the IBD must be made cautiously taking into account possible non-linearity, scale dependencies, and assumptions of genetic drift-dispersal equilibrium.

Oral CCFFR (Contributed paper)

## MERCURY LEVELS AND DAILY RATION IN NORTHERN PIKE (*ESOX LUCIUS*) OF A NEWLY CONSTRUCTED IRRIGATION RESERVOIR IN A FLOW-AUGMENTED STREAM SYSTEM.

**Brinkmann\***, L. and J.B. Rasmussen, Department of Biological Sciences, University of Lethbridge, Lethbridge, Alberta (email: [lars.brinkmann@uleth.ca](mailto:lars.brinkmann@uleth.ca)).

Mercury data for northern pike (*Esox lucius*) from a newly constructed irrigation reservoir in southern Alberta are presented. Mercury levels (range 0.37ppm to 1.54ppm) generally exceeded the consumption limit of 0.5ppm total mercury concentration (THg) in fresh muscle tissue, were significantly higher (3.5-fold) than northern pike mercury levels in the Oldman River, and in most cases exceeded (up to 2-fold) previously published data from other reservoirs of the northern hemisphere. We tested the hypothesis that the flow-augmented stream system feeding the reservoir contributes to the mercury loading in the reservoir and found, by comparison with sites along the Oldman River, that it is unlikely that the tributary contributes to the high mercury loadings within the reservoir. Mercury levels in northern pike from this reservoir were considered extremely high given that these fish were not piscivorous. The possibility of bioenergetic constraints in these fish was assessed using a mercury mass balance modeling approach. Elevated feeding rates and reduced growth rates of 3 and 4-year old fish in this new irrigation reservoir are presented as possible explanations for high mercury levels. A review of previously published research on daily ration of northern pike is provided.

Poster CCFFR

MERCURY GRADIENT IN LONGNOSE DACE (*RHINICHTHYS CATARACTAE*) IN THE ABSENCE OF POINT SOURCES ALONG THE OLDMAN RIVER CONTINUUM, UPPER SOUTH SASKATCHEWAN RIVER BASIN.

**Brinkmann\***, L. and J.B. Rasmussen, Department of Biological Sciences, University of Lethbridge, Lethbridge, Alberta (email: [lars.brinkmann@uleth.ca](mailto:lars.brinkmann@uleth.ca)).

Mercury levels in forage fish species and invertebrates from the Oldman River, upper South Saskatchewan River basin, were measured after high mercury levels were found in large sport fish, often exceeding 0.5ppm. Mercury levels in longnose dace (*Rhinichthys cataractae*) and suckers (*Catostomus catostomus*, *Catostomus commersoni*) affected by domestic sewage, urban, and agricultural runoff were measured to identify potential sources of mercury to the food webs of the river system. Fish exposed to agricultural and urban effluents had significantly lower mercury levels, or showed no difference, relative to reference sites, which suggests that these effluents contribute no significant mercury loading to river food webs. Although it cannot be ruled out that these effluents contribute a net mercury loading to the water, enrichment-derived biological processes in the food webs (biodilution) may offset the effect of increased loading. Mercury levels in longnose dace and net-spinning caddisfly larvae collected along a 286km stretch of the Oldman River continuum increased from upstream to downstream sites; however, the gradient was more than 2-fold steeper in dace relative to caddisflies, which suggests that bioenergetic factors greatly affect mercury levels in this species, although the underlying mechanism is unknown. Temperature-associated reproductive behaviour and/or cumulative effects of land-use practices and other contaminants may cause differences in growth rates among dace population along this river. This study underscores the importance of a continuum-approach to contaminant levels and cumulative effects assessment in river systems.

Oral CCFFR (River and Estuary Ecosystems)

LEARNING ABOUT DANGER: CHEMICALLY MEDIATED PREDATOR RECOGNITION  
LEARNING IN JUVENILE SALMONIDS AND THE EFFECTS OF AMBIENT pH.

**Brown\***, G.E. and Leduc, A.O.H.C.  
Department of Biology, Concordia University, ([gbrown@alcor.concordia.ca](mailto:gbrown@alcor.concordia.ca)).

A wide variety of juvenile prey fishes, including salmonids, must learn to recognize novel predators. Such learning can be facilitated when novel predator cues are paired with damage-released chemical alarm cues (acquired predator recognition learning). Our recent work has shown that the detection and response of chemical alarm cues by juvenile salmonids is impaired under weakly acidic conditions (~ pH 6.0), suggesting a constraint on chemically-mediated learning. In field trials, we demonstrate that in streams of near neutral pH, juvenile Atlantic salmon readily learn to recognize a novel cue as a predation threat. However, in weakly acidic streams (~pH 6.0), juvenile salmon show no evidence of acquired predator recognition learning. In subsequent laboratory studies, we tested the potential effects of episodic acidification on the learned intensity and retention of acquired predator recognition in juvenile rainbow trout. Trout were conditioned to recognize the odour of a novel predator at pH 6.0 or 7.0 and then tested for learned recognition of the predator odour at the same or different pH, 2 or 7 days post-conditioning. Our results demonstrate that episodic acidification may impair both the strength and retention of acquired predator recognition learning. Given the demonstrated survival benefits associated with learned predator recognition in prey fishes, such impairment will likely have considerable negative impacts at both individual and population levels.

Oral CCFFR (Contributed paper)

## CAPELIN AVAILABILITY INFLUENCES SEABIRD FORAGING DECISIONS

**Burke\***, C.<sup>1</sup>, W.A. Montevecchi<sup>1</sup>, M. Koen-Alonso<sup>2</sup> and P. Penton<sup>3</sup>.

<sup>1</sup>Cognitive and Behavioral Ecology Programme, Memorial University, St. John's, NL; <sup>2</sup>Department of Fisheries and Oceans, St. John's, NL; <sup>3</sup>Department of Zoology, University of Manitoba, Winnipeg, MB. (email: [chantelb@mun.ca](mailto:chantelb@mun.ca))

Common Murres *Uria aalge* in Newfoundland specialize on capelin *Mallotus villosus*. Successful reproduction depends on the availability of capelin during the murres' chick-rearing period (~ 3 weeks), as well as a murre's ability to adjust their foraging tactics in response to variations in prey availability. We investigated how murres at the species' largest colony (Funk Island) cope with changes in capelin availability (timing of spawning and density) by comparing the foraging ranges and diet choices of parental murres during two years (2004-2005) when capelin availability was different. Capelin spawned early (i.e. low overlap with chick-rearing) in 2005 and densities declined 6-fold from 2004. Parental murres responded by increasing their foraging range by 50% (relative to 2004) from a maximum of 60 km to 90 km and preferentially selected larger capelin for their chicks. When prey conditions deteriorate and foraging effort increases, selection of larger prey facilitates maximizing net energy delivery to chicks. However, likely owing to the energetic and time involvements of longer foraging trips, fledgling masses were significantly lower in 2005. These findings imply that specialization on capelin can lead to decreased reproductive output when there is a mis-match between chick rearing and peak food availability.

Oral CCFFR (Waterbirds in Marine and Freshwater Food Webs)

## WHY HAS THE AMERICAN EEL COLLAPSED IN THE UPPER ST. LAWRENCE RIVER BUT NOT ELSEWHERE?

**Cairns\***, David K.

Department of Fisheries and Oceans, Box 1236, Charlottetown, PEI C1A 7M8  
(email: [cairnsd@dfo-mpo.gc.ca](mailto:cairnsd@dfo-mpo.gc.ca))

The collapse of American eels in the upper St. Lawrence River and associated waters (USL) has triggered fears of a species-wide population crash and contributed to perceptions of a worldwide crisis in *Anguilla* eels. This paper seeks to understand the divergence between the USL collapse and population indicators elsewhere in the St. Lawrence system. Dams, pollution, dreissenid mussels, reduction in St. Lawrence Seaway lock openings, and St. Lawrence estuary hypoxia may have negatively affected eel populations in USL, but none can explain the magnitude and timing of the USL collapse. Trap CPUEs in the upper St. Lawrence estuary suggests that production of maturing silver eels in the St. Lawrence basin has declined by roughly 40% since the 1970s. The difference between the collapse of eels in USL and the more modest decline in total-basin eel production can be understood as a consequence of density-dependent watercourse penetration. In times of high abundance eels advance far into a river system to find unused habitat, but when abundance falls eels penetrate less far upstream. This means that upstream population indicators, such as those in USL, do not reflect total-basin population fluctuations in a linear manner, but instead amplify these fluctuations. Eel densities in the Miramichi River, which flows into the Gulf of St. Lawrence, tracks the North Atlantic Oscillation (NAO), an index of Atlantic Ocean conditions. The return of substantial eel populations to USL depends primarily on factors outside the region, including oceanic conditions and productivity of marine growth habitats.

Oral CCFFR (River and Estuary Ecosystems)

## WHAT CONTROLS THE WORLDWIDE DISTRIBUTION OF MARINE VERTEBRATE COMMUNITIES? - A TEMPERATURE-DEPENDENT PREDATION HYPOTHESIS

**Cairns\***, David K., A.J. Gaston and F. Huettmann.

Department of Fisheries and Oceans, Box 1236, Charlottetown, PEI C1A 7M8

(email: cairnsd@dfo-mpo.gc.ca)

Marine vertebrate communities show conspicuous latitudinal banding in the world ocean; e.g. birds and mammals are the leading predators at high latitudes while sharks and other large fish dominate in the tropics. We propose that temperature-dependent predation success (TPS) explains global patterns of marine vertebrate community structure. Burst speed increases with temperature in ectotherms but is independent of temperature in endotherms. If capture success depends on relative swimming speeds of predator and prey, ectothermic prey will be more vulnerable to attack by endothermic predators at low temperatures. Conversely, high temperatures will enhance the ability of ectothermic predators to prey on endotherms. Pursuit-diving seabirds (penguins, auks) and pinnipeds (seals, sea lions) are ubiquitous in ocean waters with summer surface temperatures cooler than ~15-20°C, but are virtually absent in warmer regions. We suggest that the dearth of these endothermic predators in warm waters is due to TPS, as warm water increases their difficulty in capturing fish prey and increases their vulnerability to predation by sharks. Toothed whales can occupy warm tropical waters because their superior swimming speed enables them to catch ectothermic prey even at high temperatures. Endothermy in marine communities increasingly dominates with cold temperatures and with larger animal size, whereas ectothermy dominates in warm temperatures and small body size. In an era of accelerating climate change, there is an urgent need to understand the mechanisms by which temperature influences marine community structure and to apply this knowledge to conservation forecasting and management.

Oral CCFFR (Physical Oceanography and Limnology Influences on Populations and Ecosystems)

## ESTIMATION OF DISCARD MORTALITY IN BLUE SHARKS USING ARCHIVAL SATELLITE POP-UP TAGS, WITH IMPLICATIONS FOR THE STATUS OF THE NORTH ATLANTIC POPULATION

**Campana**, Steven E.<sup>1\*</sup>, Warren Joyce<sup>1</sup> and Michael J. Manning<sup>2</sup>

<sup>1</sup> Population Ecology Division, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2; <sup>2</sup> National Institute of Water and Atmospheric Research Ltd (NIWA), Private Bag 14901, Kilbirnie, Wellington, New Zealand (email: campanas@mar.dfo-mpo.gc.ca)

A confounding issue in the interpretation of shark population status is the survival rate of sharks discarded at sea. In the Northwest Atlantic, virtually all blue sharks (*Prionace glauca*) caught by the Canadian and U.S. large pelagic longline fleets are discarded after capture, for a total of more than 30,000 mt annually. Observer records of >10,000 blue sharks indicated that 10-20% appeared to be dead at the time of discarding, with most of the remainder being injured to varying degrees. To estimate the medium-term survival rate of the discarded blue sharks, we applied popup archival transmitting (PAT) tags to more than 45 blue sharks discarded as part of ongoing commercial fishing operations. Tags were programmed to release from the sharks after 3-6 months. Survival rates greatly exceeded expectations, with most of the mortality occurring within 3 days of release. Injured blue sharks appeared to return to what was interpreted as normal behaviour about 3 weeks after release.

Oral CCFFR (Contributed paper)

## LONG-TERM AMERICAN EEL (*ANGUILLA ROSTRATA*) DYNAMICS IN THE ST. LAWRENCE RIVER-LAKE ONTARIO SYSTEM AS INDICATED BY RECRUITMENT AGE-BASED MODELLING

**Casselman, J.M.\*<sup>1</sup>**, and K.A. Scott<sup>2</sup>

<sup>1</sup>Department of Biology, Queen's University, Kingston, Ontario (e-mail: [casselmj@queensu.ca](mailto:casselmj@queensu.ca));, <sup>2</sup>KDC Consulting, Picton, Ontario; L.A. Marcogliese, Ameliasburgh, Ontario K0K 1A0.

American eel abundance at the extremity of the species' range has declined dramatically recently, particularly the upper St. Lawrence River-Lake Ontario (USLR-LO) stock, where important fisheries have been closed. Modelling used available age data and recruitment determined by numbers of eels ascending the eel ladder at the Moses Saunders Generating Station and into USLR-LO for 32 years (1974-2005). Input variables, quantified by correlation, included estimates of alternative passage (e.g., fallback), natural mortality, pathogenic mortalities in the mid-1980s, yellow eel exploitation in the USLR-LO, turbine mortality of emigrants (Moses-Saunders and Beauharnois), and silver eel exploitation in the estuary (contaminants assigning origin). Abundance estimates were compared and calibrated with quantitative electrofishing from 1984 to present, historic estimates of density (1600s, 1960s, late 1970s), and estuarial harvest of emigrants. Four model estimates were assembled: three were similar, providing means with a range from electrofishing density estimates (lowest) and silver eel emigration estimates from estuary weir fisheries (highest). Long-term changes in numbers, biomass, and fecundity were estimated for the USLR-LO population, harvestable stock (>age 13), and emigration from USLR, hydro facilities, and estuary. Population abundance in USLR-LO from the 1650s to the present shows dramatic declines, particularly over the past 50 years (mean 21.0M to 0.17M, range 16.5-29.6M and 0.14-0.23M, respectively), a 99% decrease. Model estimates quantify long-term changes in various life stages and partition mortality, showing how this stock and its fecundity have declined precipitously recently.

Oral CCFFR (Rivers and Estuary Ecosystems)

## PLANKTON COMMUNITIES IN URBAN STORMWATER PONDS: A LIMNOLOGICAL APPROACH

**Chiandret, A.\*<sup>1</sup>**, Xenopoulos, M.A.<sup>2</sup>

<sup>1</sup>Watershed Ecosystems Graduate Program. Trent University. <sup>2</sup> Department of Biology. Trent University (email: [aishachiandret@trentu.ca](mailto:aishachiandret@trentu.ca))

Stormwater management ponds (SWMPs) are designed to retain urban runoff, which reduces sediment and pollutant load to receiving waters. However, by acting as a sink, pond water accumulates contaminants in concentrations that exceed Canadian Water Quality Guidelines. Although these ponds are not intended as habitats, they "self seed" into wetlands and are colonized by aquatic flora and fauna. It is currently unknown what algae and zooplankton communities are typical of SWMPs and if pond characteristics cause variation in these communities. We sampled 56 SWMPs varying in size, age and location in Southern Ontario to: (1) characterize algae and zooplankton communities (2) determine whether nutrient levels affect plankton community structure, and (3) determine the role of pond characteristics, management protocols and landscape characteristics in structuring zooplankton and algae communities and predicting limnological parameters. Preliminary physico-chemical data show that SWMPs vary widely, and are unique and very different from surrounding waterways. SWMPs typically have high total phosphorus and total suspended solids (20-512  $\mu\text{g L}^{-1}$  and 0-97  $\text{mg L}^{-1}$  respectively), extremely high conductivity and temperature (207-3860  $\mu\text{S/cm}$  and 16-32°C respectively) and can be depleted in oxygen levels, especially in ponds that stratify (bottom dissolved oxygen as low as 0.33  $\text{mg L}^{-1}$ ). Pond age and presence of forebays were found to be important factors in influencing many of these parameters. This research will provide developers and municipalities with science-based guidelines to use in designing stormwater management systems that provide higher quality aquatic habitat in addition to improving understanding of aquatic ecosystems within urban landscapes.

Poster SCL (Contributed paper) (GS)

## CONTROL OF SEA LAMPREYS AND THEIR ORIGINS IN LAKE ONTARIO

**Christie, G.C.\***, R. B. MacGregor, and S.R. LaPan,  
Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Glenora Fisheries Station, RR4,  
Picton, ON K0K 2T0, New York Department of Environmental Conservation, Cape Vincent Biological  
Station, 541 East Broadway, Cape Vincent, NY 13618 (email: gavin.christie@ontario.ca)

Sea lampreys (*Petromyzon marinus*) have been controlled in Lake Ontario since 1972 and their suppression has been credited with improving the health of the fish community. The first authenticated record of sea lampreys in Lake Ontario was in 1835, almost a century before they were observed to invade the upper Great Lakes through the Welland Canal. Scientists have long debated whether sea lampreys invaded Lake Ontario through the Erie Canal or whether they were native to the lake. New genetic studies by Waldman et al. (2004) and by Bryan et al. (2005) used mitochondrial DNA and modeling techniques to argue that sea lampreys are native to Lake Ontario. While these studies present strong evidence questions remain. For example, the lack of record of sea lampreys by early settlers and native peoples, who exploited most migratory fishes for food, is inconsistent with their presence. The agencies responsible for fishery management on Lake Ontario (New York and Ontario) called for sea lamprey control as a critical management action necessary for their joint fish community objectives including restoration of the native top predator, lake trout (Stewart et al. 1999). But, their rationale was based on earlier science and explicitly stated that sea lampreys were an invasive species. In face of new evidence, the management agencies have confirmed that, regardless of their origin, sea lamprey must be suppressed to achieve fish community objectives and to improve ecosystem function in the offshore benthic and pelagic regions of Lake Ontario.

Oral CCFFR (Contributed paper)

## RESPONSE OF FRESHWATER DRUM TO A DISEASE OUTBREAK IN LAKE ONTARIO

Christie, G.C., J.A. **Hoyle\***, J.N. Bowlby, and B.J. Morrison, M.E. Wright  
Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Glenora Fisheries Station, RR4,  
Picton, ON K0K 2T0 (email: gavin.christie@ontario.ca)

Freshwater drum (*Aplodinotus grunniens*) is an abundant native species in the near shore waters of eastern Lake Ontario. Viral hemorrhagic septicemia (VHS) was first reported in the Great Lakes during 2005 when it was identified in freshwater drum in Lake Ontario. VHS is known to affect a range of fish species in the Great Lakes including valuable sport and commercial species. Significant numbers of freshwater drum were observed dead in the Bay of Quinte and eastern Lake Ontario during spring 2005. This die-off drew significant government and public concern about the spread of this new Great Lakes strain of the VHS virus. The relative abundance of freshwater drum was assessed through gill net and trawling surveys designed to monitor the fish community and through incidental catch recorded in creel surveys of the recreational walleye fishery. Population abundance of freshwater drum varied greatly from 1992-2004 before VHS was detected. There was no significant decline in drum abundance after the die-off. A large year class of drum was produced during 2005, the year of the VHS disease outbreak. We hypothesize: that deaths caused by this disease replaced deaths that would have occurred by other natural causes; that the strength of the 2005 year class further compensated for any effects of VHS had on abundance; and that the rapid accumulation of dead fish caused an initial over-estimation of the effect of this die-off on the population. Implications of large die-offs and their impacts on population abundance are discussed.

Oral CCFFR (Contributed paper)

## ANALYZING THE EFFECTS OF ARTIFICIAL NUTRIENT FERTILIZATION ON THE PRODUCTIVITY OF INNER BAY OF FUNDY STREAMS

**Chu\***, K.W.<sup>1</sup>, R. Cunjak<sup>1</sup> and G. Lacroix<sup>2</sup>.

<sup>1</sup>Canadian Rivers Institute, Department of Biology, University of New Brunswick, Fredericton, NB, Canada. <sup>2</sup> Department of Fisheries and Oceans, St. Andrew's Biological Station, St. Andrew's, NB, Canada. (E-mail: [katrina.chu@unb.ca](mailto:katrina.chu@unb.ca))

Overall productivity in the rivers within the Inner Bay of Fundy has been notably declining over the past several decades. This decline may stem from the decreasing numbers of anadromous fish that transport marine-derived nutrients (MDN) into these freshwater systems. This study evaluated whether artificial fertilization, as a proxy for MDN, is feasible as a means to increase Inner Bay of Fundy stream productivity. Two phosphorous-limited streams within Fundy National Park were artificially fertilized using the controlled-released fertilizer Multicote (9-44-0) over a four-month period during the spring and summer of 2007. Target concentrations increased phosphorous levels by 1, 2 and 3 µg/L at three sites within both study streams. The effects of the artificial fertilization were assessed by quantifying primary production and investigating whether there was a corresponding effect on primary and secondary consumer populations. To analyze primary production, periphyton response was gauged by measuring chlorophyll-a levels. Stable isotope analysis was utilized to interpret fertilization effects within the stream food web. We predicted that stream fertilization would shift the energy pathway to reflect the enhanced autochthonous food source. Consequently, benthic macroinvertebrates were analyzed for shifts in <sup>13</sup>C/<sup>12</sup>C levels favouring the grazer community. Preliminary results have shown an overall increase in primary production (chl-a) and a corresponding change in the macroinvertebrate community in fertilized sites. Phosphorous limitation has also decreased in the study area.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## CLASSIFICATION AND MODELLING OF STREAM TEMPERATURES IN ONTARIO

**Chu, C.\*** and N. E. Jones.

Watershed Ecosystems Graduate Program/Ontario Ministry of Natural Resources, Trent University, Peterborough, ON ([cindychu@trentu.ca](mailto:cindychu@trentu.ca))

The successful management of streams requires an ability to assess and classify the natural patterns and processes occurring within them. Many of the streams in Ontario have been altered to generate hydroelectric power or irrigate agricultural land even though some of their basic properties are not fully understood. One such property is temperature. Temperature affects the reproduction, growth and survival of aquatic organisms yet few studies have examined the patterns in, and processes affecting, stream temperatures. The objectives of this study were to classify the thermal regimes of streams in Ontario and determine which climate and landscape variables influence those classifications. Temperature data for 90 sites throughout the Great Lakes Basin were compiled into a single broad-scale temperature database. A Geographic Information System (GIS) tool was developed to summarize the climate (e.g. air temperature and precipitation) and landscape (e.g. geology and land use) conditions of the watersheds surrounding the temperature sites. Multivariate analyses indicated that the thermal characteristics of Ontario's streams can be grouped into five types and that climate and landscape variables influence the regional and local pattern of the thermal regimes in Ontario streams. These results can be used to predict the thermal regimes of different streams throughout Ontario.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## A COMPARISON OF HABITAT USE FOR CAPTIVE AND WILD ATLANTIC WHITEFISH: INFERENCES FROM HYDROACOUSTIC TRACKING

**Cook\*** A.M.<sup>1</sup>, R.G. Bradford<sup>2</sup> and P. Bentzen<sup>1</sup>.

<sup>1</sup>Marine Gene Probe Lab, Biology Department, Dalhousie University. <sup>2</sup>Population Ecology Division, Department of Fisheries and Oceans, Bedford Institute of Oceanography. (amcook@dal.ca)

Atlantic whitefish (*Coregonus huntsmani*) are an endangered species endemic to Nova Scotia. They are currently found at low abundance in three lakes within a single watershed. To improve the Atlantic whitefish's current status, a captive rearing program has been implemented, which has led to the successful release of juveniles into a non-native lake. Although the breeding program has been designed to maintain the genetic diversity within the species, the effect of captive rearing on the fish's movements and behavioral ecology are not known. These effects were examined through comparative hydroacoustic tracking studies using wild captured and captive reared Atlantic whitefish. Wild captured fish (n=17) were surgically implanted with hydroacoustic tags (Vemco- model V8) and released into their native lake. Captive reared Atlantic whitefish (F1) were implanted with similar hydroacoustic tags and released to a non-native lake. Fish movements were tracked with a combination of active and passive techniques over the subsequent ten months. Preliminary analysis showed an initial smaller area of occupancy for captive reared fish; however, after this initial 'acclimation' period, captive reared fish displayed similar habitat use and movements when compared to their wild counterparts. Survival rates were higher in wild fish than the culture releases. Results will be further discussed in relation to the habitat requirements of Atlantic whitefish, and optimal sites for further restocking.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives) (GS)

## BIOGEOGRAPHY OF RIGHT-EYED FLOUNDERS (PLEURONECTIDAE): PHYLOGENY AND FOSSILS REVEAL AN HISTORICAL RESPONSE TO ARCTIC CLIMATE CHANGE.

**Cooper, J.A.**

Department of Fisheries and Oceans, St. Andrews Biological Station, 531 Brandy Cove Road, St. Andrews, NB, E5B 2L9 (email: [coopera@mar.dfo-mpo.gc.ca](mailto:coopera@mar.dfo-mpo.gc.ca))

The greatest diversity of extant pleuronectids (48 of 60 species) inhabit the North Pacific Ocean with relatively few (10 species) in the North Atlantic Ocean and Arctic Ocean (2 species). In addition, the fossil record is relatively more diverse (15 species) in the Pacific dating from the Miocene, but contains only a single modern species (*Pleuronectes platessa*) within the Atlantic Pliocene. The present-day distributions of these species were compared against an existing cladistic phylogeny based on morphological features. The fossil record and historical geology were evaluated against this area-cladogram to further resolve potential geographic origins, relative timing of diversification, and patterns of dispersal for major lineages within the family. The combined evidence from the distribution, phylogeny, and fossils indicates origins and diversification within the Pacific and only a recent presence in the North Atlantic. Dispersal to the Atlantic is thought to have coincided with the opening of the Bering Strait approximately 3.5 to 7 million years ago. The historical biogeography of this commercially important group of species further illustrates the potential of trans-arctic invasion for taxa of the Pleuronectidae, and many other marine taxa, if global warming continues to impact the Arctic marine environment.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## FIELD GUIDE TO SKATES (FAMILY RAJIDAE) OF THE CANADIAN ATLANTIC AND ADJACENT REGIONS

K.J. Sulak<sup>1</sup>, P.D. MacWhirter<sup>2</sup>, K.E. Luke<sup>3</sup>, A.D. Norem<sup>4</sup>, J.M. Miller<sup>4</sup>, J.A. **Cooper**<sup>5</sup>, L. Harris<sup>5</sup>, C. Waters<sup>5</sup>. <sup>1</sup>Atlantic Reference Centre, St. Andrews, NB (current address: U.S. Geological Survey, 7920 NW 71<sup>st</sup> St., Gainesville, FL, USA, 32615). <sup>2</sup>Atlantic Reference Centre, St. Andrews, NB (current address: 471 Herring Cove Road, Ste. B 100, Halifax, NS, B3R 1W5); <sup>3</sup>U.S. Geological Survey, Laurel, MD, USA, 20708-4038; <sup>4</sup>U.S. Geological Survey, Gainesville, FL, USA, 32615; <sup>5</sup>Department of Fisheries and Oceans, St. Andrews Biological Station, 531 Brandy Cove Road, St. Andrews, NB, E5B 2L9.

Ecosystem-based management requires information on the distribution and abundance of species both common and rare. Therefore, the accurate identification of marine species has assumed much greater importance. The identification of skate species is notoriously difficult as several species are easily confused. This guide has been prepared to facilitate the identification of specimens of skates freshly-collected at sea, or recently landed. It is intended to assist scientist, fisher, observer, port sampler, and other technical personnel working in the field. Several skate species are currently subject to fishing mortality either in directed fisheries or as by-catch in the Canadian Atlantic region. These catches have not been attributed to individual species as the commercial fishing data group all as 'skate' limiting our ability to apply effective ecosystem-based management. Sixteen skate species are included in this guide, 14 known from within the Canadian Exclusive Economic Zone (EEZ, commonly referred to as the '200 mile limit'), plus two species that range almost into Canadian waters off Georges Bank and in the Gulf of Maine.

Poster CCFFR (Ecosystem-based Management – Science and Policy)

## THE ST. ANDREWS BIOLOGICAL STATION— A CENTURY OF MARINE RESEARCH 1908-2008

\***Cooper**, L. L., R. L. Stephenson, E. A. Trippel, B. D. Chang, and J. A. Cooper.  
Fisheries and Oceans Canada, St. Andrews Biological Station, St. Andrews NB  
(email: cooperl@dfo-mpo.gc.ca)

The year 2008 marks the 100<sup>th</sup> anniversary of marine research and the permanent biological station in St. Andrews. Canada's first marine biological station was a small portable laboratory which operated in 1899 and 1900 at St. Andrews New Brunswick on the shores of Passamaquoddy Bay, and then at other locations in Atlantic Canada and Quebec until 1907. The station was owned and managed by the federal government, but the researchers came from universities in eastern Canada and New England. Studies conducted from the portable laboratory produced a large number of research papers that helped convince the federal government to build a permanent marine laboratory at St. Andrews. The St. Andrews Biological Station (SABS) opened in May of 1908. Research on fisheries, the environment, oceanography, and aquaculture has dominated the station's history. Early research included practical problems in the fisheries and descriptive work of coastal fauna. *Contributions to Canadian Biology*, a journal founded to report the findings of the early station's researchers, in time evolved into the *Canadian Journal of Fisheries and Aquatic Sciences*. For the first 75 years, the station was managed as part of the Fisheries Research Board of Canada and its predecessors, and since 1979 by the Department of Fisheries and Oceans (from 1972 to 1978, two other government departments held this responsibility). We celebrate and remember with pride the significant contributions and accomplishments of SABS, and look forward to continuing a legacy that supports researchers within government, universities, and industry to conserve Canada's aquatic environment and marine heritage.

Poster CCFFR (Contributed paper)

## MEASURING HABITAT CONNECTIVITY IN RIVERINE SYSTEMS

Cote, D.<sup>1\*</sup>, Wiersma, Y.<sup>2</sup>, Kehler, D.<sup>1</sup> and Bourne, C.<sup>2</sup>

<sup>1</sup>Parks Canada; <sup>2</sup>Department of Biology Memorial University of Newfoundland

e-mail: ([david.cote@pc.gc.ca](mailto:david.cote@pc.gc.ca))

Since European settlement of the new world, the connectivity of aquatic habitats has become increasingly altered. In most cases, connectivity has been compromised from natural levels through the installation of dams and culverts. Fragmentation associated with dams and culverts is a pervasive stressor that impedes fish and invertebrate movement, results in lower fish production, reduced genetic diversity, demographic instability, and impeded recolonization after disturbance. A great deal of attention has been given to analyzing the effects of barriers on fish movements, but surprisingly little attention has been given to the effect of barriers on riverscape scale aquatic connectivity. Terrestrial landscape ecologists have developed a myriad of structural and process-based indices for measuring landscape/habitat connectivity (and its converse, fragmentation); however no such index exists for aquatic systems at a landscape scale. Here, we present a new index for measuring the impact of barriers (e.g., culverts) on structural aquatic habitat connectivity. We apply this method to assess longitudinal connectivity from the perspective of anadromous (adult migrations from marine to freshwater) and potadromous (adult migrations within freshwater) fish life histories. We show how overall network connectivity is influenced by both road density (number of culverts) and variation in the passability of barriers. Finally, we present how this index might be used to identify management priorities for removal of barriers, or mitigation of specific barriers to enhance fish passability.

Oral CCFFR (River and Estuary Ecosystems)

## SHOULD I STAY OR SHOULD I GO NOW? BEHAVIOURAL RESPONSES OF ATLANTIC SALMON PARR TO THE FORMATION OF ANCHOR ICE AND FLOOD EVENTS

Enders<sup>1</sup>, E.C. C.J. Pennell<sup>1</sup>, D. Cote<sup>2\*</sup> and D.A. Scruton<sup>1</sup>

<sup>1</sup>Fisheries and Oceans Canada, St. John's NL, Canada; <sup>2</sup>Terra Nova National Park of Canada, Glovertown NL, Canada (email: [david.cote@pc.gc.ca](mailto:david.cote@pc.gc.ca))

Atlantic salmon parr occur in rivers and streams that are seasonally covered with ice ranging from periodic ice skims in the southern temperature regions to thick surface ice covers in higher latitudes. Ice formation may affect the survival, distribution, and mobility of parr and it has been demonstrated that part of the population moves into deeper, slower flowing habitat as winter progresses. However, a proportion of the population remains in stream sections with steeper riverbed gradients and consequently faster flowing water, in which dynamic ice formation predominate during winter. Two different behavioral strategies have been suggested, where some authors assumed that parr leave shelter at night to avoid becoming trapped in anchor ice that tends to form during night; others suggested that anchor ice provide valuable winter habitat refuges for parr. We conducted a radio-telemetry study where we tagged 24 parr in a steep section of a small stream and observed parr activity using an array of radio-telemetry antennae. We observed that parr activity increased in nights with ice events in comparison to nights without anchor ice events. Furthermore, long distance movements were observed in relation to sudden increases in water discharge.

Poster CCFFR (Contributed paper)

## HETEROGENEITY IN ISOLATION BY DISTANCE AND SPATIAL PATTERNS OF GENETIC DIFFERENTIATION AMONG ANADROMOUS RAINBOW SMELT (*OSMERUS MORDAX*)

**Coulson\***, M. and P. Bentzen. Department of Biology, Dalhousie University, Halifax, NS (email: [mcoulson@dal.ca](mailto:mcoulson@dal.ca))

Isolation by distance theory predicts that genetic differences between populations accumulate over increasing spatial scales. Among rainbow smelt (*Osmerus mordax*) populations, two strikingly different patterns have emerged. Populations spawning in Newfoundland display a high signal of IBD ( $r = 0.85$ ,  $p < 0.001$ ) while those off the mainland portion of the range demonstrate a virtual lack of IBD ( $r = 0.14$ ,  $p = 0.045$ ), despite significant comparisons of population differentiation. Therefore, it is possible that more local-scale effects may influence structure among mainland samples. For instance, member-vagrancy has been proposed for smelt and other species whereby the spatial scale determining where the early life history stages are retained determines the scale of population structure. Mainland smelt populations were assayed for nine microsatellite loci. Factorial correspondence analysis resulted in several major regional groups being identified: (i) the Gulf of St. Lawrence, (ii) the Atlantic coast of Nova Scotia, and (iii) the Bay of Fundy. Within each of these regions, there is considerable variation in the scale at which genetic differentiation occurs. Within the Gulf of St. Lawrence, there is a lack of significant  $F_{ST}$ -based differentiation across ~1000 km while comparisons between the Bay of Fundy and the Atlantic coast show some of the highest  $F_{ST}$  values (~0.08) over less than 400 km. Analyses of migration rates and barriers demonstrate inter-regional variation in gene flow and suggest the importance of local-scale effects in contributing to population differentiation within this species.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## LITTORAL SEDIMENTS: HOW MUCH OF A REFUGE DO THEY OFFER AGAINST TEMPERATURE VARIABILITY?

**Cyr, H.\***,  
Dept. Ecology & Evolutionary Biology, University of Toronto, Toronto ([helene@zoo.utoronto.ca](mailto:helene@zoo.utoronto.ca))

Littoral organisms live in a highly variable environment, but it is generally assumed that the sediments provide a refuge that buffers environmental conditions. In this study, I test the extent to which different types of littoral sediments buffer temperature. Temperature loggers were deployed at 12 littoral sites in Lake Opeongo, ON, to measure bottom water and sediment temperatures at 8 min. interval through the summer. Sites were selected to compare different types of sediments (sand, mud), at exposed and protected sites in the shallow and deep portion of the littoral zone (1.5 to 6 m deep). The sediments were cooler than the overlying water through spring and most of the summer (1-2°C difference in spring; median differences = 0.2-0.75°C). These differences were most pronounced and persisted for a longer period at protected and deep littoral sites, but were not related to sediment texture. The sediments dampened only a small portion of the temperature variability during warming and cooling events. Clear diel cycles in sediment temperature were observed at shallow (1.5-2 m) littoral sites that were consistent with heating from solar radiations. Cooling occurred rapidly during upwelling events and at the end of summer. The sediments in littoral areas experience large temperature variability at time scales of hours to days. Differences in average temperatures and in the magnitude of temperature variability could affect the structure of benthic communities and rates of benthic processes in different parts of the littoral zone.

Oral SCL (Contributed paper)

## THE NORTH ATLANTIC GYRE AND THE OCEAN MIGRATION OF CANADIAN ATLANTIC SALMON (*Salmo salar*)

**Dadswell**, Michael <sup>1\*</sup> & Michael Stokesbury<sup>2</sup>, Aaron Spares<sup>1</sup>, and Jeff Reader<sup>1</sup>,

<sup>1</sup>Dept. of Biology, Acadia University, Wolfville; <sup>2</sup>Ocean Tracking Network, Dalhousie University, Halifax

The currently accepted marine migration model for Atlantic salmon proposes Canadian stocks migrate directly to feeding grounds of western Greenland and then over winter in the Labrador Sea and off the Grand Banks west of 44°W. Conversely, European stocks migrate in relatively straight lines to feeding grounds off West Greenland and within the Norwegian Sea. Contrary evidence accumulated during the last 50 years has lead us to agree with an alternative trans-Atlantic migration hypothesis for salmon based on the current system of the North Atlantic Gyre originally proposed by Reddin and Shearer in 1974. This hypothesis, suggests both North American and European salmon enter the gyre on their respective sides of the Atlantic and then travel counter-clockwise with surface currents around the entire North Atlantic, mixing, feeding and growing before maturing and turning homeward. Numerous studies have determined there are mixed continental stocks on feeding grounds throughout the North Atlantic. Direct evidence to support the hypothesis is demonstrated by the spatial distribution of catches and tag returns with respect to season in former, high-seas salmon fisheries, (west Greenland, Faroes, and Norwegian Sea) and recent, post-smolt catches in the Norwegian Sea. Canadian salmon have been recaptured off Norway and the Faroes, while salmon tagged in Scotland and Ireland were recaptured off Newfoundland and Labrador. Additionally, salmon tagged in winter off the Faroes were recaptured in Canadian rivers. Based on a preliminary study of bioaccumulated Cesium 137 levels in salmon from a single, Quebec river an estimated 43% of the population had fed east of Iceland. In a recent study we found that 14.2% of salmon sampled from Atlantic Canada rivers had bioaccumulated Cesium 137 levels consistent with feeding east of the Faroes Islands (8°W) before homeward migration. We suggest a concerted effort be made to expand research on ocean migration of Canadian Atlantic salmon using modern tagging methods (hydroacoustic, satellite) to test the validity of the two migration models.

Oral CCFFR (Physical Limnology and Oceanography - Influences on Populations and Ecosystems)

## THE PHYSIOLOGICAL IMPACTS OF DECOMPRESSION AND FIZZING IN SMALLMOUTH BASS *MICROPTERUS DOLOMIEU*

**DeMille\***, M., B. Tufts, and K. Esseltine.

Department of Biology, Queen's University, Kingston, ON, Canada (email: 3md8@queensu.ca)

Decompression can be an important problem for fish that are rapidly brought to the surface during an angling event. Ambient pressure, water temperature, and other physical properties are known to vary according to depth in the water column. When rapidly angled from depth, these factors in a fish's abiotic environment have the potential to cause a significant alteration to their internal physiology. Previous studies indicate that significant numbers of tournament-caught smallmouth bass exhibit physiological signs of decompression when tournaments are held on deeper water bodies. Many of the physiological changes seen in tournaments also occur when smallmouth bass are exposed to rapid changes in pressure under laboratory or field conditions. Tissue enzymes, not normally present in the blood, have been used to quantify the degree of cell damage caused by sub-lethal decompression disturbances in angled fish. Significant elevations in the plasma levels of tissue enzymes such as lactate dehydrogenase, creatine phosphokinase and aspartate aminotransferase have been found in decompressed fish. Swim bladder expansion, also caused by a rapid change in pressure, causes decompressed fish to lose control of their buoyancy. Artificial swim bladder deflation (fizzing) has been proposed as a technique to release built-up gas pressure within the swim bladder and allow a decompressed fish to regain equilibrium. Current experiments are underway to determine whether fizzing will reduce the physiological impact of decompression in angled fish.

Oral CCFFR (Contributed paper) (GS)

## THE (ART AND) SCIENCE OF RESTORING ATLANTIC SALMON TO LAKE ONTARIO

**Desjardins, M\***; Daniels, M; Wilson, C.C; Jones, N.E.

Ontario Ministry of Natural Resources ([marc.d.desjardins@ontario.ca](mailto:marc.d.desjardins@ontario.ca))

Atlantic salmon (*Salmo salar*), an important component of Lake Ontario's natural heritage, was extirpated in the 1800s due to habitat degradation and over-exploitation. Early restoration attempts were unsuccessful; however recent improvements in watershed health have renewed interest in restoration. Re-introduction of Atlantic salmon began in 1987, however, adult returns were lower than expected due to low stocking rates and a wide geographic distribution of stocked fish. A science-based restoration plan was developed in 1995. The plan focused on the feasibility of restoring self-sustaining populations of Atlantic salmon by examining factors which might enable or preclude success at each life-stage. Benchmarks were set against which to measure progress. Research demonstrated that Atlantic salmon juveniles survived well under certain habitat conditions, even in the presence of other salmonines (e.g. rainbow trout). In 2006, a collaborative partnership was established between conservation organizations, government agencies and academic institutions to move forward with restoration. "Best-bet" streams were selected for this phase of restoration, using bio-physical criteria. Stocking efforts were intensified to achieve sufficient numbers of returning adults. The increase in number of fish entering Lake Ontario will also facilitate the examination of possible constraints within a changed Lake Ontario ecosystem, considered to be one of the largest challenges to successful restoration. Key information needs were identified, including survival at each life stage, strain performance, stocking strategy assessment, adult return enumeration, in-stream habitat supply, stream carrying capacity, smoltification age, size, and cues, and Thiamine status. A science plan was developed to address these elements of restoration.

Oral CCFFR (Population Processes at Low Abundance –Recovery Rarity and Invasives)

## SURVIVAL, GROWTH AND EMIGRATION OF STOCKED ATLANTIC SALMON IN LAKE ONTARIO STREAMS

Bobrowski, R.; M. **Desjardins\***, C. Wilson, and N. Jones,

Watershed Ecosystems Graduate Program, Trent University, Ontario ([russellbobrow@trentu.ca](mailto:russellbobrow@trentu.ca))

Atlantic salmon (*Salmo salar*) were once abundant in Lake Ontario, but died out in the late 19<sup>th</sup> century. A collaborative partnership between universities, government agencies, and NGO's has been established to attempt to restore self-sustaining populations of Atlantic salmon in Lake Ontario within the next ten to fifteen years. Key information needs for restoration include determining stocking and recruitment success of different stocked life stages, and assessing life-stage specific survival contributing to adult returns. To address these, I am assessing the relative survival and growth of different life stages (fry, fingerlings, and yearlings) stocked in tributaries, as well as their timing of emigration to Lake Ontario with respect to environmental cues. Results from the first field season indicate substantial differences in survival and timing of out-migration among stocked life stages. Abundance and distribution of stocked fish in lotic habitats were assessed by backpack electrofishing; emigrating smolts were captured using a stationary fyke net in the lower reaches of Cobourg Brook. Numbers of emigrants were estimated using injected tags and stratified mark-recapture techniques; identification of life stages relied on fin clips, scale pattern analysis, and size distribution. Emigrating smolts from Cobourg Brook (n=7748) showed bimodal emigration intervals: one strong pulse coincided with spring stream discharge and warming temperatures, and a second, more diffused, emigration peak continued until mid- summer. These data will inform future stocking strategies for life stage and stocking density, and will provide baseline data for estimating percent returns of adult fish in future years.

Poster CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives)

## HAVE ROCK, WON'T TRAVEL: A STUDY TO ENHANCE JUVENILE ATLANTIC SALMON PRODUCTION.

**Emerson, P.**<sup>1\*</sup>, M. Gallant<sup>2</sup>, K. Haralampides<sup>2</sup>, C. Connell<sup>3</sup>, R. Cunjak<sup>4</sup>

<sup>1</sup>Vermont Fish and Wildlife Department, St. Johnsbury, VT <sup>2</sup>U. New Brunswick Department of Civil Engineering and Canadian Rivers Institute, Fredericton, NB; <sup>3</sup>New Brunswick Department of Natural Resources, Fredericton, NB; <sup>4</sup>U. New Brunswick Department of Biology and Canadian Rivers Institute, Fredericton, NB (e-mail Peter.Emerson@state.vt.us)

Wild Atlantic salmon populations' steady decline worldwide has lead to a joint research project between fisheries personnel at J.D. Irving, LTD and Biology and Civil Engineering Departments at the University of New Brunswick. The Little Main Restigouche River (LMR) is the principal tributary to the unregulated Restigouche River. The LMR is a 5<sup>th</sup> order river dominated by gravel and small cobble substrate. Wild Atlantic salmon use the gravel for spawning, but nursery habitat is mostly unavailable for 1+ and 2+ parr. Lack of larger cobble/boulder and the corresponding interstitial spaces that provide shelter and refuge is the suspected population bottleneck for out-migrating smolt. We attempted to increase the amount of rearing habitat by adding boulder clusters in the late summer of 2005 to select reaches of the LMR. Prior to enhancement electro-fishing and substrate surveys were conducted to determine densities, relative populations of juvenile salmon, and substrate composition at three enhancement sites, two control sites and two reference sites. Juvenile salmon were marked with either Passive Integrated Transponder (PIT) tags or Visible Implant Elastomer (VIE) marks to monitor emigration to and from sites. The focus of this presentation will be the portion of the project devoted to ranking the over 300 boulder clusters to 5 categories of integrity/embeddedness. Electrofishing and PIT tracking sample analysis supported our hypothesis that higher quality clusters would support both more and larger juvenile salmon as well as retain individuals for longer periods of time.

Oral CCFFR (River and Estuary Ecosystems)

## PLANTONIC AND BENTHIC COMMUNITY COMPOSITION IN LAKES OF THE LOWER MACKENZIE RIVER BASIN, NORTHERN CANADA

**Evans, Marlene S.**<sup>1\*</sup>, Fortune Ogbebo<sup>2</sup>, David Barton<sup>3</sup>, Hedy Kling<sup>4</sup>, Jonathan Keating<sup>5</sup>, Kerry Pippy<sup>6</sup>, and Lois Harwood<sup>7</sup>

<sup>1,2,5</sup>National Water Research Institute, Environment Canada, 11 Innovation Boulevard, Saskatoon, SK, S7N 3H5; <sup>3</sup>Department of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1; <sup>4</sup>Algal Taxonomy and Ecology Inc, 31 Laval Drive Winnipeg MB Canada R3T 2X8; <sup>6</sup>Water Quality Monitoring & Surveillance, Science & Technology Branch, Environment Canada, Yellowknife, NT, X1A 1E2; <sup>7</sup>Fisheries and Oceans, Canada, 101 5204 50th Ave., Yellowknife, NT. X1A 1E2 (\*Email: marlene.evans@ec.gc.ca)

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. While base-line environmental impact assessment studies were conducted as part of the Mackenzie Gas Project, benthic and plankton communities were not included in these investigations. Since 2004, we have been investigating lakes and stream along the pipeline route to address these deficiencies. Here we report on the highlights on benthos and plankton community structure studies along the pipeline route with a focus on the area north of Fort Good Hope; we also draw on our findings from other studies, including the Husky Lakes to the east. Overall, these lakes exhibited a wide range in size, depth, salinity, nutrients, pH and DOC concentration and, in general, there was large variation in species abundance and composition. Benthic standing stocks were low with abundances ranging from a few hundred to ca. 20,000/m<sup>2</sup>; oligochaetes, chironomids, and mollusks were the dominant taxa with estuarine taxa prevalent only in the Husky Lakes. Zooplankton standing stocks also were low generally ranging from a few hundred to <20,000/m<sup>3</sup>; estuarine taxa prevailed only in the Husky Lakes. Phytoplankton were comprised largely of small species of Cyanophyta, Chrysophyceae, Bacillariophyceae, Chlorophyta, Cryptophyta and Dinophyta. Abundances were low as were chlorophyll concentrations. There was little evidence of a marine influence in lakes located in the outer Mackenzie Delta but a strong influence in the Husky Lakes.

Poster SCL (Physical Limnology and Oceanography – Influences on Populations and Ecosystems)

## EXPLORING EASTERN SAND DARTER (*AMMOCRYPTA PELLUCIDA*) POPULATION DYNAMICS ON THE LOWER THAMES RIVER

**Finch\***, M<sup>1,2</sup>, M. Power<sup>1</sup>, and S.E. Doka<sup>2</sup>.

<sup>1</sup>Department of Biology, University of Waterloo, 200 University Ave W., Waterloo, Ontario, Canada, N2L 3G1; <sup>2</sup>Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Sciences, 867 Lakeshore Rd., Burlington, Ontario, Canada, L7R 4A6 (email: mary.finch@dfo-mpo.gc.ca)

Eastern sand darter (*Ammocrypta pellucida*) is listed as a threatened species under Canada's *Species at Risk Act* (SARA). Habitat destruction throughout its geographic range has made the species vulnerable to population declines and possible local extinction. To help protect eastern sand darter, biological recovery teams mandated by SARA have identified knowledge gaps in scientific understanding of the life-history and population ecology of the species. Population modelling has been highlighted as one method that can help determine population fates and identify critical population habitat and life stages. However, population modelling can be difficult to apply when little is known about population vital rates and life-history variation. Here, I discuss the calculation of vital rates (e.g. mortality, growth and recruitment) for use in the construction of a stage-based population model for eastern sand darter on the lower Thames River. Information for vital rates comes from a variety of sources including; field studies, habitat surveys and aging studies. Emphasis has been placed on using non lethal sampling methodologies due to eastern sand darters' SARA classification. Stage-based matrix modelling is ideal for use with SAR populations as it minimizes the biological information needed to examine population dynamics. Anticipated outcomes of the model include; estimation of population trajectories and identification of limiting life-stages, which may then be used to guide management decisions on the protection of eastern sand darter.

Oral CCFFR (Population Processes at Low Abundance – Recovery, Rarity and Invasives) (GS)

## SYNCHRONY OF CO<sub>2</sub> FLUX IN HARDWATER LAKES

**Finlay\***, Kerri, Peter Leavitt, and Bjoern Wissel  
Department of Biology, University of Regina  
(kerri.finlay@uregina.ca)

Lakes are known to process terrestrial carbon and as such are frequently found to release CO<sub>2</sub> to the atmosphere. Hardwater lakes in the Canadian Prairies drain large watershed areas and process significant quantities of terrestrial carbon, but high pH levels and high rates of production suggest that these lakes may instead exhibit an influx of CO<sub>2</sub> from the atmosphere. We calculated the CO<sub>2</sub> flux from six hardwater lakes in southern Saskatchewan from 1994 – 2007 to determine spatial and temporal patterns. CO<sub>2</sub> flux from these lakes was highly variable between years and the magnitudes of carbon flux exceeded previously recorded rates by two orders of magnitude. Despite being separated by several hundreds of kilometers, we observed very high synchrony of CO<sub>2</sub> flux in these lakes. We found that in most years, all lakes were undersaturated in CO<sub>2</sub> and experienced a net CO<sub>2</sub> influx. However, in 3 years (1999, 2000, and 2007) CO<sub>2</sub> was released from all lakes. These results suggest a regional influence on CO<sub>2</sub> flux from prairie lakes. Owing to the high magnitude of carbon flux rates from these lakes, and the extensive watersheds they drain, hardwater prairie lakes likely contribute disproportionately to the global carbon budget.

Oral SCL (Physical Limnology and Oceanography – Influences on Populations and Ecosystems)

## NORTH ATLANTIC OSCILLATION VARIABILITY INFLUENCES LATITUDINAL TRENDS IN MARINE FISH SPECIES RICHNESS

**Fisher\***, J.A.D.<sup>1,2</sup>, K.T. Frank<sup>2</sup>, W.C. Leggett<sup>1</sup>, N.L. Shackell<sup>2</sup>, and B. Petrie<sup>2</sup>.

<sup>1</sup>Department of Biology, Queen's University, Kingston, Ontario, Canada. <sup>2</sup>Ocean Sciences Division, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada. (email: [jonathan.fisher@queensu.ca](mailto:jonathan.fisher@queensu.ca))

One of the oldest and most ubiquitous patterns in biogeography is the decline in species richness from the tropics to the poles. The short term temporal dynamics of these patterns and the factors that contribute to their variation, however, are generally unexplored because latitudinal gradients are typically generated using species occurrence data summed over long periods. In order to characterize interannual variability of the latitudinal gradient, we examined 32 years of fishery independent bottom trawl survey data from the northwest Atlantic continental shelf. The 22215 samples spanned 35N to 55N and were analyzed per degree latitude. Significant poleward declines in cumulative species richness and average numbers of species per sample were observed when all years were combined. Significant annual latitudinal gradients also occurred and their slopes were negatively correlated with anomalies of the winter North Atlantic Oscillation (NAO) index. The NAO is the dominant atmospheric pressure system across this region and influences shelf bottom water temperatures. Positive (negative) NAO anomalies across the surveyed latitudes are associated with cooler (warmer) conditions in the north and warmer (cooler) conditions in the south. Steep latitudinal gradients in species richness during positive NAO anomalies are consistent with maximal dissimilarities between northern and southern bottom water temperatures. Year groups characterized by persistent positive or negative anomalies display significant differences in gradients and changes in species composition at high latitudes accompany these differences in species richness. These results demonstrate that the latitudinal gradient is temporally dynamic and strongly suggest that the NAO influences this marine biodiversity pattern.

Oral CCFFR (Physical Limnology and Oceanography – Influences on Populations and Ecosystems)

## RECONSTRUCTION OF HOLOCENE ENVIRONMENTAL CHANGES IN NORTHERN BRITISH COLUMBIA USING FOSSIL MIDGES

**Fleming\***, E. and I. R. Walker.

Environmental Science, University of British Columbia Okanagan, Kelowna, British Columbia, Canada V1V 1V7 (email: [erin.fleming@hotmail.com](mailto:erin.fleming@hotmail.com))

Lake sediments contain the remains of midge communities that may be used as biological proxies for inferring past environmental changes. Freshwater midges, including Chironomidae, Chaoboridae and Ceratopogonidae, from two alpine tarns (Pyramid Lake and Bullwinkle Lake) in the Cassiar Mountains of northern British Columbia are being used to estimate Holocene palaeotemperature changes, and more specifically, to test for the presence of the Milankovitch thermal maximum (an early Holocene warm interval coinciding with peak Holocene summer solar insolation). Mean July air temperatures will be reconstructed using midge inference models developed via weighted averaging-partial least squares (WA-PLS) regression. Preliminary results from Pyramid Lake and Bullwinkle Lake indicate the absence of midge assemblages prior to 9500 <sup>14</sup>C yr BP (shortly after the area was deglaciated). *Micropsectra atrofasciata/radialis*, *Sergentia*, *Heterotrissocladius marcidus* and *Abiskomyia* are abundant in the Pyramid Lake core, suggesting that cold-water conditions have prevailed at this site, at least through the mid-to-late Holocene (ca. 4000 to 1500 <sup>14</sup>C yr BP). However, preliminary analysis of the Bullwinkle Lake core suggests that such cold-water taxa are not as abundant, indicating slightly warmer conditions. The palaeoclimatic record for northern British Columbia is filled with inconsistencies. This study will attempt to resolve some of the discrepancies in the timing of climate change in the continental interior.

Poster SCL (Contributed paper) (GS)

## DECLINING WILD SALMON POPULATIONS IN RELATION TO PARASITES FROM FARM SALMON

Krkošek, M.<sup>1,2</sup>, **Ford**, Jennifer S.<sup>3</sup>, Lewis, M.A.<sup>1,2</sup>, Morton, A.<sup>4</sup>, Lele, S.<sup>1</sup> & R.A. Myers<sup>3</sup>.

<sup>1</sup>Centre for Mathematical Biology, Dept. Mathematical and Statistical Sciences, University of Alberta, Edmonton, AB; <sup>2</sup>Department of Biological Sciences, University of Alberta, Edmonton, AB; <sup>3</sup>Department of Biology, Dalhousie University, Halifax, NS B3H 4J1; <sup>4</sup>Salmon Coast Field Station, Simoom Sound, BC (email: jenford@ecologyaction.ca)

Rather than benefiting wild fish, industrial aquaculture may contribute to declines in ocean fisheries and ecosystems. Farm salmon are commonly infected with salmon lice (*Lepeophtheirus salmonis*), native ectoparasitic copepods. We show that recurrent louse infestations of wild juvenile pink salmon (*Oncorhynchus gorbuscha*), all associated with salmon farms, have depressed wild pink salmon populations and placed them on a trajectory towards rapid local extinction. The louse-induced mortality of pink salmon is commonly over 80% and exceeds previous fishing mortality. If outbreaks continue then local extinction is certain and a 99% collapse in pink salmon population abundance is expected in four salmon generations. These results suggest parasite infestations associated with salmon farms can erode the capacity of a coastal ecosystem to support wild salmon populations.

Oral CCFFR (Ram Myers Session)

## LIFE HISTORY STRATEGY RELEVANT TO INVASION SUCCESS?

**Fox**, M.G. Environmental & Resource Studies Program and Department of Biology, Trent University, Peterborough, Ontario (e-mail: mfox@trentu.ca)

Recent analyses of the life history traits of invasive fishes have demonstrated that species with 'equilibrium' (*sensu* Winemiller & Rose 1992) life history traits have been the most successful in colonizing modified watersheds altered towards stabilizing flow regimes, counter to the prediction in life history theory that 'opportunistic' (*r*-selected) species should be most favoured in initial establishment. However, analyses of the role of life history traits in invasive fishes typically ignore the dynamic aspects of these traits. In this presentation, I make the case that even equilibrium species utilize elements of an opportunistic strategy using two species that are invasive on different continents: the pumpkinseed (*Lepomis gibbosus*) in Europe and the round goby (*Neogobius melanostomus*) in North America.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives) (GS)

## PARENTAL DIVERGENCE PREDICTS THE DEGREE OF OUTBREEDING DEPRESSION BETWEEN FARMED AND WILD ATLANTIC SALMON

**Fraser, D.J.\*** and J.A. Hutchings.

Department of Biology, Dalhousie University, Halifax (email: [dylan.fraser@dal.ca](mailto:dylan.fraser@dal.ca))

Interbreeding between escaped farmed and wild fishes may affect the genetic integrity and viability of wild populations. Mitigating these effects would be facilitated if they could be predicted according to the degree of divergence between parental populations. Based on the known genetic/ecological divergence between populations from three different regional groups of Atlantic salmon (*Salmo salar*) in eastern Canada, including the source of salmon farming, we tested the hypothesis that a positive association existed between parental divergence and the degree of outbreeding depression. Depending on the farmed-wild hybrid (F1, F2 or backcross) and on the fitness trait being examined, inter-population crosses generated both hybrid vigor and outbreeding depression associated with co-adaptation. Importantly, however, farmed-wild hybrids experienced greater reductions in fitness as the divergence between farmed and wild parents increased. This relationship was observed for both embryonic survival and developmental time to hatch. These results are relevant to risk assessment in two regards: (i) they demonstrate that farmed-wild hybrids can have reduced fitness relative to wild fish; (ii) they suggest that the varying effects of farmed-wild interbreeding on wild populations can be forecasted to a certain degree.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## USING POPULATION-BASED ECOSYSTEM INDICATORS TO ASSESS THE STATUS OF GROUND FISH COMMUNITIES OFF BRITISH COLUMBIA COAST

**Fu\*, C.**

Fisheries & Oceans Canada, Pacific Biological Station, Nanaimo, BC (email: [FuC@dfo-mpo.gc.ca](mailto:FuC@dfo-mpo.gc.ca))

Ecosystem-based fisheries management promotes the practice of accounting for abundance changes in all species induced by environmental variations, species interactions, and fishing. Current groundfish stock assessments in British Columbia (BC) are limited to a few commercially important species. However, bottom-trawl surveys off BC coast have provided valuable information on the abundance and distribution of numerous taxa. Because of the different fishing intensity that each region experienced in the past, we divided the BC coastal water into four ecosystems: Queen Charlotte Island in the north (QCI), Central Coast (CC), Strait of Georgia (SoG), and West Coast of Vancouver Island (WCVI). For each ecosystem and for each taxon we calculated time trends in catch per unit effort (CPUE) and frequency of occurrence based on the slope of a linear regression on year. We examined the distribution of slopes across all taxa in each ecosystem, and compared the observed distribution with the one simulated under the null hypothesis of no overall trend for a balanced community. The comparisons showed that more taxa showed a decreasing trend in CPUE in SoG and WCVI, but the distributions of CPUE and frequency of occurrence in QCI and CC were more close to those from the simulation. The causes for the differences among the ecosystems were discussed.

Oral CCFFR (Ecosystem-based Management – Science and Policy)

## INSPIRATIONS FROM RANSOM A. MYERS: MARINE CONSERVATION FROM THE BOTTOM AND THE TOP DOWN

**Fuller, Susanna D.**

Department of Biology, Dalhousie University, Halifax, NS B3H 4J1 ([susannadfuller@gmail.com](mailto:susannadfuller@gmail.com))

My thesis research focuses on the impacts of fishing on marine sponge populations, the biogeography of sponges in the Northwest Atlantic, and the description of a unique population of glass sponges on the Scotian Shelf. Throughout my doctoral research, Ram supported my interest in marine policy, in how science is used fisheries management, and in advocacy for marine conservation. Ram used science to influence change. My presentation will follow the path of my scientific interest in marine sponges, particularly as fish habitat, to the various policy implications of that work as well as the advocacy and communication of science needed to make change on the water.

Oral CCFFR (Ram Myers Session)

## A SPATIO-TEMPORAL MIXED-STOCK ANALYSIS OF ATLANTIC SALMON (*SALMO SALAR*) IN THE WEST GREENLAND FISHERY

**Gauthier-Ouellet\***, M., T. King, M. Dionne, F. Caron, L. Bernatchez.

Department of biology, Laval University (email : [marika.gauthier-ouellet.1@ulaval.ca](mailto:marika.gauthier-ouellet.1@ulaval.ca))

West Greenland coast is an important foraging area where salmon from both North America and Europe migrate. Unlike many regions of the world, Greenland allows an Atlantic salmon fishery. Genetic stocks identification is a key element of managing fisheries, but this aspect has not been studied in great details for the Greenland salmon fishery. Thus, other than documenting continental origin, it is unknown which populations are being targeted by the fishery, nor how this may be affecting their demography and genetic diversity. This study focuses on those aspects. In order to achieve this, 50 salmon baseline populations from North America have been sampled and analyzed at 13 microsatellites. Simulations ran with SPAM software showed that sufficient population allele frequency differences exists at microsatellites loci to enable accurate estimation of stock composition of mixed-stocks salmon samples at a regional level. Mixed samples from the Greenland fishery were collected from 3 localities and cover a 10-year period. Results show that there are clear contribution differences between regions of North America and that those differences are greater between years of sampling than between locations of sampling. In addition, there seems to be a correlation between regional contribution estimates and regional production of salmon migrating to West Greenland area. These results provide a better understanding of the dynamics of Atlantic salmon in Greenland, which will contribute to improving the management of Atlantic salmon.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## FISHES OF THE LOWER SAINT JOHN RIVER

**Gautreau**, Mark<sup>1</sup>, Allen Curry<sup>1</sup>, Kelly Munkittrick<sup>2</sup>, and Chad Doherty<sup>3</sup>,  
Canadian Rivers Institute, University of New Brunswick, Fredericton<sup>1</sup> and Saint John<sup>2</sup> and Department of  
Natural Resources, Fredericton, NB (email: [mgautrea@unb.ca](mailto:mgautrea@unb.ca))

The lower Saint John River flows approximately 125 km from Fredericton south to Saint John. This stretch of the river is very complex, being affected by hydroelectric regulation, multiple municipal inputs, and tidally influenced. Over the past two years the Canadian Rivers Institute has continued fish community sampling of the Saint John River focusing on this lower portion. Species richness and abundance was assessed using fyke nets, gillnets, beach seines, and boat electrofishing. This is part of ongoing research to assess the overall state of the Saint John River.

Poster CCFFR (Contributed paper)

## STATISTICAL, LIFE HISTORY-BASED, ASSESSMENT MODELS FOR DIADROMOUS FISH POPULATIONS

**Gibson**, A.J.F.\*

Department of Fisheries and Oceans, Science Branch, 1 Challenger Drive, Dartmouth, NS. B2Y 4A2  
(email: [gibsonajf@mar.dfo-mpo.gc.ca](mailto:gibsonajf@mar.dfo-mpo.gc.ca))

The biology, fisheries and data for diadromous fish populations differ from those of marine fish. Activities such as hydroelectric development, water withdrawals for agriculture and pollution may affect a population's dynamics and these stressors may affect life stages differently depending on the location and timing of the activities. Additionally, auxiliary data such as escapement counts at fish ladders, larval abundance indices, redd counts or juvenile density estimates are often available. Although these data are often collected intermittently, they can be incorporated into an assessment model. Consequentially, traditional fisheries models that are designed for marine species (e.g. virtual population analyses and biomass dynamic models) are often not appropriate for diadromous species and may not make full use of the available data. However, statistical catch-at-age models can be adapted to diadromous populations by increasing the dimensionality of the numbers-at-age array so that variation in both life-history events and in the timing of human impacts can be incorporated into the model. Parameter estimates are obtained by fitting the model to the available data using maximum likelihood or else are obtained from data for other populations. The approach is demonstrated using examples of models developed for alewife fisheries as well as models being used to assess threats and recovery potential for declining Atlantic salmon populations.

Oral CCFFR (Ram Myers Session)

## TRACKING WATER QUALITY CHANGES IN NOVA SCOTIA RELATED TO ACIDIFICATION, EUTROPHICATION, AND CLIMATIC CHANGE USING PALEOLIMNOLOGICAL TECHNIQUES

**Ginn\***, BK, Cumming, BF, and Smol, JP.

Paleoecological Environmental Assessment and Research Laboratory (PEARL), Department of Biology, Queen's University, Kingston, Ontario, K7L 3N6 (email: ginnb@biology.queensu.ca)

Since 2002, the TEAM (Trends in Eutrophication and Acidification in the Maritimes) Project has studied water quality issues in Nova Scotia and southern New Brunswick using both paleolimnological techniques and biogeochemical models. While biogeochemical models use chemical parameters to assess environmental changes, paleolimnology uses biological remains from lake sediments, and known species ecology, to directly infer past environmental conditions. From these studies, we have determined the timing and extent of surface-water acidification across Nova Scotia, changes in lake trophic status due to development and landscape changes, as well as the impact of climatic changes on freshwater systems. In this presentation we give an overview of our paleolimnological results, as well as the utility of these methods as a lake management tool for assessing the impacts of environmental stressors. Comparative modeling studies led by Dr. Peter Dillon (Trent University) have also been completed and will be discussed at this conference in other presentations.

Oral SCL (Ecosystem-based Management - Science and Policy)

## ROLE OF MUTATION, MIGRATION, AND EFFECTIVE POPULATION SIZE IN THE DIVERSIFICATION OF TWO SYMPATRIC MORPHS OF ARCTIC CHARR (*SALVELINUS ALPINUS*)

**Gomez-Uchida\***<sup>1</sup>, D., Dunphy<sup>1</sup>, K.P., O'Connell<sup>2</sup>, M.F. and Ruzzante<sup>1</sup>, D.E.

<sup>1</sup>Department of Biology, Life Sciences Centre, Dalhousie University, 1355 Oxford Street, Halifax, NS B3H 4J1 Canada. <sup>2</sup>Science Branch, Department of Fisheries and Oceans, PO Box 5667, St John's NL, A1C 5X1 Canada.

Gander Lake in Newfoundland, Canada is a postglacial lacustrine system that harbors two sympatric morphotypes of Arctic charr (*Salvelinus alpinus*): a 'dark', abundant, and most common form of *S. alpinus*, and a small and less conspicuous 'pale' form. Using microsatellite multilocus genotypes and relevant methods, our study disseminates three major findings in the diversification of the ecotypes. First, we found a high degree of reproductive isolation between them, where stepwise mutations have played an equal or greater role than drift to differentiation. Second, migration rates have remained historically low across long-term and short-term evolutionary settings. Third, historical (coalescent) and current (linkage disequilibrium) point estimates of effective population size ( $N_e$ ) were stable across temporal scales with consistently higher values for dark than pale Arctic charr. Our findings argue strongly against an intralacustrine origin of Arctic charr morphotypes given the large contribution of mutations. Historical differences and low migration rates between morphs were likely ecologically reinforced once they came into secondary contact, resulting in trophic specialization, niche partitioning, and divergent morphological traits. Ultimately, exploitation of habitats that differ in quality and quantity between Arctic charr ecotypes as reported in ecological studies can result in unequal estimates of abundance and  $N_e$ .

Poster CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

LONG-TERM CHANGES IN AGE, BODY SIZE, AND GROWTH OF AMERICAN EELS, *ANGUILLA ROSTRATA*, ASCENDING THE EEL LADDER AT THE MOSES-SAUNDERS GENERATING STATION, UPPER ST. LAWRENCE RIVER.

**Greer\***, C. and J. M. Casselman.

Department of Biology, Queen's University, Kingston, Ontario (email: [4cdg@queensu.ca](mailto:4cdg@queensu.ca) )

Young American eels, *Anguilla rostrata*, travel from the spawning grounds in the Sargasso Sea to estuarial waters along the eastern coast of North America by way of the Gulf Stream. The females ascend rivers to freshwater, where they mature before returning to the sea. Eels arriving at the Moses-Saunders eel ladder in the upper St. Lawrence River have increased in size over time and appear to be older. We analyzed eels caught at the eel ladder in six years (1976, 1981, 1986, 2000, 2003, and 2004) over a 29-years period to quantify changes in otolith age, growth, and body condition. Nuclei of otoliths were analyzed to determine if they reflect changes in age and growth of eels arriving at the Gulf of the St. Lawrence. Age at capture of eels ascending the ladder increased over the years (1970s to 1980s,  $5.6 \pm 0.1$  years; 1990s,  $11.9 \pm 1.1$  years); mean length increased significantly after the 1970s (1970s,  $331 \pm 4$  mm; 2000s,  $458 \pm 8$  mm;  $P < 0.0002$ ); and smaller eels have greater body condition in recent years. The increase in size, age, and condition of eels arriving at the ladder may be the result of changes in the Gulf Stream and Labrador Current, as well as a decrease in density-related pressure to move upstream.

Poster CCFFR (Contributed paper) (Undergraduate Student)

GROWTH, MORTALITY AND BEHAVIOUR OF AGE 0 ATLANTIC COD AT LOW POPULATION SIZE

**Gregory**, R.S.\*, C. Morris, and B. Newton.

Fisheries & Oceans Canada, St. John's Newfoundland. (email: [GregoryR@dfo-mpo.gc.ca](mailto:GregoryR@dfo-mpo.gc.ca))

Density-dependant processes determine recruitment of fish populations worldwide. However, the mechanisms by which these processes operate are not clear, especially at low population size. Despite fisheries moratoria since 1992, the northern population of Atlantic cod (*Gadus morhua*) off the Newfoundland coast remains below 2% of historical levels. Interannual variability of age 0 cod recruitment to coastal nursery habitat is typically high. However, age 0 density has been a poor predictor of the future size of cohorts in the adult population. High recruitment years appear to have been dampened out during the first year of life, suggesting compensatory recruitment effects. We used net sampling over a 13 year period (1995-2007) to examine the effect of recruitment variability on growth, mortality, and habitat-associated packing in age 0 Atlantic cod in a coastal nursery habitat. In low recruitment years, age 0 cod exhibited a strong association with eelgrass (*Zostera marina*), high site-fidelity, high growth rate and low mortality rate. In contrast, in high recruitment years, habitat associations were comparatively weak, site-fidelity was low, growth rate was low and mortality rate was elevated. We have also observed substantive differences in the behaviour of juvenile cod in high and low density years. The interannual pattern of individual growth and mortality through the period has been consistent with compensatory population processes.

Oral CCFFR (Population Processes at Low Abundance – Recovery, Rarity and Invasives)

## DIFFERENCES IN MORPHOLOGY, ENERGY BUDGET, AND ACTIVITY PATTERNS BETWEEN ARCTIC CHARR FROM TWO CONTRASTING POPULATIONS

**Guénard\***, G. and D. Boisclair.

Département de sciences biologiques, Université de Montréal, Montréal (email: guillaume.guenard@umontreal.ca)

Polymorphisms are the state by which groups of individuals within a species (i.e. ecotype) adopt particular phenotypes (e.g. morphology, life history, behaviour, etc.). Though studies have highlighted that the individual morphology may, under certain conditions, impact growth rate, there are still gaps in knowledge as to impact of polymorphisms on consumption and activity rate, and spatial-temporal patterns of activity. These topics determine (1) the impact the ecotypes will have on their food resources, (2) their growth efficiency, (3) their ability to match their distribution with that of their preys and (4) engaging competitive interactions, and (5) their susceptibility to predators (including man). To help fill these gaps, we designed an experiment where Arctic charr (*Salvelinus alpinus*) originating from two populations living under contrasting environmental conditions (size, depth, and altitude of lakes, thermal regime, altitude of lakes, and absence/presence of brown trout) were reared under similar environmental conditions. We measured a set of morphological traits, obtained individual estimates of growth and consumption (using stable caesium analysis) rates, and performed short-time estimates activity rate at different times and places within the enclosures using a technique based on stereo-video-cameras recordings. The charr from the two populations had similar activity rate, but differed in terms of body morphology, growth and consumption rates, growth efficiency, and spatial activity patterns. These results supports the hypothesis individuals of the same species, but originating from ecosystems with contrasting environmental conditions may as well be specific with respect of their bioenergetics, and activity patterns.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## CONFOUNDING EFFECTS OF DROUGHT ON THE RECOVERY OF BENTHIC INVERTEBRATES IN A MINING IMPACTED STREAM

**Gunn\***, John M. and Chantal Sarrazin-Delay,

Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Ontario

For decades acid mine drainage (AMD) severely impacted the Frood Branch, a tributary of Junction Creek in Sudbury, Ontario, eliminating all fish and most benthic invertebrate species. A diversion of the most contaminated sources of AMD in 2000/2001 greatly improved downstream conditions with pH increasing from <4.5 to >7.0 and Cu, Ni and Zn concentrations decreasing by 10 fold. Seven species of fish colonized the affected 3.4 km of stream and the abundance and family richness of benthic invertebrates increased dramatically after the diversion. Using a reference condition approach (RCA) several biotic indices (diversity, richness, evenness, Hilsenhoff biotic index, EPT richness) indicated that significant recovery of the benthic invertebrate communities had occurred within 3 years of the clean up efforts. However, drought events during recent warm years have serious reversed this pattern. The water diversion itself may have increased the vulnerability of this area to drought, but the results are also a warning of the likely impact of climate warming on many industrial sites.

Oral CCFFR (Complexities in Ecological Recovery)

## INTERACTIONS OF TOTAL AMMONIA AND NITRATE TOXICITY IN THE ENVIRONMENT

**Guy\***, M<sup>1</sup>, G. Schroeder<sup>2</sup> and G. VanAggelen<sup>2</sup>.

<sup>1</sup>National Guidelines and Standards Office, Environment Canada, 7<sup>th</sup> Floor, Place Vincent Massey, 351 St. Joseph Blvd, Gatineau, QC K1A 0H3, Martha.Guy@ec.gc.ca.

<sup>2</sup>Pacific Environmental Science Centre, Environment Canada, 2645 Dollarton Hwy., North Vancouver, BC V7H 1B1

The Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life are recommended numerical or narrative limits which, if exceeded, may impair ecosystem health. CWQGs are derived for individual compounds using data from laboratory-based, aquatic toxicity tests and include values for total ammonia (NH<sub>3+4</sub>), nitrite (NO<sub>2</sub><sup>-</sup>), and nitrate (NO<sub>3</sub><sup>-</sup>). However, the natural cycling of inorganic N in lakes and rivers, as mediated by the processes of nitrification and denitrification, suggests that isolating individual N compounds in toxicity tests may not represent true N toxicity. We conducted 96-h static toxicity tests using a nitrate-dilution series in the presence of high, but not lethal, concentrations of NH<sub>3+4</sub> under controlled temperature and pH conditions using three freshwater animal species: juvenile Rainbow trout (*Oncorhynchus mykiss*), American bullfrog (*Rana catesbeiana*) tadpoles and *Hyaella azteca*. Aquarium gravel was added to each test container in order to stimulate nitrification. Preliminary nitrate LC20 for Rainbow trout is 6013.1 mg NO<sub>3</sub>/L (nominal) and 3243.4 mg NO<sub>3</sub>/L (nominal) for *Hyaella*. These values are lower than nitrate LC20 values of 6158.4 mg NO<sub>3</sub>/L for Rainbow trout and 3724.6 mg NO<sub>3</sub>/L for *Hyaella* from tests run without aquarium gravel. The drop in nitrate LC20 may be related an increase in NO<sub>2</sub> in the test vessels. The results of this work suggest guidance is needed for the application of the inorganic nitrogen CWQGs.

Oral SCL (Ecosystem-based Management – Science and Policy)

## DOES LAND USE DICTATE METHYLMERCURY CONCENTRATIONS IN SASKATCHEWAN WETLANDS?

**Hall\***, Britt D.

Department of Biology, University of Regina, Regina SK S4S 0A2 (email: [Britt.Hall@uregina.ca](mailto:Britt.Hall@uregina.ca))

The production of methylmercury (MeHg), a vertebrate neurotoxin easily bioaccumulated by humans and wildlife, occurs in prairie wetlands across Saskatchewan. Pilot studies performed in 2006 suggest that land use can be a factor in predicting MeHg concentrations in water. In an initial survey examining MeHg concentrations in water in wetlands that tend to dry up by the end of the summer at the St. Denis National Wildlife Area near Saskatoon, we found that water MeHg concentrations were higher in ponds that had intact grassland riparian zones. In contrast, MeHg concentrations in water from temporary ponds that were cultivated to the shoreline using traditional farming methods were significantly lower. Dissolved organic carbon (DOC) and sulphate concentrations were also lower in cultivated wetlands, suggesting that rates of methylation were likely lower. In 2007, we expanded our study to three treatments: 1. wetlands where modern pesticide-use agriculture farming occurred to within 1 m of the shoreline, 2. wetlands where organic pesticide-free agriculture farming occurred to within 1 m of the shoreline, and 3. wetlands that had been left in a natural grassland state for five years prior. Concentrations of MeHg in dissolved and particulate phases, DOC and sulphate concentrations, specific UV absorbance (a measure of the quality of the DOC), total suspended particulates and basic limnological data (temperature, pH, etc.) were collected from each of three ponds per treatment group. This is the first part of a study that will also be examining MeHg concentrations in aquatic invertebrates from the treatment wetlands.

Oral SCL (Ecosystem-based Management – Science and Policy)

## IS THE AMERICAN EEL PRIMARILY A MARINE SPECIES?

**Hallett\***, J.A., Cairns, D.K. and Courtenay, S.C.

Canadian Rivers Institute, Department of Biology, University of New Brunswick, Fredericton, NB, Canada (email: [jason.hallett@unb.ca](mailto:jason.hallett@unb.ca))

Recent otolith microchemistry studies have shown that some American eels (*Anguilla rostrata*) complete their life cycles in marine waters, thus indicating that catadromy is an optional life history strategy for this species. However, American eels are still referred to as "freshwater eels," implying that the majority occupy fresh water during the growth phase of their life cycle. In the southern Gulf of St. Lawrence, including Prince Edward Island, there are approximately 129,000 ha of bay and estuary habitat with a depth <3 m. Prince Edward Island has approximately 39,000 ha of sheltered bay and estuary habitat. We estimated eel populations in selected areas across PEI using electrofishing, mark-recapture, and nighttime surveys with a glass-bottom boat. Based on densities derived from mark-recapture and glass-bottom boat surveys, the population of yellow eels in marine habitats in PEI is estimated at 5.5 million. These results raise questions regarding conservation measures and the focus of management, given that 97% of the total yellow eel population in PEI occurs within these marine habitats. If densities in marine habitats in PEI apply to similar habitat found throughout the southern Gulf of St. Lawrence system, the overall contribution from these areas to spawning in the Sargasso Sea may be much greater than previously thought. This may be the beginning of a paradigm shift in thinking of the American eel as primarily a marine species, with only a minority using freshwater as growth areas.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## INTERACTIONS BETWEEN SEMIPALMATED SANDPIPERS AND INTERTIDAL MUDFLAT COMMUNITIES IN THE UPPER BAY OF FUNDY.

**Hamilton, D.**

Department of Biology, Mount Allison University, Sackville, N.B. (email [dhamilton@mta.ca](mailto:dhamilton@mta.ca))

The upper Bay of Fundy is a critical staging area for the majority of the world population of Semipalmated Sandpipers (*Calidris pusilla*). These arctic-breeding shorebirds stop in the area during their annual late summer migration to South American wintering grounds. While present, sandpipers feed extensively on intertidal mudflats, roughly doubling their mass in a 2-week period. Historically, individual birds have been thought to forage primarily on the amphipod *Corophium volutator* within a single mudflat, showing high within-season site fidelity and selecting amphipod-rich sites. It has been suggested that where birds are abundant, there is potential for a strong seasonal top-down trophic cascade in which shorebirds reduce abundance of *C. volutator*, which in turn leads to an increase in primary production (biofilm). In recent years we have challenged this interpretation. Using a series of enclosure experiments, radiotracking shorebirds, and by monitoring links between bird behaviour and diet through a combination of stable isotope analysis and videotaping of foraging birds, we have concluded that the role of shorebirds in mudflat community dynamics is far more complex and variable than previously thought. In some circumstances birds move freely among mudflats, visiting those with and without rich food supplies. Sandpiper diets also appear to be more variable than previously thought; they assimilate a wide range of foods, including biofilm. Finally, their top-down predation effects do not appear to cascade through the system, perhaps in part because of their variable diets, but also because other species in the system appear to compensate for seasonally variable top-down predation pressure.

Oral CCFFR (Waterbirds in Marine and Freshwater Food Webs)

## REFORMULATING EMPIRICAL MODELS FROM LAKES FOR USE IN ESTUARIES AND LAGOONS: WHY NOT?

**Hanson, J. Mark.**

Aquatic Resources Division, Gulf Fisheries Center, Moncton, NB (E-mail: [Hansonm@dfo-mpo.gc.ca](mailto:Hansonm@dfo-mpo.gc.ca))

Since the 1970s, freshwater researchers have expended tremendous resources developing predictive models (using the comparative approach) for the management of resources in freshwater systems. Marine systems are traditionally considered too open for similar models to apply. I argue that one class of marine ecosystem in Atlantic Canada, the semi closed estuary and coastal embayments, have much in common with lakes and reservoirs in terms of structuring processes, and they face many of the same anthropogenic stresses (e.g., land-based nutrient loading, development of the shorelines and catchment basins, aquaculture, resource harvesting). Indeed, a few published studies indicate nutrient-chlorophyll and macrophyte colonization depth relationships can be derived similar to those based in freshwaters. If these variables can be modeled, there is no *a priori* reason that biomass and production of other ecosystem components can not be empirically modeled and examples of and likely groups (Y variables) and model forms are discussed.

Oral CCFFR (River and Estuary Ecosystems)

## ESTIMATING UNREPORTED BYCATCH MORTALITY: CUSK (BROSME BROSME) MORTALITY IN THE LOBSTER FISHERY OF SOUTHWESTERN NOVA SCOTIA

**Harris\*, L.E. and A. Hanke.**

Fisheries and Oceans Canada, St. Andrews Biological Station, St. Andrews, NB. ([harrisle@mar.dfo-mpo.gc.ca](mailto:harrisle@mar.dfo-mpo.gc.ca))

Traditionally fisheries science and management have focused on commercially important species. A move towards ecosystem management entails broader considerations than in the past. Commercial fishing has been implicated in the decline of fish stocks beyond the target species, including species of concern such as cusk (*Brosme brosme*).

There has been a decline in the abundance indices of cusk over the last 2 decades and the species has been designated as 'threatened' by the Committee on the Status of Endangered Wildlife in Canada. The main source of mortality for this species is commercial fishing directed at other species. Catches in groundfish fisheries are generally landed and reported. Catches in invertebrate fisheries, such as lobster, are released at sea and so are not reported. Although cusk are released, some mortality occurs. It is necessary to quantify all sources of fishing mortality in order to successfully implement ecosystem-based management. An at-sea sampling program was undertaken to quantify cusk mortality rates in the lobster fishery of south-western Nova Scotia. Although catch rates were low, incidental catch in the lobster fishery represented a substantial source of previously unaccounted for cusk mortality due to the magnitude of this fishery.

Oral CCFFR (Ecosystem-based Management – Science and Policy)

## GENETIC STRUCTURE OF AMERICAN SHAD POPULATIONS ACROSS THE NATIVE RANGE OF THE SPECIES

**Hasselman\***, D.J., Bentzen, P.

Marine Gene Probe Laboratory, Dept. of Biology, Dalhousie University, Halifax, NS, B3H 4J1 (email: dhasselm@dal.ca)

Effective management of diadromous fishes requires knowledge of population structure, and relies on understanding how intraspecific genetic diversity is distributed spatially and temporally. American shad (*Alosa sapidissima*) constitute a broadly distributed, population rich anadromous alosine, and are of increasing conservation concern. Previous research has demonstrated that shad spawning populations are reproductively discrete, aided by a high degree of philopatry, and constitute genetically distinguishable groups. To help elucidate the population structure of shad, we assess the spatial partitioning of genetic variation at 14 microsatellite loci from 25 spawning runs of American shad distributed across their native range (Florida to Quebec). We examine how variation in estimates for genetic diversity parameters (e.g. allelic richness, observed/expected heterozygosity) are partitioned along this latitudinal gradient, and conduct BARRIER analysis to identify intrinsic barriers to gene flow among discrete spawning assemblages. We then interpret our results in the context of i) intraspecific alternative life history strategies (semelparity vs. iteroparity), ii) varying degrees of human mediated gene flow (stocked vs. non-stocked), iii) previously glaciated and non-glaciated regions, and iv) evolutionary processes at the edge of the species range.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## AND POPULATION GENETIC STRUCTURE IN BICOLOR DAMSELFISH ON THE MESOAMERICAN BARRIER REEF: LOCAL ADAPTATION VERSUS RISK-SPREADING.

**Heath\***, D.D. P. Sale, and R. J. Thiessen.

University of Windsor, Great Lakes Institute for Environmental Research and the Department of Biological Sciences, 401 Sunset Blvd, Windsor ON, Canada, N9B 3P4; phone: 519-988-0310; e-mail: dheath@uwindsor.ca

Connectivity in marine ecosystems is a critical ecological parameter for predicting the impact of resource exploitation, climate change, and habitat degradation. However, the evolutionary and ecological roles of dispersal versus retention are poorly understood, primarily due to the logistic difficulty of measuring dispersal and self-recruitment rates in marine fishes. We used microsatellite markers to assess population genetic structure in *Stegastes partitus* (Bicolor damselfish) on the Mezoamerican Barrier Reef over two years of sampling. Our analyses identified weak but significant genetic structure, consistent with local retention or match-mismatch sweepstakes recruitment. However, our temporal replicates showed this pattern to be highly unstable over time. We used genotype-assignment analyses to identify self-recruited and dispersed fish to determine the basis of the temporal instability. Our genotype assignment analyses showed a consistent proportion of fish were self-recruited among years, but the pattern of dispersal changed fundamentally. Although oceanographic current regimes coupled with behaviorally modified dispersal can account for specific patterns of connectivity, such approaches generally fail to predict chaotic temporal variation. However, unpredictable oceanographic “events” can explain temporal variation overlaid on a background of population genetic structure. A combination of retention and dispersal, as is demonstrated here, should provide the benefits of some level of local adaptation coupled with the risk-spreading benefits of dispersal.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## DIETS AND DISTRIBUTIONS OF LEACH'S STORM-PETRELS BEFORE AND AFTER AN ECOSYSTEM SHIFT IN THE NORTHWEST ATLANTIC

**Hedd, A.\*<sup>1</sup>**, W. A. Montevecchi<sup>1</sup>, G. K. Davoren<sup>1,2</sup> and D. A. Fifield<sup>1,3</sup>

<sup>1</sup>Memorial University of Newfoundland (Psychology Dept), NL, A1B 3X9 Canada (email [ahedd@mun.ca](mailto:ahedd@mun.ca));

<sup>2</sup>University of Manitoba (Zoology Dept), Winnipeg, MB, R3T 2N2 Canada

<sup>3</sup>Canadian Wildlife Service, 6 Bruce Street, Mount Pearl, NL, A1N 4T3 Canada

The Grand Banks ecosystem has undergone significant shifts during the past two decades due to oceanographic and fishing effects. Documented impacts for upper trophic level seabirds (dietary shifts, reduced reproductive performance) are mediated through changes in the biology and behaviour of capelin *Mallotus villosus*, the focal forage species. To explore potential impacts at lower trophic levels, we combine dietary data (1987-88, 2003-06) with at-sea distributional patterns (1966-90, 1998-99) for Leach's storm-petrel *Oceanodroma leucorhoa*, the smallest and most abundant seabird breeding in the Northwest Atlantic. Leach's storm-petrel is highly pelagic during breeding, being distributed from inshore colonies to beyond the continental slope. Fish and crustaceans formed the bulk of diet during chick-rearing at two large Newfoundland colonies. Fish was the dominant prey type (occurrence > 70%, reconstructed mass > 75%). Crustaceans were numerous and occurred frequently, but typically comprised ≤ 10% by mass. Ten fish species from five families were identified; mature myctophids (*Benthosema glaciale*, *Ceratoscopelus maderensis*, *Protomyctophum arcticum*) and sandlance *Ammodytes* sp. dominated. Thirteen crustacean taxa were identified, and the parasitic amphipod *Hyperia galba* dominated. Persistent reliance on myctophid fish resulted in similar general diet composition in 1987-88 and 2003-06, but decadal variability was evident. Crustacean diversity was lower in 2003-06 than previously: fewer species of hyperiids were present and small euphausiids *Thysannoessa* sp. were absent, the later paralleling changes in diets of capelin. Sandlance sp., which contributed ≥ 10% by mass in 2003-06, was not found in the 1980s. Geographic variation in diet composition was consistent with birds foraging in different oceanographic regions. Integrating information on predator-prey interactions for Leach's storm-petrels within a multi-species paradigm involving piscivorous seabirds provides insight into factors driving ongoing ecosystem changes.

Oral CCFR (Waterbirds in Marine and Freshwater Food Webs)

## INFLUENCE OF RESIDENTIAL DEVELOPMENT ON AQUATIC MACROPHYTE COMMUNITIES IN LAKES OF THE KAWARTHA REGION, ONTARIO.

**Hicks\*<sup>1</sup>**, A.L. and P.C. Frost<sup>2</sup>

<sup>1</sup>Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON., <sup>2</sup>Department of Biology, Trent University, Peterborough, ON. (email: [andrea.hicks2@trentu.ca](mailto:andrea.hicks2@trentu.ca))

Canadian shield lakes are distinct to Canada's landscape and are used extensively for residential and recreational uses especially when located near urban centres. These human uses potentially alter the ecological integrity and services, such as the provision of clean fresh water, that lakes provide. Within the Kawartha Region of Ontario, we sampled lakes (n=13) across a gradient of lakeshore development (0 to 23.1 cottages/km of shoreline) to test the hypothesis that the extent of shoreline comprised of cottage development influences the community composition of macrophytes in the littoral zone. Macrophyte communities were sampled in two water depths (0.5 m and 1.5 m) and we analyzed the samples for species diversity and total biomass. On developed lakes, sites were located next to cottage properties. Water and sediment samples were also collected to determine site specific variables. Average macrophyte species diversity by lake ranged from  $2.33 \pm 1.53$  to  $11.00 \pm 1.73$ , with lower richness being found in highly developed lakes for communities sampled at 0.5 m but not at 1.5 m. We also found differences in macrophyte biomass and are currently assessing the causes of this variability. Our results show that increasing disturbance from residential and recreational use can significantly affect aquatic macrophyte richness; however, these effects will be further analyzed to determine the importance of site-specific and lake-specific variables.

Oral SCL (Contributed paper) (GS)

## DETERMINANTS OF ZOOPLANKTON COMMUNITY STOICHIOMETRY IN CANADIAN SHIELD LAKES.

McFeeters<sup>1</sup>, B., A.L. **Hicks**\*<sup>2</sup>, and P.C. Frost<sup>1</sup>

<sup>1</sup>Department of Biology, Trent University, Peterborough, Ontario

<sup>2</sup>Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario  
(email: [andreahicks2@trentu.ca](mailto:andreahicks2@trentu.ca))

Freshwater zooplankton profoundly influence the physical, chemical and biological properties of their habitat by acting as important nutrient sinks and sources. The elemental composition of the community as a whole is important as it can determine the rates and ratios of recycling in lake pelagic ecosystems. The elemental composition of zooplankton communities among lakes having different nutrient supply may reflect species sorting or the physiological flexibility of individual taxa. We tested these two explanations by collecting pelagic zooplankton from Canadian Shield lakes (n=20) in central Ontario. For each zooplankton sample, we measured the C:N:P ratios of the whole community as well as individuals from the dominant taxa. While analysis of community composition and individual taxa is on-going, we found that the whole community C:N ratios ranged from 6.37 to 10.7 among lakes. This variation indicates the elemental composition of zooplankton is a potential determinant of nutrient cycling in these lakes and in need of further study.

Poster SCL (Contributed poster)

## ECOLOGICAL INTERACTIONS BETWEEN JUVENILES OF MULTI-GENERATIONAL CROSSES OF FARMED AND WILD ATLANTIC SALMON

**Houde\***, A.S., Fraser, D.J. and J.A. Hutchings.

Department of Biology, Dalhousie University, Halifax (email: [aimee.lee.houde@dal.ca](mailto:aimee.lee.houde@dal.ca))

It has been hypothesized that farmed-wild hybrid Atlantic salmon (*Salmo salar*) express behaviours that may be detrimental to the fitness of wild salmon populations. We evaluated behavioural differences between two wild populations (Stewiacke and Tusket Rivers, Nova Scotia), the main farmed strain used in salmon aquaculture in Eastern Canada, and their farmed-wild hybrids (i.e. F1, F2, and wild backcross). Predation susceptibility was measured using a specially designed tank and a model belted kingfisher (*Ceryle alcyon*). Individual differences in competitive ability were quantified in pair-wise comparisons in which points were awarded for displays of aggression and food capture. Population level effects were also measured in semi-natural stream environments where the proportion of hybrid offspring relative to wild offspring varied among treatments. Hybrid fry exhibited increased susceptibility to predators, a response predicted to have negative demographic consequences to wild populations. Farmed fry and hybrids were more dominant than wild fry from the Stewiacke population only. At the population level, the presence of hybrids did not affect the growth of wild fish, but it did affect the growth of hybrid fish depending on the proportion of hybrids in the replicate. Notably, one has to account for interactions between hybrids before predicting their demographic consequences to wild salmon. Wild populations that have a similar competitive ability and growth rate relative to farmed salmon are predicted to be better at coping with the presence of farmed-wild hybrid salmon than other wild salmon populations.

Poster CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

RELATIONSHIPS BETWEEN SPAWNING GROUND ARRIVAL TIMING, SPAWNING GROUND LONGEVITY, AND SPAWNING SUCCESS IN FEMALE SOCKEYE SALMON (*ONCORHYNCHUS NERKA*): AN INVESTIGATION OF PRE-SPAWNING MORTALITY

**Hruska\***, K. A. and S.G. Hinch,

Department of Forest Sciences, University of British Columbia, Vancouver, BC  
(email: [hruskak@interchange.ubc.ca](mailto:hruskak@interchange.ubc.ca))

Pre-spawning mortality, where female Pacific salmon (*Oncorhynchus* spp.) arrive at the spawning grounds but fail to spawn their eggs prior to death, affects large segments of the population in some years (up to 90%). One of the leading hypotheses about the causes of pre-spawning mortality is that the fish are running out of time and/or energy to successfully spawn. We investigated the relationships between spawning ground arrival timing, spawning ground longevity and spawning success in female sockeye salmon (*O. nerka*) from the Weaver Creek spawning channel, BC, in 2006, a year with high pre-spawning mortality (30%). A total of 259 females were tagged over three sampling periods and followed until death. Early arriving females lived significantly longer than later arriving females ( $p < 0.001$ ), but levels of egg retention were not significantly different across sampling dates ( $p = 0.955$ ). Consistent with the time/energy limitation hypothesis, there was a significant negative relationship between longevity and egg retention ( $p < 0.001$ ;  $r^2 = 0.183$ ); however, there were several long-lived females ( $> 7$  days) which failed to spawn completely before death, indicating that spawning failure was not due to a lack of time on the spawning grounds, but rather that there are different factors underlying longevity and egg retention in female sockeye salmon.

Oral CCFFR (Contributed paper) (GS)

MOSSTAKEN IDENTITY: A STORY OF AQUATIC FOOD SOURCES IN TWO INNER BAY OF FUNDY RIVER SYSTEMS.

**Hughes\***, McWilliam, S. and R. Cunjak.

Department of Biology, University of New Brunswick, Fredericton, NB (email: [c0zn6@unb.ca](mailto:c0zn6@unb.ca))

The productivity of most food webs is driven by the energy produced at its base by the primary producers. Aquatic food webs use energy from two types of primary producers: autochthonous (aquatically-derived) and allochthonous (terrestrially-derived) carbon sources. Within streams there are various autochthonous sources available to food webs. Stable isotope analysis can be used to differentiate between carbon sources and help to determine those that sustain aquatic communities. The stable isotope of carbon ( $^{13}\text{C}$ ) is an effective food source tracer because primary producer signatures can vary greatly due to source carbon availability and differing methods of photosynthetic processing and because little alteration (0-1‰) occurs as the element is transferred through the food chain. The objective of this study was to determine which of the various autochthonous carbon sources contributes to aquatic food webs in Inner Bay of Fundy river systems. The Upper Salmon and Big Salmon Rivers were sampled from headwaters to river mouth (above head of tide) with a total of 17 study sites reflecting the sub-basins and stream orders present. Vegetation samples included macrophytes, filamentous algae, biofilm, and aquatic bryophytes. Various macro-invertebrate taxa, of the 'scraper' functional feeding group, were collected to represent primary consumers who feed primarily on autochthonous food sources. Carbon isotope signatures indicated that macrophytes, filamentous algae and cyanobacteria were not important food sources to the invertebrate communities. Biofilm was also unimportant to the local food webs, and scraper-type invertebrates seemed to be utilizing aquatic bryophytes as the primary autochthonous food source.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## ALTERNATIVE REPRODUCTIVE STRATEGIES THEN AND NOW: 25 YEARS OF STUDY OF ATLANTIC SALMON

**Hutchings**, Jeffrey A.

Department of Biology, Dalhousie University, Halifax, NS B3H 4J1 ([jeff.hutchings@dal.ca](mailto:jeff.hutchings@dal.ca))

One of the most phenotypically extreme examples of alternative life histories in vertebrates is found in Atlantic salmon, *Salmo salar*. Mature male parr reproduce at sizes 2-3 orders of magnitude smaller (10-150 g relative to >1000g) and at much less than half the age (typically 1-2 yr compared to 4-8 yr) of anadromous males, which breed following a migration to sea. The evolutionary stability of these life-history tactics depends on the fertilisation success of each tactic and its frequency dependence, the trade-offs associated with each tactic, and the underlying mechanism that determines the tactic that individual males will adopt. Ram Myers' contributions to this field began with a study of survival costs of reproduction in parr (1983, 1984). Thereafter, his collaborative research included studies of parr behaviour (1985), inter-population variability in parr maturity (1986), genetically-based estimates of parr fertilisation success (1988), and the hypothesis that adoption of a particular tactic depended on the environmental triggering of a genetically-determined threshold (1986, 1994). A key prediction of this threshold-trait hypothesis – that thresholds for parr maturity differ genetically amongst populations – was recently supported by a common-garden experiment involving inter-population crosses of Atlantic salmon (2007). This may represent the first evidence, in a vertebrate, for genetic differences in threshold traits for alternative reproductive tactics among populations. Whatever the legacy of this body of work, it began with Ram's intellectual exploration of a fundamental question in ecology and evolution: How can one account for the evolutionary persistence of life-history variability within populations?

Oral CCFFR (Ram Myers Session)

## A META-ANALYSIS OF SPATIAL AND TEMPORAL SCALES OF BROWN TROUT INTERACTIONS WITH ATLANTIC SALMON

**Ings**, D.W. \*, P. Westley and I. A. Fleming

Ocean Sciences Centre, Memorial University of Newfoundland (email: [ings@mun.ca](mailto:ings@mun.ca))

Inter-specific competition occurs when a resource is limiting and it may be particularly intense among native and exotic species that have similar ecological requirements. The processes influencing competition among species of fish are known to differ across spatial and temporal scales. In Newfoundland, introduced brown trout are thought to be competing with native Atlantic salmon because brown trout densities are relatively high on some rivers, while numbers of Atlantic salmon have declined. To determine how brown trout interact with Atlantic salmon in Newfoundland at a variety of scales, we analyzed available literature on both the behaviour and habitat use of the two salmonids. Taken together, the results of previous studies suggest that competition is most intense during two periods, the spawning season and the early juvenile period. Behavioural interactions were important at small spatial and temporal scales as expected but, large scale differences in the behavioural response of salmon to brown trout are suspected. Brown trout may influence the water velocities / depths used by salmon at relatively small spatial scales. However, spatial variability in the distribution of habitat across scales may contribute to observed differences in fish distributions at small and comparatively larger scales. Taking a scaling approach to consider interactions between salmonids may be useful in explaining inconsistencies among previous studies and identifying research gaps.

Poster CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives)

## INFERRING ANIMAL BEHAVIOUR IN THE OCEAN FROM MESSY DATA

**Jonsen**, I.D.<sup>1</sup>, G. Breed<sup>2</sup> & T. Davies<sup>2</sup>.

<sup>1</sup>Fisheries & Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS. <sup>2</sup>Biology Department, Dalhousie University, Halifax, NS (email: [jonseni@mar.dfo-mpo.gc.ca](mailto:jonseni@mar.dfo-mpo.gc.ca))

Biological and statistical complexity are features common to most ecological data that hinder our ability to extract meaningful patterns using conventional tools. This problem is particularly evident in movement ecology where a plethora of remotely sensed data on animal movements promises to revolutionize our view of how animals use their environment but inherent uncertainties in both the data and the underlying behavioural dynamics pose serious impediments to analysis. Our work on state-space modeling of remotely sensed animal tracking data provides a modern statistical framework for inferring behaviour from complex, messy data allowing ecologists to tease apart interactions between behaviour and the dynamic ocean environment. I will highlight how Ram's ideas on state-space models and animal movement have helped guide our work over the past four years and show how they will continue to provide inspiration in future work.

Oral CCFFR (Ram Myers Session)

## ISOLATED POPULATION DYNAMICS AS A POTENTIAL CONSEQUENCE OF LOW ABUNDANCES FOR ATLANTIC COD.

**Kelly\***, J.E.1, K.T. Frank2, and W.C. Leggett3.

1Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada. 2Ocean Sciences Division, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada. 3Department of Biology, Queen's University, Kingston, Ontario, Canada.  
(\*e-mail: [jennifer.e.kelly@dal.ca](mailto:jennifer.e.kelly@dal.ca))

Myers et al (1995) demonstrated the occurrence of synchronous recruitment dynamics of Northwest Atlantic cod (*Gadus morhua*) stocks at large geographic scales (~500 km) and interpreted this result as evidence for large scale environmental factors influencing recruitment. An alternative, but not mutually exclusive, cause of synchronous population dynamics is dispersal between populations. During the post-1990 time period, cod abundances have been at all time lows, and many of the stocks have collapsed with no apparent recovery despite fishing moratoria. Area-abundance relationships predict range contraction at low abundances, potentially resulting in decreased immigration and increasing isolation between subgroup population dynamics, both within and between management unit-defined stocks. Couched in meta-population terms, has the capacity for one population to "rescue" another declined? We undertook a series of age-structured, scale dependent analyses of cod abundance data to examine the possibility that the correlation scales have systematically changed. For example, at the largest spatial scale examined, we found that the de-correlation scale of cod stock recruitment synchrony for the pre- and post-1990 period was not stable in time: the distance over which synchrony was observed has halved, suggesting the potential for immigration between stocks has changed and that local dynamics will dictate the time to recovery in collapsed stocks. Additional results will be presented from finer spatial resolution data derived from research survey sampling strata, across a range of collapsed, recovering, and non-collapsed cod stocks, in an attempt to define population thresholds necessary to maintain connectivity among stocks.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives) (GS)

## IS THE BIRTH CONTROL PILL AN EFFECTIVE FORM OF CONTRACEPTION FOR FISHES?

**Kidd\***, K.<sup>1</sup>, K. Mills<sup>2</sup>, P. Blanchfield<sup>2</sup>, V. Palace<sup>2</sup> and B. Evans<sup>2</sup>,

<sup>1</sup>Canadian Rivers Institute & Biology Department, University of New Brunswick, Saint John, NB;

<sup>2</sup>Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, MB.

Fish are being adversely impacted at the tissue and organism level by estrogens in municipal wastewaters but it is not known whether their population sustainability is affected. To address this unknown, a whole lake estrogen addition experiment was conducted at the Experimental Lakes Area to assess biochemical-through population-level effects of the potent estrogen, ethynylestradiol (EE2), used in birth control pills. Fathead minnow (*Pimphales promelas*), pearl dace (*Margariscus margarita*) and lake trout (*Salvelinus namaycush*) from the study lake were examined during 2 baseline years, 3 years of additions (2001-2003; EE2 at 5-6 ng/L) and for 3 additional years, and contrasted to reference lake fishes. During the EE2 additions, male and female fishes showed induced vitellogenin production (up to 15000 fold) and delayed gonadal development (fathead minnow and pearl dace only), and male fathead minnow and pearl dace developed intersex in 2002 and 2003, respectively. Fathead minnow had recruitment failures in 2002-2005 which led to a near extinction of the species from the lake; however, in 2006 the population recovered to pre-addition levels. Catch-per-unit-effort of the longer-lived pearl dace declined in 2004, shortly after EE2 amendments were discontinued. Lake trout survival, condition and abundance decreased in 2003 and this response was likely related to the decline in prey species in the lake rather than direct effects of the EE2. In summary, this experiment showed that chronic exposure to low concentrations of a potent estrogen can affect the sustainability of fish populations and that the shortest-lived species are at greatest risk from these compounds.

Oral CCFFR (Contributed paper)

## EVALUATING THE USE OF HATCHERY-REARED YOY LAKE STURGEON IN STOCKING PROGRAMS: FROM THE LAB TO THE FIELD

**Klassen\***<sup>1</sup>, C. and S. Peake<sup>2</sup>.

<sup>1</sup>Department of Biological Sciences, University of Manitoba, Winnipeg, MB, Canada

(umklas34@cc.umanitoba.ca). <sup>2</sup>Canadian Rivers Institute and Department of Biology, University of New Brunswick, Fredericton, NB, Canada.

Efforts to increase lake sturgeon population numbers often involve the release of hatchery-reared individuals in the fall of their first year. Despite the widespread use of such stocking programs there is limited information on the short-term performance of these fish following release events, which is likely associated with the difficulty in marking and recapturing small age-0 juveniles. In this study, hatchery-reared young-of-the-year (YOY) lake sturgeon were assessed for their potential stocking fitness in 2005 and 2007. Tests including swim performance, healing rate and the ability to consume live prey were conducted on lake sturgeon of stocking size to determine their performance in areas that would likely play an important role during the vulnerable period immediately after release. On average fish swam at water velocities nearing 0.46 m/s, healed from small wounds within 3 to 5 hours and consumed the majority of live prey offered within one hour. Following experiments in 2007, individuals were placed in mesocosms for a one week period to relate performance in laboratory fitness-tests with short-term survival and growth in a semi-natural environment. No mortalities occurred; however, all individuals lost weight. Finally, groups of variously sized age-0 lake sturgeon were implanted with 12 or 8 mm passive integrated transponders in the fall of 2007 to determine subsequent survival, growth and swim performance in comparison to non-tagged controls. Ultimately, it is hoped that individual performance following stocking events into natural waterways can be monitored to evaluate the effectiveness of stocking programs for conservation of this species and to validate lab-based findings.

Oral CCFFR (Contributed paper) (GS)

## BLACK FLY LARVAE: A NOVEL APPROACH TO LAKE STURGEON CONSERVATION AQUACULTURE

**Klassen\***<sup>1</sup>, C. and S. Peake<sup>2</sup>.

<sup>1</sup>Department of Biological Sciences, University of Manitoba, Winnipeg, MB, Canada

(umklas34@cc.umanitoba.ca). <sup>2</sup>Canadian Rivers Institute and Department of Biology, University of New Brunswick, Fredericton, NB, Canada.

Lake sturgeon, *Acipenser fulvescens*, conservation efforts typically include release of artificially propagated individuals raised in hatcheries using an initial diet of brine shrimp, *Artemia* spp., with a transition to bloodworm (Diptera: Chironomidae). This procedure is costly and labour intensive. As such, experiments conducted in 2004 and 2005 set out to establish if black fly (Diptera: Simuliidae) larvae are a more efficient food source than bloodworm, without compromising hatchery performance (i.e., survival and growth) or potential stocking fitness (i.e., healing rate, swimming performance and live prey consumption). Six weeks following the start of exogenous feeding, lake sturgeon transitioned to black fly larvae from brine shrimp at week 2 had better final survival rates than fish transitioned to bloodworm. Final weights of fish reared on black fly larvae were equal or superior to those reared on bloodworm, despite being fed two to three fewer times daily. This study suggests that transitioning larval lake sturgeon to black fly larvae following 2 weeks on an initial diet of brine shrimp can improve survival and growth, while reducing effort and cost associated with culturing brine shrimp, as potential stocking fitness was not compromised in comparison to standard rearing procedures using bloodworm.

Poster CCFFR (Contributed paper) (GS)

## BEHAVIOURAL AND PHYSIOLOGICAL RESPONSE OF OVER-WINTERING BROOK TROUT (*SALVELINUS FONTINALIS*) TO INSTREAM FLOW MANIPULATIONS FROM THE CANADIAN ROCKY MOUNTAINS

**Krimmer\***, A., Rasmussen, J. and A. Paul.

Department of Biology, University of Lethbridge, Lethbridge Alberta (alison.krimmer@uleth.ca)

As human populations grow and water use increases, the effects of harnessing and manipulating water resources will continue to intensify. Because this water demand leads to changes in the natural flow regime, it is pertinent to evaluate and understand instream flow needs (IFN) to effectively manage stream and river systems. It is important to assess IFN across all seasons, including winter in order to provide a holistic understanding of flow manipulations. To date few studies have focused on the effects of water withdrawal on over-wintering fish populations in small streams. During the winter of 2007, we studied the behavioural and physiological response of brook trout (*Salvelinus fontinalis*) to experimental flow manipulations in a small stream from Kananaskis Country, Alberta. We hypothesized that pulsed deviations from natural flow during winter would increase brook trout (BKTR) activity. The hypotheses were tested using in situ experimental channels located in a spring-fed stream; experimental treatments consisted of 4h daily water withdrawals from one of the enclosures. Activity levels were studied using radio telemetry to track movement of BKTR. The activity levels of the BKTR did increase but the increase in activity was only significant for the first six days of both two week pumping regimes. The BKTR moved to deeper water with greater undercut banks. There was a significant relationship between fish movement and weight loss.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## TWO-DIMENSIONAL HYDRODYNAMIC FLOW MODELS AND MECHANISTIC APPROACH TO FISH HABITAT INSTREAM FLOW NEEDS ANALYSIS

**Laliberte\***, J.<sup>1</sup>, Post J.<sup>1</sup> and A. Paul<sup>2</sup>.

<sup>1</sup>Department of Biological Sciences, University of Calgary, Calgary, Alberta. <sup>2</sup>Alberta Sustainable Resource Development, Cochrane, Alberta. (email: [jjlalibe@ucalgary.ca](mailto:jjlalibe@ucalgary.ca))

Fish habitat instream flow needs (IFN) studies have long been criticized for using one-dimensional hydrodynamic models that fail to describe complex flow patterns in rivers. Weighted useable area (WUA), an estimate of suitable physical habitat availability, is assumed to correlate directly with population biomass and has been criticized for being based solely on physical habitat suitability curves. Recent studies in the Bow River, Alberta, have demonstrated that WUA does not correlate well with trout biomass and it is recommended that a mechanistic approach be taken to make more realistic fish habitat IFN models that incorporate fish bioenergetics. We will present a mechanistic approach being used in Jumpingpound Creek, Alberta, to model fish habitat IFN that incorporates: 1) a two-dimensional hydrodynamic flow model 2) a macroinvertebrate drift model and 3) a foraging model for drift-feeding fish. These models allow us to estimate the net rate of energetic intake (NREI), which approximates the growth rate of an individual fish, given a particular location and present environmental conditions. The sum of NREI for the entire reach of interest can then be used to compare against WUA and allow us to empirically test whether our proposed mechanistic model more closely approximates biomass than the physical habitat model.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## AMONG-DAY VARIATIONS IN FISH COMMUNITY STRUCTURE: IMPLICATIONS FOR THE DEVELOPMENT OF HABITAT QUALITY MODELS.

**Lanthier**, G.\*<sup>1</sup>, Bourque, G.<sup>1</sup>, Boisclair, D.<sup>1</sup>, Legendre, P.<sup>1</sup>, Angers, B.<sup>1</sup>, and Lapointe, M.<sup>2</sup>

<sup>1</sup>Département de sciences biologiques, Université de Montréal, Montréal, Québec

<sup>2</sup>Department of Geography, McGill University, Montréal, Québec

Habitat quality models (HQM) are relationships between biological attributes and habitat characteristics. HQM are often developed by sampling a large number of sites over a large spatial extent. This approach permits the representation of the complete range of environmental conditions found in a survey area. In order to achieve this objective, sampling sites are often sampled only once. However, fish distribution and habitat requirement may vary over time. Among-day variations of the association between fish and their habitat may decrease the explanatory power of HQM. The purpose of this study was to assess the magnitude of among-day variations of descriptors of fish community structures in rivers, to evaluate the effect of such variations on HQM, and to identify the number of visits to a sampling site that is required to obtain reliable HQM. Field work was done in 12 sections of 100 m located in the hydrographic basins of the Rivière Rouge and the Rivière du Nord (Laurentian region of Québec). All sampling sites were visited 10 times in a period extending from mid-June to mid-August. The relative abundance of the fish species encountered and the environmental conditions that characterised habitats were noted for each subsection of 10 m. Data were collected by calibrated snorkellers swimming in an upstream direction following linear transects. The results suggest that even within a relatively small timeframe at least some fish species tend to change their patterns of habitat utilization and that repeated sampling may be prudent to develop reliable HQM.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## IDENTIFYING TEMPERATURE SENSITIVITIES OF FISH COMMUNITIES IN BRITISH COLUMBIAN STREAMS

**Lea\***, E.V.<sup>1</sup>, E.A. Parkinson<sup>2</sup> and J.R. Post<sup>1</sup>.

<sup>1</sup>Department of Biological Sciences, University of Calgary, Calgary, AB. <sup>2</sup>British Columbia Ministry of Environment, Vancouver, BC. (email: [evlea@ucalgary.ca](mailto:evlea@ucalgary.ca))

In British Columbia, a province covering a wide range of latitudes and elevations, temperature is one of the key forces in determining fish distribution, abundance and community composition. Developing models that demonstrate how increases in stream temperatures affect both individual species and entire fish communities is necessary to be able to make spatial and temporal predictions of how land-use practices or long-term global climate change could affect BC's freshwater fish. In 2003 and 2004, field data on physical characteristics, growing season temperature records and fish community composition were collected from 50 tributaries to two large rivers: North Thompson and Upper Fraser, selecting tributaries that varied in temperature drivers but were similar in physical habitat characteristics. I will be developing models of temperature sensitivity by species using logistic regressions on presence and absence data as well as examining patterns in community composition using canonical correspondence analysis (CCA) taking into account factors such as temperature, gradient, stream flow and other site characteristics. The objective of this work is to quantitatively identify critical temperature thresholds for individual species and for significant fish community shifts in BC streams. Ultimately this should help to designate streams as temperature sensitive, where small temperature changes have the potential to result in large shifts in the biotas of the stream, especially of fish. Designating streams as temperature sensitive is an essential step in developing effective management strategies to maintain the diverse and unique freshwater fish communities in BC in the face of short-term and long-term temperature increases.

Oral CCFFR (Ecosystem-based Management – Science and Policy) (GS)

## COMPARISON OF THE BIOCHEMICAL COMPOSITION OF SHORTRNOSE STURGEON (*ACIPENSER BREVIROSTRUM*) EGGS FROM WILD AND CAPTIVE SOURCES

**Leadbeater\***, S<sup>2</sup>., Lall, S.P<sup>1</sup>., and M.K. Litvak<sup>2</sup>.

<sup>1</sup>Institute for Marine Biosciences, National Research Council of Canada, Halifax, NS, Canada, B3H 3Z1;

<sup>2</sup>Department of Biology and Centre for Coastal Studies and Aquaculture, University of New Brunswick Saint John. Saint John, NB, Canada, E2L 4L5. (email: [LeadbeaterS@mar.dfo-mpo.gc.ca](mailto:LeadbeaterS@mar.dfo-mpo.gc.ca))

Of the 27 known species of sturgeon, all are listed as either endangered or threatened. Unfortunately the resultant shortfall in supply of caviar has increased the lure of poaching, which along with global pollution and other human activities such as damming and habitat destruction has put at risk of extinction one of the oldest biological vertebrates. Aquaculture production for caviar may not only help protect wild stocks of sturgeon by reducing the demand for wild products and also provide a supply of juveniles for enhancement and re-introduction. High quality eggs, and therefore broodstock, are vital to the early success of larval rearing in culture settings. Fortunately, sturgeon broodstock can be adapted to captive conditions and produce eggs. However there are no feeds developed specifically for these species due to little available information on their nutritional requirements. Typically these fish are fed commercial diets designed for other species. In New Brunswick, where there is interest in development of shortnose sturgeon, they are fed salmonid diets. This may not only lead to poor egg, larval and juvenile quality, but caviar quality of farmed sturgeon may suffer. In our study, we conducted a biochemical analysis of eggs from wild and captive reared shortnose sturgeon to assess the potential effects of captive holding on egg quality. Mineral, fatty acid, amino acid, and proximate composition of the eggs from wild and captive sources were determined. We discuss the differences and similarities observed in the composition of eggs from the two sources.

Oral CCFFR (Contributed Paper) (GS)

## NESTING SUCCESS OF SMALLMOUTH BASS (*MICROPTERUS DOLOMIEUI*) IN NOVA SCOTIA : PRELIMINARY ASSESSMENT OF FACTORS AFFECTING NEST SUCCESS RATES

**LeBlanc**, J.E\*. and R. Heighton.

Nova Scotia Department of Fisheries and Aquaculture, Inland Fisheries Division PO Box 700 Pictou, NS  
B0K1H0 (email: [leblanje@gov.ns.ca](mailto:leblanje@gov.ns.ca))

Smallmouth bass were first introduced in Nova Scotia in 1942, are now established in more than 200 lakes and contribute substantially to the sport fishery. Nest success rates were assessed in 7 lakes (567 nests). All nests were assessed for habitat features such as substrate, cover, depth and distance from shore and categorized by stage whereby class A = newly excavated nest, class B = eggs present, class C = newly hatched black fry present, class D = swim up fry present, class F1 = a nest abandoned after previously being assessed as class A and class F2 = a nest abandoned after previously being assessed as class B or C. Class D or successful nests ranged from 16 to 70% in a given lake (mean = 32.8%). Total nest starts increased with temperature but was variable among lakes and in the same lake from year to year. Preferred substrate was dominated by cobble, gravel or a cobble-gravel combination, accounting for 94% of all substrate types. Nest cover also varied from lake to lake and was dominated by large woody debris such as logs and boulders. Success rates were low in other substrate types (silt, detritus, rock, or vegetation), 0-25%. Nest depth (0.1 – 1.6 m,  $P < 0.36$ ) and distance from shore (0.2 – 50.0 m,  $P < 0.65$ ) did not influence nest success, however all nest built >20.0m from shore did not successfully produce fry. Nesting success could be a valuable management tool for assessing establishment, recruitment and year class strength.

Poster CCFFR (Contributed paper)

## DESCRIPTIVE MODELS OF RECRUITMENT FOR WHITE BASS AND WALLEYE IN IRRIGATION RESERVOIRS

**Lewis\***, C.W. and K.L. Pope.

Nebraska Cooperative Fish and Wildlife Research Unit, School of Natural Resources, University of  
Nebraska-Lincoln, Nebraska (e-mail: [clewis16@bigred.unl.edu](mailto:clewis16@bigred.unl.edu))

Slight environmental variations significantly alter fish survival during their first year of life, and hence, recruitment (i.e., year-class strength). Irrigation reservoirs experience substantial environmental variation due to large fluctuations in water levels within and among years. In Midwestern irrigation reservoirs, white bass *Morone chrysops* and walleye *Sander vitreus* are important sportfishes. Though year classes of white bass are generally produced each year in Nebraska irrigation reservoirs, recruitment is variable (i.e., weak and strong year classes are common). In contrast, recruitment of walleye in Nebraska irrigation reservoirs is erratic (i.e., weak and missing year classes are common) likely because of low natural reproduction. Thus, we developed descriptive models of recruitment variations for white bass and walleye in four reservoirs to gain better new understanding of recruitment processes in irrigation reservoirs. Catch rates of fish from standardized annual fall gill-net surveys (1994-2006) conducted by the Nebraska Game and Parks Commission were used to index year-class strengths of white bass and walleye, and were described as functions of environmental variables (e.g., water-level fluctuations, spring-warming rates, degree-growing days, stocking rates). We will present the better descriptive models and rank the relative influence of abiotic and biotic variables on recruitment of white bass and walleye in irrigation reservoirs.

Oral CCFFR (Physical Limnology and Oceanography – Influences in Populations and Ecosystems) (GS)

## THE RELATIONSHIP BETWEEN OTOLITH GROWTH AND SOMATIC GROWTH

**Li, L.\*<sup>2</sup>, H. Hoie<sup>1</sup>, A. J. Geffen<sup>1</sup> and A. Folkvord<sup>1</sup>.**

<sup>1</sup>Department of Biology, University of Bergen, Norway; <sup>2</sup>Fisheries Centre, University of British Columbia, Vancouver, BC ([L.Li@fisheries.ubc.ca](mailto:L.Li@fisheries.ubc.ca))

Young Atlantic cod were reared under different food treatments and temperature conditions (seasonally variable or stable at 8°C) and individually tagged and marked with alizarin red S every second month for five times. Fish sizes were recorded at each marking time. Otoliths were transversely sectioned and the dorsal radii, distal radii, ventral radii and maximum otolith widths were measured. We can therefore trace fish growth trajectory in otolith and fish length. Mixed effects models are used to analyze the repeated measurements. The environmental conditions are shown to affect otolith growth and somatic growth differently. The quantitative relationship is investigated between the average daily otolith increment along different growth axes and the corresponding average daily fish length increment incorporating temperature and otolith size factors and its application is tested and discussed. The quantitative relationship is expected to be an alternative of back-calculation to obtain growth rate and of great value in future age and growth interpretations.

Oral CCFFR (Contributed paper) (GS)

## IT'S A MATTER OF TIME: DURATION OF NON-ACIDITY PROMOTING RECOVERY OF ZOOPLANKTON SPECIES RICHNESS

**Linley R.D.\*<sup>1</sup>, Yan, N.D.<sup>1</sup> and Keller, W.<sup>2</sup>**

<sup>1</sup>York University <sup>2</sup>Ontario Ministry of the Environment, Sudbury.  
(email: [dallas.linley@ontario.ca](mailto:dallas.linley@ontario.ca))

Recent SO<sub>2</sub> emission control programs in North America and Europe have led to impressive water quality improvements in many of world's atmospherically acidified lakes; however, biological recovery is lagging. How long a lag in biodiversity recovery should we expect once a suitable pH threshold has been reached, and if we do detect an increase in species richness is it due to increased sampling of a static pool of species, or actual increases in species richness? Using 25 year zooplankton datasets from Sudbury and Dorset ON, we examine species richness changes relative to pH and calculate species-time relationships (STR) for 15 lakes. We group our lakes into recovering, acidic, and reference lakes, based on if and when pH levels were <6. Comparing observed STR with a random sampling model (expected) we first determine if species richness changes through time are the result of a non-random change in species distribution or simply the result of random year to year assembly from a static species pool. Using the slope of the STR's (a measure of temporal turnover), we determine differences between the 3 lake types. Then we use a two-phase model to estimate the time scale over which ecological processes become dominant over sampling effects. This allows us to determine the duration of non-acidity needed to detect the recovery of zooplankton species richness given its dynamic nature. We interpret the observed temporal trajectories in richness with respect to these minimum detection durations to determine if zooplankton are recovering in expected time frames.

Oral SCL (Complexities of Ecological Recovery)

EFFECTS OF SPERMATAZOA DENSITY, LONGEVITY AND DURATION OF EGG RECEPTIVITY ON FERTILIZATION SUCCESS OF WINTER FLOUNDER (*PSEUDOPLEURONECTES AMERICANUS*) L.

**Litvak**, M.K., Butts, I.A.E., and P. Roustaian

Department of Biology and Centre for Coastal Studies and Aquaculture, University of New Brunswick, Ganong Hall, P.O. Box 5050, Saint John, New Brunswick, E2L 4L5, Canada

Winter flounder (*Pseudopleuronectes americanus* W.) are one of the most commonly used models for understanding teleost biology in North America. However, little is known about their reproductive ecology, especially during the reproductive event. This area of research has particular importance to our understanding of reproductive potential and therefore recruitment. In addition, examining sperm-egg interactions provides insights on their reproductive strategies, evolutionary relationships with other species, and management of living gene banks and sperm banks, and aquaculture development. Artificial fertilization has long been used to generate progeny of winter flounder for research and aquaculture, yielding high fertilization and hatch success rates. However, no research has been conducted on sperm density required to fertilize a winter flounder egg. Thus, the objectives of this research were to determine the effect of sperm density and sperm and egg longevity after activation on fertilization success in winter flounder. Results of these studies will be discussed in light of their implications for recruitment, reproductive behaviour and gene banking.

Oral CCFFR (Contributed Paper)

THE EFFECT OF SPERM TO EGG RATIO AND GAMETE CONTACT TIME ON FERTILIZATION SUCCESS IN ATLANTIC COD

Butts, I.A.E., Trippel, E.A. and M. K. **Litvak**\*

Historically, Atlantic cod (*Gadus morhua* L.) has been the most important gadoid species in the North Atlantic from both economic and cultural perspectives. Despite this, very little research has been conducted on sperm-egg interactions as they relate to fertilization, mating success in the wild, breeding programs, and cryopreservation or gene banking. Although the general view is that eggs and not sperm are in limited supply; however, sperm produced by each male is "limited" in its supply and its quality varies seasonally. Thus an understanding of the sperm-egg interaction is important for understanding recruitment potential and development of this species for aquaculture. The present study was conducted to assess the effects of sperm density and gamete contact time (short & long) on artificial fertilization of Atlantic cod under controlled conditions. Male and female gametes were crossed using a nested factorial design. Mixed-model ANOVAs indicated that sperm cell density and gamete contact time had significant effect on fertilization success. Below a sperm to egg ratio of 100,000 to 1 fertilization success significantly decreased for the short contact time treatment. However, lengthening contact time significantly increased the fertilization success for the lower sperm cell density treatments. The implications of these findings are relevant for the long-term sustainable development of this species for aquaculture, and for understanding reproductive success in the wild.

Poster CCFFR (Contributed paper) (GS)

## HISTORICAL CATCHES AND DECLINES IN LARGE MARINE FISHES

**Lotze\***, H.K., Department of Biology, Dalhousie University, Halifax (email: hlotze@dal.ca)

More than 500 years ago, Europeans left familiar waters and set out to harvest the bounty of Newfoundland's cod, a bounty that disappeared not long ago. Ram witnessed the collapse of Newfoundland's cod close by, and engaged in reconstructing the history of cod catches in Newfoundland and Labrador. Inspired by Ram's endeavour in estimating the full magnitude of historical declines in the oceans' large fish, me and others used various approaches to trace historical changes in marine animal populations in many parts of the world. In this presentation, I will illustrate this scientific journey through the ocean's past with examples from different regions and species, and using a wide array of historical reconstruction methods. I will attempt to show how estimates from diverse methods have converged, and present a timeline from the early exploitation of coastal seas to more recent declines in the open ocean and the deep sea, somewhat following Ram's own expansion in his research subjects.

Oral CCFFR (Ram Myers Session)

## RECOVERING BENTHIC INVERTEBRATE COMMUNITIES: A BOTTLENECK FOR WHOLE LAKE BIOLOGICAL RECOVERY? – PRELIMINARY RESULTS FROM AN EXTENSIVE FIELD STUDY

**Luek**, Andreas, George Morgan and Charles Ramcharan  
Dept. Biology & Freshwater Coop Unit, Laurentian University, Sudbury, ON

Although many lakes in the Sudbury area have shown dramatic improvements in water chemistry biological recovery still lags. The only fish species which has successfully re-established in all Sudbury lakes above pH 5.0 is yellow perch (*Perca flavescens*). At all trophic levels in these lakes there are impoverished benthic and pelagic communities which may present various bottlenecks along the path to full biological recovery. The impoverished benthic fauna might be a particular problem for fish, as they are often a major component of the diet. Many Sudbury lakes display low benthic invertebrate diversity and biomass caused by the loss of the larger-bodied species that are metal- and pH-sensitive. This loss may reduce the amount of food available to fish. The focus of this study is a comparison of benthic communities, fish population structure, and fish growth across lakes at different states of recovery. Yellow perch undergoes an ontogenetic diet shift from planktivory to benthivory, and, if it grows large enough, to piscivory. A loss of benthic resources can strongly affect growth rates and population size structure. The study lakes varied in their state of chemical recovery and were selected along a gradient of the amount of suitable benthic invertebrate habitat, as well as contrasting dominance of yellow perch in the fish community. Three lakes had only perch and three also had piscivores (such as northern pike, *Esox lucius*, walleye, *Sander vitreus*, and smallmouth bass, *Micropterus dolomieu*). Perch were well-established in all study lakes except for one piscivore lake to which perch were recently introduced. During the 2007 ice-free season we conducted standard water chemistry sampling, detailed bottom substrate and aquatic macrophyte mapping, and intensive quantitative sampling of the zooplankton, benthic invertebrates, and fish communities in the pelagic and littoral zones of each lake. The goal of this research is to develop a model for the influence of benthic invertebrates in the diet of yellow perch, and the role of this trophic link in the recovery of a whole lake ecosystem.

Oral CCFFR (Complexities in Ecological Recovery) (GS)

## CONSISTENCY OF COSEWIC SPECIES DESIGNATIONS: FRESHWATER FISHES AS A CASE STUDY

**Lukey\***, James.

Department of Integrative Biology, University of Guelph, Guelph, Ontario (email: [jlukey@uoguelph.ca](mailto:jlukey@uoguelph.ca))

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the risk of extinction for Canadian species using a process that is based on available evidence for five quantitative criteria regarding abundances, distributions, population trends, habitat trends, and limiting factors/threats. Two serious errors can occur in status designation: (1) species 'not at risk' could be assessed as 'at risk', potentially leading to limited resources being wasted; or (2) species 'at risk' could be assessed as 'not at risk', potentially leaving a species with a high risk of extinction unprotected. Values for each of the five criteria were extracted from 54 available COSEWIC freshwater fishes species reports from 2000 to 2007. The COSEWIC decision-making process was simulated using a computer algorithm (predicted), and these evaluations were then compared to the registered COSEWIC species assessments (observed). The status designations predicted by the algorithm were significantly different than the observed COSEWIC designations ( $p < 0.01$ ). For the observed, a negative bias for 'endangered' and 'not at risk' designations, and a positive bias for 'threatened' and 'special concern' designations were when compared to the predicted evaluations. These results strongly suggest that COSEWIC may need to reevaluate its decision-making methodology and its implementation at the subcommittee level. Increasing the knowledge about these species through scientific studies, altering the COSEWIC procedures to more accurately reflect the freshwater fishes, and explicitly incorporating uncertainty into decision-making are all recommended to COSEWIC.

Oral CCFFR (Contributed Paper) (GS)

## SPATIAL AND TEMPORAL VARIABILITY IN N<sub>2</sub>O EMISSIONS AND N BUDGET FOR LAKE SAINT-PIERRE A LARGE FLUVIAL LAKE OF THE ST. LAWRENCE RIVER, CANADA

Tall, L. and R. **Maranger\***.

Département des sciences biologiques, Université de Montréal, Montréal QC  
(email : [r.maranger@umontreal.ca](mailto:r.maranger@umontreal.ca))

Freshwater aquatic ecosystems, per unit area are considered hotspots on the landscape for denitrification. One of the by-products of denitrification, nitrous oxide (N<sub>2</sub>O) is a potent greenhouse gas and with anthropogenic N loading on the rise to aquatic ecosystems this should result in increased N<sub>2</sub>O emission from rivers and lakes. Direct measurements of N<sub>2</sub>O flux in large rivers are still rare and factors regulating the relative production of N<sub>2</sub>O to N<sub>2</sub> are poorly understood in freshwaters. Here we measured N<sub>2</sub>O concentrations from 25 sites over the summer, in Lake Saint-Pierre (LSP) a broadening of the St Lawrence River. LSP is spatially heterogeneous with 3 main water masses differing in chemical characteristics that do not mix laterally loading into this system. Overall LSP is a net atmospheric source of N<sub>2</sub>O averaging 255% saturation in the surface waters. Saturation was spatially and temporally highly variable ranging from 69% undersaturation to 585% supersaturation. . NO<sub>3</sub><sup>-</sup> concentrations explained 69% of the variance in N<sub>2</sub>O concentration and the N<sub>2</sub>O hotspot shifted from downstream to upstream sites over the summer. LSP retained approximately 25% of its NO<sub>3</sub><sup>-</sup> load with N<sub>2</sub> production accounting for 60% of this retention. When we compared our annual flux estimate with those of other systems in a comparative survey, two classes of rivers emerged. Systems with lower mean depth to water residence time ratio were considerably leakier in terms of N<sub>2</sub>O emissions per unit NO<sub>3</sub><sup>-</sup>. Our results also suggest a variable N<sub>2</sub>O: N<sub>2</sub> ratio in LSP and other aquatic systems.

Oral SCL (River and Estuary Ecosystems)

## WETLAND AND RIPARIAN HYDROLOGIC RESPONSE TO FOREST MANAGEMENT IN THE BOREAL FOREST

Allan<sup>1</sup>, C.J., R.W. **Mackereth**\*<sup>2</sup> and D.M. Morris<sup>2</sup>

<sup>1</sup>University of North Carolina, Charlotte, <sup>2</sup>Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources (email: rob.mackereth@ontario.ca)

The Escape Lake watershed study was initiated to evaluate the impacts of forest management on the hydrologic connectivity between terrestrial and aquatic habitats and to observe the catchment scale hydrologic (groundwater levels, surface water flow, water chemistry) and soil chemistry response. Beginning in March 2003, a 23 Ha catchment, 45 km northeast of Thunder Bay, Ontario, was surveyed (high resolution DEM, vegetation plots, soil pits) instrumented (wells and pizometers in wetland and along 3 experimental and 1 reference hillslope transect, resin bag transects) and monitored for 1.5 years. Clearcut harvesting was carried out in June 2004, and included harvesting merchantable trees within the prescribed 30m buffer which increased the net merchantable volume by 13%. Following harvest, catchment water yield approximately doubled relative to pre-harvest and hillslope water flux increased significantly relative to the reference. Concentrations of DOC and some nutrients (e.g. K, N, P) and metals (e.g. Mn, Fe) increased 2 to 3 times in the year after harvest. Other water quality parameters, most notably MeHg, had a flux rate approximately double that of reference conditions, although concentrations did not increase. Preliminary analyses linked the outflow potassium flux to a terrestrial source where a clear growing season pulse in K<sup>+</sup> concentration occurred after the harvest, primarily sourced from the upper slope positions. Examination of the spatial and temporal patterns of the elevated post-harvest water and nutrient fluxes is underway and will be used to evaluate the potential impacts on aquatic habitat and site productivity in the catchment.

Poster CCFFR (River and Estuary Ecosystems)

## VISUAL SENSITIVITY IN JUVENILE PACIFIC BLUEFIN TUNA, *Thunnus orientalis*

**Matsumoto**<sup>1</sup>, T., H. Ihara<sup>1</sup>, Y. Ishida<sup>2</sup>, M. Kurata<sup>3</sup>, T. Okada<sup>3</sup>, Y. Sawada<sup>3</sup>, Y. Ishibashi<sup>1\*</sup>

<sup>1</sup>Department of Fisheries, School of Agriculture, Kinki University, Naka, Nara 631-8505, Japan, <sup>2</sup>Osaka School of Communication Arts, Shinmachi, Nishi-ku, Osaka 550-0013, Japan, <sup>3</sup>Ohshima Experiment Station, Fisheries Laboratory, Kinki University, Ohshima, Kushimoto, Wakayama 649-3633, Japan (\*email: isibasi@nara.kindai.ac.jp)

Bluefin tuna is one of the most important commercial marine fish in the world. The tuna stock has decreased in recent years so the need for artificial seedling production technology is on the rise. High mortality rates of juvenile fish due to collision with the tank or net wall is a serious problem in seedling production. Collision is frequently caused in juveniles from about 30 through 60 dph (30–160 mm standard length, SL) under crepuscular or dark conditions. Therefore, visual functional change appears to be an important factor in juvenile collision. To determine the changes in retinal function with growth, we examined an electroretinogram (ERG) of the retina of juvenile Pacific bluefin tuna (PBT). ERG responses to stimuli of various wavelengths, ranging from 369 to 652 nm, and intensity were obtained from dark-adapted fish at 77–180 mm SL and from light-adapted fish at 145–175 mm SL. In the dark-adapted fish, a spectral sensitivity peak was observed at approximately 469 and 505 nm. The spectral sensitivity peak tended to exhibit a shortwave shift with growth. A similar trend was observed in the light-adapted fish as well. These results indicated that the spectral sensitivity varied with growth in PBT. Light sensitivity change at 505 nm was also observed in the dark-adapted fish at 28–175 mm SL. Light sensitivity at 505 nm tended to increase with growth. These visual function changes may contribute in increasing nocturnal visual sensitivity and reducing the number of deaths due to collision in cultivated PBT.

Poster CCFFR (Contributed paper)

## STATUS AND THREATS TO FRESHWATER FISH COMMUNITIES IN ONTARIO'S NORTHERN BOREAL FOREST

**McDermid<sup>1\*</sup>**, J., and D.R. Browne<sup>1,2</sup>.

<sup>1</sup>Wildlife Conservation Society Canada, 100 Main St., Suite 425, Thunder Bay, ON, <sup>2</sup>Canadian Wildlife Service, Environment Canada, 351 St. Joseph Blvd., Gatineau, QC. (email: [jmcdermid@wcs.org](mailto:jmcdermid@wcs.org))

Freshwater ecosystems are among the most threatened and altered environments in the world as a result of water withdrawal, overexploitation, pollution, and non-native species. The area north of the current legal limit of industrial forestry in Ontario (ca. 450,000 km<sup>2</sup>) is one of the largest areas of unaltered boreal forests in Canada. Consequently, freshwater ecosystems in this area are relatively pristine compared to their southern counterparts. As human development continues to move increasingly northward, the primary impediment to conservation oriented land-use planning is the lack of comprehensive baseline information including distribution, abundance, and life history information on fish species in this area.

Multivariate statistical techniques (PCA and CCA) were applied to existing presence / absence data collected by the Ontario Ministry of Natural Resources for fish species in lakes across Ontario's northern boreal forest to identify species community types and the environmental variables associated with each. The vulnerability of specific freshwater fish communities to human development (i.e. logging, mining, climate change, and water diversion) were identified using information derived from known impacts of such activities on key environmental variables in southern freshwater ecosystems. This type of analysis will aid in identifying planning criteria for human development activities in this relatively pristine area of northern Ontario prior to the expansion of the human footprint.

Oral CCFFR (Contributed paper)

## WATER QUALITY MONITORING AT ABANDONED MINE SITES – SILVER BEAR MINES, NORTHWEST TERRITORIES

**McEachern<sup>\*</sup>**, L.

Water Resources Division, Indian and Northern Affairs Canada, Yellowknife, NT X1A 2N3  
(email: [mceachernl@inac.gc.ca](mailto:mceachernl@inac.gc.ca))

There are many abandoned mines, military and other sites in the Northwest Territories. The responsibility for cleaning up these sites is that of the Contaminants and Remediation Directorate (CARD) of Indian and Northern Affairs Canada (INAC). Water monitoring is crucial at many of these sites in order to identify contaminant types and sources, as well as to determine the extent of affected areas. Additionally, water quality is the primary concern of local communities. The Silver Bear Mines are comprised of five mine sites, located approximately 390 km northwest of Yellowknife, just south of Great Bear Lake. Terra Mine was the largest of the sites, and was equipped with camp facilities, a mill and an airstrip. The other four sites are located nearby. This presentation will focus on water quality results at the Terra Mine site. Terra Mine operated as a silver mine from 1969 through 1985. The contamination at this site is largely a result of the exposed tailings and waste rock which remain on site. Levels of arsenic and copper are elevated above the CCME guidelines for the Protection of Freshwater Aquatic Life in the tailings pond (Ho-Hum Lake), which discharges periodically into the Camsell River and eventually into Great Bear Lake. Results of water quality monitoring will be presented, including evidence of arsenic removal by the small wetlands which separate Ho-Hum Lake from the Camsell River. The influence of the monitoring results on the development of the remediation plan will be discussed.

Oral SCL (Complexities in Ecological Recovery)

## PERSONALITY AND FORAGING BEHAVIOUR IN YOUNG BROOK CHARR

**McLaughlin\***, R.

Department of Integrative Biology, University of Guelph, Guelph, ON (email: rlmclaug@uoguelph.ca)

Recently-emerged brook charr (*Salvelinus fontinalis*) foraging in still-water pools along the sides of streams tend to be either sedentary, feeding from the lower portion of the water column (a sit-and-wait tactic) near the stream bank, or very active, feeding from the upper portion of the water column (an active search tactic) away from the stream bank. I will synthesize evidence indicating that these individual differences in foraging behaviour are linked to personality traits exhibited in standardized lab and field tests. In novel environments, individuals using a sit-and-wait foraging tactic in the field were less active, less likely to approach the water surface, and less willing to exit shelter than individuals using an active foraging tactic in the field. For a given body size, sedentary individuals also had a smaller telencephalon, the brain region involved in spatial learning in fish, and higher basal levels of cortisol, a stress hormone influencing activity and appetite, and forming the basis for personality differences in domesticated rainbow trout (*Oncorhynchus mykiss*). Differences in willingness to exit shelter observed in lighted conditions, were not observed in low-light conditions, suggesting vision is involved. Alternative hypotheses that individual differences in foraging behaviour in the field are linked to differences in resting metabolic rate or in locomotor ability were not supported. Such personality differences early in life could provide important raw material for the development and evolution of alternative foraging, dispersal, and migratory behaviours.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)

## EFFECTIVENESS AND NON-TARGET EFFECTS OF IN-STREAM BARRIERS USED TO CONTROL SEA LAMPREY IN THE LAURENTIAN GREAT LAKES

**McLaughlin\***, R. Department of Integrative Biology, University of Guelph, Guelph, ON (email: rlmclaug@uoguelph.ca)

Ecosystem tools that restrict (e.g. instream barriers) or facilitate (e.g. fishways, dam removals) the movements and reproduction of fishes can be the focus of tensions between competing management objectives: control of invasive species and reduction of habitat fragmentation for native species. Greater assessment of these tools in light of both management objectives is needed to ensure the tools are used in sound and scientifically defensible ways. I will highlight efforts to rigorously and quantitatively assess the application of these tools to sea lamprey (*Petromyzon marinus*) control in the Great Lakes. I will provide evidence that permanent barriers alter the diversity of non-target fishes found upstream of a barrier by restricting the movements of migratory species. Seasonally operated barriers are unlikely to mitigate these effects because of overlap in the migration phenologies of sea lamprey and other non-target species, and because the population growth rate for sea lamprey is less sensitive to perturbation of reproduction than are population growth rates for non-target fishes. Decision analysis indicates that (i) the “best” barrier/fishway design is highly sensitive to the weightings placed on sea lamprey control versus non-target passage, (ii) some newer barrier/fishway designs developed for sea lamprey control have likely sacrificed control too much, and (iii) new control options that selectively block sea lamprey, while passing non-target fishes are needed to reconcile the opposing management objectives.

Oral CCFFR (Ecosystem-based Management – Science and Policy)

## STREAMFLOW, SALMON AND BEAVER DAMS – ROLES IN THE STRUCTURING OF STREAM FISH COMMUNITIES WITHIN AN ANADROMOUS SALMON DOMINATED STREAM.

**Mitchell**, Sean C. \*, and R.A. Cunjak.

Canadian Rivers Institute, Department of Biology, University of New Brunswick.

(email smitchel@stfx.ca)

The current paradigm of fish community distribution is one of a downstream increase in species richness by addition of species, but this concept is based on a small number of streams from the mid-west and southern United States which are dominated by cyprinids. We hypothesize that fish community diversity will be affected by the presence of the anadromous species in streams dominated by anadromous salmonids, and therefore be influenced by those factors affecting the salmonid population. Catamaran Brook, New Brunswick, Canada, provides a 15 year data set to evaluate fish community diversity upstream and downstream of an obstruction (beaver (*Castor canadensis*) dam complex) which affects distribution of Atlantic salmon (*Salmo salar*). Fish community diversity was greatest upstream of the beaver dams and in the absence of Atlantic salmon. The salmon appear to depress the evenness of the community but do not affect species richness. The community upstream of the beaver dams changes due to replacement of slimy sculpin (*Cottus cognatus*) by salmon, rather than addition, when access is provided. Within Catamaran Brook, locations of beaver dams and autumn streamflow interact to govern adult Atlantic salmon spawner distribution which then dictates juvenile production and effects on fish community. These communities in an anadromous Atlantic salmon dominated stream do not follow the species richness gradient pattern shown in cyprinid –dominated streams and an alternative model for stream fish community distribution in streams dominated by anadromous salmonids is presented.

Oral CCFFR (Physical Limnology and Oceanography – Influences on Populations and Ecosystems) (GS)

## MODELING LIPID ALLOCATION STRATEGIES IN YOUNG OF THE YEAR RAINBOW TROUT (ONCORHYNCHUS MYKISS)

**Mogensen\***, S. and J. Post.

Department of Biology, University of Calgary, Calgary (email: smogense@gmail.com)

I investigated lipid allocation strategies in young of the year rainbow trout (*Oncorhynchus mykiss*), using an individual based model to simulate annual growth and survival patterns. The model was parameterized based on data from the literature in order to create a realistic picture of growth and mortality. An individual fish's lipid allocation strategies are assumed to comprise both proportional allocation to lipids and a temporal shift in this proportional allocation. Different lipid allocation strategies will be simulated using this model, in order to investigate annual patterns in lipid allocation. This should provide insight into the range of plausible allocation strategies available to young of the year rainbow trout, as well as the effects of environmental differences in terms of winter severity on the optimal allocation strategies. There is a trade-off between allocating to growth, and therefore decreased risk of predation, and allocation to lipids, and therefore improved chance of overwinter survival. Investigation of this trade-off should provide a better understanding of the limitations on survival and distribution of young of the year rainbow trout, which are imposed by environmental factors such as winter severity.

Oral CCFFR (Contributed paper) (GS)

## WINGING IT WITH RAM: SEABIRD SIGNALS, SALMON AND SHIFTS

**Montevecchi, W.A.,**

Psychology Department, Memorial University of Newfoundland, St. John's (email: [mont@mun.ca](mailto:mont@mun.ca))

Seabirds are wide-ranging, top predators that manifest changes, perturbations and regime shifts in the marine food webs and ecosystems that sustain them. Here I overview three areas of research collaboration with Ram Myer that involved seabirds: 1 – multi-scaled associations of pelagic prey landing by birds and commercial fishers, 2 – predation on marine-phase salmon and 3 – ocean climate change. 1 - Catches of mackerel and short-finned squid by gannets and commercial fishers (and independent research indices) were robustly associated over multiple spatial and temporal scales. An oceanographic-driven hypothesis about the movements of migratory warm-water fish and squid was proposed. 2 - Gannet predation on marine-phase post-smolt Atlantic salmon in the Labrador Sea increased from the 1970s through 2005. Predation levels were positively associated with returns of 1 year sea winter fish in the following year. 3 - Sharp decadal transitions between the 1970s/80s and 1990s/00s in the prey landings of gannets and murrelets signaled a regime shift in the NW Atlantic pelagic food web. Associated with a centennially-significant cold surface water perturbation in the early 1990s, the prey landings of gannets and murrelets at large colonies shifted from migratory warm-water fish and squids to cold-water prey and from large gravid to small spent capelin respectively. Though sea surface temperatures returned to pre-perturbation levels by the mid-1990s, the food web shifts persisted for about a decade longer. These multi-species studies oriented to meso- and mega-scale biophysical processes and interactions laid the groundwork for ongoing inter-disciplinary ecosystem research projects involving collaboration among scientists and commercial fishers.

Oral CCFFR (Ram Myers Session)

## SEABIRDS HELP DETECT ARCTIC ECOSYSTEM CHANGE: A CANADIAN INTERNATIONAL POLAR YEAR (IPY) INITIATIVE

**Montevecchi<sup>1</sup>**, William A., Anthony J. Gaston<sup>2</sup>, Gail K. Davoren<sup>3</sup>, Chantelle Burke<sup>1</sup>, April Hedd<sup>1</sup>, Paul Regular<sup>1</sup>, H. Grant Gilchrist<sup>2</sup>, David A. Fifield<sup>1,8</sup>, Stefan Garthe<sup>4</sup>, Keith Hobson<sup>5</sup>, Mark L. Mallory<sup>6</sup>, Jean-François Rail<sup>7</sup>, Gregory J. Robertson<sup>8</sup>

<sup>1</sup>Memorial University of Newfoundland (CABE), NL A1B 3X9 Canada; <sup>2</sup>Carleton University National Wildlife Research Ctr, Ottawa ON, K1A 0H3 Canada; <sup>3</sup>University of Manitoba (Dept Zoology), Winnipeg, MB R3T 2N2 Canada; <sup>4</sup>University of Kiel (Research & Technology Ctr), Germany; <sup>5</sup>Canadian Wildlife Service, Saskatoon, SK S7N 0X4 Canada; <sup>6</sup>Canadian Wildlife Service, Iqaluit, NU X0A 0H0 Canada; <sup>7</sup>Canadian Wildlife Service, QC G2E 1K1 Canada; <sup>8</sup>Canadian Wildlife Service, 6 Bruce Street, Mount Pearl, NL A1N 4T3 Canada

The primary objective of our International Polar Year project (2006-2011) is to use seabirds to detect climate-induced biological changes in High and Low Arctic regions in eastern Canada. Research centers on key forage species (Arctic cod, capelin, Myctophids, crustaceans) and their seabird predators. In collaboration with Inuit researchers and Newfoundland fishers, we use seabirds to sample the marine environment over multiple spatial and temporal scales. Seabird diets, reproductive performance, foraging and migratory tactics are measured and evaluated as indicators of changes in food-web and ocean conditions (temperature, sea ice). Synoptic research in the High and Low Arctic is integrated through a 'downstream' (Labrador Current) link to evaluate influences of High Arctic climate on marine life in Low Arctic ecosystems. Seabird diets collected during 2007-08 extend existing time series data (1970s and 1980s) and assess changes in zooplankton and forage fish in relation to regional and holarctic physical oceanography. Miniature bird-borne data loggers are employed to track year-round foraging and migration behaviour and habitat use. Vessel surveys conducted around colonies provide information on oceanographic conditions and the distributions of birds, fish, crustaceans and marine mammals synoptic with collections of seabird diets at colonies and at sea. Integration of these data will assess the influence of changing ocean climate on predator - prey dynamics. We use interactive outreach projects to disseminate and gather information in local communities.

Poster CCFFR (Waterbirds in Marine and Freshwater Food Webs)

## THE INTERACTION OF TRANSGENIC AND NON-TRANSGENIC ATLANTIC SALMON SIBLINGS ACROSS MULTIPLE ENVIRONMENTS

**Moreau\***, D. T. R., C. Conway, D. W. Ings, G. L. Fletcher and I. A. Fleming.  
Ocean Sciences Centre, Memorial University of Newfoundland, St. John's. NL  
(e-mail: dmoreau@mun.ca)

Growth hormone transgenic Atlantic salmon exhibit tremendous growth rates under hatchery conditions. This phenotypic response has created interest within the aquaculture industry; however, possible escapee events have raised concerns regarding their potential ecological impacts. Our approach to assessing ecological risk includes lab-based experimentation, comparing various fitness-related traits of 0+ transgenic and non-transgenic fry; an age of strong selection in stream salmonids. The use of hemizygous-crossed families allows for the direct comparison of full siblings, differing only in the presence or absence of the transgene. Previous work indicates no discernable differences in the developmental rate, respiratory metabolism and competitive ability of transgenic and non-transgenic individuals prior to and at the onset of exogenous feeding. Our current investigation measures the growth and survival of four hemizygous-crossed families across a range of environments over the initial eight to twelve weeks following exogenous feeding. Specifically, four replicates of high kinship and low kinship treatments were reared in each of the following environments: (A) stream-type, high density, (B) stream-type, low density, (C) hatchery-type, high feed, and (D) hatchery-type, low feed. Our results suggest that transgene-induced phenotypic divergence begins within eight weeks following exogenous feeding and that the magnitude of the response is heavily influenced by environment. These data will be discussed in light of potential ecological risk, kin selection and the evolution of fast growing phenotypes.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## YELLOW PERCH (*Perca flavescens*) POPULATION RESPONSES TO INTRODUCED PISCIVORES

**Morgan\***<sup>†</sup>, G., Gunn<sup>†</sup>, J., Wissel<sup>‡</sup>, B., Luek<sup>†</sup>, A., and A. Tremblay<sup>†</sup>.

<sup>†</sup> Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, Ontario. <sup>‡</sup> Department of Biology, EQAL Manager, Faculty of Sciences, University of Regina, Regina, Saskatchewan

Over the past quarter of a century improved water chemical conditions have resulted in the recovery of many acid-sensitive aquatic biota in Sudbury area lakes. One of the first colonist fish, the yellow perch tends to dominate the fish community in many lakes. In recent year piscivores such as the smallmouth bass (*Micropterus dolomieu*) and walleye (*Sander vitreus*) have begun to invade. The depauperate fauna in the Sudbury lakes offer a unique opportunity to test whether behavioural shifts due to a variation in predation risk among different habitats cause adaptive morphological changes in fish populations. We compared two perch-only lake (Clearwater and Lohi) to two lakes with introduced piscivores (Hannah and Middle). Yellow perch populations in lakes with introduced smallmouth bass or walleye exhibited marked habitat shifts and anti-predator morphological responses. In the presence of piscivores yellow perch quickly abandoned the pelagic zone and significantly increased their use of the shallow (<6m depth) littoral zone. This habitat shift lead to increased use of benthic food resources as reflected in changes to stable isotopic signatures and these yellow perch also had larger mouth gapes and were in better condition. Yellow perch in lakes with increased predation risk also exhibited variation in body depth and dorsal spine length, both anti-predator morphologies. Genetic variation among the study lakes was detected with greater diversity in lakes with introduced piscivores. The deliberate introduction of piscivores into the perch dominated Sudbury lakes may be a useful biomanipulation tool to assist recovery of the aquatic biota.

Oral CCFFR (Complexities in Ecological Recovery)

## SPAWNING DISTRIBUTION OF ATLANTIC COD OVERWINTERING IN SMITH SOUND: A POTENTIAL MECHANISM OF COD RECOVERY ALONG THE NORTH EAST COAST OF NEWFOUNDLAND.

**Morris \***, C. J., Bratney, J., and Rideout, S.

Fisheries and Oceans Canada, St. John's, Newfoundland and Labrador, Canada, A1C 5X1.  
(email: [Morrisc@dfo-mpo.gc.ca](mailto:Morrisc@dfo-mpo.gc.ca); [Bratneyj@dfo-mpo.gc.ca](mailto:Bratneyj@dfo-mpo.gc.ca), and [Rideouts@dfo-mpo.gc.ca](mailto:Rideouts@dfo-mpo.gc.ca)).

Since 1995, a dense aggregation of Atlantic cod has overwintered in Smith Sound, Trinity Bay, Newfoundland and Labrador. It represents the largest group of northern cod identified since the stock collapsed in 1992. Progeny of this aggregation play an important role in the recovery of Atlantic cod, particularly along the north east coast of Newfoundland. We examined the movement and reproductive status of Atlantic cod from Smith Sound throughout the spawning season, using a combination of sonic tagging and tracking and examination of fish maturities. Several Atlantic cod that overwintered in Smith Sound moved north into Bonavista Bay during spawning. Atlantic cod are broadcast spawners that release several batches of eggs. The unusually large size of overwintering Atlantic cod in Smith Sound suggest they release multiple batches of eggs over a several week period. Although many Atlantic cod overwinter and conduct some spawning in Smith Sound, individual cod are in fact spreading their eggs in time and space along the northeast coast which may enhance larval survival and subsequent recruitment.

Oral CCFFR (Complexities in Ecological Recovery)

## PREVALENCE AND RECURRENCE OF ESCAPED FARMED ATLANTIC SALMON (*SALMO SALAR*) IN EASTERN NORTH AMERICAN RIVERS

**Morris**, M.\*, D. Fraser, A. Heggelin and J. Hutchings.

Department of Biology, Dalhousie University, Halifax, NS (email: [matthew.morris@dal.ca](mailto:matthew.morris@dal.ca))

Knowledge of the prevalence of escaped farmed fishes in the wild is an essential first step to assessing the risk resulting from interactions between farmed and wild fishes. This is especially important in eastern North America, where Atlantic salmon (*Salmo salar*) aquaculture occurs near wild salmon rivers and where many wild salmon populations are small and/or declining. Here, we review the literature on the incidence of escaped farmed salmon in eastern North American rivers, for which there has been no comprehensive compilation to date. Escaped farmed salmon have been found in 54 of 62 (87%) monitored rivers since 1984, including eleven rivers that contain endangered salmon populations. Averaged among all years and all rivers, the proportional representation of farmed salmon among adults entering the rivers from the sea was  $15.6 \pm 0.3\%$ SD (range: <1% to >90%). Although comparable to that for Norwegian rivers, but higher than that in Scotland and Northern Ireland, the incidence of farmed salmon in Canadian rivers is high despite lower aquaculture production in eastern North America. Where data were sufficient to examine temporal trends, the proportions varied considerably over time, suggesting that escape events are episodic in nature. Our review also identified deficiencies in the means by which farmed salmon escapes are monitored in eastern North America. We conclude that escaped farmed salmon are sufficiently prevalent in eastern North American rivers to pose a potentially serious risk to the persistence of wild salmon populations.

Oral CCFFR (Contributed paper)

## EXPLORING FISHERIES OPTIONS DURING PERIODS OF ECOLOGICAL CHANGE.

**Morrison, B.J. \***, and J.A. Hoyle,

Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Glenora Fisheries Station, RR4, Picton, ON K0K 2T0 (bruce.morrison@ontario.ca)

On Lake Ontario, an individually transferable quota system was established to manage the lake whitefish commercial fishery during a period (1984 to 1988) when lake whitefish abundance was increasing. But during the 1990s, following rapid and dramatic ecosystem change associated with dreissenid mussels, lake whitefish showed signs of stress including low adult body condition, die-offs, and virtually zero recruitment; the population abundance declined steeply. To better utilize quota following the changes within the whitefish population and to address concerns that fishery independent data and the assessment of the whitefish populations were not representative, two collaborative studies were implemented in sequence. The first began as a designed 'test netting' experiment to study whitefish fishing using commercial gillnet but at times of the year other than currently permitted. The second component incorporated a common reserve or pool of quota available during the regular fall and spring fishery in an attempt to provide access to underutilized quota. Test netting resulted in highly variable catch per unit effort within and among years. The pool provided access to quota, as shown by harvest of other species, but did not provide an increase in harvest as expected for lake whitefish. Surprisingly, improved survival of larval whitefish occurred concurrently but early observation on their growth bodes poorly for the fishery. Implications of incidental harvest of lake trout, landed value of whitefish and environmental factors to the future management of this fishery are also discussed.

Oral CCFFR (Contributed Paper)

## ASSESSING THE HEALTH OF FISH POPULATIONS IN THE SAINT JOHN RIVER SYSTEM.

**Munkittrick<sup>1\*</sup>**, Kelly, Allen Curry<sup>2</sup>, Simon Courtenay<sup>2,3</sup>, Dave Methven<sup>1</sup>, Mark Gautreau<sup>2</sup>, Chad Doherty<sup>4</sup> and Collin Arens<sup>1</sup>,

Canadian Rivers Institute, University of New Brunswick, Saint John<sup>1</sup>, and Fredericton<sup>2</sup>, NB; <sup>3</sup>Fisheries & Oceans Canada, CRI,@UNB; <sup>4</sup>NB DNR, Fredericton, NB (email: [krm@unbsj.ca](mailto:krm@unbsj.ca))

The Canadian Rivers Institute focuses many of its collaborations on the Saint John River. A major initiative is the development of a framework for understanding the assimilative capacity of the river system. The Saint John is a 700 km long 7<sup>th</sup>-order river system that crosses the international border between the US and Canada in the upper third of the basin, and forms the border between Canada and the US for >50 km. An assessment of the health of fish populations was initiated in 1999, progressing downstream and examining community structure, and the growth, reproduction and age distributions of sentinel species in the main stem and major tributaries. More than 30 species are found in the freshwater portion of the basin, and changes in the performance of white sucker, yellow perch, and slimy sculpin populations have been used to identify areas of concern. Differences between sites for growth and size-at-age exceed 500% for two of the species. The results determine the sites for more detailed studies used to identify major stressors of importance, which have included food processing effluents, sewage discharges, agricultural inputs, and hydroelectric regulation in the upper 500 km of the basin. Studies in the estuary have collected more than 40 additional species, but there are a number of challenges in developing a comparable sentinel species approach in the estuary and marine portions adjacent to the basin. Baseline studies have been completed to identify potential sentinel species, and preliminary studies are underway to complete the lower river assessment.

Oral CCFFR (River and Estuary Ecosystems)

## FACTORS LIMITING WARMWATER FISH HABITAT SUITABILITY IN AN EMBAYMENT IN TOMMY THOMPSON PARK, TORONTO, ONTARIO

\***Murphy**, S.C.<sup>1\*</sup>, Collins, N.C.<sup>1</sup> and Doka, S.E.<sup>2</sup>

University of Toronto at Mississauga, <sup>2</sup>Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries & Aquatic Sciences, Burlington, ON (email:shidan.murphy@utoronto.ca)

Warmwater embayments connected to large coldwater lakes are subjected to a variety of factors not experienced in typical Canadian inland lakes. A single manmade embayment, in Tommy Thompson Park, along Lake Ontario's north shore, is virtually devoid of fish yet in possession of seemingly suitable fish habitat. The embayment is susceptible to coldwater intrusions from the Lake and situated adjacent to a large double-crested cormorant and gull colony. We hypothesized that exchange with the lake, prey availability and/or bird predation may serve to limit the suitability of this embayment as a nursery fish habitat for warmwater fish. To explore these hypotheses we 1) simulated and evaluated, using the Wisconsin fish bioenergetics model, how pumpkinseed and largemouth bass growth was altered during minor coldwater incursions 2) compared seasonal water quality and food availability with neighboring embayments populated with fish and, 3) simulated bird predation impacts on the local fish community.

Oral CCFFR (Contributed paper) (GS)

## DOUBLE-CRESTED CORMORANT PREY CHOICE AND AVAILABILITY DURING THE CHICK REARING PERIODS, ONTARIO, CANADA

Andrews, D.<sup>1</sup> \***Murphy**, S.C.<sup>2\*</sup> and Fraser, G.<sup>1</sup>

<sup>1</sup>York University, <sup>2</sup>University of Toronto (email: shidan.murphy@utoronto.ca)

Double-crested cormorants, (*Phalacrocorax auritus*), are colonial waterbirds native to North America. They are of particular interest to wildlife managers because of their perceived threats to sport fisheries, habitat, and other colonial waterbirds. We assessed cormorant chick diet at the largest colony in Lake Ontario from June to August in 2006 and compared it with the nearshore fish communities. Fish were collected through boat electrofishing transects from protected warmwater embayments and open coast areas, stretching for 50 kilometers along the shoreline which includes the colony. In 2006, alewife (*Alosa pseudoharengus*) comprised 93% of the cormorant chick diet, with little temporal variation during the breeding season. The dominance of alewife in chick diet did not reflect the relative abundances of the nearshore fish community. Although alewife is the most numerous species when catches from embayments and open coast sites are summed together, the most abundant species, centrarchids and shiner *spp.*, in embayments and along open coast respectively, are not well represented in chick diet. Preliminary results suggest cormorant selection of alewife may represent a dietary preference.

Oral CCFFR (Waterbirds in Marine and Freshwater Food Webs) (GS)

## EFFECTS OF INTRODUCED TROUT ON FORAGE FISH BEHAVIOUR IN BOREAL FOOTHILLS LAKES

**Nasmith, L.<sup>1\*</sup>, W. Tonn<sup>1</sup>, C. Paszkowski<sup>1</sup>, and G. Scrimgeour<sup>2</sup>.**

<sup>1</sup>Department of Biological Sciences, University of Alberta, Edmonton, Alberta. <sup>2</sup>Parks Canada, Calgary, Alberta, Canada. (\*email: [lnasmith@ualberta.ca](mailto:lnasmith@ualberta.ca))

The Alberta Conservation Association and Alberta Sustainable Resource Development stock non-native trout species into small lakes to create recreational angling opportunities; some of these lakes are also aerated to prevent winterkill. We are studying a suite of lakes in the boreal foothills to document effects of these management practices on native forage fishes (dace species, fathead minnow, and brook stickleback). We conducted 24-hour sampling, stratified by depth and distance from shore, to assess the spatial and temporal distributions of forage fishes on 8 lakes in 2006 (4 stocked, and 4 unstocked) and 4 lakes in 2007 (2 stocked, and 2 unstocked). The activity patterns of forage fishes in all treatments were similar over the sampling periods; fish were most active during the day and less active at night. In both treatments fish were caught most often in inshore traps. However, in unstocked lakes, most forage fishes occupied the water column throughout the 24 hours. In contrast, forage fishes in all stocked lakes were largely restricted to the lake bottom. Among all treatments, fish that were caught in the water column were consistently smaller than bottom-caught fish. Due to observed behavioural responses of forage fish to stocking and aeration, ecological and fitness costs should be explored before these management practices are applied to new lakes.

Poster SCL (Contributed paper) (GS)

## HABITAT SELECTION BY SHORTJAW CISCO (*COREGONUS ZENITHICUS*) IN LAKE HURON

**Naumann, B.**

Department of Intergrated Biology, University of Guelph, Guelph Ontario ([bnaumann@uoguelph.ca](mailto:bnaumann@uoguelph.ca))

Shortjaw cisco (*Coregonus zenithicus*) is a deepwater fish historically found in central and western Canada. It has been declining in distribution and abundance since the early 1900's, resulting in a COSEWIC designation of shortjaw cisco as "Threatened". If shortjaw cisco is listed under SARA, the species will receive legal protection, including protection of its critical habitat. Currently, little is known about the habitat selection by shortjaw cisco, either generally or specifically. The purpose of this research is to evaluate the degree to which habitat selection affects shortjaw cisco distribution in Lake Huron. Based on the available literature, three habitat variables emerge as being potentially important for shortjaw cisco: water depth, bottom slope, and substrate type. I compiled effort and catch data for targeted shortjaw cisco samples (n=79) for years 2003 to 2007. Each of the habitat variables were quantified for each targeted shortjaw cisco sample sites. The resulting matrix of quantified habitat variables was combined with shortjaw cisco presence/absence data, and was analyzed using resource selection functions and the "best fit" model was determined using Akaike's information criteria. That model was used to create shortjaw cisco habitat maps showing predicted distribution probabilities. These predicted distribution maps will be tested to determine their accuracy in reliably predicting shortjaw cisco distribution in Lake Huron. If listed under SARA this habitat information will aid in the recovery planning for shortjaw cisco management decisions and is an essential prerequisites for describing its critical habitat.

Oral CCFFR (Contributed paper) (GS)

## COMMUNITY METABOLISM IN THE SAINT JOHN RIVER.

Noel<sup>1\*</sup>, L.J., J.M. Culp<sup>1,2</sup> and L.I. Wassenaar<sup>3</sup>

<sup>1</sup>Canadian Rivers Institute and Department of Biology, University of New Brunswick, Fredericton, NB, Canada E3B 6E1; <sup>2</sup>Environment Canada, Fredericton, NB; <sup>3</sup>Environment Canada, Saskatoon, SK.

(email: [laura.noel@unb.ca](mailto:laura.noel@unb.ca))

River community metabolism and air-water gas exchange rates control dissolved oxygen in rivers. Dissolved oxygen is a key parameter as it sustains aquatic life and maintains biodiversity. These processes are affected by nutrient loading and discharge regulation. Riverine communities within the Saint John River, NB, are under increasing pressure from nutrient loading and discharge regulation and it is unknown how these pressures will affect community metabolism. Along nutrient and algal biomass gradients in regulated (Florenceville) and unregulated (Edmundston) reaches of the Saint John River, community metabolism was measured during summer and fall 2004, 2005, and 2006. Metabolism of the river community was measured by a) open-system, single station, diel measurement of dissolved oxygen and stable oxygen isotopes, b) a dynamic O<sub>2</sub> and  $\delta^{18}\text{O}$ -O<sub>2</sub> model (PoRGy) that quantifies average photosynthesis, respiration, and gas exchange rates and allows predictive modeling, and c) using experimental domes to measure diel dissolved oxygen created by substrate. Dissolved oxygen concentrations measured were below CCME guidelines repeatedly. Diel patterns of dissolved oxygen exist in the Saint John River, and nutrient loading and daily desiccation caused by discharge regulation cause shifts to a more respiration-dominated community. The direct measurement of fundamental community functions, such as metabolism, will allow us to assess the health of river ecosystems, providing tools for ecologically sustainable management.

Oral SCL (River and Estuary Ecosystems) (GS)

## THE BOWRON RIVER WATERSHED: A LANDSCAPE LEVEL ASSESSMENT OF THE POST-BEETLE CHANGE IN STREAM AND RIPARIAN FUNCTION

Nordin<sup>\*1</sup>, Lisa, D. Maloney<sup>2</sup>, John Rex<sup>1</sup>, Phillip Krauskopf<sup>2</sup>, Peter Tschaplinski<sup>3</sup>, Dan Hogan<sup>3</sup>

<sup>1</sup>Stewardship Section, Northern Interior Forest Region, Ministry of Forests & Range, 5<sup>th</sup> Flr. 1011 4<sup>th</sup> Avenue, Prince George, BC V2L 3H9; <sup>2</sup>Forest Practices Branch, Ministry of Forests & Range, 5<sup>th</sup> Flr. 1011 4<sup>th</sup> Avenue, Prince George, BC V2L 3H9; <sup>3</sup> Research Branch, Ministry of Forests & Range, 1st Floor - 722 Johnson Street, Victoria, BC, V8W 1N1. (email: [lisa.nordin@gov.bc.ca](mailto:lisa.nordin@gov.bc.ca))

Substantial harvesting occurred in the British Columbia Bowron River watershed between the mid-1970's and 1980's as a response to a spruce bark beetle infestation. This large scale salvage activity was initiated to check the beetle's spread and reduce fire risk. It bears a striking resemblance to current mountain pine beetle (MPB) related salvage operations because of the infestation's watershed scale. As a result, the 20-30 year record of post-harvest response within the Bowron can be used to identify potential stream and riparian impacts from harvesting and allow the development of best management practices for today's MPB salvage operations. Riparian and stream conditions were assessed using a riparian evaluation procedure which includes 15 indicators to assess the level of functioning condition. Results suggest that a 30 year period of recovery after streamside logging is insufficient for the restoration of riparian qualities to pre-harvest condition. In-stream response was more variable and was found to be heavily influenced by site-specific physical characteristics such as soil type, slope and stream channel width. Recommendations for future salvage harvest planning include retention of riparian timber and the consideration of site characteristics to mitigate potential future adverse impacts.

Oral SCL (Ecosystem-based Management – Science and Policy)

## RISK ASSESSMENT OF ALTERNATIVE INITIAL ALLOCATIONS OF LAKE ERIE WALLEYE USING CATCH AT AGE SIMULATION AND A BAYESIAN APPROACH TO UNCERTAIN STOCK-RECRUIT DYNAMICS

**Obushenko\***<sup>1</sup>, N., Reid<sup>2</sup>, K.B. and Nudds<sup>1</sup>, T.D

<sup>1</sup>Department of Integrative Biology, University of Guelph;., <sup>2</sup>Ontario Commercial Fisheries' Association;., (email: [nobushen@uoguelph.ca](mailto:nobushen@uoguelph.ca))

Initial allocations of walleye quota to the Ontario commercial fishery occur in January each year, which permits a limited harvest until May when the final total allowable catch is set. A catch at age model with discrete time simulated population dynamics and catch was used to evaluate risk associated with various initial allocation decisions. Bayesian methods were used to analyze uncertainty in the stock-recruit relationship. An extended Ricker function with a log-normally distributed error term described recruitment to the population. The standard deviation of the error described environment-induced fluctuations in recruitment about the stock-recruitment relationship. Parameters of the Ricker function and the standard deviation of the error were estimated by Markov Chain Monte Carlo (MCMC) methods. At low fishing mortality rates (i.e., less than 0.2), there was little difference in risk of stock collapse for initial allocations ranging from 5% to 50% of the total allowable catch. At higher rates of fishing mortality (0.3), risk of walleye fishery collapse increased marginally from 0.8% when the initial allocation was 10%, to 1.8% when the initial allocation was 50%, of the TAC. Highly precautionary, or risk averse, initial allocation decisions can have negative economic consequences for the commercial fishery. Our result is consistent with a view that there may be more capacity in the walleye population to withstand reasonable initial allocations than has been assumed. Armed with it, managers might more confidently go forward with an active adaptive management approach to setting initial allocations.

Oral CCFFR (Contributed paper)

## LATITUDINAL GRADIENTS IN NUTRIENT CONCENTRATIONS AND ALGAL BIOMASS IN NORTHERN CANADIAN WATERS.

**Ogbebo**<sup>1\*</sup>, Fortune, Marlene S. Evans<sup>2</sup>, Marley Waiser<sup>3</sup>, Dirk de Boer<sup>4</sup>, Jonathan Keating<sup>5</sup>, and Kerry Pippy<sup>6</sup>.

<sup>1, 2, 3, 5</sup>National Water Research Institute, Environment Canada, 11 Innovation Boulevard, Saskatoon, SK, S7N 3H5; <sup>4</sup>Department of Geography, University of Saskatchewan, Saskatoon, SK; <sup>6</sup>Water Quality Monitoring & Surveillance, Science & Technology Branch, Environment Canada, Yellowknife, NT, X1A 1E2 (\*Email: [fortune.ogbebo@ec.gc.ca](mailto:fortune.ogbebo@ec.gc.ca))

The increase in biomass and productivity from the poles to equatorial region is well documented for a variety of terrestrial plants and animals. Several hypotheses have been advanced to explain this ecological pattern, most of them related to either energy or nutrients availability. However, this latitudinal pattern is not well studied in aquatic organisms. In this paper, we determine how nutrients [(total phosphorus (TP), dissolved phosphorus (DP), total nitrogen (TN), nitrate and ammonia)] concentrations and algal biomass [(chlorophyll-a (Chl-a)] vary with latitude, using data from a large number of rivers and lakes in the Mackenzie River Basin (MRB). For many decades, the MRB remained a relatively isolated and undeveloped watershed. This is rapidly changing with the increasing development and extraction of the region's vast natural resources. The catchment of the MRB spans nearly 20° of latitude (from about 52°N to 70°N), covers a wide variety of climatic conditions and vegetational gradients. For both rivers and lakes, analyzed data showed declining gradients in nutrients (TP, TN), dissolved organic carbon (DOC) and Chl-a with increasing latitude. In addition, more pronounced gradients with latitude were recorded for dissolved phosphorus, ammonia and nitrate concentrations. Using multiple regression analyses, the influence of other factors including lake size, water temperature, suspended sediments and DOC on Chl-a will be highlighted. The expected impact of climate change on nutrients, algal biomass and DOC influx into lakes in these high northern latitude lakes are discussed in the context of these results.

Oral SCL (Physical Limnology and Oceanography – Influences on Populations and Ecosystems)

## CONSEQUENCES OF LIFE-HISTORY FOR ESTIMATING EFFECTIVE POPULATION SIZE ( $N_e$ ) IN SALMONID FISHES: AN EMPIRICAL EVALUATION IN ATLANTIC SALMON (*SALMO SALAR*) POPULATIONS IN NEWFOUNDLAND AND LABRADOR.

**Palstra**, F.P.\* and Ruzzante, D.E.

Department of Biology, Dalhousie University, Halifax, Nova Scotia. (email: [fpalstra@dal.ca](mailto:fpalstra@dal.ca))

Atlantic salmon abundance has recently declined across much of its latitudinal range, invoking the need for urgent conservation measures that are both ecologically and evolutionarily informed. The effective population size ( $N_e$ ), a critical parameter in conservation biology, is an indicator of a population's ability to deal with changing environmental conditions. Mirroring its evolutionary importance however is the notorious difficulty to estimate it in natural populations. There are many approaches to estimate  $N_e$ , both demographic and genetic, and all make critical assumptions about a species' biology. Atlantic salmon is an excellent example of a species with life history features violating many of the standard assumptions underlying effective size estimation methods. Here we examine the influence of variation in precocious parr contribution and in the incidence of iteroparity on temporal estimates of effective population size, using an analytical model explicitly developed for species with age-structured populations and iteroparity. By using long-term demographic and genetic data from several rivers in Newfoundland we assess empirically the consequences on temporal estimates of  $N_e$  of variation in these two life history traits. We assess the relative importance of assumptions of the analytical model, by comparing results with empirically derived estimates of effective size using a different genetic approach. Our results illustrate some of the potential complexities in estimating this crucial evolutionary parameter in conservation.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## THE BIOECONOMIC EQUILIBRIUM IN RECREATIONAL FISHERIES

**Parkinson\***, Eric and John Post.

BC Ministry of Environment. (email: [eric.parkinson@gov.bc.ca](mailto:eric.parkinson@gov.bc.ca))

When participation is not restricted, the balance of costs and benefits drives commercial fish stocks to a bioeconomic equilibrium. Frequently, high and improving gear efficiency results in lower costs, which produces over capitalization and severe over fishing. In recreational fisheries, gear is much less efficient but there is a large pool of potential anglers and anglers appear to be willing to continue to fish at very low catch rates. Using data from BC sport fisheries, we parameterize the relationships between supply and demand versus cost (days/fish) for different administrative Regions and combine these with a simple fish population model. Our results suggest that the bioeconomic equilibrium presents little risk to rainbow trout populations near small population centers. However, large population centers produce bioeconomic equilibriums that parallel the situation for severely over harvested commercial stocks. Using the cost of licenses and the US exchange rates as examples, we show how economic factors can change participation rates in the fishery, which has a cascading effect on the bioeconomic equilibrium and the status of local fish populations.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity, and Invasives)

## EXPLORING CAUSES OF INCREASES IN TASTE AND ODOUR-CAUSING CHRYSOPHYTE ABUNDANCE IN CANADIAN SHIELD LAKES

**Paterson\***<sup>1</sup>, A.M., Winter<sup>2</sup>, J.G., Chueng<sup>3</sup>, C.S., Hyatt<sup>1</sup>, C.V., and J.P. Smol<sup>3</sup>.

<sup>1</sup>Ontario Ministry of the Environment, Dorset Environmental Science Centre, Dorset, ON; <sup>2</sup>Ontario Ministry of the Environment, Water Monitoring Section, Toronto, ON; <sup>3</sup>Paleoecological Environmental Assessment and Research Laboratory, Department of Biology, Queen's University, Kingston, ON. (e-mail: andrew.paterson@ontario.ca)

Increases in the abundance of taste and odour-causing colonial chrysophytes have been reported in several Canadian Shield lakes in central Ontario. By examining the siliceous remains of these organisms in lake sediments, earlier studies from Ontario reported increases in the relative abundance in more than 90% of the ~ 50 lakes examined since pre-industrial times. Furthermore, rapid increases since the 1980s indicated that these changes were the result of one or more anthropogenic stressors affecting lakes within the southern Canadian Shield. With new analyses, we continue to explore the specific causes of these algal changes in Shield lakes. Using a combination of paleoecological and contemporary monitoring data, including assessments of algal data collected at multiple temporal and spatial scales, we report that the degree of change varies regionally with the number and intensity of anthropogenic stressors affecting lakes. Lakes in central Ontario, for example, that are subjected to both elevated levels of acid/metal deposition and recent droughts, show significantly greater increases in colonial chrysophytes over time than lakes in remote regions (e.g., Experimental Lakes Area in northwestern Ontario). This conclusion is further supported using variance partitioning analyses (VPA) of monitoring data from seven-intensively studies lakes near Dorset, Ontario. VPA show that phytoplankton variance through time is best explained by a combination of water chemical and climatic variables. These new results, coupled with paleoecological studies, indicate that increases in the relative importance of colonial chrysophytes coincide with water chemistry changes associated with industrial activity since the mid-1900s, and physical changes in lakes associated with climate drivers including large-scale climatic patterns (e.g., NAO) and recent increases in local air temperature.

Oral SCL (Contributed paper)

## ECOLOGICAL RESPONSE OF NILE PERCH TO ENVIRONMENTAL CHANGE IN LAKE NABUGABO, UGANDA

**Paterson**, Jaclyn and Chapman, Lauren J.

Department of Biology, McGill University (email: jaclyn.paterson@mail.mcgill.ca)

Fishing can be a potent ecological force in aquatic systems affecting the density and distribution of stocks, and leading to shifts in life-history characters and other traits. For example, fishes may become smaller and slower-growing in response to fishing pressure. In Lake Victoria, the introduced predatory Nile perch (*Lates niloticus*) has contributed to dramatic ecological changes. Their upsurge in the 1980's resulted in an important export fishery, but coincided with the mass extinction of endemic cichlids. Decades later, the Nile perch has shown signs of intense fishing, and some native fishes are re-emerging. Our goal is to quantify phenotypic changes in Nile perch in response to heavy fishing. We focus on Lake Nabugabo, a satellite of Victoria that has also experienced Nile perch introduction and intense fishing pressure. In the summer of 2007, we sampled the major habitats of the lake, recorded species composition, and collected Nile perch specimens for diet analysis. Relative to earlier studies conducted by our lab in 1995 and 2000, Nile perch are now less abundant and smaller; a larger proportion of the population is now found near wetland ecotones; and Nile perch near wetlands consume a much higher proportion of cichlids than in other areas of the lake.

Oral CCFFR (Contributed paper)

## GAIT TRANSITION AS AN ALTERNATE ESTIMATOR OF MAXIMUM AEROBIC CAPACITY IN FISH.

**Peake, S. J.**

Canadian Rivers Institute and Department of Biology, University of New Brunswick, Fredericton, NB.  
(email: [speake@unb.ca](mailto:speake@unb.ca))

The highest swimming speed that can be attained using energy supplied from aerobic metabolic pathways is almost universally estimated by measuring critical swimming speed (or  $U_{crit}$ ). Although the protocol is straightforward, it is relatively time consuming, the endpoint of the test is subjective, and the data can be highly variable and poorly correlated to morphological and physiological parameters. In this study, a specially designed flume was developed to determine if the swimming speed at which fish transition from a steady locomotory gait (powered by red muscle) to unsteady, white muscle supported swimming can be used as an alternative estimator of maximum sustained speed. Results indicate that the highest speed that juvenile brook trout (*Salvelinus fontinalis*) could maintain using a steady gait accurately estimated critical swimming speed. Furthermore, data could be collected very quickly, required no subjective input from the investigator, and accurately described the relationship between maximum aerobic capacity and fish size, with much less unexplained variation than in the  $U_{crit}$  data. Gait transition speeds also produced the same estimate of  $U_{crit}$ , regardless of whether fish moved through the flume voluntarily or were forced to swim. Finally, it was determined that gait transition speed can only be estimated in a respirometer if ground speed during the test is monitored. It is concluded that this new protocol can be used as an alternative to the critical speed test, to estimate maximum sustained speed and investigate the impacts of various stressors on aerobic capacity.

Oral CCFFR (Contributed paper)

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

Keefe, D.G. R.C. **Perry\***, and J.G. Luther.

Department of Environment and Conservation, Wildlife Division, P.O. Box 2007, Corner Brook, Newfoundland and Labrador, Canada, A2H 7S1 (email: [robperry@gov.nl.ca](mailto:robperry@gov.nl.ca))

Estimation of angler catch rates commonly involve on-site interview methods based on access point (complete trip) or roving (incomplete trip) creel surveys. On the island portion of Newfoundland and Labrador, Canada, the conservation authority relies on roving creel surveys to assess the brook trout *Salvelinus fontinalis* fishery. 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. To date, biases associated with catch rate estimators have been tested using statistical theory and simulation modeling rather than using actual catch statistics from anglers. In an attempt to validate the mean of ratios estimator, we used a modification of the roving creel survey design that allowed us to intercept anglers while fishing and again after completion of the fishery. Our results show that the mean of ratios estimator significantly overestimated the actual catch rate, which, in turn, impacts estimates of total harvest. We provide a model to correct for this potential bias.

Oral CCFFR (Contributed Paper)

## THE ROLE OF DISSOLVED OXYGEN IN AQUATIC PREDATOR-PREY INTERACTIONS: DO DECREASES IN LEVELS OF OXYGEN RESULT IN INCREASED PRESENCE OF AVIAN PREDATORS?

**Pink,\*** M. and M.V. Abrahams.

Department of Biological Sciences, University of Manitoba, Winnipeg, Manitoba  
(email: [umpink@cc.umanitoba.ca](mailto:umpink@cc.umanitoba.ca))

In a shallow water ecosystem where daily air temperatures can exceed 30°C for prolonged periods of time, water temperatures increase to 25°C. Oxygen levels in these ecosystems can become very low; in particular dissolved oxygen (DO) in Blind Channel, Delta Marsh, MB can fall below 0.5 mg/L. Within Blind Channel, surface waters consistently have higher levels of DO. In times of prolonged hypoxic conditions, to reduce physiological stress small fishes may use the upper proportion of the water column where DO levels are higher. If DO levels do result in increased use of surface areas, it is expected that there will be an increase in the presence of avian predators as they cue in to the increased visual availability of their prey. In this study, DO, temperature, and turbidity were measured every 30 minutes from mid-May until early August 2007 using a YSI Data Sonde. During this same time period, three CCTV cameras were recording separate areas of the marsh. The recorded daylight hours were divided into 30 minute intervals. Randomly selected two minute video clips were viewed during each 30 minute interval and the number and species of birds observed were recorded. The average number of birds observed per hour during periods of low DO days will be compared to the average number of birds observed per hour during days of high DO. I will also determine if temperature and/or turbidity have an effect on avian predator presence.

Oral CCFFR (Waterbirds in Marine and Freshwater Food Webs) (GS)

## LACUSTRINE HABITAT USE AND ITS INFLUENCE ON ATLANTIC SALMON PARR POPULATIONS IN SOUTHERN LABRADOR

**Poole\***, R. J.<sup>1,2</sup>, I.A. Fleming<sup>1</sup>, D. G. Reddin<sup>2</sup> and R. J. Gibson<sup>1</sup>

<sup>1</sup>Ocean Sciences Centre, Memorial University, St. John's, NL, A1C 5S7, Canada; <sup>2</sup>Department of Fisheries and Oceans, St. John's, NL, A1C 5X1, Canada (email: [poolerj@dfo-mpo.gc.ca](mailto:poolerj@dfo-mpo.gc.ca))

Juvenile Atlantic salmon are typically thought to inhabit the runs, riffles and pools of fluvial habitat. Studies in northern geographic regions have shown that Atlantic salmon parr may also use lacustrine habitat. We undertook a study to assess lacustrine habitat use by Atlantic salmon parr in southern Labrador and the attributes of the fish choosing to rear in one habitat over another. Atlantic salmon parr were sampled from lacustrine and adjacent fluvial habitat of six sites in southern Labrador. The parr were measured for weight and fork length, sexed, photographed for subsequent morphological analysis, sampled to obtain scales for aging and frozen for subsequent analysis of body composition (moisture, protein, lipid and ash). The data collected were used to examine questions of age and size segregation, morphological divergence and growth benefits to rearing in one habitat versus the other. The results indicate that Atlantic salmon parr in southern Labrador utilize lacustrine habitat extensively. Moreover, parr of the same age appear to differ depending on the habitat from which they were captured. These findings not only provide insight into the plasticity of life history decisions shown by juvenile Atlantic salmon, but also provide information to assist in the conservation and management of this valuable resource.

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems) (GS)

## DYNAMICS AT LOW DENSITY: THRESHOLDS FOR SUSTAINABILITY AND CONSERVATION

**Post\***<sup>a</sup>, John R., and Elena Braverman<sup>b</sup>.

<sup>a</sup>Department of Biological Sciences and <sup>b</sup>Department of Mathematics and Statistics, University of Calgary, Calgary, Alberta. (email: [jrpost@ucalgary.ca](mailto:jrpost@ucalgary.ca))

Many population models used to explore harvest dynamics presume that the rate of per capita population increase is highest at low density, implying that there are processes that compensate for harvest. But there are often also a series of ecological and/or harvest related processes that work in opposition to these compensatory processes (i.e. allee or depensatory processes). In this work we develop an extension of the Gordon-Schaefer harvest model that we use to explore implications of the strengths of compensation and depensation to thresholds of sustainability and conservation. We explore two forms of compensation based on: (1) variation in maximum intrinsic rates of increase, and (2) the shape of density-dependent per capita growth rate. Depensation is characterized by the magnitude of deviation from linear density-dependence of harvest per unit effort. We then explore the implications of strengths of compensatory and depensatory processes to sustainable yield, population size at maximum sustainable yield, and the threshold at which populations approach critical depensation and risk extirpation.

Oral CCFFR (Population Processes at Low Abundance – Rarity, Recovery and Invasives)

## CONTINUED USE OF ANCIENT SUBMERGED CAPELIN SPAWNING BEACHES 350 km FROM SHORE

**Purchase\***, Craig F.<sup>1,2</sup> and Fran K. Mowbray<sup>2</sup>

<sup>1</sup>Department of Biology, Memorial University (email: [cfpurchase@mun.ca](mailto:cfpurchase@mun.ca))

<sup>2</sup>Aquatic Resources Division, Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada

Recognition and use of appropriate spawning habitat is an important selective force in fishes; embryo survival being greatly influenced by environmental variability. Capelin comprise a critical link in the northwest Atlantic food web and are found to the edge of the continental shelf. Optimal breeding sites are hypothesized to be a combination of appropriate substrate and temperature, leading to inshore migrations and spawning on Newfoundland beaches. The Southeast Shoal population however reproduces offshore. Spawning occurs on ancient submerged beaches, located in the shallowest area of the Grand Bank of Newfoundland. Much of the shoal is outside Canada's 200-mile economic exclusion zone and the stock once supported a large foreign fishery. We investigated the physical characteristics of this spawning location, as well as its total size, distribution, and temporal and spatial variability. Moored temperature loggers, acoustic ground discrimination systems, towed underwater video cameras, and grab samples were used to identify bottom temperature and substrate variability. Habitat characteristics were compared to presence of spawning capelin using acoustics, fishing sets, and underwater videos. Analyses to date indicate an apparent absence of spawning substrate typical of that used in beach spawning, and that spawn timing is less dependent on local temperature.

Oral CCFFR (Physical Limnology and Oceanography – Influences on Populations and Ecosystems)

## USE OF HEAT CONTENT TO STUDY LONG-TERM TRENDS IN LAKE THERMAL REGIMES

**Ramcharan**, C.W.<sup>1</sup>, Keller, W.B.<sup>2</sup>, Yan, N.D.<sup>2</sup>, Gunn, J.<sup>1</sup>.

cramcharan@Laurentian.ca; 1. Department of Biology, Laurentian University, Sudbury ON; 2. Ontario Ministry of the Environment.

The effect of climate change on the thermal regime of lakes is commonly studied with response parameters such as surface and bottom water temperature, depth of mixing, and strength of stratification. In many cases, it's difficult to detect climatic effects because these response parameters can have fairly high seasonal and interannual variability. A solution might be to use a thermal characteristic that integrates over all depths and through the season. Heat content is an easily-calculated value that gives the total thermal energy in a water body at a point in time. Using long-term data on temperature profiles we calculated seasonal heat content for several lakes in the area of Sudbury, Ontario. Some of these lakes were undergoing simultaneous influences of chemical recovery from acidification, decreased wind speed, and climate change. We found quite good temporal synchronicity of heat content for similar-sized lakes in the local area. We also found some evidence for maximum heat content tending to now occur later in the year compared to previous years, perhaps as a result of climatic warming. Comparisons of heat content to climatic data should verify that pattern. We also compare heat content to other measures of temperature regime.

Oral SCL (Complexities in Ecological Recovery)

## PERSPECTIVE ON A HABITAT AREA-PRODUCTION APPROACH FOR ASSESSING THE PRODUCTIVE CAPACITY OF FISH HABITAT.

**Randall**, R.G.

Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON L7R 4A6.  
(Robert.Randall@dfo-mpo.gc.ca)

A Habitat Area-Production approach (HAP) for determining first-order estimates of the productive capacity of different ecosystems and habitats is examined. HAP is a two-step method. First, an estimate of habitat capacity is determined by regressing surface area of lakes, rivers or marine areas against total production (or yield as a proxy of production) for each area. Area-production plots are not novel, but the explicit premise of this perspective is that surface area is often the dominant factor that determines total fish production for a region or site. The second step is to investigate the region- or site-specific environmental or habitat factors that affect production. Case studies based on literature data are used to demonstrate the utility of the HAP method of estimating habitat capacity in freshwater and marine areas, both among and within ecosystems. Advantages of the area-production approach are: 1) first-order estimates of capacity, explicitly showing the relative importance of the quantity and quality of habitat, can be determined if area-production data are available; 2) area-production plots will guide further research for refining habitat capacity; 3) HAP provides a quantitative method of identifying both habitat perturbations and important habitat; 4) a lack of a significant area-production relationship is instructive; and 5) the approach can be applied at different spatial scales in different ecosystems. Adopting the HAP approach for assessing habitat capacity will lead to compilations of existing or new data that explicitly incorporate ranges in habitat area into the survey design.

Oral CCFFR (Contributed paper)

## CAPELIN, MURRES AND OCEAN CLIMATE: INTER-ANNUAL ASSOCIATIONS ACROSS A DECADEAL SHIFT

**Regular**<sup>1\*</sup>, P.M., W.A. Montevecchi<sup>1</sup>, and G.J. Robertson<sup>2</sup>

<sup>1</sup>Cognitive and Behavioural Ecology Program, Memorial University of Newfoundland, St. John's, NL A1B 3X9, Canada; <sup>2</sup>Canadian Wildlife Service, Environment Canada, 6 Bruce Street, Mount Pearl, NL A1N 4T3, Canada. (email: b23pmr@mun.ca)

Capelin *Mallotus villosus* is the primary forage fish in the Northwest Atlantic that sustains populations of large predatory fish, marine birds and mammals. Capelin availability is essential for the successful reproduction by marine birds. We analyzed associations between the timing of the inshore arrival of capelin and the breeding chronology of common murres *Uria aalge* at Cape St. Mary's, Newfoundland, 1980-2006. We also assessed the potential influences of ocean temperature and the North Atlantic Oscillation (NAO) on these interactions. We found a lagged linear relationship between variations in the timing of murre breeding and capelin arrival in the previous year. On a decadal scale, we found a non-linear relationship between ocean temperature and the timing of capelin arrival and murre breeding. Centennially anomalous cold water in 1991 generated a pervasive shift in the timing of capelin spawning inshore and murre breeding, delaying both by more than 2 weeks. By the mid-1990s, ocean temperatures returned to pre-perturbation levels, however the temporal breeding responses of capelin and murres were lagged, remaining delayed for about a decade or more. As a consequence of the complex nature of biophysical interactions at different scales, oceanographic conditions, such as ocean temperature and NAO, were found to be potentially less reliable predictors of the timing of the inshore arrival of capelin in comparison to capelin timing in the previous year. Therefore, our results suggest that knowledge on the timing of capelin availability in the previous year may serve as the best cue for murres, allowing them to maximize the temporal overlap between breeding and peak capelin availability.

Oral CCFFR (Waterbirds in Marine and Freshwater Food Webs) (GS)

## SPECIES TRAITS INFLUENCE THE GENETIC CONSEQUENCES OF RIVER FRAGMENTATION ON TWO CO-OCCURRING REDHORSE SPECIES.

**Reid\***, S.M.<sup>1</sup>, C.C. Wilson<sup>2</sup>, and L.M. Carl<sup>3</sup>

<sup>1</sup>Harkness Laboratory of Fisheries Research, Aquatic Science and Development Section, Ontario Ministry of Natural Resources, Peterborough, Ontario; <sup>2</sup>Aquatic Science and Development Section, Ontario Ministry of Natural Resources, Peterborough, Ontario; <sup>3</sup>Great Lakes Science Center, United States Geological Survey, Ann Arbor, Michigan (email: [screid@trentu.ca](mailto:screid@trentu.ca))

We used microsatellite DNA markers to test whether fragmentation of the Trent River (Ontario) has reduced genetic diversity and increased genetic differentiation among populations of river redhorse (*Moxostoma carinatum*) and shorthead redhorse (*M. macrolepidotum*). Allelic richness of both species was significantly greater along the free-flowing Muskegon River (Michigan) than along the fragmented Trent River. Contrary to expectations, there was no evidence of a fragment length effect on genetic diversity, recent population bottlenecks, or increased relatedness among individuals in fragmented populations. High levels of linkage disequilibrium indicate extinction-recolonization population dynamics along the Trent River. For both species, pairwise  $F_{ST}$  tests identified weak but statistically significant population differentiation. In the Trent River, differentiation was significantly greater for river redhorse than shorthead redhorse and, for both species, greater than the Muskegon River. Moderate fragmentation effects likely reflect the permeability of the dam-lock system to redhorse movement. Differences between species indicate that, as a result of smaller effective population sizes, habitat specialists, and species at the periphery of their geographic range are more sensitive to river fragmentation.

Oral CCFFR (River and Estuary Ecosystems)

## THE EFFECT OF ACIDIFICATION ON THE SURVIVAL OF AMERICAN EEL ELVERS

**Reynolds\*** K.C.<sup>1</sup>, R.G. Bradford<sup>2</sup> and P. Bentzen<sup>1</sup>.

<sup>1</sup>Marine Gene Probe Lab, Biology Department, Dalhousie University. <sup>2</sup>Population Ecology Division, Department of Fisheries and Oceans, Bedford Institute of Oceanography. (email: [craig.reynolds@dal.ca](mailto:craig.reynolds@dal.ca))

American eel (*Anguilla rostrata*) has experienced a substantial decline in numbers within specific regions during the last few decades, and has recently been designated as a species of special concern by COSEWIC. The sustainability of the American eel depends ultimately on the abundance of arriving eels from the Sargasso Sea and on their subsequent survival throughout each life stage (elver, yellow and silver eel). Therefore, conservation efforts should be centered on maximizing survival at all stages of the life-cycle. Although the leading causes of eel mortality have not yet been defined, potential key threats have been identified. In some watersheds, particularly in Nova Scotia, these potential threats include high levels of acidity (low pH). The effect of low pH on elver survival was examined in laboratory based trials using wild glass eel/elvers that were captured upon entry to freshwater. Each trial examined the mortality rate of elvers for a specific pH level within the range of 4.0 - 7.0 over a 10 day period. This range of pH values was chosen because it corresponds to the range of ambient pH levels experienced by eels in different Nova Scotia rivers. Initial results show that American eel elvers are highly acid tolerant with zero mortality in acidic environments as low as pH 4.0. Results will further be discussed in terms of sublethal effects by examining differences in growth, pigmentation and behaviour of elvers among treatment pH levels.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## RESPONSE OF FISH AND DOUBLE-CRESTED CORMORANTS TO A LARGE SCALE EGG OILING EXPERIMENT IN THE COASTAL REGIONS OF LAKE HURON.

**Ridgway**<sup>1</sup>, Mark & John Casselman<sup>2</sup>.

<sup>1</sup>Harkness Laboratory of Fisheries Research, Aquatic Research, Ontario Ministry of Natural Resources, Trent University, 2140 East Bank Dr., Peterborough, ON K9J 7B8 (email: [mark.ridgway@ontario.ca](mailto:mark.ridgway@ontario.ca))

<sup>2</sup>Department of Biology, Queen's University, Kingston, Ontario

The role of Double-Crested Cormorants in coastal food webs of the Laurentian Great Lakes is a topic of considerable policy interest. The key question is whether or not a change in cormorant consumption of fish over realistic policy scales leads to a change in the abundance of nearshore fish and the cormorants themselves. Here we describe the results of a large scale management experiment to address this question in coastal regions of the North Channel and Georgian Bay, Lake Huron (2000-2005). Cormorants were estimated to be consuming 2-4 kg/ha at the beginning of the experiment. A staircase design was employed where egg oiling was implemented in a staggered fashion to tease apart site and year effects from effects due to oiling. We found that cormorant nest numbers declined due to oiling activity, then reversed and increased relative to areas that did not receive oiling. We also found that inshore fish biomass (by electrofishing) increased and then declined towards the end of the experiment. Smallmouth bass total catch in a randomized trapnet survey increased due to egg oiling over a coastal scale. We believe the 'scare effect' initially detected in nest numbers was followed by a process of retention/recruitment in nesting birds towards the end of the experiment. This effect was more pronounced in the productive North Channel. The reversal in inshore fish biomass may be due to this retention/recruitment process. The clear increase in smallmouth bass itself points to a large scale connection between cormorant consumption and nearshore fish abundance.

Oral CCFFR (Waterbirds in Marine and Freshwater Food Webs)

## ON BEING FORTUNATE: KNOWING AND WORKING WITH RAM MYERS FROM 1983-2007.

**Rosenberg**, Andrew A.,

Institute for the Study of Earth, Oceans and Space, University of New Hampshire, Durham, NH 03824-3525 (Email: [Andy.Rosenberg@unh.edu](mailto:Andy.Rosenberg@unh.edu))

The life and work of Ram Myers touched many people in many ways, including those who knew him and many who didn't but read, heard or heard of his work. I was tremendously lucky. As I student I landed in the laboratory of Roger Doyle at Dalhousie and there was Ram – and we remained friends thereafter. He changed the way I thought about things every time we talked. Ram's early work on estimating natural mortality was a précis of things to come. He looked at the problem and the data differently, as he did with so many issues in science. His work on stock and recruitment is fundamental and will have a long lasting influence on population dynamics and conservation biology. In addition to these fundamental science papers, Ram changed the debate in marine science. Through all the argument, his influence was fundamentally in how we as scientists look at problems, analyze data and speak out about what we see. As a scientist and as a policy analyst I watched him change the perspective of marine resource management, and he is doing it still.

Oral CCFFR (Ram Myers Session)

## THE EFFECTS OF COMPETITION ON THE GROWTH OF THREE COHABITING JUVENILE GADIDS; GADUS MORHUA, GADUS OGAC, AND UROPHYCIS TENUIS.

**Ross\***, S.E. and R.S. Gregory.

Department of Biology, Memorial University of Newfoundland. Newfoundland, Canada. (e-mail: [seross@mun.ca](mailto:seross@mun.ca))

Intra- and interspecific competition may be important factors affecting the growth and survival of juvenile (age-0) Atlantic cod (*Gadus morhua*), Greenland cod (*G. ogac*), and white hake (*Urophycis tenuis*) in coastal Newfoundland water. Over the past 10 years white hake densities have been increasing, whereas Atlantic cod densities have been decreasing. The primary nursery habitat of all three species is eelgrass (*Zostera marina*). Competition between the three species may limit the access of cohabitants to space and food resources in their preferred habitat. We used 1.0 m<sup>3</sup> enclosures to determine the threshold density for each species in an eelgrass meadow. Juveniles were placed with conspecifics at densities ranging from 1 to 5 fish/m<sup>2</sup>. Interaction effects between species were also determined by placing combinations of the three species together at a density of 2 fish/m<sup>2</sup>. White hake showed higher survival and growth rate than Atlantic and Greenland cod, and Greenland cod show a higher survival than Atlantic cod. This data suggests that white hake may limit the abundance of juvenile cod in eelgrass.

Oral CCFFR (Contributed Paper) (GS)

## ASYMMETRICAL FOOD WEB RESPONSES IN TROPHIC-LEVEL RICHNESS, BIOMASS AND FUNCTION FOLLOWING LAKE ACIDIFICATION: IMPLICATIONS FOR ECOSYSTEM RECOVERY

**Rusak<sup>1\*</sup>**, J.A., K.L. Hogsden<sup>2</sup>, and M.A. Xenopoulos<sup>2</sup>

<sup>1</sup>Center for Limnology, University of Wisconsin – Madison, Boulder Junction, Wisconsin, USA

<sup>2</sup>Department of Biology, Trent University, Peterborough, Ontario, Canada (email: \*jarusak@wisc.edu)

We tested for disproportionate changes in annual and seasonal species richness and biomass among five trophic levels as well as altered trophic structure and ecosystem function following the five-year experimental acidification of Little Rock Lake (Wisconsin, USA) from pH 6.1 to pH 4.7. Abiotic and biotic controls of a changing assemblage structure at each trophic level were also identified. Asymmetric reductions of species richness among trophic levels were evident and changes in trophic structure were most pronounced as pH approached 5. Relative declines in richness of fish and carnivorous zooplankton were greater than herbivores and phytoplankton, which were generally unaffected, leading to a disproportionate reduction of upper trophic level diversity. pH was a direct agent of change for only carnivorous zooplankton, while all other trophic levels were affected more by indirect interactions caused by acidification. Fluctuations in ecosystem function (zooplankton biomass and primary production) were also evident, with losses at all trophic levels only detected during the last year of acidification. The acidified basin displayed a tendency for greater variation in biomass of upper trophic levels relative to reference conditions implying greater unpredictability in ecosystem function. The implications of asymmetrical food web response for subsequent recovery are explored. Together, these results suggest that trophic asymmetry and increased variability following disturbance may be an important and recurring feature of ecosystem response to anthropogenic stress and another factor contributing to delayed recovery in aquatic systems.

Oral SCL (Complexities in Ecological Recovery)

## INVESTIGATION OF POTENTIAL FOR BIAS IN ACOUSTIC ESTIMATES OF ALEWIFE (ALOSA PSEUDOHARENGUS) IN LAKE ONTARIO.

**Schaner\***, T, M. J. Connerton<sup>1</sup>, R. O’Gorman<sup>2</sup>, and L. G. Rudstam<sup>3</sup>.

\*Ontario Ministry of Natural Resources, RR #4, Picton, Ontario K0K 2T0; <sup>1</sup> New York State Department of Environmental Conservation; <sup>2</sup> U.S. Geological Survey; <sup>3</sup> Cornell University (e-mail: [ted.schaner@ontario.ca](mailto:ted.schaner@ontario.ca))

Traditional downward-looking acoustics are used throughout the Great Lakes to assess populations of prey fish. Comparison of alewife population estimates from acoustics with bottom trawling area-swept estimates in Lake Ontario suggests that the acoustic estimates are significantly lower. We examined the vertical distribution of alewife using upward-looking acoustics, in order to assess the acoustic blind region and potential boat avoidance as sources of negative bias.

Poster CCFFR (Contributed paper)

## DO INTRODUCED TROUT AFFECT THE ABUNDANCE AND PATTERNS OF METAMORPHOSIS OF NATIVE AMPHIBIANS?

**Schank**, Candra M.M.\*, Cynthia A. Paszkowski, and William M. Tonn  
Department of Biological Sciences, University of Alberta, Edmonton, AB. T6G 2E9,  
cschank@ualberta.ca\*

Alberta Conservation Association (ACA) and Alberta Sustainable Resource Development (AB SRD) are managing and stocking lakes with salmonids to encourage recreational fishing in the eastern slopes region of Alberta. However, introduced salmonids can cause changes to the structure and processes of a receiving ecosystem, including effects on native biota. We studied 12 lakes in the boreal foothills to document the effects of trout stocking on amphibian communities. Lakes were grouped into three treatments: stocked (n=5), unstocked (n=6), and fishless (n=1). All study lakes contain populations of forage fish, except for the fishless lake. We assessed young-of-year (YOY) amphibian abundance, and timing and size at emergence using transect surveys. Three species of amphibians inhabit the lakes: the wood frog (*Lithobates sylvaticus*), boreal chorus frog (*Pseudacris maculata*) and western toad (*Anaxyrus boreas*). Young-of-year wood frogs were the most abundant species on all lakes, whereas YOY boreal chorus frogs and western toads YOY were only found on a subset of stocked and unstocked lakes. Wood frog YOY abundance tended to be higher in unstocked lakes, compared to stocked lakes. However this was not significant. Date at emergence and median snout-vent lengths of YOY wood frogs did not differ among treatments. A single lake in each of the stocked (without aeration) and unstocked treatments produced exceptionally large number of YOY wood frogs and western toads. Our results suggest that, contrary to results from alpine lakes, trout-stocking does not always have catastrophic effects on amphibian communities.

Poster SCL (Contributed Paper) (GS)

## LINKING ENVIRONMENT, SPATIAL DISTRIBUTION AND FUNCTIONAL TRAITS IN STREAM FISH COMMUNITIES.

**Senay**, Caroline<sup>\*1</sup>, Peres-Neto, Pedro<sup>1</sup>, and Boisclair, Daniel.<sup>2</sup>

<sup>1</sup>Département des sciences biologiques, Université du Québec à Montréal (UQÀM), <sup>2</sup>Département des sciences biologiques, Université de Montréal.  
(email: enay.caroline.2@courrier.uqam.ca)

Description of spatial patterns over a range of scales is important for understanding and modelling the processes that are responsible for species distribution as well as defining appropriate sampling strategies for hypothesis testing. It was only recently recognized that the importance of different environmental factors depends on the spatial scale being investigated. Increasingly, ecologists are also interested in understanding the role that functional traits have on determining distribution. Functional traits are characteristics involving morphology, physiology, and/or behaviour that can be measured at the individual, population, species and community levels. Moreover, traits vary according to their means and variances, which can be also important in determining the type of environments that a species can inhabit. Streams are often organized as a sequence of pools, riffles and runs. This organization allows replicated conditions at different spatial scales regarding habitat type (micro and macrohabitat) and environmental heterogeneity (within and across sites). In this study, we present the results of a field survey of 39 streams that aimed at assessing the links between habitat use, habitat variation and functional traits that influence fish distribution at different spatial scales. The main goals of this study were 1) to model habitat suitability at small (microhabitat) and large spatial scales (stream, watershed), and 2) to study the importance of habitat suitability and heterogeneity as well as morphological traits on species distribution. Moreover, we identify the spatial scales at which environmental variables and morphological features influence fish distribution. Those results are compared across 10 fish species from the Laurentides, Québec.

Oral CCFFR (River and Estuary Ecosystems) (GS)

## GENERAL EMPIRICAL MODELS FOR PREDICTING THE RELEASE OF NUTRIENTS FROM FISH WITH A COMPARISON BETWEEN DETRITIVORES AND NON-DETRITIVORES

**Sereda, Jeff M\***, Jeff. J. Hudson, Philip D. McLoughlin

Department of Biology University of Saskatchewan (e-mail: jeff.sereda@usask.ca)

We developed empirical models for predicting the release of nutrients (N and P) by fish communities across aquatic systems. We obtained fish release rates from studies that directly measured the release of nutrients from 56 species of fish across a broad range in fish mass, feeding histories, and water temperature. Models were developed for two groups of fish species based on feeding habits: detritivores and non-detritivores. Four models of nutrient release were derived from multiple regression analysis: detritivore release rates of N ( $n = 371$ ,  $R^2 = 0.79$ ,  $p < 0.001$ ) and P ( $n = 384$ ,  $R^2 = 0.88$ ,  $p < 0.001$ ); and non-detritivore release rates of N ( $n = 260$ ,  $R^2 = 0.93$ ,  $p < 0.001$ ) and P ( $n = 188$ ,  $R^2 = 0.82$ ,  $p < 0.001$ ). Fish mass explained the majority of the variance (78–92%) in release rates. Release rates of P predicted by the models were comparable to rates obtained from other studies for lakes containing similar fish biomass. The influence of a diet shift (planktivory to detritivory) by a single species (gizzard shad, a facultative detritivore) on nutrient release rates was large. During periods of detritivory gizzard shad accounted for up to 98% of all nutrients released by fish, and increased release rates by an average of 134%. These models provide a rapid means for predicting the release of nutrients by fish communities. In addition, they will assist with putting fish into context with other internal and external nutrient pathways.

Oral SCL (Contributed paper) (GS)

## STREAM AND CATCHMENT SCALE EFFECTS ON FISH CONDITION AND COMMUNITY COMPOSITION IN AN AGRICULTURAL LANDSCAPE.

**Smedley\***, R., R.A. Curry, J.Culp, and M. Gray.

Canadian Rivers Institute, Department of Biology, University of New Brunswick, Fredericton, New Brunswick. (roz.smedley@unb.ca)

Agricultural land-use can cause significant sediment input into adjacent streams. The severity of effects of suspended sediment input on fish has been modeled for southern USA streams based on duration and intensity of the sediment event, i.e., suspended sediment where effects is scored from no impact to mortality of fishes. The project will test the severity of ill-effects (SEV) impact assessment model in northern New Brunswick, a region comprising Canada's third largest potato production region. Sixteen sites comprising a gradient of agricultural impact are being used to assess stream and catchment scale effects on fish. Environmental variables, such as suspended sediment levels, were collected throughout the agricultural season while electrofishing surveys were conducted in the late summer. The relationship between fish condition and environmental variables is explored to determine the most significant impact on health and community composition. Preliminary work found lower fish abundance in streams within the most intense potato production. Continuing research will establish the link between SEV, suspended sediment loading and other increased pressures from agriculture and the impacts on fish in Canadian waters.

Oral CCFFR (River and Estuary Ecosystems) GS)

ARCTIC SEABIRDS AS BIOVECTORS FOR THE TRANSPORT OF MARINE-DERIVED  
NUTRIENTS AND CONTAMINANTS TO POLAR LAKES AND PONDS: A  
PALEOLIMNOLOGICAL PERSPECTIVE

**Smol\***, John P.<sup>1</sup>, Bronwyn Keatley<sup>1</sup>, Marianne S.V. Douglas<sup>2</sup>, Neal Michelutti<sup>1</sup>, Mark Mallory<sup>3</sup>, and Jules Blais<sup>4</sup>

<sup>1</sup>Paleoecological Environmental Assessment and Research Lab (PEARL), Dept. Biology, Queen's University, Kingston, Ont. K7L 3N6, Canada. <sup>2</sup>Canadian Circumpolar Institute, University of Alberta, Edmonton, Alberta. <sup>3</sup>Canadian Wildlife Service, Iqaluit, NU; <sup>4</sup>Dept. Biology, University of Ottawa, Ottawa; \*Author for correspondence ([SmolJ@Queensu.Ca](mailto:SmolJ@Queensu.Ca))

The Canadian Arctic is an important breeding ground for many seabirds. Determining the histories of bird colonies is critical to understanding whether current fluctuations in seabird populations are within the range of natural variability, as well as a suite of other scientific and management questions. Such data would also help set realistic management goals, and identify important, long-term bird habitats. Moreover, it is now becoming clear that seabirds can dramatically alter terrestrial ecosystems. This presentation will summarize our limnological and paleolimnological research detailing how seabirds transport significant quantities of marine-derived nutrients and contaminants to freshwater systems via their guano. Here, we assess the influence of seabirds on the present-day limnology of high Arctic ponds at Cape Vera, Devon Island, Nunavut. A large colony of northern fulmars (*Fulmarus glacialis*) nests in the cliffs along Cape Vera. Below these cliffs are many ponds that reflect a gradient of productivity that can be linked to seabird influence. This paper summarizes the limnological and paleolimnological data from a suite of these study ponds, documenting the influence of marine-derived nutrients and contaminants on these sensitive ecosystems, both on a spatial and temporal (i.e. paleolimnological) gradient.

Oral SCL (Waterbirds in Marine and Freshwater Food Webs)

MODELING PHOSPHORUS CONCENTRATION IN NOVA SCOTIA LAKES USING THE ONTARIO  
LAKESHORE CAPACITY MODEL: TRACKING CHANGES IN TROPHIC STATUS AND  
IDENTIFYING SHORELINE DEVELOPMENT CAPACITIES.

**Soliman**, Christina<sup>\*1</sup>, Peter Dillon<sup>2</sup>, Julian Aherne<sup>3</sup> and David Lasenby<sup>4</sup>

<sup>1</sup>Watershed Ecosystems Graduate Program, Trent University; <sup>2</sup>Environmental and Resource Studies and Chemistry, Trent University; <sup>3</sup>Canada Research Chair in Environmental Modeling, Trent University; <sup>4</sup>Biology Department, Trent University. (email: [christinasoliman@trentu.ca](mailto:christinasoliman@trentu.ca))

Because phosphorus has been implicated as the primary limiting nutrient in most freshwater aquatic systems (SCHINDLER ET AL. 1971), controlling its input rate into these systems is an effective means of managing trophic status. Excess inputs result in increased growth of algae and other aquatic plants, increased respiration, as well as changes in species composition, assemblage and diversity. An abundance of algae and plants can also cause taste and odour concerns, as well as negative human health and recreational consequences. In Nova Scotia (NS), Canada, there is concern that surface water quality has deteriorated since human settlement and could further deteriorate from increasing shoreline development. The goal of this study was to test the ability of an existing model (the Ontario Lakeshore Capacity Model LCMv.3.0) to predict current phosphorus levels and to determine pre-settlement phosphorus levels in 34 lakes in NS. Once calibrated, the LCMv.3.0 was used to make recommendations for future development. Model performance, sensitivity and uncertainty are discussed.

Poster SCL (Ecosystem-based Management – Science and Policy) (GS)

## SEASONAL SPATIAL DISTRIBUTION, HABITAT PARTITIONING, AND TEMPERATURE OF OCCUPANCY OF LAKE ONTARIO CHINOOK SALMON AND RAINBOW TROUT

**Stewart\***, T. J. and J. N. Bowlby.

University of Toronto at Mississauga, 3359 Mississauga Rd. N., Mississauga ON L5L 1C6

(email:stewartt@utm.utoronto.ca)

Chinook salmon (*Oncorhynchus tshawytscha*) and rainbow trout (*Oncorhynchus mykiss*) are important top-predators in the Great Lakes but little is known about their distributions. We describe their seasonal catch depth and bottom depth distribution, and temperature of occupancy from 1997-2005 using angling catch rates and a cross-validated model of Lake Ontario temperatures. We test the hypotheses that these species partition available habitat, test for differences in occupied temperatures, and assess trends. In April, Chinook salmon were caught deeper (7-11 m) than rainbow trout (4-7 m) but both species were found nearshore (20 m). During May and June, both species moved deeper and farther offshore occupying similar habitat. In July and August, catch depth distributions were similar, but rainbow trout were found further offshore (40-70 m) than Chinook salmon (35-55 m). In September, Chinook salmon moved closer to shore (25-45 m) and to shallow water (10-14 m), while rainbow trout remained offshore (40-70 m) in deeper water (12-21 m). The species occupied significantly different habitats except during May and June. Seasonal occupied temperatures were not significantly different and ranged from ~13-15°C during August and September. There was a trend to an increasing depth of capture for both species, a trend to increasing bottom depth of capture for rainbow trout, but no trends in occupied temperatures. Lake Ontario Chinook salmon and rainbow trout segregated in space, but occupied similar temperatures different than previously assumed in bioenergetic models, and may have moved with their prey to deeper depths.

Oral CCFFR (Contributed paper)

## MOLECULAR CLONING AND EXPRESSION OF OPSIN GENES DURING LARVAL AND JUVENILE DEVELOPMENT IN THE CHUB MACKEREL *SCOMBER JAPONICUS*

**Suzuki<sup>1</sup>**, Takashi, Shinji Yamamoto<sup>2</sup>, Osamu Murata<sup>2</sup>, and Yasunori Ishibashi<sup>1\*</sup>

<sup>1</sup>Department of Fisheries, School of Agriculture, Kinki University, Naka, Nara 631-8505, Japan,

<sup>2</sup>Shirahama Experiment Station, Fisheries Laboratory, Kinki University, Kogaura, Shirahama, Wakayama 649-2211, Japan (\*email: isibashi@nara.kindai.ac.jp)

To detect the expression time of opsin genes during fish development, we cloned amplified fragments encoding exon 4 of opsin cDNAs obtained from the retina of Chub mackerel and examined the differences in the expression time of each opsin gene during larval and juvenile development. Total RNA was extracted from the retina and pineal body of a young fish. The total RNA was reverse transcribed using a T-primer. Degenerate primers designed on the basis of conserved amino acid sequences of vertebrate opsin proteins were used to amplify the cDNA fragments encoding visual pigments by PCR. PCR products of 210 bp were subcloned into the pGMT vector and sequenced. RT-PCR was performed using opsin-specific primers individually designed on the basis of each opsin sequence in order to determine the expression time of each opsin gene during the larval and juvenile development. Based on the sequence homology with previously characterized fish visual pigments, 1 clone was identified as blue opsin (Sj-B); 2 clones, as green opsin (Sj-G1, Sj-G2); and 1 clone, as rhodopsin (Sj-Rod). Red opsin and ultraviolet opsin genes were not obtained. RT-PCR analysis showed that the expression of the genes Sj-B, Sj-G1, Sj-G2, and Sj-Rod in the larva started from 4, 0, 1, and 6 days post-hatching, respectively. Thus, the sequence of opsin gene expression in the Chub mackerel was Sj-G1, Sj-G2, Sj-B, and Sj-Rod. This was different from the sequence of expression of these genes in salmonid and cyprinid fishes.

Poster CCFFR (Contributed paper)

## CONCORDANCE OF TERRESTRIAL AND AQUATIC RECOVERY: DOES FULL RECOVERY OF AQUATIC SYSTEMS HAVE TO AWAIT IMPROVEMENTS ON THE LAND?

**Szkokan-Emilson, E.\***, B. Wesolek, and J. Gunn.

Cooperative Freshwater Ecology Unit, Biology Department, Laurentian University, Sudbury, Ontario.  
(email: Ex\_SzkokanEmilson@laurentian.ca)

Daisy Lake is in very close proximity (3.5-6.5 km) to an abandoned Cu and Ni smelter in Coniston near Sudbury, Ontario. The smelter began operation in 1913 and severe soil erosion (sediment cores) and a major shift in forest composition (pollen data) followed soon after. Paleolimnological reconstructions based on the occurrence of acid and metal tolerant diatom and chrysophyte species suggested that the buffering capacity of the lake was not lost until about 1940. Since the smelter's closure and the opening of the 381 m high "Super Stack" (1972) emissions reductions have decreased atmospheric deposition of sulphate and particulate metals by about 90%. Lake chemistry data shows a steady and rapid reversing of the metal and acid damage from 1991 to 2007. The fish community is recovering, and reproductive success of the Common Loon (*Gavia immer*) was observed in 2003 for the first time in 20 years. Re-growth of forest and vegetative layers in the watershed of Daisy Lake is also evident, but the landscape remains relatively barren. Monitoring from 1991 to 2001 of an inlet stream shows a slow recovery with slight increase in pH and decreases in SO<sub>4</sub> and metal concentrations (Al, Ni, Zn, Pb) of the water draining into Daisy Lake from the recovering watershed. It is evident that destruction to the landscape preceded the damage in the lake, and it appears that the opposite is true in the recovery process. Daisy Lake's biota is recovering but there is still room for improvement, and the absence of a healthy watershed may be lagging the response in the lake.

Poster CCFR (Complexities in Ecological Recovery) (GS)

## LANDSCAPE-SCALE PATTERNS OF ZOOPLANKTON COMMUNITY STRUCTURE IN LAKES RECOVERING FROM ACIDIFICATION AND METAL CONTAMINATION

**Valois\***, A<sup>1</sup>., C. Ramcharan<sup>1</sup>., W. Keller,<sup>1,2</sup>., and G.E. Morgan.<sup>3</sup>

<sup>1</sup>Department of Biology, Laurentian University, Sudbury, ON; <sup>2</sup>Ontario Ministry of the Environment, Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, ON; <sup>3</sup>Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury ON

Identifying patterns in community organization and explaining the processes that govern these patterns in space and time is one of the most fundamental concepts in ecology. We now know a good deal about how abiotic and biotic factors influence zooplankton community structure, however, lakes that are industrially damaged offer new challenges to our understanding. Although often recovered in terms of pH, many of the lakes in the Sudbury area have residual metal contamination and fish communities that are variously missing piscivores and planktivores. In 2005, we surveyed the zooplankton of 93 lakes in the Sudbury area along gradients of nutrient levels, DOC, metal contamination, and planktivorous fish abundance. The goal of this survey was to assess large-scale patterns of zooplankton community composition in lakes, to assess the relative importance of environmental and geographic factors affecting their composition, and to evaluate the implication of these patterns for the use of zooplankton as indicators of water quality, particularly acidification and metal contamination. Preliminary analysis of geographic patterns of zooplankton communities failed to reveal any strong relationships between zooplankton metrics and physico-chemical lake characteristics, including metal contamination. Instead, strong top-down effects seem evident. With the absence of top predators, many lakes are dominated by planktivores, and their strong, size-selective predation on cladocerans may be slowing or even stalling recovery of this vulnerable prey. The results of an analysis of a subset of lakes for which zooplankton, chemistry, and relative fish data are available will be discussed.

Oral SCL (Complexities in Ecological Recovery)

## EXPLOITATIVE COMPETITION BETWEEN ANGLER GROUPS LIMITS POTENTIAL CATCH OF VISITING ANGLERS

**van Poorten\***, B.T., M.A. Hawkshaw, E.A. Parkinson and C.J. Walters.  
Fisheries Centre, University of British Columbia, Vancouver, BC (email: [b.vanpoorten@fisheries.ubc.ca](mailto:b.vanpoorten@fisheries.ubc.ca))

Recreational angling is practiced by people with a wide variety of skills and experience. While some anglers are highly skilled and have fished a particular lake or river stretch many times in the past, others are visiting for the first time. Local, highly skilled anglers will have knowledge about a particular population that will lead to higher catch rates than visiting anglers. We theorize that when a lake fishery opens in the spring, most anglers are local and present in high numbers. Recent research suggests that released fish have a lower catchability than previously uncaught fish. Therefore, between harvest and lower catchability of a subset of the population, catch rates will rapidly decline. As the season progresses, experience shows that local angling effort will decrease as catch rates drop below what is considered worthwhile. When visiting anglers arrive later in the summer, catch rates are lower due to both the inferior skills of these anglers and the often drastic reduction in abundance of catchable fish. In the long-term, this can lead to dissatisfaction of visiting anglers and may reduce angling tourism to the area. We explore the plausibility of a recreational fishery with two competing groups using field data and models.

Oral CCFFR (Contributed paper) (GS)

## INVASION DYNAMICS OF ROUND GOBY (*Neogobius melanostomus*) IN HAMILTON HARBOUR, LAKE ONTARIO

**Vélez-Espino**, Luis A. \*, Marten A. Koops, and Sigal Balshine  
Email: [VelezEspinoLA@dfo-mpo.gc.ca](mailto:VelezEspinoLA@dfo-mpo.gc.ca)

Most introductions of non-native species fail to establish soon after introduction either through mortality or reproductive failure. The presence of an established population increases the probability of survival and reproductive success of new propagules by avoiding both Allee effects and demographic stochasticity. Previously, attention has been paid to the establishment phase of the invasion process and the probability of establishment has been modelled as a stochastic process, while the spread phase and habitat saturation has received little attention. We model this aspect of the invasion process as a stochastic progression. We use the invasion dynamics of round goby, *Neogobius melanostomus*, in Hamilton Harbour, Lake Ontario, as a case study. Our modelling predicts that (1) propagule pressure in the form of adults can be very low and still represent a significant probability of establishment, (2) much higher concentrations of juveniles would be needed to pose a significant risk of invasion, (3) the round goby exhibited a short time lag between arrival and establishment, probably establishing before it was detected, and (4) very aggressive management actions would be needed to halt population growth after the population has established. This suggests that preventative measures are the most effective management options available to reduce the risk of future invasions.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives)

AN EMPIRICAL EXAMINATION OF THE THEORY OF ALTERNATIVE STABLE STATES IN SHALLOW LAKES: THE IMPACT OF NUTRIENT ENRICHMENT ON ENVIRONMENTAL VARIABILITY.

**Vermaire J. C.\*<sup>1</sup>**, I. Gregory-Eaves<sup>1</sup>, T.A. Davidson<sup>2</sup>, C.D. Sayer<sup>2</sup>, and R.W. Bachmann<sup>3</sup>

<sup>1</sup>Department of Biology, McGill University, Montreal, Canada; <sup>2</sup>Department of Geography, University College London, London, U.K; <sup>3</sup>Department of Fisheries and Aquatic Sciences, University of Florida, Gainesville, U.S.A (email: [jesse.vermaire@mail.mcgill.ca](mailto:jesse.vermaire@mail.mcgill.ca))

The theory that eutrophic shallow lakes exist in two alternative stable states (AltSS) has increasingly become the dominant paradigm in shallow lake ecology. The standard AltSS model for shallow lakes predicts that at low and very high nutrient levels only a single state is possible (a clear water macrophyte-dominated state and a turbid water phytoplankton-dominated state respectively). In eutrophic lakes however two stable states are possible: a clear-water state dominated by macrophytes and a phytoplankton-dominated state with turbid water. Because natural systems are inherently variable it is not expected that shallow lakes clearly fall on the equilibrium line but rather they would cluster around these basins of attraction. A simple prediction based on this model is that systems with a single equilibrium should have lower variability than systems with alternate equilibrium. Therefore in a snapshot of shallow lakes from a region, the variability in turbidity should be greater for eutrophic lakes where two equilibria are expected compared to oligotrophic lakes where a single equilibrium is expected. We are testing this prediction with a 319 shallow lake data set (mean depth < 4m) that spans three different geographic regions (northeast U.S., 109 lakes; Florida, 171 lakes; and Europe, 39 lakes). We are using a randomization test and the coefficient of variation in turbidity to quantify changes in variability across the nutrient gradient. We are also exploring the sensitivity of this randomization test based on 1000 simulated lakes with varying magnitudes of state shifts.

Poster SCL (Contributed paper) (GS)

MULTILOCUS MICROSATELLITE DNA ANALYSIS AS A STOCK DELINEATOR IN MIGRATORY BULL TROUT.

**Warnock\***, W.G. and J. B. Rasmussen.

Department of Biological Sciences, University of Lethbridge, Lethbridge, Alberta  
(email: [will.warnock@uleth.ca](mailto:will.warnock@uleth.ca))

Bull trout (*Salvelinus confluentus*) populations in Alberta have declined greatly relative to historical levels in both their range of occurrence and abundance due to overharvest and habitat degradation. Previous studies have shown that with low effective population sizes, high homing precision in migrants and low dispersal in residents, bull trout exhibit high interpopulation but low intrapopulation genetic diversity. This type of genetic structure is ideally suited for assigning migrants from a mixed migrant population to their stream of origin using genetic analysis. In 2006, we sampled 41 bull trout belonging to mixed migrant groups in the Oldman River basin, Alberta. All fish were genotyped across 9 microsatellite loci. The genotypes of these migrants were then compared to 8 putative populations from which they may have arisen. Genetic mixture analysis was performed to assign each fish to the population from which it had the highest likelihood of belonging according to a Bayesian estimator. Results of this study can be used to identify populations which contribute the most migrant individuals to the basin, and which ones are isolated and may be more susceptible to local extinction events.

Poster CCFFR (River and Estuary Ecosystems) (GS)

## DENSITY OF JUVENILE ATLANTIC (GADUS MORHUA) AND GREENLAND COD (G. OGAC) WITH SPATIAL EXPANSION AND RECOVERY OF EELGRASS (ZOSTERA MARINA)

**Warren\***, M.A.<sup>1</sup>. and R.S.<sup>2</sup>. Gregory.

<sup>1</sup>Memorial University of Newfoundland, <sup>2</sup>Fisheries and Oceans Canada. (\*margaretwarren@warp.nfld.net)

Eelgrass (*Zostera marina*) is well known to provide productive nursery habitat for young marine fishes and invertebrates. The spatial extent of eelgrass throughout much of its current range is in decline, mainly due to anthropogenic causes, climate change, and pathogens. In coastal Newfoundland, Canada, there has been no such evidence of decline. In our study area – Newman Sound, Newfoundland – the plant has been expanding. We investigated the consequences of these naturally expanding and recovering eelgrass beds on the densities of juveniles for two cod species – Atlantic (*Gadus morhua*) and Greenland (*G. ogac*) cod – in the field. We sampled juvenile fish densities in 12 sites, using a 25 m demersal seine net at 10-11 two-week intervals July to November each year, over an 11 year period, 1995-2006 (no sampling 1997). At two of our sites, an eelgrass removal experiment was conducted in 1999 and 2000 and artificial eelgrass was temporarily added in two "non-vegetated" sites. We used a Randomized Intervention Analysis technique (sensu Carpenter et al. 1989) to determine annual changes in relative density of post-settled age-0 cod. We obtained eelgrass percentage substrate cover densities for each site from aerial photographs of our sampling sites in 2000-2002 and 2006, using a "box counting" method. Since the 1999 and 2000 manipulations, eelgrass cover in the two removal sites had noticeably increased. Three natural expansion sites showed a positive relationship between percent eelgrass cover and relative fish density. This suggests significant and rapid increases in age 0 cod density associated with eelgrass habitat expansion and recovery following a disturbance.

Oral CCFFR (Complexities in Ecological Recovery)

## IS THERE PROGRESS TOWARD ECOSYSTEM-BASED MANAGEMENT

**Waters**, C.L.<sup>1,2</sup>, <sup>1</sup>Memorial University of Newfoundland and Labrador, <sup>2</sup>Fisheries and Oceans Canada, St. Andrews Biological Station

One of the most significant challenges facing the Canadian fishing industry and fisheries management is meeting the increasingly rigorous national and international standards for conservation and the inclusion of socio-economic objectives to create an ecosystem based approach to resource management. The requirements for an ecosystem based approach were outlined and used to examine the existing management plans that govern the Grand Manan gillnet fishery in the Bay of Fundy. The results showed that there has been some progress toward an ecosystem based approach by the inclusion of management boards, the development of the harbour porpoise management plan and by the inclusion of such management measures as spawning area closures and the small fish protocol. However, it was found that there is a need for additional consideration of other issues such as right whale entanglement, ghost fishing and noise levels in addition to the inclusion of more socio-economic objectives. It is recommended that all fisheries management plans incorporate the outlined structural process and include the conservation and socio-economic objectives in order to fulfill nationally and internationally obligations.

Poster CCFFR (Ecosystem-based Management: Science and Policy)

## FACTORS INFLUENCING THE PRESENCE OF AN INVADING MACROINVERTEBRATE PREDATOR, BYTHOTREPHES LONGIMANUS, IN CANADIAN SHIELD LAKES

**Weisz\***, E. and N. Yan.

Department of Biology, York University, Toronto (email: eweisz@yorku.ca)

The Eurasian aquatic invader, *Bythotrephes longimanus*, has spread rapidly throughout southern Ontario and parts of northern United States since its initial discovery in the Great Lakes in 1982. In Muskoka, Ontario, more than 40 lakes have confirmed Bythotrephes populations. Bythotrephes reduces cladoceran zooplankton richness and abundance, thus causing an increase in rotifer density, effects which could propagate up the food web and negatively impact the lake-based tourism economy of the Muskoka region. In order to determine effective strategies to control the spread of Bythotrephes, we must determine the vectors of its dispersal and geographic characteristics that facilitate its establishment. A survey of 200 lakes was conducted in the Muskoka watershed to determine the importance of lake size, hydrological connection, and various physical, chemical, and human use parameters in predicting the spread of Bythotrephes. Univariate and multivariate analyses revealed that invaded lakes differ physically and chemically from uninvaded lakes. Most significantly, invaded lakes are much larger in size. Contingency analyses indicated that invaded lakes are more accessible to humans and have a greater proportion of waterfront homes than uninvaded lakes. Shoreline coverage by cottages was the strongest predictor of Bythotrephes presence when all variables were included in a logistic regression model. As the parameters most strongly linked with Bythotrephes presence were those related to human use, we hypothesize that humans are primarily responsible for the spread of Bythotrephes.

Oral SCL (Population Processes at Low Abundance –Recovery, Rarity and Invasives) (GS)

## SPATIAL PATTERNS IN BENTHIC INVERTEBRATE RECOVERY: USE OF SITE SPECIFIC AND SUBCATCHMENT SCALE VARIABLES TO PREDICT CHANGE

**Wesolek\***, B., E. Szkokan-Emilson, and J. Gunn.

Cooperative Freshwater Ecology Unit. Department of Biology, Laurentian University, Sudbury, Ontario. (bx\_wesolek@laurentian.ca)

In the Sudbury region, both the lakes and their terrestrial catchment areas are severely impacted by acid and metal deposition from nickel-copper smelters. Daisy Lake is within the severely damaged area and is located 3.5 km away from the abandoned Coniston smelter. This long, narrow lake extends 3 km southwest along a pollution gradient and has 14 distinct subcatchments (2-38 ha) with seasonally intermittent streams and four basins within the lake itself. Biological recovery within Daisy Lake and linkages to the terrestrial recovery of its watershed is being addressed using the spatial gradients evident across these subcatchments and basins. The use of aerial photo interpretation and GIS software reveal a terrestrial vegetation gradient recovering from west to east across the Daisy Lake watershed. Similar trends are seen in soil quality measurements (soil respiration and humic layer depth) within subcatchments. However, GIS analysis also reveals differences in physical landscape variables like slope across subcatchments. Water chemistry data of Daisy Lake's intermittent streams also shows spatial variation in pH. Site specific littoral habitat surveys of subcatchment sediment fans show variability in the products of physical and chemical conditions of the terrestrial inputs. Leaf pack colonization and traveling kick and sweep techniques reveal differences in benthic invertebrate communities at the aquatic-terrestrial interface of each subcatchment. Implications of this study will help determine which spatial variables best predict benthic invertebrate recovery within acid damaged lakes.

Poster CCFFR (Complexities in Ecological Recovery) (GS)

## TOWARD UNRAVELING THE INVASION PARADOX: EVOLUTIONARY ECOLOGY OF INTRODUCED BROWN TROUT IN NEWFOUNDLAND

**Westley**, P.A.H. \*, D.W. Ings, and I.A. Fleming  
Ocean Sciences Centre, Memorial University of Newfoundland  
\*(email: [pwestley@mun.ca](mailto:pwestley@mun.ca))

Natural selection is predicted to favour individuals adapted to local environmental conditions and to ultimately result in resident advantage (i.e. local adaptation). Paradoxically, invasive species that have evolved elsewhere and are not adapted to local conditions are often capable of out-competing and displacing presumably superior populations. Ecologists suggest that differences in biotic and environmental resistance, human disturbance, and natural enemies can explain the patterns of invasion successes and failures. Unfortunately, none of these hypotheses provide robust explanations for perplexing patterns of global salmonid invasions. In this talk we discuss a project that aims to use brown trout introductions to Newfoundland as a model system for testing emerging evolutionary hypotheses. Initial findings suggest that natural colonization via anadromous straying is wide-spread and non-random throughout insular Newfoundland, although the dynamics leading to colonization success or failure are currently unclear.

Oral CCFFR (Evolutionary Ecology of Marine and Freshwater Ecosystems)

## SCIENCE AND ACTION: WINDERMERE BASIN CASE STUDY

**Wichert**, G.A.,  
Gartner Lee Limited, Markham, ON (Email: [gwichert@gartnerlee.com](mailto:gwichert@gartnerlee.com))

The restoration of Windermere Basin project, presently underway, provides a case study opportunity to examine the dynamic interactions among policy objectives for the Basin, and associated scientific findings. Restoration of the Basin requires the integration of multiple technical fields of inquiry with sometimes competing objectives under the scrutiny of a public process. A multidisciplinary team was assembled to investigate and provide insight to multi-jurisdictional policy objectives, and more technical aspects including engineering, water flow and sediment transport, ecological assessment, and human health and ecological risk assessments. Located in the southeast part of Hamilton Harbour, Windermere Basin represents an expression of relatively narrow focused industrial-urban land use. The Basin was transformed during the 1950s and 1960s from a natural wetland by extensive filling to support Hamilton's key industrial and port needs. Windermere Basin receives flow from Redhill Creek, treated and wet weather overflows from the Woodward sewage treatment plant, and discharge from combined sewer overflows (CSOs) and CSO storage tanks. The Basin also supports numerous colonial waterbirds and some fish species. The City of Hamilton identified numerous objectives after the Hamilton Harbour Commission transferred the Basin to the City in 2000. These objectives include: a sustainable solution for dredging the basin; coordination with the Hamilton Remedial Action Plan; improvements to environmental quality; habitat creation; recreational opportunities; and development of greenspace for a gateway to Hamilton. Achievement of the multiple objectives is the balance sheet by which success of the policy-science interaction can be measured.

Oral CCFFR (Ecosystem-based Management – Science and Policy)

## POPULATIONS IN DECLINE: EARLY LIFE HISTORY RESPONSE OF ENDANGERED ATLANTIC SALMON TO INADVERTENT SELECTION DURING CONSERVATION BREEDING

**Wilke\***<sup>1</sup>, N.F., I.A. Fleming<sup>1</sup> and P. O'Reilly<sup>2</sup>.

<sup>1</sup>Ocean Sciences Centre, Memorial University, St. John's, NL ([nfwilke@mun.ca](mailto:nfwilke@mun.ca)).

<sup>2</sup>Bedford Institute of Oceanography, Department of Fisheries and Oceans, Halifax, N.S.

In recent decades, rapid environmental change wrought by anthropogenic influences has resulted in steep population declines for various species worldwide. As populations decrease drastically, managers attempt to protect remaining individuals in efforts to conserve populations as a whole. Captive and supplemental breeding programs have been and will continue to be involved heavily in such conservation and restoration efforts. One such case is New Brunswick's Atlantic salmon of the Inner Bay of Fundy (iBoF), which were listed as endangered in 2001. Currently, iBoF populations undergo an intensive, pedigree-based captive breeding and supplementation program. Such programs face distinct challenges including, but not limited to, adaptation to captive conditions as a result of inadvertent artificial selection (domestication). While there is evidence to suggest that domestication can indeed lead to behavioral variation among populations, it is unclear how quickly, or even if, such divergence may occur in conservation programs aimed at limiting it. We are using up to 3 generations of pedigree information to conduct an intensive study investigating the effects of domestication on the behavior, growth and survival of endangered Atlantic salmon in captivity and in the wild. This talk will address two components of the larger study: 1) Does limited and inadvertent domestication influence egg and yolk-sac fry survival; and, 2) Does limited and inadvertent domestication influence dominance in dyadic lab trials? This study will help uncover the rate at which domestication may or may not influence the early life history of small populations undergoing conservation breeding.

Oral CCFFR (Population Processes at Low Abundance –Recovery, Rarity and Invasives) (GS)

## NUTRIENT RECYCLING BY STREAM FISH ASSEMBLAGES

**Wilson H.F.\***<sup>1</sup>, M. A. Xenopoulos<sup>1,2</sup>.

<sup>1</sup>Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario. <sup>2</sup>Biology Department, Trent University, Peterborough, Ontario. (email\*: [henrywilson@trentu.ca](mailto:henrywilson@trentu.ca))

Fish can play an important role in nutrient cycling by supplying nutrients (N, P) to freshwater ecosystems. Here we examined the overall contributions of excreted N and P by fish assemblages in 12 temperate streams along a gradient of land use (10% to 90% cropland). In addition, to calculate the relative importance of nutrients excreted by each fish assemblage we quantified the whole-stream uptake velocity of N and P in one highly agricultural and one relatively pristine stream. Fish excretion rates are consistently predictable based on body size. We used these predictable relationships to estimate overall excretion by each fish assemblage across our study area. Preliminary results indicate that N and P excreted by fishes explains very little of the overall demand for these nutrients (0.05 to 2%). However, our results indicate that the role played by fishes in nutrient cycling changes significantly with watershed land use. The overall amount of N and P excreted by fish assemblages increases exponentially with the amount of agricultural land use in each watershed. This pattern appears to be largely driven by changes in species composition and body size distributions.

Oral SCL (Physical Limnology and Oceanography – Influences on Populations and Ecosystems) (GS)

## THE INFLUENCE OF EXCHANGEABLE BASE CATIONS OF CATCHMENT SOILS ON THEIR CORRESPONDING ION CONCENTRATIONS IN 34 HEADWATER LAKES IN NOVA SCOTIA

**Wolniewicz\***, M.B., J.Aherne, P.J. Dillon, and C.J. Whitfield.

Watershed Ecosystems, Trent University (email: martawolniewicz@trentu.ca)

During the 1970s and 1980s the acidification of surface waters by atmospherically deposited sulphur became a major international concern. As a result sulphur emission control programs have been implemented across North America and Europe and surface water recovery was anticipated. While some initial surface water recovery has been observed, many lakes still remain acidified. Surface water ability to recover has been attributed to ion exchange properties of catchment soils, specifically the size of base cation pools available to buffer incoming acid. In current study, the influence of soil ion exchange characteristics on lake water chemistry for 34 headwater lakes in Nova Scotia was evaluated. Water and soil samples were collected during two consecutive years (2004 and 2005). To determine catchment soil chemistry, samples were collected from a minimum of 3 soil profiles within each lake's basin area. Lumped catchment averages of exchangeable base cations (calcium, magnesium, sodium and potassium) from surface soils (LFH and A horizons) and soils at lower depths (horizons B and BC) were regressed against their corresponding ion concentrations in lake waters. Of the two soil depths considered, surface soils exhibited a larger influence on water chemistry. However, the best predictive model derived in this study (with exchangeable calcium of the upper soil horizons explaining 20 percent of variation in lake water magnesium concentration) suggests that lake base cation concentrations weakly reflect that of concurrent soil counterparts.

Poster SCL (Complexities in Ecological Recovery) (GS)

## SPATIAL PREDICTIONS OF UNIONID POPULATIONS BASED ON FISH DISTRIBUTION IN THREE SOUTHWESTERN ONTARIO RIVERS

**Woolnough, D. A.\*<sup>1</sup>**

<sup>1</sup>Biology Department, Trent University, Peterborough, Ontario. (email\*: daelynwoolnough@trentu.ca)

In order for freshwater mussels (Family: Unionidae) to survive, their distribution must spatially and temporally overlap with their hosts. Spatial patterns in unionid communities and their host fish were examined to determine the degree of biological connectivity among mussel beds that host fish provide. Because the analyses accounts for heterogeneity within the river reaches they can be used to predict the success of unionid populations. We can increase the likelihood of survival by artificially rearing the juveniles in the lab to augment populations yet once reared the decisions about where to transplant these individuals into "recovery habitat" must not rely solely on where species are currently. I considered the spatial patterns of host fish and non-host fish by collecting fish in ~ 2.5 km reaches of three rivers in southwestern Ontario (Sydenham, Thames, and Ausable) in areas where spatially explicit unionid data was available from excavation surveys. Fish communities from the centre, left and right banks for 50m sections of the river was explicitly mapped and prediction surfaces made for host communities. Host communities for 6 unionid species were compared to see if the biological connectivity of Species at Risk (SAR) provided by host fish between known mussel locations differed from the biological connectivity provided by hosts to more common species of freshwater mussels.

Oral CCFFR (Ecosystem-based Management – Science and Policy)

## COLONIZATION OF AQUATIC ECOSYSTEMS AFTER URBAN DEVELOPMENT

**Woolnough, D. A.\*<sup>1</sup>, M. A. Xenopoulos<sup>1</sup>, L.S. McAlister<sup>1</sup> and P.C. Frost<sup>1</sup>**

<sup>1</sup>Department of Biology, Trent University, Peterborough, Ontario.  
(email\*: daelynwoolnough@trentu.ca)

The colonization of ‘newly formed’ water bodies by aquatic organisms has long attracted the interest of scientists studying the dispersal and establishment of aquatic species. The open or closed nature of boundaries to dispersal can profoundly influence variation in aquatic assemblages. Such differences in boundary permeability to dispersal and colonization can occur over very small spatial scales and likely occur in fragmented urban settings. Municipalities commonly build stormwater ponds into new developments to store stormwater and reduce pollutant flux into downstream aquatic systems. It has recently become clear that stormwater ponds serve other ecological functions by providing habitat for animal and plant species and greenspace for nearby residents. Here we examine the factors controlling species diversity of amphibian, fish, and benthic macroinvertebrates in urban streams and ponds located in primarily residential developments. We assessed the rate of colonization of amphibians and invertebrates in urban streams and related fish diversity to primary environmental drivers. Our data show that one year is sufficient for the reestablishment of amphibian species (n=6), fish species (n=11), and benthic invertebrate populations (22 species increase in 4 years) in urban streams. We discuss potential controllers of colonization in urban settings and how they differ from natural settings. This illustrates that the composition and distribution of species have a strong association with the kind of terrestrial landscape elements (e.g., housing or agriculture) in conjunction with water quality and the importance of a landscape approach to management of aquatic ecosystems. Our results show the potential for urban aquatic ecosystems to provide habitat for diverse communities even in systems typically regarded as highly degraded.

Oral SCL (Population Processes at Low Abundance –Recovery, Rarity and Invasives)

## ECOSYSTEM EFFECTS OF FISHING MARINE PREDATORS

**Worm\*<sup>1</sup>, B. and Baum<sup>2</sup>, J.**

<sup>1</sup>Department of Biology, Dalhousie University, Halifax (email: bworm@dal.ca)

<sup>2</sup>Scripps Institution of Oceanography, La Jolla (email: juliakbaum@gmail.com)

One of the central interests of Ram Myers was to quantify the magnitude of change in marine predator populations, and to trace the wider ecosystem consequences. Here we review the ecosystem effects of fishing large marine predators, using recent evidence compiled by Myers and colleagues, among others. The evidence suggests that top-down effects of marine predators can be pervasive, fundamentally reorganizing marine food webs. By utilizing long-term time series, large-scale surveys, and appropriate statistical techniques such as meta-analysis, researchers have now uncovered evidence of top-down control on continental shelves, coral reef atolls, and in the open ocean. Functional elimination of single predators or guilds of predators triggered top-down effects in subsets of, or entire, oceanic food webs, including increases in mesopredatory fishes and invertebrates. While changes can cascade through multiple consumer levels, attenuation of such effects at the zooplankton level may be typical in the ocean. Both geographical variation in species diversity and changes in diversity through fishing may influence how these effects play out in particular locations. These new findings, suggest oceanic top-down control is more prevalent than has been appreciated, underscoring the need to consider potentially complex ecosystem effects of exploiting marine predators and the importance to maintain these species above thresholds of ecological extinction.

Oral CCFFR (Ram Myers Session)

## GENETIC ASSESSMENT OF POPULATION FRAGMENTATION OF LAKE STURGEON (*ACIPENSER FULVESCENS*) IN THE OTTAWA RIVER

**Wozney\***, K., T. Haxton, S. Kjartanson, and C. Wilson.

\*Ontario Ministry of Natural Resources, Peterborough, ON (e-mail: kristyne.wozney@ontario.ca)

Lake sturgeon (*Acipenser fulvescens*) is of conservation concern throughout their range. Lake sturgeon is a fluvial dependant species, which have been increasingly impacted and fragmented by human development. Although lake sturgeon was historically abundant in the Ottawa River and its tributaries, commercial harvest caused severe decline in lake sturgeon populations. Other anthropogenic factors such as logging, agriculture, and water quality decline have continued to suppress lake sturgeon numbers. In addition, river fragmentation by hydroelectric and water control dams may be increasing isolation among habitat patches and local rates of decline, raising concerns for persistence of local populations. We used fourteen microsatellite DNA markers to assess population structure and diversity of lake sturgeon in the Ottawa River, and analyzed samples from 10 sites that cumulatively represent more than 500 kilometers of riverine habitat. To test for evidence of anthropogenic fragmentation, patterns of genetic diversity and connectivity (dispersal and gene flow) within and among river segments we tested for concordance with geographic location (upper vs. lower reaches), separation by distance and obstacles to migration, considering both natural and unnatural barriers as well as barrier (dam) age. The results of this study will have implications as to the proper conservation and management of this species throughout this river system.

Oral CCFFR (River and Estuary Ecosystems)

## PREY AVAILABILITY, NOT A REFUGE, REGULATES *BYTHOTREPES LONGIMANUS* ABUNDANCE IN HARP LAKE, ONTARIO

**Young\***, J. D.<sup>1</sup> and N. D. Yan<sup>1,2</sup>.

<sup>1</sup>Department of Biology, York University, Toronto, Ontario, <sup>2</sup>Dorset Environmental Science Centre, Ontario Ministry of the Environment, Dorset, Ontario (email: jdyoung@yorku.ca)

Since its introduction to Harp Lake, Ontario, the abundance of the zooplanktivore *Bythotrephes longimanus* has fluctuated substantially both among and within years. Yan et al. (2001. Can. J. Fish. Aquat. Sci. 58: 2341–2350) hypothesized that summer *Bythotrephes* abundance was affected by the thickness of an ephemeral, dark, daytime refuge from their cold-water, visual predator, the planktivorous, *Coregonus artedii* (cisco) that establish at the bottom of the metalimnion. Their preliminary evidence from 1994–1997 supported this refuge hypothesis. However, we estimated refuge thickness in 2003 from light energy visible to cisco and found it was not correlated with *Bythotrephes* death rates, and, with additional years 2000–2004, average summer *Bythotrephes* abundance and refuge thickness were no longer correlated. The refuge hypothesis appears to fail as cisco had sufficient light for foraging on *Bythotrephes* in the metalimnion every summer day, and the amount of metalimnetic illumination was always above the level at which cisco reaction distance to prey was highest. Selection of *Bythotrephes* by cisco increased once *Bythotrephes* became abundant, as cisco consistently selected non-trivial numbers even after *Bythotrephes* abundance decreased. Further analysis of *Bythotrephes* yearly abundance revealed that prey availability was driving the observed differences. In years when *Bythotrephes* abundance was low cladoceran prey abundance was also low, while in most other years, prey and *Bythotrephes* abundance peaked in June and mid-summer, respectively. Despite the contribution of cisco predation to death rates, prey availability appeared to be the main regulator of *Bythotrephes* abundance in Harp Lake.

Oral SCL (Contributed paper) (GS)

POPULATION STRUCTURE AND MANTLE DISPLAY POLYMORPHISMS IN THE WAVY-RAYED LAMPMUSSEL, *LAMPSILIS FASCIOLA* (BIVALVIA: UNIONIDAE).

**Zanatta\***<sup>1</sup>, David, Stephen Fraley<sup>2</sup>, and Bob Murphy<sup>1</sup>

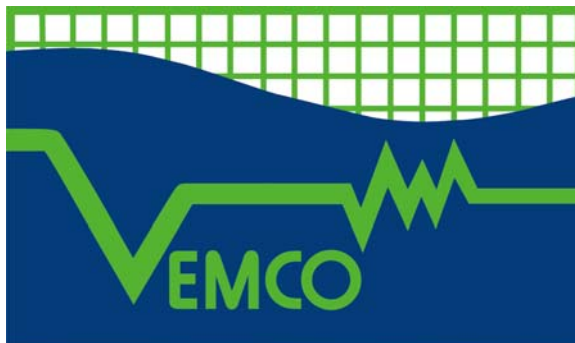
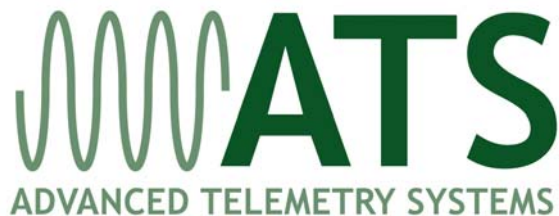
<sup>1</sup> Royal Ontario Museum, Department of Natural History, 100 Queen's Park, Toronto, ON Canada, M5S2C6; <sup>2</sup> North Carolina Wildlife Resources Commission, 50 Trillium Way, Clyde, NC 28721, USA

Genotypes from ten polymorphic DNA microsatellite loci were used to make assessments of population structure, measurements of gene flow and attempts to genetically segregate polymorphic host fish-attracting mantle displays for the wavy-rayed lampmussel, *Lampsilis fasciola* Rafinesque, 1820 – an endangered species in Canada. Specimens were collected from seven localities — six in the Great Lakes drainages of Ontario, Canada and one from the Little Tennessee River in North Carolina, USA. Four distinct and sympatric mantle display morphologies were observed on female *L. fasciola*. Displays could not be distinguished genetically, using analysis of molecular variance and genotypic assignment tests. The diversity of mantle displays was correlated with the overall genetic diversity observed among populations of *L. fasciola*. In managing populations of *L. fasciola* for propagation, augmentation, and translocation, polymorphic lures should be represented in proportion to what is observed in wild populations. Through moderately high  $F_{ST}$  values, and high assignment to population in genotype assignment tests, genetic structure was evident among the river drainages. Within drainage gene flow was very high and sampling localities within the Ontario drainages displayed panmixia. Efforts in artificial propagation and possible translocations to reintroduce or augment populations should be made to maintain the significant levels of genetic variation while maintaining distinctiveness

Oral CCFFR (Evolutionary Ecology in Marine and Freshwater Ecosystems)



# CCFFR/SCL thank the following sponsors:



Jeff Hutchings (Ram Myers session)

