Oral Presentation Abstracts
(alphabetical order by presenter)

LIFE HISTORY-BASED POPULATION MODELS: PREDICTING POPULATION RESPONSES TO EXPLOITATION IN RECREATIONAL FISHERIES

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A life history-based modeling approach is being developed to address the substantial resource and logistical constraints that impede the effective management of regional freshwater fisheries. Data are being collected from 18 lakes, at 4 field sites, over a 3-year study, representing a large portion of the know life history variation in brook trout. Adult growth rates ranged from 1.8 to 9.1 cm/yr. Gonadosomatic Index ranged from 0.04 to 0.21. Adult survival ranged from 0.27 to 0.74 per annum. These data are being used to parameterize a population model based on the Euler-lotka equation. Monte Carlo re-sampling of empirically derived distributions for each variable are used to account for the broad range of life history variation observed within and among populations. The probability distributions of intrinsic rates of increase (*r*) are used to predict population persistence under current environmental conditions and responses to changes in those conditions (e.g., exploitation rate). Preliminary results suggest this modeling approach is an effective method for assessing population status, especially where population specific data are sparse.

Oral; Aquatic Conservation

EFFECT OF THE COMMERCIAL FISHERY ON THE ICELAND SCALLOP (*CHLAMYS ISLANDICA*) IN THE ST. LAWRENCE ESTUARY: ASSESSMENT OF THE IMPACTS ON SCALLOPS AND THE BENTHIC COMMUNITY

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Many studies have shown that scallop dredging seriously disturb marine substratum and could decrease scallops size. This study was done to evaluate the dredging impact on scallop and benthic communities on the Ile Rouge Icelandic scallop bed, in Saguenay-St-Lawrence Marine Park. The results of photographic sampling and experimental dredging did not showed effects of dredging on benthic communities on this highly dynamic ecosystem (high velocity currents, upwelling zone, etc.). Harvesting of the bed began only in 1998, and fishing pressure has been relatively light owing to the quotas put in place in 2000. The data on the scallop size over the past years suggest that the fishery has affected the target species during the first year (1998-2003) of exploitation but seems to be stabilized since 2003. Presently, with a relatively low fishing effort and the use of a less damaging dredge, there is no evident sign of a decline in the size of scallops, contrary to many studies around the world. The study site, a sandy-gravel substrate with high velocity currents seems to recover in a few months from the impacts of dredging gear.

Oral; Aquatic Conservation

DENSITY DEPENDENT MECHANISMS IN SIZE-STRUCTURED POPULATIONS: WHOLE LAKES EXPERIMENTS ACROSS AN ENVIRONMENTAL GRADIENT

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In this presentation I examine the size and density-dependent recruitment processes for juvenile rainbow trout (*Oncorhyncus mykiss*). Growth and survival rates for several size-classes of juvenile rainbow trout are measured over manipulated gradients of fish density in two nearby regions that vary substantially in environmental conditions. I consider a wide scope of predictive models for juvenile growth and survival that are bracketed between simple empirical fits to the data and more explicit, mechanistically derived models. For example, models predicting mortality rates contrast factors such as size-dependent vulnerability to predation, foraging behaviour, and predator density. Thus, the aim of this study is to contrast experimental data with alternative depictions of the ecological processes. This approach should improve on inferences that could be made based on observational data or experimental data that is not contrasted against clear mechanistic alternatives.

Oral; Student; Habitat-fish mortality linkages

GHG FLUXES (CO_2, CH_4, N_2O) AND pCO_2 MONITORING BEFORE AND DURING THE FIRST FLOODING YEAR OF THE EASTMAIN-1 RESERVOIR (QUEBEC, CANADA)

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The recent flooding (November 2005) of Eastmain-1 (EM-1) reservoir is currently being monitored within a multiparty study (Hydro-Québec, Université du Québec à Montréal, McGill University, Environnement Illimité Inc.). This study's ultimate goal is to determine the GHG fluxes from various terrestrial and aquatic environments before and after flooding in order to establish the impacts, in terms of net GHG emissions, of creating reservoirs in northern environments. The results of two GHG fluxes and pCO_2 measurement campaigns (July and September 2006) carried out during the first flooding year of the EM-1 reservoir are presented, and compared to those obtained in the natural aquatic environments present before flooding. The pCO_2 (median ± C.V. (%), 2,086 ppm ± 24%, n = 83 stations) and CO_2 fluxes (8,059 mg CO_2 m^{-2} d^{-1} ± 58%, n = 79) measured in the EM-1 reservoir during this first year are around 4 to 10 times higher, respectively, than those measured in the aquatic environments before flooding (574 ± 14% ppm, n = 17 and 758 mg CO_2 m^{-2} d^{-1} ± 98%, n = 188). The CH_4 fluxes (6.8 mg CH_4 m^{-2} d^{-1} ± 118%, n = 79) are also 6 times higher than before flooding (1.0 mg CH_4 m^{-2} d^{-1} ± 124%, n = 57). Contrary to CO_2 fluxes, CH_4 fluxes are similar to those observed in reservoirs of more than 10 years old.

Oral; Hydroelectric Power and Aquatic Ecosystems

THE EFFECT OF SEDIMENTARY LINKS ON THE DISTRIBUTION PATTERNS OF JUVENILE ATLANTIC SALMON (*SALMO SALAR*) AND ATTACHED ALGAE

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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 identify areas that should be protected for conservation purposes. Several conceptual models have been proposed to explain the biological and physical structures of rivers and to help scientists and managers to develop HQM over complete rivers. The River Continuum Concept (Vannote *et al.* 1980) has been used to represent the potential relationship between biotic and abiotic gradients at the scale of complete rivers (10^2-10^4 km). In contrast, the Link Discontinuity Concept (Rice *et al.* 2001) suggests that organisms respond to discontinuities that may occur within a river at intermediate scales (10^0-10^2 km). This concept proposes that such discontinuities (or sedimentary links -discrete river segments characterized by downstream fining of alluvium-) operate to structure the distribution pattern of the biota. However, it is not clear which concept best explains the distribution pattern of the biota and which mechanisms may underlay a specific pattern. The purpose of our study was to assess the effect of the presence of sedimentary links on the distribution pattern of juvenile Atlantic salmon (JAS) and attached algae. Field work was performed in four links of the Ste-Marguerite River (Saguenay, Québec). JAS density was estimated by underwater observations and attached algae biomass was estimated according to the rapid periphyton survey. Our results suggests that sedimentary links might have a relative effect on JAS distribution but not on the attached algae biomass.
Oral; Student; Aquatic Ecosystem Science

POPULATION STRUCTURE IN CANADIAN GREENSIDE DARTERS: CONSERVATION ONE SITE AT A TIME

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A good understanding of population dynamics and genetic structure is necessary for effective management and conservation efforts in freshwater fish; however both can vary temporally and spatially. Such variation can be natural, as in dispersal or range expansion, or may be a result of human disturbance. This study examines the greenside darter, *Etheostoma blennioides,* for genetic population structure analysis in both natural and anthropogenically altered habitats. This small benthic fish is found in fast-flowing streams in eastern North America, and is currently listed by COSEWIC as a species of Special Concern. In Canada, this species is believed to be native to three, and introduced into one, Great Lakes tributaries in southwestern Ontario. There are currently no data for the Canadian greenside darter to warrant management designation below the species level. However, it is suspected that this species may have very complex genetic structure, even within a single drainage, due to pronounced habitat preference. To test for genetic structure at large and small scales, we developed ten polymorphic microsatellite markers and used them to characterize the genetic structure of the Canadian greenside darter. Preliminary results indicate significant genetic structuring both among rivers and more surprisingly, within rivers.

Oral; Student; Aquatic Conservation

DEVELOPMENT OF ENVIRONMENTAL PERFORMANCE STANDARDS FOR STREAM SEDIMENTS IN AGRICULTURAL REGIONS OF ATLANTIC CANADA

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Within the Water Theme of the National Agri-Environmental Standards Initiative (NAESI), sediments have been identified as a primary stressor for which standards are needed. Elevated sediment loads in streams can impair ecological functions and alter the structure of aquatic communities. Potato (*Solanum tuberosum* L.) production regions of Atlantic Canada are particularly prone to soil erosion due to rolling topography, high intensity rainstorm events and conventional tillage practices. To assess the influence of watershed heterogeneity and agricultural practices on total suspended solids (TSS) in streams and to develop performance standards for sediments, field sampling programs were established in northwestern New Brunswick (NB) and in central Prince Edward Island (PEI). Watershed sizes ranged from 12–30 km^2 in NB and 5–25 km^2 in PEI. TSS was measured at fixed weekly and monthly time intervals and, where available, according to episodic rainfall/discharge events. GIS was used to quantify agricultural intensity within watersheds as coarse land cover (% agriculture), extent of forest cover and riparian zones, and (beneficial management practice) BMP implementation rates. Results to date indicate that background (i.e. "normal" flow periods) TSS is positively related to agricultural coverage (range: 5–95% in NB and 50–95% in PEI). In PEI, differences in BMP implementation rates help to explain some of the variation in TSS among watersheds. As fine soil particles and sediments can function as substrate for agriculturally-derived nutrients, pathogens and pesticides, trends observed for TSS are likely to be correlated with other agri-environmental stressors at watershed scales.

Oral; Land-Water Interactions

DOWN BUT NOT OUT? GENETIC EVIDENCE FOR THE PERSISTENCE OF A STRIPED BASS POPULATION THAT HAD BEEN CONSIDERED EXTIRPATED

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Striped bass, *Morone saxatilis*, formerly spawned in five Canadian rivers, the St. Lawrence (Quebec) the Miramichi (New Brunswick), the Shubenacadie (Nova Scotia), Annapolis (Nova Scotia) and the Saint John (New Brunswick). Currently, only two confirmed spawning populations remain in Canada, the Miramichi and the Shubenacadie. The other populations are generally regarded to have become extirpated by the 1970s (St. Lawrence and Saint John) or 1980s (Annapolis). However, the situation is complicated by the continued presence of striped bass in the Saint John River. Previous studies suggested that these fish are seasonal migrants from the U.S. and the Shubenacadie River. We genotyped microsatellite loci in striped bass from the Miramichi River, the Shubenacadie River, two Chesapeake Bay rivers, the Hudson River (New York) the Kennebec River (Maine), and the Saint John River. Our data revealed that the U.S. populations are closely related to each other, and that the two Canadian populations are genetically distinct from U.S. populations and from each other. A Bayesian clustering analysis conducted on the Saint John River samples revealed three genetically distinct groups of bass in the river. One group was genetically similar to U.S. populations, another group resembled the Shubenacadie population, and a third group differed from all known populations of striped bass, but was most similar to the Shubenacadie population. We suggest that the two former groups comprise migrants from the U.S. and the Shubenacadie River, respectively, and that the third group may represent a remnant native spawning population of striped bass in the Saint John River.

Oral; Aquatic Conservation

PARASITES AND MORPHOLOGY AS INDICATORS OF TROPHIC POLYMORPHISM IN BROOK CHARR POPULATIONS

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Previous studies show that lacustrine brook charr (*Salvelinus fontinalis*) exhibit a subtle trophic polymorphism in some Canadian Shield lakes where some individuals are morphologically and physiologically better adapted to exploit the littoral and others, the pelagic zone. Here, we investigated brook charr resource polymorphism at the intra-lake and inter-lake levels in two interconnected lakes of the Canadian Shield using parasites, morphological measurements and stomach contents analysis. In lac Baie des Onze Iles, the analysis of parasites, morphological characters, and stomach contents of individuals captured in the littoral and pelagic zones suggest that some individuals are specialists of either the littoral or the pelagic habitats. In lac Caribou, no difference was observed between fish captured in the littoral and pelagic zones for all response variables. These contrasting results between the two lakes may be a result of differences in lakes morphometry and intensity of competition: lac Baie des Onze Iles offers two well-developed discrete niches, namely the littoral and pelagic zones, while lac Caribou offers essentially only one habitat, the open-water zone. Furthermore, intraspecific competition is probably stronger in lac Baie des Onze Iles where brook charr density was higher than in lac Caribou. Fish from both lakes differed in their parasitic and morphological characteristics reflecting the dominant influence of either a limnetic or a littoral habitat which was consistent with the overall morphometry of the lakes.

Oral; Student; Aquatic Ecosystem Science

ASSESSING FISH PRODUCTION IN RIVERS, TRIBUTARIES AND LAKES OF THE ROMAINE RIVER BASIN

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One principal problem encountered in assessing the impacts of a given hydroelectric project on the aquatic environment is to relate changes of fish habitat quality or quantity to potential changes in productive capacity. According to the federal policy for the management of fish habitat, promoters should develop mitigation/compensation measures in order to preserve the productive capacity of the aquatic environment. Therefore, a thorough description of baseline condition is critical. Many productive capacity or productive capacity related indices have been developed over the years, for different types of water bodies. These methods are often derivatives of the morphoedaphic index and use physical characteristics of the water bodies and water quality parameters as inputs. However, using a single method or approach to assess the actual productivity or the productive capacity of water bodies as different as rivers and lakes is a complicated task. One key factor is to be able to determine fish density as an input to a productivity model. To describe the baseline condition of the Romaine river basin, the approach proposed by Randall, Kelso and Minns 1995 (C.J.F.A.S. **52**: 631-643) was used. Fish density in rivers and lakes were determined through a fish weight vs density correlation and fish density in tributaries was directly measured by electrofishing. In order to reduce error related to fishing gear differences, the shallow area and deep area productivities were assessed separately in rivers and lakes. A Monte-Carlo simulation was made to test the robustness of the model. Results are discussed as a contribution to the ongoing debate about the differences in productivities of rivers and lakes.

Oral; Habitat-fish mortality linkages

ASSESSING MORPHOLOGICAL DIFFERENTIATION IN NON-NATIVE PUMPKINSEED SUNFISH (*LEPOMIS GIBBOSUS* L.) OCCUPYING FOUR HABITAT ZONES WITH TRADITIONAL AND GEOMETRIC MORPHOMETRIC ANALYSES

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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. 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 three Portuguese reservoirs and tested the hypotheses that habitats with the least similar characteristics will show the most differentiation, and that morphological differences will relate to flow and/or foraging adaptations. Results from the traditional distance-based morphometric analysis showed that there were significant differences in external morphology in pumpkinseeds captured from the four habitat zones in all three reservoirs, the differences between littoral and pelagic zones being most pronounced. The most significant parameters that separated individuals were pre-pectoral length, body depth, ventral caudal peduncle length, anterior caudal peduncle depth and pectoral fin maximum length. Geometric morphometric analysis, involving the thin-plate spline (TPS) approach was used to assess shape differences, independent of size, between the 4 habitat populations. The results of the traditional and geometric morphometric analyses will be compared to test for congruency, and the implications of morphological differentiation among pumpkinseed populations will be discussed in the context of further spread and rapid evolution among a potentially invasive species.

Oral; Student; Aquatic Invasive Species

SELF-LIMITATION OF DOMINANT PHYTOPLANKTON SPECIES AND THE NEUTRALITY OF COMMUNITY INTERACTIONS

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The structure and dynamics of phytoplankton communities cannot yet be explained or modelled, except in very general terms. Following current models in forest ecology, we set out to determine to what extent community structure in the plankton, as described by the partitioning of biomass among species, could be treated as a result of a purely random process of noninteracting species. Time series data on community structure were collected in two temperate and two tropical eutrophic systems. A neutral theory approach was consistent with the distribution of biomass among species, but not with the identity or persistence of dominant species. From this point of view, it was as if the distribution of biomass around the (log) mean were neutral, but the behaviour of the upper tail were niche-based. The dynamics of individual species could be modelled as random walks, except when their biomass exceeds a certain threshold. At high biomass, there was statistical evidence of biomass limitation. A closer look at the dynamics of the dominant species, including especially cyanobacteria, provided evidence suggestive of self-limitation. Although the dynamics of the dominant species controlled total biomass variation in these lakes, the most abundant species were in fact relatively constant in time, in comparison to the more volatile rarer species. Self-limitation of dominant species might explain in part the lack of evidence of interaction among phytoplankton species in time in lakes and reservoirs.

Oral; Cyanobacteria: Causes, Consequences and Toxicity

POPULATION STRUCTURE OF LAKE TROUT IN GREAT BEAR LAKE, NWT: EVIDENCE FOR REPRODUCTIVE ISOLATION AMONG LAKE TROUT MORPHOTYPES

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Elucidation of population structure can be of critical importance when dealing with the evolution of sympatric morphotypes. Much attention has been paid to the evolution of morphs of freshwater fishes inhabiting young proglacial lakes in the northern hemisphere. Here we present results from an ongoing study on lake trout (*Salvelinus namaycush*) morphotypes from Great Bear Lake, Northwest Territories. We collected spawning lake trout from five spawning sites in the Dease Arm of Great Bear Lake and conducted morphological and genetic analyses. Using a combined geometric and linear morphometric approach, we determined that lake trout found on respective spawning reefs displayed specific morphological attributes, namely differences in their level of fusiformity, mouth size, fin size and overall body size. Using nine microsatellite loci, we determined that each of the five spawning areas were differentiated from one another and that they displayed a relatively high degree of population structuring. Neighbour-Joining phenograms revealed that lake trout spawning groups clustered more closely with other groups of similar morphology. These findings illustrate that population structure among morphotypes can occur on small spatial scales and can serve as a tool for management activities.

Oral; Student; Aquatic Conservation

BIOLOGICALLY MEDIATED TRANSPORT OF CONTAMINANTS TO AQUATIC SYSTEMS

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The prevailing view is that long range transport of semivolatile contaminants is primarily conducted by the physical system, (e.g. winds, currents) and biological transport is typically ignored. Although this view may be correct in terms of bulk budgets and fluxes, it neglects the potential of animal behavior to focus contaminants into foodwebs due to their behaviors and lifecycles. In particular, gregarious animals that biomagnify and bioaccumulate certain contaminants and then migrate and congregate can become the predominant pathway for contaminants in many circumstances. Fish and birds provide prominent examples for such behavior. This review examines the potential for biovector transport to expose populations to contaminants. In addition, we apply a modeling approach to compare the potential of biotransport to physical transport for a hypothetical lake receiving large numbers of fish. We conclude that biovector transport should not be neglected when considering environmental risks of biomagnifying contaminants.

Oral; Aquatic Ecosystem Science

CO_2 PARTIAL PRESSURE AND FLUXES UNDER-ICE IN THE ROBERT-BOURASSA RESERVOIR (QUÉBEC, CANADA)

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The magnitude of the loss of CO_2 at spring ice-melt is not well known in northern reservoirs. In order to evaluate it, field campaigns of measurement of the pCO_2 under-ice and CO_2 fluxes associated were carried out in the winter of 2005 and 2006 in the Robert-Bourassa reservoir (~2 800 km^2, z_{moy} 22m). The pCO_2 (1 m) of the Robert-Bourassa reservoir (mean ± SD, 867 ± 232 ppm, n = 44 stations), flooded almost 30 years ago, appeared to be comparable to that of large natural lakes. Such pCO_2 would result in a spring emission at ice-melt, estimated from Cole and Caraco (1998)'s model and for local wind conditions, of around 1 000 to 2 000 mg CO_2 m^{-2} d^{-1}. This is the equivalent of 5 to 10% of the total CO_2 emissions (2,8 x 10^5 mg CO_2 m^{-2}) of the Robert-Bourassa reservoir during the remaining of the open-water period. This estimated flux is one order of magnitude higher than the flux measured during the ice-covered period (141 ± 88 mg CO_2 m^{-2} d^{-1}, n = 45), which do not integrate the effect of wind on the gaseous exchange coefficient. This first estimate of the magnitude of the loss of CO_2 at spring ice-melt will have to be adjusted in order to take into account the spatial and temporal heterogeneity of the pCO_2 in winter and spring. However, it seems already that the spring CO_2 emissions of the Robert-Bourrassa reservoir, oligotrophic and well oxygenated, are relatively not important and would not affect significantly the annual CO_2 budget emission of this reservoir.

Oral; Hydroelectric Power and Aquatic Ecosystems

SPATIAL HETEROGENEITY OF THE NITROGEN CONTENT IN PLANTS OF LAKE ST-PIERRE, A FLUVIAL LAKE ON THE ST-LAURENCE RIVER

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The nitrogen (N) cycle has been greatly affected by various human activities such as fertilizer synthesis and fossil fuel combustion, doubling the amount of bioavailable N in the global environment. A large part of this excess N ends up in aquatic ecosystems. Rivers are important sites for the transportation, retention and transformation of this excess N. For this study, we quantified the amount of N retained in the submerged aquatic plants of Lake St-Pierre, a fluvial lake on the St-Laurence River, Québec. In summer 2005, nutrient samples were collected at 25 sites throughout the lake of which 11 sites where selected for plant collection. C:N ratios of shoots, stems and roots where measured for *Valisneria americana*, an ubiquitous specie of the Lake St-Pierre. The nitrogen content of *Valisneria* varied spatially, with a 3 fold difference in plant N content along the south shore of the lake, where a nutrient plume from tributaries highly impacted by agriculture decreased along the axis of flow. Our study is among the first to document the spatial variability of the N content of submerged aquatic plants in large rivers and highlights the importance of spatial sampling to come up with estimates of the whole ecosystem.

Oral; Student; St. Lawrence Ecosystem

MODELLING SPECIES COMMUNITIES IN RIVERS: ASYMMETRIC EIGENVECTOR MAPS (AEM)

Guillaume Blanchet, Pierre Legendre and Sophia I. Passy

Distributions of species, either animals or plants, terrestrial or aquatic, are influenced by numerous factors such as physical gradients. Altitude and current direction are the cause of gradients in physical conditions, which are known to influence the spatial distributions of many species. Gradient intensities often vary in space in a linear or nonlinear way. No spatial modelling technique has been developed that considers the asymmetry of the controlling factors when studying species distributions along a gradient. Here will be presented a new spatial modelling method that can model species spatial distributions when a known asymmetry is present. This method is an extension of Dray *et al.* (2006) Moran's eigenvector maps (MEM); it is called asymmetric eigenvector maps (AEM). To better illustrate how well this method works in the presence of asymmetry, AEM will be compared to MEM in a study of the distribution of epilithon in Batavia Kill, a stream in the Catskill Mountains (Greene county, New York, United States of America). In the context of the Big Hollow restoration program (a broad-scale stream restoration program on Batavia Kill), epilithon has been sampled to better understand the impact of restoration on the streambed flora. This is a typical situation where AEM can be used because epilithon species are significantly influenced by current.

Oral; Contributed

FOUR DECADES OF WHOLE ECOSYSTEM RESEARCH AT THE EXPERIMENTAL LAKES AREA

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Since 1968, the Experimental Lakes Area (ELA) has been the site of numerous whole-lake manipulations and long-term studies. Located in a sparsely inhabited region of north-western Ontario, the ELA is relatively unaffected by external human influences and industrial activities. As such, it serves as a natural laboratory for the study of physical, chemical and biological processes and interactions operating on an ecosystem spatial scale and a multi-year time scale. The combination of long-term monitoring and manipulative whole-lake experiments at the ELA has proven to be an important tool to demonstrate the impacts of human activities on watersheds and lakes in addition to understanding aquatic ecosystem function. The realism of ecosystem manipulation is by far one of the strengths of this approach and the often dramatic results make a strong case to direct policy decisions. Here we present an overview of past and present aquatic ecosystem research at the ELA and discuss current challenges facing ecosystem research in Canada.

Oral; Aquatic Ecosystem Science

MODIFICATION OF BIODIVERSITY OF BENTHIC INFAUNA IN THE ST. LAWRENCE ESTUARY DURING 35 YEARS OF INCREASING HYPOXIA

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Dissolved oxygen is a limiting factor for organisms in marine ecosystems. Historical data of the last 70 years show that oxygen concentrations in the bottom waters of the Lower St. Lawrence estuary (LSLE), Quebec, Canada, have decreased by more than 50%, from 110-135 μmol L^{-1} in the 1930s, to values below 65 μmol L^{-1} in 2003. This suggests that the bottom environment is hypoxic (62.5 μmol L^{-1} or less). Studies have shown that hypoxia causes modifications of benthic community structure, especially decreases in biodiversity. Hypoxia can also lead to an increase in abundance of small, short-lived species, and lower abundance of large, long-lived species and have an profound effect on demersal fish. However, the existing literature on the distribution and biodiversity of benthic organisms in the deep LSLE is very limited. Benthic macroinvertebrate assemblages and trophic organization were investigated in the deep part of the LSLE in 1970-71, 1980 and in 1990, but are limited to a small portion of the LSLE. Thus, it is difficult to estimate the current state of the benthos. The objective of this study was to compare current and past biodiversity and assemblages of benthic infauna in the LSEL and Gulf. We collected samples, which were compared with the data obtained in the past. The preliminary results show that the total abundance of macrobenthic taxa decreased from 1970 to 2005. Furthermore, it can be stated that a fundamental shift in polychaetes species composition has taken place during the past 35 years.

Oral; Student; St. Lawrence Ecosystem

EPIZOIC ALGAE FROM FRESHWATER TURTLES IN SOUTHWESTERN NOVA SCOTIA

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Material scraped from various surfaces of 22 Blanding's (*Emydoidea blandingii*) and Snapping turtles (*Chelydra serpentina*) from Nova Scotia were examined for the presence of algae. Painted turtles (*Chrysemys picta*) were also examined but lacked epizoic algae. The cladophoroid green alga *Basicladia chelonum* is reported for the first time in Canada east of Ontario. *Basicladia chelonum* was observed on the shell of both Blanding's and Snapping turtles and was also present on the head and tail of the latter. A filamentous cyanobacterium, tentatively identified as *Schizothrix* sp., formed extensive colonies solely in the leg bases of Blanding's turtles. Although the nature of the interaction is unknown, this is the first potential symbiosis between a cyanobacterium and a turtle. Incidence of the two identified algal species was determined from macroscopic features in digital photographs of 168 Blanding's turtles from the Nova Scotia population complex. Incidence varied by population and, in some populations, by host age. Globally, *Schizothrix* sp. was more common than *Basicladia chelonum*. Differences in algal incidence are likely attributable to turtle species-specific behaviour, and to site microhabitat availability and use.

Oral; Student; Wetlands

AQUATIC CONNECTIVITY AND FISH METACOMMUNITIES IN WETLANDS OF THE LOWER GREAT LAKES

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Many local and regional variables structure fish assemblage composition, although few studies have assessed the effects of aquatic connectivity on fish assemblages in wetlands. Fish and habitat surveys were conducted in 12 wetlands across the lower Great Lakes basin. Spatial and temporal connectivity was classified into four connectivity classes to evaluate the interaction between aquatic connectivity and fish assemblage structure. Sequential, nested ANCOVA models were used to test the effect of habitat size and connectivity on different richness estimates. Results of the ANCOVA analysis indicated that various area estimates did not play a role in determining species richness, piscivore richness, abundance or diversity, while increasing connectivity did positively affect species richness and piscivore richness for all area estimates. Redundancy analysis (RDA) and unbiased variation partitioning, based on 10 000 bootstrap samples, was used to examine the role of aquatic connectivity in structuring fish assemblages. The results indicated that a combination of local environmental and area variables, in addition to aquatic connectivity, was best suited to describe the fish assemblage.

Oral; Wetlands

MICROEVOLUTION OF ANADROMOUS SMELT IN NEWFOUNDLAND: PARTITIONING THE INFLUENCES OF DISPERSAL, HITCH-HIKING SELECTION, AND GLACIAL ISOLATION ON MICROSATELLITE STRUCTURE

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Spatial structuring in marine and estuarine species is likely the result of the interaction between the homogenizing forces of dispersal, and the differentiating influences of natural selection and genetic drift. Recent work has shown limited larval dispersal and strong spawning site fidelity within smelt populations throughout Newfoundland and as such the homogenizing influences of gene flow may be weak. We examined spatial genetic structure in rainbow smelt throughout Newfoundland and Labrador using 8 neutral loci and one putatively non-neutral locus (Omo11). Spatial pattern in the eight neutral loci suggest extremely high structuring for a marine fish ($F_{ST} \sim 0.11$) and strong linear isolation by distance is observed at scales of 0-200km. Furthermore, Bayesian clustering suggests spatial independence at the estuary level. In contrast to the neutral loci, Omo11 displayed elevated divergence ($F_{ST} \sim 0.23$) and was characterized by two predominant alleles. Spatial distribution at Omo11 suggests a distinct southern Avalon Peninsula assemblage indicative of strong historical isolation supported by multilocus clustering and Barrier analysis. Simulation and lnRH based tests for selection indicate significant reductions in variation consistent with contemporary hitch-hiking selection. Moreover, we observed a scalar dependency in the distribution of significant tests such that neutrality predominated at small spatial scales, and deviations from neutrality at larger scales consistent with the transition from purifying to diversifying selection. We suggest that limited dispersal has reduced the homogenizing influences of gene flow and preserved the signature of glacial isolation likely maintained by weak contemporary selection.

Oral; Student; Aquatic Conservation

BEHAVIOUR AT HIGH TEMPERATURES: DOES PHYSIOLOGY EXPLAIN MOVEMENT OF ATLANTIC SALMON (*SALMO SALAR*) TO COOL WATER?

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During the summer, wild salmonids experience water temperatures that approach their upper lethal limit. In the Little Southwest Miramichi River (NB, Canada), juvenile Atlantic salmon of different age classes exhibit different behavioural responses to high temperatures (>23^{o}C). Yearling (1+) and two-year (2+) old salmon cease feeding, abandon territorial behaviour, and swim continuously in aggregations near cool water refugia; however, young-of-the-year (0+) fish continue to feed and defend territories. Movements of individually marked salmon prior, during and after these temperature events were studied in the field using pit- technology. A laboratory experiment was conducted to determine 1) if the behavioural shift in older juvenile salmon occurs when basal metabolic rate, driven by increasing water temperature, approaches maximum metabolic rate; and 2) if anaerobic pathways were being recruited to provide energy to support vital processes. Behaviour (feeding, startle response), oxygen consumption, circulating lactate and glucose levels, and muscle lactate and glycogen were measured in fish acclimated to temperatures between 16^{o}c and 28^{o}c. Results indicate that oxygen consumption of the 2+ salmon increased with temperature and reached a plateau at 26ºc, a temperature that also corresponded to a significant increase in lactate levels and cessation of feeding. In contrast, oxygen consumption in 0+ fish did not plateau, feeding continued and lactate did not increase, even at the highest temperatures tested. We therefore conclude that some behavioural responses of 2+ salmon to temperature stress may be employed in an effort to mitigate the physiological imbalances associated with an inability to aerobically support basal metabolism.

Oral; Student; Habitat-Fish Mortality Linkages

MULTI-SCALE ASSESSMENT OF THE FUNCTIONAL RELATIONSHIPS BETWEEN SPECIES TRAITS AND ENVIRONMENTAL CONDITIONS FOR LITTORAL FISH COMMUNITIES

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We assessed the relationship between fish spatial distribution, fish morphological and behavioral traits, and habitat characteristics in the littoral zone of two Canadian Shield lakes across multiple spatial scales. We observed associations among species traits, suggesting the presence of three functional groups of species defined by the positions of the mouth and the feeding location within the water column (superior-surface, terminal-mid-water, and inferior-benthic). Species traits within a same functional group were consistent across spatial scales and varied similarly with habitat conditions. For instance, habitat depth, macrophyte densities (emergent and submersed), rocky and woody substrates discriminated the three functional groups at the very broad spatial scale (corresponding to 40% of the total perimeter of a lake). Density of emergent macrophytes and presence of rocky substrate discriminated the same three functional groups at the broad spatial scale (corresponding to 10-20% of the total perimeter of a lake). Our study suggests that it may be possible, for littoral fish communities and potentially elsewhere, to detect the mechanisms underlying the relationship between species traits, community organization, and environmental complexity. From a management perspective, the development of fish-habitat relationships based on species traits may provide habitat models that are more transferable among species and among ecosystems than the typical one species-one model approach.

Oral presentation; Aquatic Conservation

DISPERSION PATTERNS OF KIN FROM NATURAL REDDS IN YOUNG-OF-THE-YEAR ATLANTIC SALMON (*SALMO SALAR* L.) IN CATAMARAN BROOK, NEW BRUNSWICK

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Recently developed microsatellite markers were used as a method to identify young-of-the-year (YOY) Atlantic salmon (*Salmo salar* L.) at the individual and family level. We sampled the tissue of anadromous adults moving into the stream to spawn, four redds and 313 of their offspring in a 1.6 km reach of Catamaran Brook. The initial dispersal of offspring from the four redds and resulting dispersion patterns of families were mapped. The average dispersal distance of 69 YOY salmon from the sampled redds ranged from 50 – 955m downstream, and 9 – 154m upstream. Five maternal and nine paternal half-sibling families were captured over an average dispersion distance (linear distance between the most upstream and most downstream sites of capture) of 1340m and 1018m, respectively. Four full-sibling families were identified with an average dispersion distance of 945m. Dispersion distance was significantly, and positively correlated with putative redd location of a family, with most families dispersing to the mouth of the brook. Alternative mating strategies take place in Atlantic salmon males, whereby both anadromous adults and precocious parr compete for fertilization opportunities with anadromous females. The present study suggests that precocious male parr may have fertilized up to 53% of the 313 sampled YOY salmon.

Oral; Student; Contributed

DYNAMIC THREAT-SENSITIVITY IN JUVENILE CONVICT CICHLIDS

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The threat-sensitivity hypothesis predicts that prey should adjust the intensity of their antipredator behaviour according to the degree of predation risk in order to balance the conflicting demands of predator avoidance and other fitness-related behaviours. While this model has received wide empirical support, few studies have examined factors that may influence an individual's perception of local risk. A dynamic approach to threat-sensitivity predicts that factors that influence an individual's perception of risk should alter the form and intensity of threat-sensitive decisions. In a series of laboratory experiments, we examine the influence of group size and recent exposure to predation risk on the form and intensity of threat-sensitive response patterns in juvenile convict cichlids. In the first experiment, cichlids were tested as individuals, or in small or large shoals to a standardized gradient of chemical alarm cues (and a distilled water control). As predicted, both the form of the antipredator response (graded versus non-graded) and the minimum concentration of alarm cues required to elicit a behavioural response was influenced by group size (individual risk). In the second experiment, we examined the effects of background levels of predation risk on the threat-sensitive response patterns of juvenile cichlids. Cichlids were conditioned 1x or 3x per day for 3 days to a standard predation threat and subsequently tested for their response to a standardized gradient of conspecific alarm cues. Our results demonstrate a dynamic interaction between threat-sensitive tradeoffs and background predation risk. Together, these studies highlight the sophisticated nature of threat-sensitive predator avoidance.

Oral; Contributed

IS CLIMATE CHANGE PLACING INNER BAY OF FUNDY SALMON POPULATIONS AT RISK?

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Inner Bay of Fundy (iBoF) Atlantic salmon have experienced greater than 99% decline in abundance since 1970 and are presently designated as an endangered species by COSEWIC. While the exact reasons for decline are unknown, evidence points to decreased survival in the marine environment. This is indicated by field programs that monitor salmon return rates, population models that show that increased marine mortality is consistent with observed population decline and evidence that the freshwater environment is currently capable of supporting captive reared populations. Data collected for iBoF salmon populations varies among rivers and years and includes: recreational catch and effort, fence counts, redd counts, dive counts and juvenile densities estimated by electrofishing. Despite gaps in the data series, recent advances in statistical, life history based, population dynamics modeling have allowed the estimation of time-varying age- and stage- specific mortality rates for iBoF salmon, and provide a mechanism for examining the relationships between life history parameters and climatic, environmental and oceanographic variables. Relationships are evaluated by including these variables in the population dynamics model as predictors of the life history parameters. Models are fit to the population data using maximum likelihood, and fits are examined to determine whether changes in the environmental variables are sufficient to explain the observed pattern in the population data. The relationship between climatic and oceanographic variables (ex. North Atlantic Oscillation Index, Sea Surface Temperature, North Atlantic Multidecadal Oscillation, etc.) and the population dynamics of iBoF salmon populations will be described.

Oral; Student; Climate Change

ECOSYSTEM RESEARCH: A REVIEW AND SYNTHESIS OF WHERE DFO HAS BEEN AND WHERE WE MIGHT GO

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Fostering the sustainable development of Canada's aquatic their resources from an ecosystem-oriented framework is a large task. Recently, DFO has forged ahead with the Oceans Action Plan and the Science Management Board has proposed a Five Year Strategic Research Plan where science in support of ecosystem-based management is one of the four key priorities. However, scientific expertise in ecosystem research resides throughout Canada's DFO laboratories with a diverse range of on-going research programs and objectives. We ask the question, "what ecosystem research is being conducted within DFO, and where are we going?" In this paper we review the ecosystem research carried-out within DFO based on a survey conducted within each region and we identify important gaps in our research efforts. Furthermore, we address the theme of the session, and propose that in order to support ecosystem-based management an increase of Canada's understanding of the structure and dynamics of its aquatic ecosystems is needed. An essential first step in this direction is the development and maintenance of an open collaboration of experts nationwide. We propose the embryonic Ecosystem Research Network as a mean to achieve this goal by sharing expertise, data, and by providing a formal envelope for research projects that compare the responses of aquatic ecosystems to human and environmental perturbations nationwide.

Oral; Aquatic Ecosystem Science

RESEARCH-BASED CONSERVATION OF THE PORBEAGLE SHARK POPULATION OFF THE EASTERN COAST OF CANADA

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Shark populations tend to have low productivity, but in principle, should be capable of being fished sustainably if enough information is available. That's the theory – the practice has often been stock collapse. A point in case is the population of porbeagle shark (*Lamna nasus*) off the eastern coast of Canada, which has been reduced to 20% of its virgin abundance since the early 1960s, and was listed as an endangered species by COSEWIC. However, an intensive research program launched in 1998 has reversed the declining trend, as the products of the research were used to conserve and protect the population. Use of a comprehensive age- and sex-structured population model, closed areas and the explicit support by the shark fishing industry appear to have turned the tide. But what will it take to make it last?

Oral; Aquatic Conservation

EMPIRICAL PHOSPHORUS MODELS FOR QUÉBEC'S LAURENTIAN LAKES

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Classical eutrophication models linking P concentration to watershed properties are inadequate for the sustainable development of Québec's villegiature lakes. Between 2000 and 2005, 26 Laurentian lakes were sampled (TP, TDP, TN, NO_3-N, NH_4-N, DOC, chl *a*) monthly from May through November in order to relate (mechanistically and empirically) water quality to watershed properties and lake morphometry. For these lakes, epilimnetic TP (4-15 µg/L) was strongly ($r^2 = 0.88$) related to residential development, wetland abundance, lake volume and water residence time. DOC and colour were strongly ($r^2 = 0.84$) related to wetland abundance and watershed slope. When DOC concentration was substituted to wetland abundance, 93% of the variance in TP (SE = 1.5 µg/L) was explained by simple models involving only DOC, residential development and lake volume. In 2006, 20 new lakes were sampled in order to verify the accuracy of the models.

Oral; Land-Water Interactions

MOLECULAR GENETIC IDENTIFICATION OF STOMACH CONTENTS OF YELLOW PERCH PREDATORS

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Yellow perch (*Perca flavescens*) (YP) is an economically important species for the Great Lakes. However, yellow perch populations in Lake Erie have declined since the 1980's, and although considerable effort has been made to recover previous abundance, YP population levels remain low. Predation of YP larvae may represent an significant limitation in first year survival of YP (and consequentially recruitment); however, measuring predation on larval fish is difficult due to the very fast digestion rate for larval fish. The objective of this project is to develop a molecular genetic technique to identify stomach contents of predators of yellow perch larvae. We sequenced a fragment of the mitochondrial gene cytochrome oxidase I (CO1) in all likely fish prey and predator species from the Western basin of Lake Erie. DNA extracted from homogenized stomach contents of potential predators from the western basin of Lake Erie was PCR-amplified for CO1. The amplified fragments were sub-cloned, and sequenced. The resulting sequences were compared to known CO1 sequences for species of Lake Erie forage fish to identify prey species presence. Identification of fish larvae in stomach contents using traditional methods is time consuming and likely inaccurate due to rapid digestion or larval fish in predator stomachs. The development of genetic tools for use in Fisheries research can provide more effective management of commercially important fish species, as well as provide a better understanding of one of Ontario's most extensive aquatic ecologies.

Oral; Student; Environmental Physiology and Genomics

NUTRIENT DYNAMICS IN COASTAL STREAMS OF SOUTHEASTERN VANCOUVER ISLAND: ANTHROPOGENIC AND SALMONID INFLUENCES

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Fall rain brings an influx of carbon and nutrients to coastal streams from terrestrial and in some cases, marine sources. Loose debris and nutrients are swept from catchments and the variety of landuse within them. Concurrently, Pacific salmon begin their upstream migration to their spawning grounds where they ultimately die. Within a couple weeks their spent carcasses become a source of marine-derived nutrients for the organisms that inhabit the catchment and receiving estuary. The current concept that salmon runs bring nutrients to freshwater may be overly simplistic. There are likely many complex interactions among anthropogenic, salmon derived nutrients and climate variability in determining the productivity of costal salmon bearing streams and the downstream estuarine ecosystems. Catchment landuse patterns and the returning anadromous salmon are both factors that can significantly influence the temporal dynamics and sources of carbon, nitrogen, and phosphorus in stream water. We explored this concept by examining four catchments along south eastern Vancouver Island during the fall and winter of 2005-2006, which includes the period of salmon spawning. Total nitrogen, total phosphorus and total organic carbon were measured every two weeks; and particulate organic matter was collected monthly for chlorophyll *a*, ash-free dry mass and stable isotope analysis. In this presentation we will discuss the potential of these measurements as an index of catchment landuse patterns and historical/current use by Pacific salmon.

Oral; Student; Land-Water Interactions

A REVIEW OF THE HABITAT ASSOCIATIONS AND DISTRIBUTION OF THE AMERICAN EEL WITHIN NEWFOUNDLAND

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The American eel (*Anguilla rostrata*) has recently been reviewed by COSEWIC with a recommendation that it be listed as a species of Special Concern under Canada's 'Species at Risk Act'. Newfoundland waters represent a significant amount of available habitat for the American eel but the assessment process revealed a paucity of information for this part of the eel's range. Thus, we have reviewed the historical and current data on American eel within Newfoundland. Detailed habitat associations are presented for three watersheds focusing on the relationship between the amount of lake habitat present in the watershed and the size frequency within the population. As has been shown in studies from more southern locales, larger eels, which tend to be females, were produced in lakes. This data is augmented by published and unpublished data of eels using brackish and purely marine habitats within the province. Finally, a preliminary eel distribution map for Newfoundland will be presented outlining watersheds where eels may have been impacted by anthropogenic means. This overview of habitat associations and the distribution of available habitat for eels within Newfoundland should provide the basis for future management decisions as well as highlight knowledge gaps for future research.

Oral; Aquatic Conservation

SPATIAL AND TEMPORAL VARIABILITY OF POND ASSEMBLAGES ON WHOOPING CRANE BREEDING GROUNDS IN WOOD BUFFALO NATIONAL PARK, CANADA

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While developing a prey monitoring program in the breeding-area ponds of whooping cranes (*Grus americana*) in Wood Buffalo National Park (WBNP), we assessed spatial and temporal variability of prey assmeblages, including fish and invertebrates. In total, we sampled 32 ponds during three sampling periods from May to August, 2005. To focus on spatial variation, four ponds were sampled from each of six crane nesting areas in WBNP (NA ponds). We also sampled eight ponds (PC ponds) that were similar to nesting area ponds, but more easily accessible. This accessibility allowed us to examine temporal variation, as most of the PC ponds were sampled in each sampling period. All ponds were sampled using timed dip-net sweeps and minnow traps, and crane-use of the seven areas was classified a priori as either high- (NA ponds), low- (NA ponds) or no-use (PC ponds). Analysis of similarity (ANOSIM) on presence/absence data for the 32 ponds indicated that prey composition in high-use ponds was significantly different from both low- and no-use ponds, which did not differ. Indicator species analysis showed that dace and stickleback are indicators of high-use ponds, though not all high-use ponds have fish present. ANOSIM on PC pond data found that prey composition differed significantly among each of the three sampling periods. Predatory invertebrate taxa shifted from beetle dominance at the beginning of the summer to odonate dominance towards the end of the summer. Both temporal and spatial changes in prey must be considered when developing the whooping crane prey monitoring program.

Oral; Student; Wetlands

INTERACTIONS BETWEEN THE INVASIVE GREEN ALGA *CODIUM FRAGILE* SSP. *TOMENTOSOIDES* AND MUSSEL AQUACULTURE IN THE MAGDALEN ISLANDS

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Concerns about the impacts of invasive species on aquaculture practices are increasing. Despite this, however, little research has investigated interactions between invasive species and aquaculture. For example, the invasive alga *Codium fragile* spp. t*omentosoides* is commonly referred to as the "oyster thief" due to its ability to smother shellfish and in some cases lift them from beds causing them to float away. To our knowledge, however, little research has quantified its effects of bivalve growth and survival. To determine the impact *Codium* has on mussel growth and survival, *Codium* was experimentally added to mussels in aquaculture in the Magdalen Islands. This experiment was repeated in summer, winter and spring to test the importance of the timing of invasion of *Codium*. Furthermore, following the observation that *Codium* may benefit from an increase in nitrogen based compounds in the water column as a result of bivalve aquaculture, the hypothesis that the growth and survival of *Codium* could be positively affected by mussels was also tested. The length and degree of branching of *Codium* attached to live mussels was compared to two control treatments, dead mussel shells and rocks. Preliminary results suggest that *Codium* is having little effect on the growth and tissue mass of mussels in aquaculture. In contrast, however, it may benefit from growing on or in close proximity to mussels. Consequently, the presence of aquaculture may enhance the dispersal and production of this species.

Oral; Aquatic Invasive Species

LINKING THE FUNCTIONAL AND COMPOSITIONAL BACTERIOPLANKTON SUCCESSIONS ALONG THE WATER FLOW PATH IN A NORTHERN WATERSHED

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Bacterioplankton succession was followed along the flow path in a complex watershed from headwater systems downstream in Québec. We focused on transition zones (e.g lake-river, river-marsh) which are characterized by strong environmental gradients (e.g in DOC and nutrient concentration), to explore whether distinct patterns in functional bacterial metabolism are observed, and if these are accompanied by compositional shifts. Bacterial assemblage composition was determined by *DGGE*. Bacterial metabolic potential changes were estimated using carbon substrate utilization patterns (*BIOLOG*). Hierarchical analyses of *BIOLOG* data showed major differences between bacterial communities along the flow path; lakes were clearly separated from rivers and marshes. *DGGE* banding patterns also revealed clear differences in the composition of bacterial communities along this watershed gradient. Our data suggest a large degree of functional heterogeneity in these freshwater bacterial communities along transition zones in the watershed, and that this metabolic diversity seems to be linked to the phylogenetic composition of the communities. Since the systems sampled are all interconnected, these transition zones represent habitat patches occupied by distinct local communities that are part of a larger regional watershed metacommunity.

Oral; Student; Environmental Physiology and Genomics

ACIDIFICATION EFFECTS ON HABITAT SUITABILITY FOR ATLANTIC WHITEFISH

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Acidification of watersheds across eastern North America was reported throughout the latter part of the last century and still affects many systems today. Changes in fish assemblages were also reported, with some species thriving and others becoming decimated as interspecific differences in pH tolerances were revealed. Atlantic whitefish *(Coregonus huntsmani*) had their native range decreased by 50% as one of only two global populations were extirpated. The extirpated population, in Tusket River of Nova Scotia, suffered from a much greater decrease in pH than the extant Petite Riviere population. Confounding the above hypothesis about the Tusket River extirpation were the concurrent reports of overfishing and introduction of nonindiginous species. Therefore, it was the goal of this study to determine the effect of low pH on the sole remaining population of Atlantic whitefish to discover what role environmental acidification may have played in the decline of Atlantic whitefish populations. The low pH tolerance of Atlantic whitefish was studied in Dalhousie's Aquatron facilities. A series of experiments were performed to determine the critical pH's during early life stages. These data will be used in conjunction with a time series of pH measurements from the fish's native range to simulate population changes over time.

Oral; Student; Aquatic Conservation

INVESTIGATING THE EARLY MIGRATION BEHAVIOUR AND IN-RIVER SURVIVAL OF ADULT LATE-RUN FRASER RIVER SOCKEYE SALMON THROUGH MULTIDISCIPLINARY RESEARCH

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The late-run sockeye stock complex is one of the major groups of salmon in the Fraser River. Historically, these fish milled in the estuary for several weeks before initiating their up-river spawning migrations. However, since the mid 1990's, some late-run sockeye have entered freshwater 5-6 weeks earlier than normal, without holding in the estuary. Associated with this abnormal behaviour has been extraordinarily high mortality, in some years exceeding 90%. Beginning in 2002, we initiated a multi-year, multi-agency (government, academia, industry), and multidisciplinary (physiology, behaviour, genomics, oceanography) study to understand the causes and consequences of this aberrant behaviour. During the early phases of our work, we were successful at identifying the proximal mechanisms associated with mortality in late run sockeye that entered the Fraser River without holding in the estuary. However, the underlying reasons behind the altered behaviour have been more difficult to assess. In 2006, we undertook one of the largest single-year fisheries research projects in Canadian history in an attempt to understand the causes for early river entry. Research included microarray and biochemical studies linked with biotelemetry to resolve the differences in physiology between early- vs. normal-entry late-run fish to identify biomarkers for predicting entry-timing. Additional experiments involved manipulating animal condition (i.e., hormone titres) and environmental conditions (i.e., salinity levels), as well as oceanographic surveys, in an attempt to understand the cues associated with entry timing. Collectively, this integrative research programme is yielding novel insight into one of the most pressing fisheries management and conservation problems in Canada.

Oral; Environmental Physiology and Genomics

DOES THE PRESENCE OF AIR-BREATHING, DEPTH LIMITED PISCIVORES ENHANCE NURSERY AREAS FOR FISH IN COASTAL AREAS?

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Study of fish behaviour in a coastal area of Newfoundland has provided insight on mechanisms that create nearshore fish distributions. Such insight suggests that young fish occupy shallow water primarily to avoid heightened predation risk associated with deeper water habitats occupied by larger fish. What is less clear are the mechanisms causing larger fish to avoid shallow water environments. Previous arguments (e.g. metabolic) have not been entirely convincing given field observations. An alternate suggestion is that larger fish avoid nearshore waters to reduce predation risk from depth-limited piscivores such as semi-aquatic mammals and birds. In this study we examine the potential for one such piscivore, the river otter (*Lutra canadensis*), to shape nearshore fish community structure. Fish communities in Newman Sound, Newfoundland, were sampled with beach seines at monthly intervals and compared to otter diet for the period June-November, 2001 and May, 2002. Fish remains were found in 75% of scats, and cod and sculpins were the most commonly consumed prey. Larger size-classes of prey were utilized disproportionately higher than their abundance in the nearshore would predict; however the size-threshold beyond which prey were selected was species-specific. Interestingly, the size-threshold also corresponded to that at which prey became less abundant in the nearshore zone. Our results suggest that selective predation pressure by otters may trigger a behavioural response in larger fish to avoid foraging in shallow nurseries during periods of high predation risk (daytime). Therefore, we postulate that the presence of depth-limited predators may enhance shallow nursery areas for small juvenile fish.

Oral; Habitat-Fish Mortality Linkages

PHYLOGEOGRAPHY AND COLONIZATION HISTORY OF ANADROMOUS RAINBOW SMELT (*OSMERUS MORDAX*): A REVISED SCENARIO?

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Among fishes, much emphasis has been placed on the role of historical phylogeography in structuring present-day distributions and evolutionary trajectories, particularly as this relates to glaciation events. We explore the phylogeographic pattern of variation in the mitochondrial DNA (mtDNA) for anadromous rainbow smelt (*Osmerus mordax*) across much of their native range. Prior work (based on RFLP data), has identified two glacial races of smelt: an 'Atlantic' lineage considered to have originated along the Atlantic coastal plains and an 'Acadian' lineage thought to have originated on the exundated Grand Banks. The current colonization hypothesis involves the 'Acadian' race colonizing much of the Atlantic provinces and the south shore of the St. Lawrence estuary, while the 'Atlantic' race extended through the Hudson River Valley and along the North shore of the St. Lawrence estuary. Therefore, it has been proposed that these two races have their most extensive secondary contact throughout the St. Lawrence estuary. Sequencing of candidate mitochondrial regions and more extensive geographic sampling, reveals several differences from the previously resolved phylogeographic patterns. We detect the presence of two mtDNA lineages, one presumably 'Acadian' and the other 'Atlantic' throughout much of Newfoundland and the Maritime provinces, which had previously been thought to be dominated by the former race. Additionally, comparisons of our data with published sequence data from the sympatric St. Lawrence estuary reveal further sequence complexity. These results suggest the need for a revision of the current paradigm for glacial refugia and post-glacial dispersal in this species.

Oral; Student; Aquatic Conservation

INEDIBLE PREDATORS IN LITTORAL FOOD WEBS: THE CASE OF METHYLMERCURY TRANSFER

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Transfer of toxic methylmercury (MeHg) in littoral food webs is poorly known despite that littoral contribution to lake productivity is comparable or higher than the pelagic and that littoral macrophytes beds are a crucial habitat for fish. The aim of our research is to assess the importance of littoral macroinvertebrates in MeHg transfer to fish. The organisms were sampled in the macrophyte beds of Lake St. Pierre (St. Lawrence River, Québec) in 2003 and 2004 in order to assess their MeHg concentrations and burden. The macroinvertebrates were classified into four functional groups: detritivores, herbivores, edible predators and inedible predators i.e. insects that are seldom preyed upon by fish because of their chemical defences. The highest MeHg concentrations, percentage of MeHg, as well as MeHg burden were found in inedible predators while detritivores and herbivores had the lowest concentrations and edible predators exhibited intermediate values. Furthermore, inedible predators constituted one sixth of the total MeHg pool found in macroinvertebrates. Fish might thus have to feed on edible but less contaminated lower trophic levels. These findings could explain low MeHg concentrations reported in fish from Lake St. Pierre and the inaccuracy of models employed in littoral zone food webs which do not take in account edibility of prey.

Oral; Student; St. Lawrence Ecosystem

CHANGES IN LIPID CONTENT AND FORAGING ECOLOGY OF FISHES IN AN AUSTRALIAN DRYLAND RIVER

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Australian dryland rivers experience some of the most of the most extreme variations in streamflow in the world. Infrequent, large floods inundate vast areas of floodplain. The aim of this study was to measure changes in body condition and foraging ecology of native fishes in relation to flooding and subsequent disconnection of waterholes during drought conditions. Specifically, how do body composition and energy levels reflect the 'boom-and-bust' nature of the system? Four species representing a range of ecological niches and feeding strategies were sampled from five waterholes (billabongs) in Cooper Creek (QLD) in 2004. Fishes were frozen and proximate body composition was determined in the lab. Stable isotopes of C and N were determined for whole, ground fishes. In January a large flood inundated all the waterholes. Lipid levels were highest in March when waterholes started to disconnect; there was a huge biomass of fish. By June, catches had decreased significantly and remained low. Fish body condition for all species declined dramatically between March and June, particularly in the silver tandan where lipid content dropped from 13% to 3%. Body condition continued to decline thereafter in response to drought conditions with mean lipid content between 1% and 2% indicating that some individuals were experiencing severe physiological stress. By December, two waterholes had completely dried up. Responses of fish between waterholes varied, and appeared related to the duration of the disconnection. Most striking was the variability in lipid content amongst individuals within a sample date. In the silver tandans, the SD was 50% of the mean lipid value in March but 2-3 times greater in December when conditions were most difficult for survival. Stable isotope data indicated large overlap in diet sources except for bony bream, the algivore. Why some fish did relatively well and others so poorly will be discussed in relation to foraging ecology and local hydrological conditions.

Oral; Contributed

ASSESSMENT OF LARVAL ODONATE BIODIVERSITY IN TWO TRIBUTARY WATERSHEDS OF THE SAINT JOHN RIVER, NEW BRUNSWICK

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Assessing the various components of biodiversity is a basic requirement of much research in community ecology. In freshwater ecosystems, an accurate assessment of species richness is a key component in developing predictive models for biomonitoring, in addition to forming the basis of other metrics used to characterize ecological status. However, research considering multiple habitats or larger spatial scales require that careful attention be paid to how limited sampling effort is distributed. In this study we demonstrate an approach to the assessment of freshwater biodiversity using larval dragonflies and damselflies (Odonata) as a focal group. Odonates were selected because of their high species richness (>130 species recorded in New Brunswick), ease of collection, and high dispersal ability. Main channel and off-channel habitats within two contrasting sub-catchments of the Saint John River were characterized and surveyed for larval odonates. Rarefaction curves were constructed to estimate the number of samples required to measure species richness at a sub-catchment scale. Habitat associations of species were determined using environmental data collected from field samples and GIS. Furthermore, we investigated the differences in larval odonate community composition between main channel and off-channel habitats. Together, this information will be used to direct future sampling at sub-catchment scales and to develop hypotheses regarding biodiversity patterns in the Odonata. In addition, lessons learned will inform the development of rapid biodiversity assessment methods for Canada's inland waters, as part of the Canadian Aquatic Biomonitoring Information Network (CABIN).

Oral; Student; Aquatic Ecosystem Science

THE ROLE OF AN ABUNDANT NATIVE UNIONID MUSSEL, *ELLIPTIO COMPLANATA*, IN LINKING PELAGIC AND BENTHIC FOODWEBS AND IN NUTRIENT DYNAMICS

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Freshwater unionid mussels are very diverse in North America and although many species are threatened with extinction, some species are still widely distributed and abundant. *Elliptio complanata* clearly dominates the littoral benthic biomass in Lake Opeongo, ON, with densities ranging up to 150-200 m^{-2}. In this study, we measured their distribution in a large stratified basin and in a shallow polymictic basin, and used published allometric equations for feeding and excretion rates to compare their role in these ecosystems. *Elliptio* were clearly more abundant in the shallow littoral zone of the smaller basin, but interestingly their densities were similar in both basins below 3-4 m depth down to 7 m, the lower limit of their distribution. The mussels were also smaller in the shallowest basin. In all basins, mussels < 5 cm in shell length, presumably juveniles, appeared later in the summer and disappeared earlier than other mussels. Based on these patterns of distribution, we discuss the potential role of *Elliptio* in linking pelagic and benthic foodwebs and in the nutrient dynamics of littoral areas.

Oral; Contributed

PHENOTYPIC PLASTICITY IN THE BODY MORPHOLOGY OF *PIMPHALES PROMELAS*

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Northern temperate and boreal lakes and wetlands are subject to seasonal hypoxia, especially associated with high summer temperatures in wetlands, marshes and winter stratification in lakes. This creates a high fish mortality skewing the population and selecting for smaller individuals as it has been found that smaller fishes are more tolerant of low oxygen environments, meaning that there is a direct link between size and hypoxia. Fish have developed different mechanisms and strategies to survive hypoxia, including changes in the behaviour, morphology, physiology and biochemistry. The fathead minnow *Pimephales promelas*, an inhabitant of northern watersheds and a non air-breathing fish, must use one or more morphological and physiological mechanisms to enhance their tolerance to hypoxia. This study compares the body morphology of two populations of *P. promelas* from different dissolved oxygen environments (4.6 ± 0.9 mg L^{-1} Espanola marsh and 9.4 ± 1.2 mg L^{-1} for the Silver Lake). Fathead minnows were collected towards the end of their reproductive cycle to minimize the effect of reproduction on body morphology. Individual fish were place in anesthesia and then scanned. We place 13 different landmarks that represent the general body morphology of the fish. Then, the pictures were analyzed using the Thin Plate Spline (TPS) programs. Results from this study indicate a change in body morphology between the two populations ($p < 0.0001$). Overall, fish from Silver Lake have deeper mid-body and larger caudal peduncle compared to fish from Espanola marsh.

Oral; Student; Aquatic Ecosystem Science

CGRASP: THE CONSORTIUM FOR GENOMIC RESEARCH ON ALL SALMONIDS PROJECT

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Over the past five years resources required to carry out genomic studies on salmonids have been developed through the genome Canada funded genomics research on Atlantic salmon project (grasp) and related projects in other countries. The consortium for genomics research on all salmonids project (cgrasp) will combine and integrate current and future international initiatives so that the power of genomics can be harnessed efficiently. The number of ests from Atlantic salmon and rainbow trout both exceed 300,000 with smaller amounts from other salmonids. These have been placed in contigs, giving an estimate of the number of genes and providing information to expand the 16k grasp microarray for examining patterns of gene expression in response to environmental factors, pathogens and pollutants. A physical map comprising ~4,300 contigs has been constructed based on the fingerprint patterns of ~225,000 bacs from two libraries. Sequencing selected regions of the genome is revealing the highly repetitive nature of salmonid genomes. Bac end sequencing has enabled the identification of genetic markers (microsatellites and snps) that have been placed on the linkage maps initially generated by the salmap consortium. Along with genetic markers from ests, these have expanded the linkage maps to ~900 loci and permitted the integration of the physical and linkage maps and the karyotype. The information being generated by cgrasp forms the foundation for sequencing and annotating the Atlantic salmon and rainbow trout genomes. This will allow salmonid biologists to reap the benefits currently enjoyed by researchers who work on organisms with sequenced genomes.

Oral; Environmental Physiology and Genomics

ACCUMULATION-DEPURATION OF MICROCYSTIN BY THE NILE TILAPIA (*OREOCHROMIS NILOTICUS*) AT A BRAZILIAN FISH FARM.

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Although accumulation of the liver toxin microcystin in phytoplanktivorous fish has been demonstrated in captive fish and in natural ecosystems, the relation between available microcystin in ingested algae and the level of microcystin in fish has not yet been determined. In this month-long study performed at a Brazilian fish farm, 45 *Oreochromis niloticus* were fed daily with fresh seston dominated by a toxic *Microcystis* sp. Microcystin was measured daily in food and every 5 days in liver and muscle samples. Initially, microcystin available for fish increased from 6.5 to 66.9 ng MC $fish^{-1}$ d^{-1}, which was accompanied by an increase from 5.5 to 35.4 ng MC g $liver^{-1}$. MC in muscle was below our detection limit of 4 ng g $tissue^{-1}$ for the entire study. In the second, bloom phase, available microcystin reached its highest concentration (4,450 ng MC $fish^{-1}$ d^{-1}) then decreased to 910 ng MC $fish^{-1}$ d^{-1} on day 32. During this period, MC reached its highest concentration of 81.6 ng MC g $liver^{-1}$ and stayed high until the end of the experiment. Based on an exponential hyperbolic model, accumulation rate was 95% d^{-1} of available toxin and depuration rate was 93% d^{-1} of liver burden. The accumulation rate confirms the high contamination potential of MC. On the positive side, the high depuration rate may be due to efficient systemic elimination, or to disappearance to our measuring technique; which can occur when MC forms a complex with its target enzyme in liver and muscle tissues.

Oral; Student; Cyanobacteria

INVESTIGATING *IN SITU* DOC RELEASE BY SUBMERGED MACROPHYTE COMMUNITIES IN QUEBEC LAKES

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Dissolved organic carbon (DOC) release by living submerged macrophyte-epiphyte complex has been shown in laboratory for some freshwater species, but this phenomenon has not been studied *in situ*. Incubations with benthic chambers in five eastern Quebec lakes of various trophic status show a net DOC production for different communities of *Myriophyllum spicatum* and *Potamogeton sp*. In parallels, these *in situ* incubations permit to follow the metabolism of the communities. We propose a method to eliminate the environmental artefacts leading to estimate the net DOC release and metabolism of macrophyte-epiphyte complex. Doing the proposed corrections, we find no relationship between DOC release rates (DOCme) and the net primary production rates (NPPme) of the macrophyte-epiphyte complex, but the release represents 39.1 % of the NPPme in average. DOCme rates range from 0.1 to 13.5mgC.m^{-2}.h^{-1}; NPPme rates range from1.9 to 85.9 mgC.m^{-2}.h^{-1}. The link between DOCme and both light and temperature is not generally found but clear for L. Stukely separately. Since we find no difference in DOCme between species, the overall mean DOCme rate of 104 µgC.gdw^{-1}.h^{-1} (SD ± 78) can be used for extrapolations at the lake scale, therefore underlying a possible implication of macrophyte-epiphyts complex in carbon budget. We also investigate the effect of pCO_2 on NPPme and DOCme.

Oral; Student; Contributed

CONTEMPORARY EVOLUTION OF ZOOPLANKTON FOLLOWING LAKE ACIDIFICATION AND RECOVERY

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Contemporary evolution of organisms following recovery from environmental degradation is poorly understood, but has an essential role in the biological re-establishment of stressed ecosystems. We evaluated rapid adaptive responses of zooplankton to the appearance and removal of acidification in boreal shield lakes across spatial and temporal scales. Rapidly-evolved acid tolerances could be detected in community properties, such as species richness and total abundance, after six years of recovered pH. Transplant experiments revealed a dominant copepod species, *Leptodiaptomus minutus*, became locally adapted to historical acidification in acidified lakes. We found neutral genetic variants of these copepods in acidified lakes that were scarce in un-acidified lakes, supporting evidence for population bottlenecks during lake acidification. However, in the six to eight years following chemical recovery of acid-stressed lakes to circum-neutral pH, there were adaptive reversals in acid tolerance in recovered lakes because of a physiological trade-off in *L. minutus*. Rapid adaptive responses to changes in the direction of selection can affect community characteristics, with the potential to alter the ecology of lake ecosystems as they become re-colonized during ecosystem recovery.

Oral; Student; Contributed

POTENTIAL LARGE SCALE IMPACTS OF CHANGING WATER REGULATION AT THE MOSES-SAUNDERS DAM: EVALUATION OF NEARSHORE FISHES AND FISH HABITAT AT THE SYSTEM SCALE

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Water levels fluctuate naturally at different temporal scales but the intra- and inter-annual water level regime of a lake can be modified by water regulation. Over longer periods, mean lake and river levels can vary significantly due to changes in water supplies but highs and lows are often dampened by water regulation for navigation and hydroelectric generation. Spatial and temporal interactions among local elevation profiles, water level fluctuations, wetland distributions, and thermal regimes, coupled with fish habitat usage patterns, influence overall nearshore production and habitat supply. Therefore, an understanding of how water levels interact with habitat availability is necessary for assessing how fishes may respond to changes in water regulation. In a GIS-based modelling analysis of habitat supply dynamics, we assessed the impact of water level fluctuations, via changes to water regulation, on fish guilds and select fish populations. The habitat supply for representative fishes was used to assess the long-term effects of habitat quality and quantity on population dynamics. These habitat-based models used shoreline classifications, habitat information, and digital elevation models to assess the changes in suitable habitat supply at whole-system and zonal scales. Habitat and potential production changes were compared between run-of-the-river, current regulation, and proposed plans. Results indicate that some species and guilds are more sensitive to concomitant water level, temperature, and habitat changes. A nonlinear response between habitat supply and population responses suggested that lags and compensatory mechanisms may confound short-term responses. Key uncertainties and future application of the modelling approach are discussed.

Oral; Hydroelectric Power and Aquatic Ecosystems

SEX-DIFFERENCES IN ARRIVAL TIME AT BREEDING SITES IN RELATION TO MATING SYSTEMS IN A LAKE ONTARIO STREAM FISH COMMUNITY

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The relative timing of arrival of reproductively active individuals at breeding sites is an important component of mating systems, and may provide knowledge into the selection pressures faced by individuals during the spawning season. We tested for the incidence of the earlier arrival of males than females to breeding areas (protandry) for an entire fish community in five tributaries of Lake Ontario. Fish were captured from mid-March to late-June in both 2005 and 2006 using nets placed close to the mouths of each stream. For each captured individual, we recorded the date, species, fork length (mm), weight (g), sex, and sexual maturity. Overall, 35 species were captured in the two field seasons, but comparisons were only possible for nine species. Results show that protandry was observed in 15 out of 26 possible comparisons, while protogyny (earlier arrival of females than males), was observed in 10 comparisons (in the one remaining case, males and females arrived at the same time). However, significant differences in arrival times between males and females were observed in only 5 species. Protandry was predominant in the blacknose dace, creek chub and white sucker, whereas protogyny was predominant in the bluntnose minnow and northern redbelly dace. Surprisingly, the degree of protandry was not related to the type of mating system (scramble vs. territorial). However, sexual dimorphism, as predicted, was related to the type of mating system. This study provides the opportunity to examine how sex-differences relate to protandry in fishes with different mating systems in a stream community.

Oral; Student; Aquatic Ecosystem Science

IS RECREATIONAL FISHING A THREAT TO GLOBAL FISH CONSERVATION?

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There is a growing body of research that has evaluated the life history characteristics of commercially harvested fish that may predispose certain species to imperilment, but similar studies are lacking for recreationally harvested species (herein referred to as "game fish"). Considering that recreational fisheries are being increasingly implicated in the decline of global fish populations, there is a need for additional research on this topic. The purpose of this study was to quantify the role of recreational fishing as a threat to global fish conservation by assessing the number of global game fish species that are internationally imperiled. Specifically, we examined the life history and biological characteristics that define a "game fish" and the factors that may predispose certain species to imperilment. We compared 384 game fish species from the International Game Fish Association world record list to 384 randomly selected non-game fish species to determine differences in the proportions of World Conservation Union (IUCN) red-listed game fish and non-game fish species. We then characterized the biological factors and life history traits of game fish versus non-game fish species to gain a better understanding of what makes a game fish a "game fish" and to evaluate the factors that may make certain game fish more vulnerable to imperilment. For the first time, we quantify the role of recreational fishing as a global threat to the conservation of game fish species based on life history characteristics and identify the extent to which recreational fishing is associated with global imperilment of some species.

Oral; Student; Aquatic Conservation

ENVIRONMENTAL FACTORS AFFECTING GROWTH OF EASTERN SAND DARTER

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Environmental factors affecting growth of the threatened eastern sand darter *Ammocrypta pellucida* were analyzed from specimens sampled from the northern edge of its range to determine the species' critical growth habitat. Length increments were calculated from scale samples as surrogates for growth rates following length-at-age back-calculation using the Fraser-Lee method. During the first of four years of life 82 % of total length is attained, which suggested considerable energetic partitioning towards reproduction following age-0. Positive relationships between mean per-site age-0 length increments and sand (over silt) substrates, and between mean annual age-0 length increments and mean annual channel discharge suggested greatest first-year growth within sand-dominated, high-discharge habitats. However, we observed size-selective mortality which suggested that those habitats which contributed towards greatest age-0 length may also have posed the greatest risk of predation, and thus signified an ecological trade-off in habitat use between growth and mortality. The environmental factors which occurred at large spatial and temporal scales (i.e., mean annual channel discharge) explained more growth variability within eastern sand darters than those occurring at limited scales (i.e., site-level substrate composition). The results of this study suggested that environmental factors can be used to explain growth of certain imperiled fishes.

Oral; Student; Aquatic Conservation

CHARACTERIZING DISPERSAL AND COLONIZATION OF THE INVASIVE ROUND GOBY (*NEOGOBIUS MELANOSTOMUS*) IN THE GREAT LAKES USING NOVEL MICROSATELLITE MARKERS

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As a Great Lakes invader, the round goby (*Neogobius melanostomus)* provide a unique model system in which to study the evolution and dispersal mechanisms of invasive fish species in novel environments. The round goby was first reported in 1990 and their range now covers all five of the Great Lakes. This rapid expansion combined with their aggressive behaviour and high population densities are causing concern for fisheries managers and recreational anglers. Here, we describe the development and application of 10 novel polymorphic microsatellite markers to determine population structure and dispersal patterns in nonindigenous round goby populations in Ontario, Canada. We sampled 50-100 adult round gobies from sites known to have been colonized over 10 years ago, as well as from sites thought to have been recently colonized. Preliminary genetic analyses indicate that the established populations are highly genetically differentiated, and that they follow an isolation-by-distance pattern of differentiation. This suggests that the population genetic divergence observed is likely due to founding effects driven by dispersal within the Great Lakes, although the magnitude of the divergence is more consistent with multiple invasion events. A genotype assignment analysis using the recently colonized populations will provide evidence uniquely suited to resolving this issue. Characterizing and eventually mapping the dispersal mechanisms of the Great Lakes round gobies will provide valuable information that will be integrated into the construction of effective management plans aimed at reducing the impacts of this invasive species.

Oral; Student; Aquatic Invasive Species

CREATION OF AN EST DATABASE FROM CHINOOK SALMON cDNA LIBRARY, AS A RESOURCE FOR FABRICATION OF SMALL, INEXPENSIVE, MICROARRAYS FOR POPULATION-LEVEL APPLICATIONS

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The ever expanding microarray technique is providing a new tool with which molecular ecologists, environmental and evolutionary biologists can survey genome-wide patterns of gene expression within and among populations. We have carried out Expressed Sequence Tag (EST) analysis on normalized SMART amplified cDNA constructed from pooled mixed tissue total RNA of Chinook salmon *Oncorhynchus tshawytscha*. We have to date, sequenced from the 5′ ends 1,295 clones chosen at random. These sequences were analyzed with EGassembler (Institute of Medical Science, University of Tokyo). Out of 1,289 valid sequences, 768 were unique with the remaining 521 distributed into 102 clusters containing 2 to 8 sequences. These sequences have been deposited in a local database created with PHOREST software. The database consists of the sequences of annotated singletons and representative clusters containing details of BLAST hits. A subset of these genes will be used to print focused Chinook salmon biochips containing gene transcripts representing broad gene classes such as growth, immune response, metabolism, transcription and reproduction in replicates of five at three different cDNA spot concentrations. The fabricated chip will be used to study intra and extra population transcriptional differences in fish.

Oral; Aquatic Conservation

THE EFFECTS OF HORIZONTALLY- AND VERTICALLY-ORIENTED VORTICES ON THE SWIMMING PERFORMANCE OF UPSTREAM MIGRATING BROOK CHARR (*SALVELINUS FONTINALIS*)

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Considerable effort has been expended to construct fishways and culverts that allow for fish passage. However, fish bypass designs have seldom considered fish behavior, energetics, and biomechanics. We performed controlled experiments, in which upstream migrating brook charr (*Salvelinus fontinalis*) were allowed to volitionally enter two open-channel flumes. These flumes were outfitted with structures that induced turbulence dominated by horizontal- and vertical-axis vortices, respectively. Trials were run at two water depths; mean velocities under all conditions were approximately 1.8 $m \cdot s^{-1}$. Passage performance was measured, both in terms of attraction (entry and re-entry rates) and distance of ascent under each flow condition. Turbulent flow conditions were evaluated in a model using Particle Image Velocimetry. Fish were tagged with Passive Integrated Transponder (PIT) tags and swimming performance was monitored using both PIT technology and high speed video analysis. The results indicated that brook charr conducted significantly more attempts to enter the channel with vertically-oriented vortices compared to the channel with horizontally-oriented vortices. Greatest distance of ascent, however, was attained against the horizontal-axis at shallow water condition. This information furthers our understanding of behavioral responses of fish in relation to turbulent flow and indicates that more research is needed to obtain for valuable data in future design of both fishways and culverts.

Oral; Hydroelectric Power and Aquatic Ecosystems

RELATING INDIVIDUAL VARIATION IN SENSORY AND PHYSIOLOGICAL MEASURES TO DIVERGENT FIELD ACTIVITY IN YOY BROOK CHARR

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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), or very active, feeding from the upper portion of the water column (an active search tactic). A recent study on this system suggested that this behaviour may be due to individual differences in perception of new environmental situations. However, it did not exclude any physiological measures that may also account for these activity differences. We tested whether this divergent field activity could be explained by individual variation in both sensory and physiological measures. After quantifying the behaviour of fish in the field, focal individuals were captured and sensory response, swimming performance and oxygen consumption were measured. In a clear plexiglass aquarium with mesh bottom in a stream, individuals that used an active search tactic in the field took less time overall to escape from a black PVC tube with trap door than did individuals that used a sit-and-wait tactic in the field. Active fish also escaped in proportionally less time when a novel object was introduced (a white plastic base vs. sediment) than the sedentary fish. There was no relationship between field activity and swimming performance or oxygen consumption. Individual variation in sensory mechanisms within a population may explain observed differences in fish ecology and responses to novel environments.

Oral; Student; Environmental Physiology and Genomics

EFFECTS OF PHYSICAL SHOCK FROM BLASTING ON INCUBATING SALMONID EGGS

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Blasting in or near water has the potential to affect fish negatively. While pressure changes in the water can cause mortality of fish, the shaking of the substrate measured as peak particle velocity (PPV) has the potential to cause mortality of eggs that incubate in that substrate. In Canada, maximum allowable limits exist for both pressure (100 kPa) and PPV (13 mm/s) to protect fish and their incubating eggs. Although past research has related mortality of fish to pressure changes, no studies have related PPVs from blasting to egg mortality. Thus, the PPV limit was developed using minimal information. To address this information gap, a field study and laboratory blast simulations were developed to measure egg mortality at different PPV exposures. Despite exposures more than double the current guideline, no increased mortality attributable to blasting was observed in lake trout (*Salvelinus namaycush*) eggs in the field over a 10-mo incubation period. In the laboratory, increased mortality of rainbow trout (*Oncorhynchus mykiss*) eggs required exposures greater than 132 mm/s, and only during a very short period of egg development. Results indicate that the current PPV guideline provides ample protection for spawning beds and could be increased substantially, at least for salmonids. Future research is needed to address the egg sensitivity of other species; our blast simulation methodology provides an effective approach to meet this need.

Oral; Habitat-Fish Mortality Linkages

USE OF BOTH GEOMETRIC MORPHOMETRICS AND FOURIER ANALYSIS OF SAGITTAE OTOLITHS TO AID IN IDENTIFYING FOUR SPECIES OF CISCOES (GENUS: *COREGONUS*) FROM LAKE SUPERIOR, CANADA

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The shortjaw cisco (*Coregonus zenithicus*) is listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Information on the status of all of the Great Lakes stocks, specifically the Lake Superior stock, is currently being collected to aid in possible Schedule 1 listing under the Canadian *Species at Risk Act* (SARA). To better understand the proportion of shortjaw ciscoes being captured in commercial catches compared with other Coregonine species it has become imperative to develop tools that will aid both biologists and fishers in identifying the different species of Coregonus. These tools require some sort of a validation technique to confirm the identification. Otolith shape has been shown to be reliable in species identification. We used simple geometric morphometrics (length, width, the L/W ratio and perimeter) and otolith shape (as revealed through Fourier analysis) to aid in the identification of four Coregonine species (bloater (*Coregonus hoyi*), kiyi (*C. kiyi*), cisco (*C. artedii*), and shortjaw cisco) captured during sampling events in Lake Superior in 2004. We will describe how effective these techniques are in aiding or confirming identification of the 4 Coregonine species collected from Lake Superior.

Oral; Aquatic Conservation

DEPTH SELECTION PATTERNS OF CRUSTACEAN ZOOPLANKTON BIOMASS IN 8 OLIGO-MESOTROPHIC LAKES IN THE LAURENTIAN REGION, QUÉBEC, CANADA

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Water quality and crustacean communities of 8 lakes were studied during July 2003 in the Laurentian region of southern Québec. All lakes were stratified and 4 of them developed anoxic conditions in the deeper layers. They presented high vertical environmental heterogeneity in light, nutrient and algal biomass. Sampling was carried out at 4 depths in all lakes (mid-epilimnion, mid-metalimnion, 1% light depth, mid-hypolimnion). Neither crustacean nor *Daphnia* biomass were correlated with TP or Chl *a* depth distribution. Mean residence depth (MRD) of six crustacean functional groups and *Daphnia* species were always situated above the anoxic zone. MRD of crustacean functional groups and *Daphnia* species did not showed day/night variation patterns but varied among lakes. MRD did not significantly vary among crustacean functional groups. However, it varied significantly among *Daphnia* species. The body length of *Daphnia* species did not vary among depths except for *D. catawba* for which body size was smaller in the epilimnion. Redundancy analysis of the relationships between the biomass of macrozooplankton functional groups and *Daphnia* species, and environmental factors showed that the euphotic zone depth was the most important variable explaining crustacean zooplankton depth distribution. The study indicates that vertical heterogeneity in the physical and biological environment influences the depth selection of zooplankton.

Oral; Student; Land-Water Interaction

USING LITTORAL ZONE FISH AND BENTHIC MACROINVERTEBRATE COMMUNITIES TO ASSESS RECOVERY OF ACID DAMAGED LAKES IN SUDBURY, ONTARIO

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Recent studies indicate the use of multiple organism groups in bioassessment results in increased discriminatory power and lower assessment error. While some studies have examined the responses of various organism groups to nutrient enrichment and habitat degradation, multiple organism responses to acidification or metal contamination has not been thoroughly considered. The objective of this study is to investigate the interactions of fish and benthic macroinvertebrates in littoral zone communities and to use the combined community information to create a multimetric inference model to assess impacts and recovery from acidification in 40 lakes around Sudbury, Ontario. Typically in metal contaminated lakes the benthic community is less diverse and lacks large-bodied invertebrates; this is reflected in the diet, growth and condition of yellow perch (*Perca flavescens)*, an acid-tolerant fish species that dominates many Sudbury lakes and relies heavily on benthic food resources. Relatively few studies have examined the effects of reduced diversity of taxa type or size of taxa in contaminant-exposed benthic invertebrate communities on fish. To do this, stomachs of yellow perch were collected from a subset of lakes and inspected for invertebrates which will be identified to family level. Lakes were selected along a gradient of disturbance so that comparisons can be made between regions with varying degrees of damage. In addition, if sensitive invertebrate taxa are found in the stomachs but not in the benthic community survey, then this will emphasize the importance of fish diet in detecting the presence of rare invertebrate families. The results of this study will be discussed.

Oral; Student; Aquatic Ecosystem Science

QUANTIFYING INVASION PATHWAYS: PROPAGULE PRESSURE FROM THE AQUARIUM TRADE

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Given the harm that can arise from alien species, estimating the risks posed by potentially harmful species is essential. Several studies have developed risk assessment models for alien species based on biological characteristics, but few have quantified actual rates of introduction via different pathways. Numbers introduced from different pathways is an essential component of risk assessment because alien species must enter new environments in great enough numbers for reproduction and spread to occur. Thus, we developed an approach to estimate propagule pressure, using the St Lawrence River – an important entry point of aquatic invaders into eastern parts of North America - as our model system. We 1) determined fish owner behavior through surveys, 2) identified and quantified the fish sold in the aquarium trade, 3) quantified the uncertainty in our empirical estimates, and 4) integrated the empirical data and uncertainty into a cohesive model. We found that over 10,000 individual fish are released to the St Lawrence every year, from Montreal alone. Although fish characteristics of size and aggressiveness influenced the probability of release, they only had a small effect on the overall propagule pressure for any fish species. Our study demonstrates that the aquarium pathway accounts for a significant number of introductions of potentially harmful species. Therefore, there is great need to consider this pathway in conservation efforts.

Oral; Student; Aquatic Invasive Species

TEMPORAL STABILITY OF FISH COMMUNITY DESCRIPTORS IN THE LITTORAL ZONE OF FOUR CANADIAN SHIELD LAKES

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In a worldwide context where destructions and perturbations of habitats represent serious threats to the survival of fish species and populations, it is important to study the relationship between fish communities and attributes of their environment. Such Fish Habitat Quality Models (FHQM) are generally developed by estimating indices of habitat quality (e.g. fish density) and environmental conditions observed in numerous sites at specific moments. However, among-day and among-year temporal variations of fish density at given sites may affect the validity of the FHQM. The objectives of this study were to quantify the magnitude of among-day and among-year variations of fish density at specific sites and to test whether different approaches to analyse fish density could improve the temporal stability of indices of habitat quality assigned to sites. The four approaches considered consisted in defining habitat quality as either 1) fish densities at specific sites, 2) ranks of sites defined by their fish densities, 3) average fish densities over sites that shared similar environmental conditions (habitat types), 4) averaged ranks over sites that shared similar environmental conditions. Fifteen sampling sites were surveyed one to three times in four Canadian Shield lakes (Québec) over four years. On each survey, environmental conditions and fish communities were quantified. ANOVAs indicated that average fish densities over sites that shared similar environmental conditions was the only approach that minimized among-day and among-year variations of indices of habitat quality. Our study suggests that the analysis of fish density averaged over habitat types may allow scientists to develop temporally more stable, and consequently, more robust FHQM.

Oral; Student; Aquatic Ecosystem Science

PREDICTING POST-TOURNAMENT MORTALITY OF SMALLMOUTH BASS USING PHYSICAL, BEHAVIOURAL AND PHYSIOLOGICAL INDICATORS

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In North America, catch and release tournaments involving black bass (*Micropterus spp*) are becoming increasingly popular with recreational anglers. To date, much work has examined the physiological effects of tournaments, but little is known about post-tournament behaviour and survival of released fish. The goal of our study was to use physical, behavioural and physiological indicators in an attempt to predict post-tournament mortality. At a fall competitive angling event in Northwestern Ontario, we used these indicators to classify 86 smallmouth bass into two categories: poor and good condition. To assess post-tournament behaviour and survival, a subset (n = 23) of these fish were released at a common site and radio-tracked for 5-6 days. Of the poor condition fish, all showed signs of barotrauma (i.e. loss of equilibrium). In addition, a number of these individuals in poor condition exhibited some of the highest blood glucose and lactate levels recorded for freshwater fish. Thirty percent of fish categorized as being in poor condition died post-release, whereas no mortality was observed among the fish categorized to be in good condition. Although tournament organizers considered all fish to be alive after the weigh-in process, our work reveals that post-tournament mortality may be underestimated and appears to be associated with barotrauma. This study provides important insight on key indicators of post-release mortality, which may be a useful tool for tournament organizers and fisheries managers.

Oral; Environmental Physiology and Genomics

POLYCHAETE BIODIVERSITY: DOES A CLOSER LOOK REVEAL THE HIDDEN STRUCTURE OF THE ST. LAWRENCE FOOD-WEB?

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The analysis of food-web structure is often derivative of incomplete or unresolved food- webs of allegedly simple ecosystems. Taxonomic groups, frequently invertebrates, are black-boxed. This obscures their functional diversity and misrepresents connectivity, energy flow, and biodiversity. In the St. Lawrence ecosystem, polychaetes contribute significantly to benthic biodiversity in terms of abundance and species richness. In addition to their taxonomic diversity, polychaetes are a trophically diverse group of scavengers, sedentary filter-feeder and motile predators. In turn, polychaetes are eaten by demersal fish such as cod and flounder. Reckoning with polychaete biodiversity increases the resolution of the food-web structure of the St. Lawrence ecosystem, and its apparent complexity. However, assessing polychaete biodiversity can be problematic. While specimens from the gut of a demersal fish may be identified using existing guides, most descriptions of polychaetes found in the St. Lawrence River actually describe polychaetes from European waters. Original descriptions and taxonomic revisions of polychaetes are rarely published for the St. Lawrence. Recently, the discovery of hypoxic zones in the deep channels of the St. Lawrence River has renewed interest in local polychaete biodiversity. There have also been calls to resuscitate the taxonomic discipline in biodiversity and ecosystem research. With a focus on trophic ecology, an up-to-date evaluation of what is and is not known about polychaete biodiversity of the St. Lawrence ecosystem would seem timely.

Oral; St. Lawrence Ecosystem

VALIDATION OF TWO BIOLOGICAL MODELS OF SPAWNING HABITAT IN A LARGE-SCALE BOREAL RIVER IN QUEBEC, CANADA

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Biological models were created to describe the physical conditions (water depth, water velocity and substrate composition) preferred by 1) a spring guild composed of the longnose sucker, the white sucker and the walleye and 2) the lake whitefish, when spawning. The habitat probabilistic index (HPI) is a multivariate model based on a multiple logistic regression that distinguishes between the physical conditions used and avoided by fish. This provides an index of habitat quality, ranging from 0 to 1, based on the probability of observing fish. The two HPI models were used within the context of an instream flow incremental methodology (IFIM) to determine minimal flows in a large hydroelectric project. Considering this important role of the models in the project, we undertook to validate the HPI models. Using georeferenced independent datasets, we looked for a positive relationship between the quality of spawning habitats as predicted by each model and the number of eggs found in the river for each species/guild. Globally, the HPI models accurately predicted the spawning habitats of both the spring guild (r^2 = 0.53, n = 9, P <0.05) and the lake whitefish (r^2 = 0.67, n = 12, P <0.01). This suggests that HPI models are an effective tool within the framework of IFIM studies.

Oral; Hydroelectric Power and Aquatic Ecosystems

PATTERNS IN SHORT- AND LONG-TERM BACTERIAL CONSUMPTION OF DISSOLVED ORGANIC CARBON IN FRESHWATER ECOSYSTEMS: A DYNAMIC STUDY ALONG A WATERSHED FLOW PATH

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It is now well accepted that dissolved organic carbon (DOC) in natural waters is composed of various pools characterized by their own intrinsic properties and availability to microbes. Thus, the persistence of these pools in the aquatic ecosystem is different, as is the role they play in total system metabolism, although the connections that exist between the various DOC pools are not well understood. We have compared short-term (< 6 hours) DOC consumption, measured using changes in O2, with long-term (up to 1 month) DOC consumption measured in DOC lability bioassays. The patterns of short- and long-term DOC consumption were followed along a flow path that includes lakes, rivers and wetlands within the same drainage basin. We found distinct patterns of carbon consumption between lakes, rivers and wetlands, and in particular, the coupling between short and long-term DOC consumption in lakes was weakest. The physical characteristics of the watershed, and the chemical properties of the DOC seem to play an important role in modulating the covariation of short and long-term carbon consumption.

Oral; Wetlands

INVESTIGATING NITROGEN TOXICITY AND EUTROPHICATION IN AGRICULTURAL LANDSCAPES

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In water, nitrate (NO_3^-) and total ammonia (NH_3) are produced and consumed through the natural processes of the nitrogen cycle. Natural waters in Canada typically contain less than 0.9 mg NO_3-N/L and 0.002 mg NH_3-N/L. Concentrations above these levels indicate a eutrophic condition and/or the influence of anthropogenic sources. In an agricultural landscape, nitrogen sources can include manure or chemical fertilizers such as ammonium nitrate. Mean nitrate concentrations in rivers draining Canadian agricultural regions range from 0.25 to 5.8 mg NO_3-N/L. Similarly, mean total ammonia concentrations range from 0.15 to 0.20 mg NH_3-N/L. The Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life are derived from toxicological data and represent nationally-consistent benchmarks designed to protect, sustain and enhance present and potential uses of a water body. The freshwater CWQG for nitrate is 2.9 mg NO_3-N/L and falls within the range of concentrations seen in agricultural landscapes. The freshwater CWQG for total ammonia is 0.47 mg NH_3-N/L (at pH =7.5 and 15°C) and is greater than concentrations typically seen in agricultural landscapes. Recent evidence, however, suggests nitrate is more toxic in the presence of ammonia suggesting the need to consider both ammonia and nitrate in the application and interpretation of guideline in agricultural landscapes.

Oral; Land-Water Interactions

IDENTIFYING THE ROLES OF RIVER REGULATION AND VARIABILITY OF CLIMATE AND RIVER DISCHARGE ON HYDRO-ECOLOGICAL DYNAMICS OF THE PEACE-ATHABASCA DELTA: INSIGHTS GAINED FROM A 1,500 YEAR PERSPECTIVE

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We are using multiproxy paleolimnological analyses, coupled with dendroclimatic records, to assess the roles of river regulation for hydroelectric production on the Peace River and variability of climate and river discharge on hydroecological conditions of the Peace-Athabasca Delta, Canada. Landscape analyses of lake sediment records do not detect an effect of hydroelectric regulation, but provide unprecedented insight into this highly dynamic ecosystem. For example, results from an upland, perched basin provide evidence for 18th century drought that exceeds dryness experienced during the past few decades. Analyses of laminated sediments from an oxbow lake adjacent to a distributary of the Peace River similarly indicate an extended interval without major river-flooding during the 1700s. In contrast, evidence from several lowland ponds documents a multi-centennial high-water stand of Lake Athabasca at this time and throughout the Little Ice Age (LIA, ~AD 1600-1900). These reconstructions suggest snowmelt-dominated runoff in the eastern Rocky Mountains sustained greater summer discharge in the Peace and Athabasca rivers and higher levels in Lake Athabasca during the LIA, whereas an arid climate led to low water levels in the upland areas of the delta. Preliminary results also suggest that post-LIA hydroecological conditions, which reflect a shift to a rainfall-dominated runoff regime, may be analogous to conditions that prevailed during the Medieval Warm Period. These long-term perspectives are essential to inform ecosystem stewardship in light of continued reduction in glacial meltwater supply and warming.

Oral; Hydroelectric Power and Aquatic Ecosystems

THE GROWTH CONSEQUENCES OF CANNIBALISM IN ATLANTIC COD POPULATIONS IN CANADIAN ARCTIC LAKES

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Low diversity throughout most high-latitude food webs often results in intense cannibalism among northern fishes. Not surprisingly, cannibalistic individuals tend to be large and fast growing, which can generate polymodal adult size distributions. Field, experimental and modeling studies of cannibalistic populations of northern fishes have revealed several explanations for the occurrence of giant cannibalistic individuals. In some cases, the onset of rapid growth occurs at an advanced life-history stage when individuals that make the switch to cannibalism sustain rapid adult growth rates, whereas non-cannibalistic individuals sharply slow or cease growth. In contrast, other cases reveal an early onset of rapid growth and cannibalistic behaviour in future giants during juvenile stages. The landlocked Atlantic cod population in Ogac Lake, Nunavut, includes few highly cannibalistic giants and a larger population of smaller individuals. We compare individual growth-rate trajectories between cannibalistic and non-cannibalistic individuals to assess the growth consequences of cannibalism in Ogac Lake, and to reveal at what age growth trajectories diverge. We also compare growth rates between cod from Ogac Lake and cod from other Arctic lakes where cannibalism rates are lower, and between Arctic lacustrine and Atlantic marine cod. In particular, we examine the question of whether cannibalistic growth polyphenism in the Arctic lacustrine populations imparts greater growth rate variability relative to Atlantic marine cod.

Oral; Student; Aquatic Conservation

EPIBENTHIC SPECIES ASSEMBLAGE AT LARGE SPATIAL SCALE: BENTHIC BIODIVERSITY ON BUOYS (BeBOB) PROJET

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Environmental monitoring is necessary to study the magnitude of spatial and temporal variation in aquatic environments and the effects of anthropogenic activities. Benthic species are more appropriate than many other biological groups for environmental monitoring because they provide important quantitative, site specific information and are effective indicators of impacts at a high level of biological organisation. The use of navigation buoys as collectors in monitoring programs has the specific advantages of large spatial coverage and low sampling costs. The objectives of the BeBOB (Benthic Biodiversity On Buoys) project were to evaluate the diversity and abundance of benthic species on navigation buoys from different areas of the Estuary and Gulf of St. Lawrence (EGSL) and to potentially detect the presence of exotic species. The epibenthic invertebrates and algae from the EGSL were studied in the fall 2005, on 113 navigation buoys moored by the Canadian Coast Guard from May through November. The assemblages were studied using a multivariate approach. Geographic variations were observed in the diversity and abundance of species. In general, number of species and individuals decreased on a gradient from the Gulf of St. Lawrence to the lower estuary to the upper estuary. The relationships between the distribution and abundance of species and some environmental factors such as temperature, salinity and chlorophyll a were also examined. The results are compared to previous studies conducted between 1975 and 1984.

Oral; Student; St. Lawrence Ecosystem

WATER CHEMISTRY MEDIATES YELLOW PERCH PREDATION ON INVASIVE MUSSELS

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Exotic dreissenid mussels (*Dreissena* spp.) are among the most disruptive invaders in freshwater ecosystems. They may become the dominant benthic invertebrate where they invade, thereby providing an abundant potential food resource. However, their hard shells protect them from benthivorous predators such as yellow perch (*Perca flavescens*) that lack adaptations for crushing hard prey. We collected yellow perch for diet analysis from multiple sites in the upper St. Lawrence River. Yellow perch were found to consume substantial quantities of dreissenid mussels in the Soulanges Canal, an artificial waterway west of Montreal. This unexpected foraging behaviour was not observed in perch collected from Soulanges Canal in the 1990s or from other St. Lawrence River sites in 2005. We hypothesize that the consumption of mussels was promoted by the weak condition of their shells at this site. A comparison of shell crushing resistance across sites revealed that mussels in the Soulanges Canal in 2006 had weaker shells than those from other sites and from the same site in the 1990s. We attribute the weakness of mussel shells to periodic exposure to calcium-poor water from the Ottawa River. Our results suggest the potential role of abiotic factors in mediating interspecific interactions involving native and exotic organisms.

Oral; Student; Aquatic Invasive Species

LARGEMOUTH BASS MOVEMENT AND DISTRIBUTION IN RELATION TO DISSOLVED OXYGEN

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Past research has shown that when habitat parameters become sub-optimal (ie. increased temperature), fish may move to more advantageous areas to seek out more favourable environmental conditions, find adequate resources and to avoid interactions with competitors. Low dissolved oxygen concentrations have been shown to cause physiological stress and behavioural changes for a number of fish species, including largemouth bass which have been shown to avoid dissolved oxygen concentrations below 1.5mg/L. Most of what we know about the affect of dissolved oxygen on fishes however comes from laboratory studies; few field studies have quantified the role of low dissolved oxygen on fish movement and distribution in the wild. We used a 3-dimensional acoustic telemetry system to quantify seasonal movements of nine largemouth bass in relation to lake-wide dissolved oxygen concentrations. Results showed that when water becomes oxygen deficient as winter progresses, fish alter their behaviour and move to areas with greater oxygen, but utilized depths that are hypoxic. To investigate the habitat selection more directly, we used resource selection analysis to determine that fish during the day had equal preference for normoxic, hypoxic and anoxic water, as well as during the night. Results are further discussed in the context of oxygen requirements of largemouth bass and habitat selection theories.

Oral; Student; Habitat-Fish Mortality Linkage

POPULATION STRUCTURE OF AMERICAN SHAD WITHIN AND AMONG CANADIAN RIVERS

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Knowledge of population structuring is essential to the management of diadromous fishes, within the context of fisheries that may target mixed stock assemblages, to maintain biodiversity, and in the context of species at risk. Fishery-based indices, or simple presence/absence are not always adequate or accurate for understanding population structure of highly migratory species. Genetic analyses can resolve population structure, but may be compromised by stocking efforts. These considerations apply to American shad (*Alosa sapidissima*), a wide-spread, and seemingly loosely structured population-rich anadromous alosine of increasing conservation concern. Unlike their U.S. counterparts, Canadian populations of American shad have not been subject to artificial stock transfers, and present an opportunity to study population structuring on a variety of spatial scales via genetic markers. We used 12 microsatellite markers and advanced statistical techniques (e.g. Bayesian clustering method) to examine broad and fine-scale population structuring among and within six drainages in the Canadian portion of the species range. We detected significant structuring among rivers, as well as within some drainages, and explored the potential to distinguish independent breeding populations from migrant mixtures. We discuss the implications of our results for the homing behavior of shad and the conservation of genetic diversity within the species.

Oral; Student; Aquatic Conservation

WATERPOWER MANAGEMENT AND THE UNPREPOSSESSING RECOVERY OF LAKE STURGEON IN A LARGE REGULATED RIVER

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We examine why lake sturgeon (*Acipenser fulvescens*) have not substantially recovered in a large regulated river. Three primary anthropogenic stressors have been identified as potentially limiting lake sturgeon populations including 1) commercial harvest; 2) contaminants; and 3) water power management. Two hypotheses (1 & 3) were tested by comparing lake sturgeon abundance and examining growth in different reaches carrying in the level of the hypothesize factor; the third hypothesis (2) was tested by assessing contaminant loads in lake sturgeon of various sizes and examining effects on growth and condition. Relative abundance, growth, mortality and mean size of lake sturgeon were not significantly different among river reaches with and without a commercial harvest. Mercury was the only contaminant elevated in lake sturgeon samples; growth nor condition were affected with increasing mercury contamination. Relative abundance of lake sturgeon was significantly greater in natural reaches than managed reaches; lake sturgeon grew significantly greater in managed than natural reaches suggesting density dependent compensation. Water power management appears to be the primary factor affecting lake sturgeon populations in the Ottawa River.

Oral; Hydroelectric and Aquatic Ecosystems

FOOD FOR THOUGHT: ADAPTATION OF GIVING-UP DENSITIES FOR FISH HABITAT ASSESSMENT

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Since 1988, giving-up densities (GUD) have provided small mammal and bird researchers a simple tool for assessing habitat quality from the animal's perspective. Animals forage upon artificial food patches, giving-up when their net rate of energy acquisition represents the integrated value of that habitat. For example, the GUD for very favourable locations will be much lower than those that are marginal. This approach has been highly successful for measuring habitat quality in terrestrial ecosystems but to date has seen very limited application within aquatic ecosystems. Here we describe a technique that allows the GUD to be applied to aquatic ecosystems. We created artificial food patches by attaching a trout crumble/gravel mixture to clear plastic sheets using Tree Tanglefoot™. Food density from the plastic sheets was measured with a flatbed scanner. The scanned images were background subtracted and converted to absolute black and white images (not gray scale) and a standard curve (linear regression, adjusted R^2=0.9457, $p<0.001$) that related average image intensity (the average amount of white in the picture) to food density was created. A lab experiment was conducted using 4 aquaria, each containing a school of 10 fathead minnows (*Pimephales promelas*), to verify that foraging rates by minnows were affected by food density, a fundamental assumption of the methodology. A positive relationship (repeated measures regression, Greenhouse-Geisser correction, $p=0.008$) was found between food density and minnow foraging rate.

Oral; Student; Aquatic Ecosystem Science

A HOLOCENE RECORD OF TERRESTRIAL-AQUATIC DYNAMICS AND VOLCANIC INFLUENCE

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A post-glacial record of diatoms from subalpine Sicamous Creek Lake, British Columbia is presented in context of landscape and vegetation change, based on palynological evidence. Diatom-based water quality and pH changes slightly from the lake's origin to present day, and the ratio of benthic – planktonic diatoms provides evidence of moderate lake level fluctuation. Deposition of Mazama and Mt. St. Helens volcanic tephra layers indicates short-term changes in both terrestrial and aquatic ecosystems. The shift in primary forest composition from pine to ESSF in the late Holocene is reflected in water chemistry and biotic response. Multi-proxy paleolimnological studies show great promise in documenting terrestrial-aquatic interactions over long time periods.

Oral; Land-Water Interactions

RAPID EVOLUTION OF FITNESS IN WILD GUPPIES

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Abrupt environmental change can impose strong directional selection on local populations. If these populations are to persist, they must show rapid adaptation. Many studies have shown that environmental change can indeed drive the adaptive evolution of specific traits. Overall adaptation, however, is an integrated product of changes in multiple traits subject to selection. We examine these aspects of adaptation in a population of Trinidadian guppies that were experimentally introduced 7 years previously into a river that lacked guppies, the Damier. We first use mark-recapture experiments in the Damier to show that a large waterfall separates two distinctive selective environments: high predation and low predation. We next show that the guppies in these two environments differ in some traits (male colour and female life history) known to be under divergent selection between predation regimes. Finally, we use an experimental reintroduction into the Damier to demonstrate that local guppies now show higher survival than do guppies from the original ancestral source. These differences confirm that a major fitness component (survival) can show rapid evolution in the wild.

Oral; Aquatic Conservation

BENTHIC CYANOBACTERIA IN THE ST. LAWRENCE RIVER (LAKE SAINT-PIERRE, QUEBEC, CANADA)

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In contrast with lakes, where planktonic cyanobacteria predominate, widespread occurrence of colonial, benthic, nitrogen-fixing cyanobacteria has been increasingly reported in nutrient-rich sectors of the St.Lawrence River. *Gleotrichia pisum* forms spherical colonies epiphytic on submerged vascular plants whereas *Lyngbia wollei* develops as dense mats of benthic filaments. To assess and explain cyanobacterial distribution and abundance, a 72–stations survey was carried out in August 2006 in Lake Saint-Pierre (400 km^2). Physical (depth, clarity, current speed, conductivity, colour), chemical (TN, NO_2-NO_3, NH_4, TP, TDP, DOC) and biological (biomass of vascular plants and chlorophytes) characteristics were measured simultaneously at each station. *Gleotrichia* occurred in all areas surveyed, in shallow and clear-water stations characterized by markedly low nutrient concentrations, particularly nitrate (19 μg L^{-1}) and ammonium (4 μg L^{-1}). In contrast, *Lyngbia* grew only along the south shore; highest biomass (10-15 g dry mass m^{-2}) also corresponded with stations poorest in nitrate (4 μg L^{-1}) and ammonium (4 μg L^{-1}). We hypothesize that cyanobacterial distribution and abundance reflect the frequency and duration of nitrogen deficit episodes, which occur commonly in summer in areas of slow water transit time and intense biological activity (assimilation by macrophytes, bacterial denitrification). A predictive model of benthic cyanobacterial biomass will further allow to quantify their contribution to lake-wide primary production and nitrogen budget in this heavily-enriched sector of the St. Lawrence River. Future work will focus on the ecosystemic impacts of benthic cyanobacterial proliferation in terms of macrophyte survival, food-chain structure, potential toxicity and production of volatile organic compounds.

Oral; Cyanobacteria: Causes, Consequences and Toxicity

INFLUENCE OF REPRODUCTIVE BEHAVIOUR ON FISHERY-INDUCED EVOLUTION

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Reproductive behaviour has the potential to influence the direction and rate of evolutionary change in exploited populations. Genetic and behavioural data on Atlantic cod (*Gadus morhua*) are consistent with the hypothesis that both males and females prefer spawning with larger mates. In addition to this potential mate selection, fecundity selection might also favour large over small individuals; this has the potential to generate selection against early-, small-maturing genotypes. Fisheries, by contrast, tend to select against late-, large-maturing genotypes. To date, estimates of the rate of evolutionary change in fished populations have implicitly incorporated the assumption that the contribution of genes to future generations is independent of body size. Here, we simulate changes to the mean and variance in body size concomitant with increases in fishing intensity. We then compare changes in the selection differential (*S*) for body size under the assumptions that size does and does not affect reproductive success. We find that an effect of body size on reproductive success can significantly influence the rate of evolutionary change. Maintenance of larger individuals in the population as fishing intensity increases can reduce the rate of genetic change in exploited populations. However, we also find that if the variance in body size remains constant or declines as fishing pressure increases (as is commonly observed), the rate of genetic change is predicted to be faster than that estimated under the assumption that body size has no effect on reproduction.

Oral; Aquatic Conservation

DENSITY-DEPENDENT POPULATION REGULATION IN JUVENILE ATLANTIC SALMON (*SALMO SALAR*) IN CATAMARAN BROOK, NEW BRUNSWICK

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While density-dependent mortality and emigration have been widely described in stream salmonid populations, density-dependent growth is less frequently reported. Most notably, Elliott argued that the high density brown trout population in Black Brows Beck is regulated solely by density-dependent mortality and emigration. Recent studies, however, demonstrated that density-dependent growth in stream-dwelling salmonids is strongest at low population densities and suggested that stream salmonid populations may be regulated in two ways: density-dependent growth at low population densities and (2) density-dependent mortality and emigration at high densities. The purpose of this study was to investigate patterns of loss and growth in young-of-the-year (YOY) Atlantic salmon (*Salmo salar*) in Catamaran Brook, New Brunswick, to test the above hypothesis. As expected, density loss rate increased significantly with increasing summer population density. Contrary to the expectation, however, YOY Atlantic salmon suffered mortality and/or emigration even at very low summer population densities, where no density-dependent responses would be expected. Our study found a weak negative relationship between average summer mass and summer population density of YOY Atlantic salmon. Density-dependent loss and growth was evident both within and across years. The weak negative relationship between average mass and density of YOY Atlantic salmon changed by fall. In fact, YOY density alone explained more of the variation in average fall mass than any other factor. Our results suggest that populations of YOY Atlantic salmon are regulated by two different mechanisms: density-dependent growth at low densities and density-dependent mortality and emigration at both low and high densities.

Oral; Contributed

LANDSCAPE CONTROLS OF NUTRIENT EXCRETION BY STREAM INVERTEBRATES ALONG A GRADIENT OF AGRICULTURAL LAND USE

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We examined the relationship between watershed land use and nutrient release by mayflies in south-central Ontario streams. Excretion rates and ratios of dissolved organic carbon (DOC), nitrogen (N), and phosphorus (P) were measured using mayflies collected from streams flowing through watersheds having contrasting agricultural land use. Our results show strong positive correlations between the mass specific release rates of N and P by mayflies and the percentage of agricultural land use in the watersheds (% ag; r^2=0.48, p<0.01 and r^2=0.58, p<0.05 respectively). Changes in excretion rates and ratios were likely due to lower periphyton C:nutrient ratios, which were associated with elevated TDP and TDN concentrations (r^2=0.30, p<0.05 and r^2=0.38, p<0.001 respectively) in agricultural streams. While excretion rates and periphyton C:N:P ratios varied among streams, we found relatively constant body C, N, and P content in mayflies across all sites suggesting relatively strong homeostasis in these consumers. Our results demonstrate that the balance of elements fluxing through invertebrate consumers can be tied to watershed land use with potentially large effects on nutrient cycling in agricultural streams.

Oral; Student; Land-Water Interactions

PREVALENCE AND REPRODUCTIVE STATUS OF ESCAPEE DOMESTIC RAINBOW TROUT IN SPAWNING TRIBUTARIES OF NORTHERN LAKE HURON

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Most of the aquaculture production in central Canada comes from relatively few rainbow trout (*Oncorhynchus mykiss*) cage culture farms concentrated in northern Lake Huron. Domestic rainbow trout from cage culture operations are occasionally lost into the surrounding environment when cages are damaged; these fish could eventually mature and compete or interbreed with spawning naturalized rainbow trout. We investigated the potential for such effects by determining the prevalence and reproductive status of escapee domestic trout in known rainbow trout spawning tributaries of northern Lake Huron. Adult fish were sampled using catch-and-release angling during April and May of 2005 and 2006. Length, sex, and maturity were recorded, and scales and fin tissues were collected from each fish. The fish samplers also made an initial assessment of fish origin (wild or domestic) based on body shape and appearance. This categorization was then compared with wild-vs-domestic categorizations derived from early-life growth history (as elucidated from scale analyses), and from multilocus microsatellite genotypes. Genotyping identified two distinct groups of rainbow trout, which largely corresponded with the phenotypic groups identified in the field. Results to date indicate that escaped domestic rainbow trout are maturing and spawning in the Manitoulin Island region, but are generally utilizing spawning tributaries close to current cage culture operations. Successful interbreeding between wild and escaped domestic rainbow trout appears to be limited based on the genotypic data. The genetic and ecological implications of escaped domestic fish on naturalized rainbow trout populations will be discussed.

Oral Presentation; Aquatic Invasive Species

THE NOSE KNOWS: GENOMIC ISOLATION AND CHARACTERIZATION OF OLFACTORY GENES IN ATLANTIC SALMON

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Olfactory senses are essential in food selection, mate choice, defense against predators and migration in salmonid fish. The anadromous life cycle of salmonids requires the use olfactory senses to return to their natal habitats. Physical tagging studies on Atlantic salmon have shown a high accuracy in homing. This is an important ecological and evolutionary phenomenon because salmon returning to their natal habitats leads to genetically distinct populations. We are isolating and characterizing odorant receptor genes in Atlantic salmon. Atlantic salmon BAC library (CHORI-214) was screened with an oligonucleotide probe designed from conserved sequence of several fish V1R genes. Eight hybridization positive BACs were identified from the six genome equivalents of CHORI-214 segment 1. All of these BACs reside in the same fingerprint contig of the Atlantic salmon physical map. All members of this contig were screened for V1R using PCR and 24 of the 31 BACs were positive. These results indicate that there is a single V1R gene in Atlantic salmon as has been observed in zebrafish. We are continuing to identify other olfactory genes with the ultimate goal of examining their expression during sensitive developmental and imprinting periods. The information from this study will provide a bearing on understanding salmonid life histories and how discrete populations are established and maintained.

Oral; Student; Environmental Physiology and Genomics

PREDICTING IMPACTS OF INVASIVE SPECIES: VARIATION IN ZEBRA MUSSEL FOULING INTENSITY OF NATIVE MUSSELS

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The ecological impacts of invasive species vary across environmental gradients. However, predictive models of impact may be constructed by synthesizing data from multiple invaded sites. The introduction of the Eurasian zebra mussel (*Dreissena polymorpha*) to North American lakes and rivers has led to the intense fouling of native unionid mussels, often causing massive mortality of unionid populations in systems that support high densities of zebra mussels. We conducted a multi-site survey in the St. Lawrence River and Richelieu Rivers to determine whether variation in fouling intensity of zebra mussels on unionids is predicted by local environmental variables. Fouling intensity increases across sites with increasing calcium concentration and decreasing sediment size; in a multiple regression model, these variables explain 86% of the variation in fouling intensity ($p < 0.0005$). Given that unionid population mortality is correlated with fouling intensity, our findings highlight the role of environmental variables in mediating the impact of zebra mussels on native biodiversity.

Oral; Student; Aquatic Invasive Species

OXYGEN ISOTOPE ANALYSIS OF COD OTOLITHS RECONSTRUCTS TEMPERATURE REGIME DURING FISHERY COLLAPSE

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Atlantic cod (*Gadus morhua*) stocks on the eastern Scotian Shelf in the Canadian Maritimes collapsed during the early 1990s. The main cause of this decline was overfishing, but an influx of cold water into the relatively warm, shallow spawning grounds of the 4Vs region during the mid-1980s may have contributed to this collapse. To test this hypothesis, we determined the fractionation of stable oxygen isotopes in the yearly growth bands (annuli) of otoliths (or "ear stones") in order to reconstruct the temperature exposure history of the 4Vs cod from 1972 through 2001. Stable oxygen isotope ratios derived from the annuli of propeller clams (*Cyrtodaria siliqua*) were used to provide independent estimates of the isotope ratio of seawater. Growth back calculation shows decreased lengths-at-age following the influx of cold water. Reconstruction of an ambient temperature history of the 4Vs cod shows a temperature timeline similar to the station data for that region. Although the influx of cold water in the mid-1980s may have contributed to the decline of the 4Vs stock, a distribution shift away from traditional spawning grounds is unlikely based on these findings.

Oral; Student; Climate Change

ROAD ACCESS AS THE VECTOR FOR TWO INVASIVES IN LAKE TROUT LAKES OF NORTHEASTERN ONTARIO: ANGLERS AND BASS

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Regional scale aerial surveys of fishing activity and extensive gillnet fish community assessments were used to assess the effects of road access on angling effort and the presence of invasive smallmouth bass (*Micropterus dolomieu*) in lake trout (*Salvelinus namaycush*) lakes of northeastern Ontario. The suveys showed that fishing effort increased with the ease of access. Total angling effort was highest and often exceeded sustainable levels on large lakes with good road access that allowed for high open water effort. Many (~ 25 %) of the smaller more remote lakes also received excessive pressure, and were angled most intensive during the winter season. Angling effort increased with lake trout density in remote lakes, but operated independent of density in road accessible lakes. Smallmouth bass were more prevalent in lakes with easy access and the presence of human settlement (either cottages or lodges). Lake trout density appeared low throughout the study lakes, suggesting a broadscale effect of exploitation or other stressors. In lakes with neither smallmouth bass nor easy road access there was still a 47 % reduction in lake trout density relative to unexploited or extremely remote reference lakes. With the addition of either or both of these stressors, there was a reduction of nearly 90 %. This study shows that remote lake trout populations are clearly vulnerable to the negative impacts of improved access, a vector for both over-exploitation and the introduction of invasive species.

Oral; Aquatic Invasive Species

HISTORICAL WATER QUALITY DYNAMICS IN NATURALLY EUTROPHIC ALBERTAN BOREAL PLAIN LAKES: DOES LAND-USE MATTER?

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Lakes in the Cold Lake Region in northern Alberta are an important resource for inhabitants by providing drinking water, recreational areas, and fishing grounds. There is a tremendous amount of variability in water quality, but there is a lack of understanding on the relative importance of the potential causes of these changes. The phosphorus-rich soils in North-Central Alberta favour the development of eutrophic lake conditions. However, land use changes and climate are other potential factors playing a role for water quality dynamics in the region. Using paleolimnological techniques, we aim to identify the timing and extent of past changes in the water quality and quantity of several lakes in the Beaver River Basin, and attempt to relate them to possible causes such as climate variability, land-use, and water use. Our objective is to identify baseline conditions that are necessary for setting realistic targets and goals for water management decisions. We analysed fossil remains of diatoms (*Bacillariophyceae*), organic matter and carbonate content in ca. 40-cm long sediment cores from three lakes with differing degree of land use in the respective watersheds. Diatom assemblages were remarkably similar between lakes and indicated that the lakes had been eutrophic since pre-settlement times. Surprisingly, the lake with the highest degree of urbanization and agricultural use in the watershed showed the least amount of change in diatom assemblages since European settlement. We will discuss the implications of our results for watershed management and restoration in the Cold Lake Region.

Oral; Land-Water Interactions

USING GENOMICS TO IDENTIFY GENES ASSOCIATED WITH UPPER TEMPERATURE TOLERANCE IN SALMONIDS

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It is predicted that climate change will severely affect the northern regions of Canada, with devastating ecological and economical impacts. Indeed, the aquaculture industry in the Yukon, Canada has reported massive losses in Arctic charr stocks over recent summers due to elevated ambient water temperatures. It is therefore of interest to develop temperature tolerant strains of salmonids using genomics-assisted selective breeding for aquaculture purposes. Previous studies have identified several QTL for upper temperature tolerance (UTT) in Arctic charr. These studies artificially controlled for dissolved O_2 concentration, which normally decreases with increased water temperature; however, a fish's ability to sequester and store O_2 is likely to be a key factor in determining its ability to survive in warm waters. We are using the well-studied Atlantic salmon genome to examine UTT QTL and Haemoglobin (Hb) genes in salmonids. Hybridization probes were designed and used to screen the Atlantic salmon BAC library for BACs containing Hb genes and UTT QTL microsatellite markers. The hybridization positive BACs were analysed using PCR and subsequently placed into contigs in the Atlantic salmon physical map. This suggested that there are two Hb clusters, presumably the result of the ancestral salmonid genome duplication. We are now sequencing selected BACs to look for candidate genes for UTT and to detect regulatory regions in the Hb genes. The information that will be produced from this research will feed into a gene- and marker-assisted breeding program for Artic charr, and will potentially be of benefit to other salmonid species.

Oral; Environmental Physiology and Genomics

LINKING MORTALITY RISK IN LACUSTRINE FISHES TO HABITAT FEATURES BY MEANS OF TETHERING TRIALS AND SURVIVAL ANALYSES

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Habitat features influence the ecological interactions and spatial distribution of fish species. For example, water transparency and macrophyte cover, as well as their interaction, can strongly influence predation risk and mortality. We conducted tethering trials in Lake Saint Pierre, a shallow fluvial lake in the Saint Lawrence River system, to assess the effects of water transparency and macrophyte cover on the mortality risk of eight abundant species of fish (blacknose shiner, brown bullhead, emerald shiner, golden shiner, mooneye, spottail shiner, trout-perch, and yellow perch). Survival analyses (Kaplan-Meier survival curves and Cox regressions with time-varying covariates) were used to account for non-normality and "censoring" (fish still alive at end of trial) in the outcome variable, time-to-death. Kaplan-Meier estimates showed that mortality risk varied substantially among three groups of species having high, intermediate, or low survival rates. Cox regressions showed that mortality risk for six of the eight species was influenced by water transparency or by an interaction of transparency with macrophyte cover. These results indicate that variation in water transparency may generate spatial heterogeneity in fish abundance either through direct effects, such as local reduction in population numbers by predation, or indirect effects, such as behavioural avoidance of risky areas.

Oral; Student; Habitat-Fish Mortality Linkages

COMPARATIVE HABITAT ASSOCIATIONS IN JUVENILE PACIFIC COD AND OTHER GADIDS USING SEINES, BAITED CAMERAS AND LABORATORY TECHNIQUES

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Pacific cod are a commercially and ecologically important in the North Pacific, currently ranking 2nd in tonnage and value landed in the Alaskan groundfish fishery. To date, few studies have focused on the habitat requirements of Pacific cod, and as a result, our understanding of their ecology has largely been borrowed from better-studied gadid species e.g., Atlantic cod. In July-Aug 2006, we used field and laboratory techniques to explicitly examine habitat associations of Pacific cod and two co-occurring gadids, saffron cod (*Eleginus gracilis*) and walleye pollock (*Theragra chalcogramma*), in coastal areas around Kodiak Island, AK. Seine catches indicated that Pacific cod were most abundant in the gadid assemblage, followed by saffron cod and walleye pollock respectively. Small Pacific cod (3.5-7.5 cm TL) preferred structured habitats (i.e., *Laminaria* sp.) but moved into unstructured habitats at larger sizes i.e., >8.0 cm TL. Baited cameras and beam trawls also indicated that larger juvenile Pacific cod were common in deeper (4-20 m), unstructured habitats. In contrast, saffron cod showed high affinity for eelgrass beds (*Zostera marina*) throughout their first year (3.5-13.0 cm) and into maturity i.e., 30-50 cm. Pollock were highly variable in their distribution, and were almost absent from the nearshore in late August. Laboratory experiments indicated that Pacific and Saffron cod chose these habitats under increased predation risk and but also innately associated with these habitats at larger scales. Our results indicate both distinct differences and parallels between Pacific and Atlantic cod that will guide future process-oriented habitat research in both species.

Oral; Contributed

EFFECTS OF AMBIENT ACIDITY ON WILD JUVENILE ATLANTIC SALMON ALARM RESPONSE: A RECIPROCAL TRANSPLANT EXPERIMENT

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Under weakly acidic conditions (pH ~6.0), several species of salmonids are impaired in their ability to detect and respond to chemical alarm cues. Chemical alarm cues are found in the skin of a wide range of prey fishes and are typically released following lesions to the skin, as would likely occur during predation. These alarm cues represent a reliable indicator of local predation risks and can confer survival benefits to responding individuals. As different populations of salmonids may have different tolerances to acidity, our experiment was aimed at assessing if the inability to respond to chemical alarm cues found under acidic conditions was the result of a loss in chemical alarm function or to differences in acidity tolerance. Using wild juvenile Atlantic salmon, we conducted experimental trials in acidic and neutral streams in which we placed enclosures. Salmon of different origins (from neutral or acidic streams) were placed in these enclosures, exposed to chemical alarm cues and their alarm response was quantified. Our results suggest that while the origin of the fish had no effect on alarm response intensity, the conditions in which they were tested (either in a neutral or acidic stream) had a significant effect on their ability to perform 'normal' alarm responses. As such, this suggests that weak levels of acidity may create a direct loss in 'normal' alarm function.

Oral; Aquatic Ecosystem Science

DIET ANALYSIS OF FISHES FROM TWO DISTINCT WATER MASSES IN WESTERN LAKE ERIE

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Tributary networks influence the physical, chemical, and biological factors of aquatic ecosystems, which simultaneously influence fisheries dynamics. This study sought to describe the diets of fishes from two distinct water masses created within the western basin of Lake Erie by discharge from the Maumee and Detroit Rivers. The Maumee River drains a highly agricultural watershed and its discharge is highly correlated with springtime total suspended solid inputs, phosphorous inputs, zooplankton biomass, and age-0 yellow perch (*Perca flavescens*) abundance. In comparison, the Detroit River is a much less productive, less turbid system. Discharges from both rivers create two distinct plumes within the western basin. Characteristics within each plume likely affect feeding, growth, condition, and survival of fishes. Fishes were sampled during May and June using short set gillnetting and bottom trawling. Over 3,000 stomachs were removed from sampled fishes, most of which were from white perch (*Morone americana*), white bass (*Morone chrysops*), walleye (*Stizostedion vitreum vitreum*), and yellow perch. Diets were analyzed morphologically and analyzed for an effect of river plume. Understanding diet variations of western Lake Erie fishes could provide insight to the mechanisms that drive recruitment variation, which will lead to management techniques based on watershed level approaches.

Oral; Student; Land-Water Interactions

DISTRIBUTION OF BACTERIOPLANKTON IN THE ST. LAWRENCE ESTUARY AND PROPORTION OF HIGH AND LOW NUCLEIC ACID CONTENT CELLS DURING LATE FALL AND WINTER TIME

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The spatial distribution of free bacterioplankton was investigated in the St. Lawrence estuary (SLE, Québec, Canada) in October 2005 and December 2005. The distribution of high nucleic acid (hna) and low nucleic acid (lna) bacteria was monitored through the entire water column at 12 different stations located along the salinity gradient. These biological data were related with classic biogeochemical variables to determine the main factors affecting bacterial populations in the SLE during low temperatures and low primary productivity periods. A special interest was put on the relation between bacteria and nitrogen distributions in the estuary. Our results show that in the upper estuary, total free bacteria (tb) abundances ranged from 8.21×10^5 cells.ml^{-1} to 6.72×10^5 cells.ml^{-1} in October and December, respectively. In the lower estuary, average tb concentrations observed in October ranged between 8.25×10^5 cells.ml^{-1} in surface waters, 4.44×10^5 cells.ml^{-1} in the intermediate layer and 3.92×10^5 cells.ml^{-1} in deep waters. In December, tb abundances were homogeneously distributed in the entire water column reaching (c.a. 3.5×10^5 cells.ml^{-1}). Statistical analyses exhibit that the abundance pattern is not directly related to distribution of hna cells within the bacterial population. It is generally assumed that, in aquatic ecosystems, bacterial production and activity are mainly limited by temperature and nutrients. Nevertheless, our results clearly demonstrate that bacterial community abundance and activity were mostly determined by nitrogen availability in the SLE during late fall and winter periods.

Oral; St. Lawrence Ecosystem

CHARACTERIZING THE CAUSES OF SPATIAL STRUCTURE IN LAKE ZOOPLANKTON

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Given that an understanding of a community's spatial structure can affect species interactions and thereby influence community dynamics, we sought to investigate what factors might be important in determining how zooplankton are spatially distributed in lakes. Specifically, we quantified zooplankton spatial structure by measuring zooplankton abundance with horizontal transects using a Laser Optical Plankton Counter, taken at six hour intervals repeated over two days in a sheltered bay. We concurrently assessed the influence of local environmental variables (temperature, pH, dissolved oxygen, turbidity and chlorophyll) on the distribution of zooplankton abundance by size class. We analyzed the spatial structure using semivariograms and canonical analysis (CCA, RDA and variation partitioning), where a shorter autocorrelation distance suggests variables are acting on a more local scale. In general, semivariograms showed that biotic variables (chlorophyll, predation), which tend to be more important on smaller scales, better explained zooplankton abundance in the morning, while abiotic variables (e.g. fetch, current), which tend to be more influential on larger scales, better explained zooplankton abundance through the day into the night. Also, while canonical analyses showed that environmental variables explained a significant portion of the variation in zooplankton abundance, the relationship lost significance when their spatial variables were considered. Thus, our results indicate that an explanation of zooplankton spatial structure will require an understanding of both factors influencing autocorrelation patterns and the spatial distribution of environmental variables.

Oral; Student; Aquatic Ecosystem Science

EFFECT OF VERTEBRATE AND MACROINVERTEBRATE PREDATION ON ZOOPLANKTON PRODUCTIVITY

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Predation by fish and macroinvertebrate predators is well known to strongly affect zooplankton species composition and mean community body size. Less well-known is that these predators can also affect the rate of zooplankton secondary production. We explored the effects of different predation regimes on zooplankton productivity in 20 day mesocosm experiments with a factorial design: No fish, low fish, high fish x presence and absence of *Chaoborus*. The biomass of individual species groups was unaffected by either fish or macroinvertebrate predators, but total biomass increased with macroinvertebrates. We also could not detect any change in mean community body size, or the body size of species groups. Effects of both fish and macroinvertebrates were evident, however, in zooplankton productivity (estimated using the egg-ratio method). Zooplankton under predation from macroinvertebrates more than doubled their production; fish predation caused a variable response. The changes in productivity caused by both vertebrate and macroinvertebrate predation would likely have led to effects on biomass and body size, had our experiment been run for a longer time.

Oral; Student; Aquatic Ecosystem Science

EFFECTS OF COLONIZING PREDATORS ON YELLOW PERCH (*PERCA FLAVESCENS*) POPULATIONS IN LAKES RECOVERING FROM ACIDIFICATION AND METAL STRESS

Kelly A. Lippert, John M. Gunn, and George E. Morgan

We examined the effects of predator species such as smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*) and northern pike (*Esox lucius*) on yellow perch (*Perca flavescens*) from lakes in the Sudbury mining region, Ontario, where fish communities are beginning to recover from decades of acidification and metal stress. The predation regimes investigated included six lakes with no predators, four lakes recently invaded (< 3 years) by predators, and eight lakes with well established ($\geq$ 5 years) predator populations. Netting survey results suggested that yellow perch populations declined (69%) in lakes with predators. In lakes recently invaded by predators, perch displayed much earlier ontogenetic diet shifts from zooplankton to benthos and much poorer growth during their first growing season. Energy investment (egg lipid content) in eggs by mature females was also less in the lakes with recently invaded predators. Growth potential in adult perch (age 1), estimated by nucleoside diphosphokinase, was highest in lakes with established predators. Round weight, controlling for size of perch was also greatest in established predator lakes. Perch body shape in lakes with recently invaded predators showed a shift from a typical streamlined, pelagic body form towards a deeper-bodied benthic body form, a change that may increase foraging efficiency for benthos, or may represent an anti-predator strategy. While the observed multi-character phenotypic plasticity of perch in reaction to recent predator arrivals should be of general interest, observed departures from expected patterns in the recovery of industrially damaged lakes may prove to be a useful measure of the timing of the predator invasion or the state of the recovery of such lakes.

Oral; Aquatic Ecosystem Science

EFFECTS OF DIFFERENT MACROPHYTE SPECIES AND ARTIFICIAL AERATION ON NITROGEN TRANSFORMATIONS AND N_2O GAS FLUXES IN CONSTRUCTED WETLANDS

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Increased agricultural/aquacultural intensity in Quebec has resulted in higher nitrogen (N) loads to receiving aquatic ecosystems. Given their satisfactory pollutant removal efficiencies, constructed wetlands (CWs) may be used to treat various types of wastewater prior to delivery to adjacent water bodies and could therefore act as important buffers to help conserve water quality. However, the role of CWs in terms of N transformations and greenhouse gas (GHG) emissions such as nitrous oxide (N_2O) remains poorly understood and could mitigate their environmental benefits. We studied the combined effects of artificial aeration and the presence of 2 macrophyte species (*Phragmites australis*, *Typha angustifolia*) on N transformations and GHG gas fluxes in twelve mesocosms supplied with trout farm effluent. Removal of total nitrogen (TN) and dissolved organic nitrogen (DON) was high in all beds, except in unplanted non-aerated controls. High DON mineralization rates resulted in net production of nitrate and nitrites (NO_3^-+NO_2^-) in aerated mesocosms and ammonium (NH_4^+) in non-aerated units. Aerated and planted units generally emitted less N_2O, while non-aerated units planted with *T. angustifolia* had the lowest fluxes. No diurnal pattern in N_2O fluxes was observed among treatments. Based on these results, planted constructed wetlands should be favoured over unplanted units because of higher TN removal and lower GHG emissions. When readily available at a low capital cost, additional aeration should be used to lower gaseous fluxes and promote the release of NO_3^-+NO_2^- over NH_4^+ in surrounding ecosystems.

Oral; Student; Wetlands

FISH, FOOD AND FERTILIZER: COMMERCIAL FISH HARVEST PARTIALLY BALANCES ANTHROPOGENIC NITROGEN EXPORT FROM LAND TO SEA

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Global nitrogen (N) transport has been altered dramatically by human activity over the past half century. Export of N from land to coastal areas has nearly doubled primarily due to increased fertilizer application on agricultural lands. The reverse flow of N from sea to land is generally considered to occur by natural processes such as anadramous fish returns and seabird guano. A human mediated component to this reverse flow must also occur through fisheries harvest but the return of N through commercial fisheries has never been estimated at the global scale. Here we quantify the return of N to land in fish biomass and compare this flux with fertilizer input to the ocean for the time period 1960-2002 globally, and regionally for 58 coastal areas (large marine ecosystem zones, LMEs). We find fish N return to be significant compared to fertilizer export to the sea. In the early 1960s, the equivalent of 63% of global fertilizer N export was removed as fish biomass in the global commercial harvest. However, fisheries N removals have not kept pace with increased fertilizer N exports. By the year 2000, this fraction declined to 22%. Fish N returns were spatially variable, ranging from less than 1% to more than 500% of fertilizer N export. These global trends of increasing fertilizer inputs relative to fish harvest suggest that the coastal zone is retaining increasing amounts of N. Although fish removal should not be considered a counter measure to reduce the impacts of high N load, the declining export of fish may magnify the impact of fertilizer N export and exacerbate coastal eutrophication.

Oral; Land-Water Interactions

SURFACE TEMPERATURE ANT TAXONOMY EXPLAIN REGIONAL $\delta^{15}N$ ZOOPLANKTON VARIABILITY IN OLIGOTROPHIC ECOSYSTEMS

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In aquatic ecosystems, the nitrogen isotopic composition ($\delta^{15}N$) of primary consumers may exhibit wide spatial and temporal variations arising from a number of different sources, which has important consequences when comparing multiple ecosystems food webs. The aim of this study was to assess the sources of variation in the $\delta^{15}N$ signature of various zooplankton taxa from a series of oligotrophic lakes and large reservoirs situated in the boreal ecoregion of Northern Canada. Seasonality and taxonomy were the most important sources of variance (35 and 51%, respectively) for zooplankton $\delta^{15}N$. Based on the seasonal data, an ANCOVA based on temperature and taxonomy was constructed to predict $\delta^{15}N$ values of zooplankton and we verified its validity by using several data sets from the literature. Our results suggest that the model takes into account both variations due to differences in nutrient loads occurring between spring and summer and nitrogen transformation processes.

Oral; Student; Land-Water Interactions

COMPARATIVE ESTIMATES OF EFFECTIVE POPULATION SIZES IN THREE SPECIES OF WOLFFISHES (*ANARHICHAS* SPP.)

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Due to a combination of extensive habitat degradation and capture as by-catch in other fisheries, wolffishes in the North Atlantic Ocean have suffered severe population declines since the 1970s. All three species of wolffishes in the Atlantic are currently listed by the Species at Risk Act, SARA, as either "special concern" (Atlantic wolffish, *Anarhichas lupus*) or "threatened" (spotted wolffish, *A. minor*, and northern wolffish, *A. denticulatus*). Effective population size (N_e), in particular the ratio of effective population size to census size (N_e: N), can be critical in determining the conservation status of exploited or depleted marine populations where census size may still be large, but effective population size may have become severely reduced. N_e estimation in wolffishes may provide an interesting contrast to other studies of marine fishes due to their relatively unusual life history and mating behaviour. They seem to form monogamous mating pairs, they exhibit paternal care of young, and the larvae are thought to have a limited pelagic stage. Using mitochondrial DNA and microsatellite loci, we assessed genetic variation in Atlantic, spotted, and northern wolffishes, and used the data to obtain comparisons of N_e among marker types, estimation methods, and species. A comparison of long-term N_e estimates with contemporary species abundance suggests that current differences in abundance among wolffish species have had a long history. Our data show that wolffishes have low genetic variation compared to other marine species, suggesting a vulnerability that warrants protection.

Oral; Student; Aquatic Conservation

EVOLUTIONARY DIVERGENCE AMONG INTRODUCED POPULATIONS OF LAKE TROUT

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Divergence in life history and morphological traits is often observed when organisms are introduced to new environments. Lake trout (*Salvelinus namaycush*) were introduced into several high altitude lakes in California a century ago and have experienced little to no subsequent disturbance. These lakes differ in a number of environmental attributes, such as lake size, elevation, and forage base. As a result, these populations exhibit substantial divergence in life history traits such as age at maturity, asymptotic length, and egg size/developmental timing. Populations have also undergone morphological divergence that exceeds that observed among established Lake Superior lake trout morphotypes. This variation may be caused by three ecological or evolutionary scenarios: (i) phenotypic plasticity, (ii) natural selection, and (iii) genetic drift. Levels of phenotypic divergence in morphological and life history traits (Q_{ST}) were compared with differentiation in neutral genetic markers (F_{ST}) to assess whether observed divergences reflect adaptive (natural selection) or non-adaptive (genetic drift/phenotypic plasticity) divergence. These comparisons present evidence that morphological and some life history divergences are likely driven by natural selection, thus providing evidence of contemporary evolution in these populations.

Oral; Contributed

WALLEYE VS. CORMORANTS: WILL ALL THE FISHES COME HOME TO ROOST?

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In the last 100 years Lac La Biche, located in northeastern Alberta, has changed from a system with walleye (*Sander vitreus*) as the top fish-eating predator, to one where Double-crested Cormorants (*Phalacrocorax auritus*) are at the top of the aquatic food chain. Along with the major prey species in the lake, (yellow perch (*Perca flavescens*)), cormorants and walleye have been identified as the main species that define and drive the system. Recent and historical changes to the fishery have altered the ways in which these species interact. Such changes in predator-prey dynamics in response to increases in avian predators may be related to the existence of alternate but stable ecosystem states in aquatic systems. Alternate stable state theory suggests that a single environment can stably support more than one community with the transition between states being marked by a sudden and difficult-to-reverse change in a controlling variable. Identification of the threshold variable that causes these shifts and the positive feedback mechanisms that maintain it are necessary for the development of policy options capable of encouraging the existence of either state. Ecological restoration utilizes specific management activities to overcome these critical thresholds and to guide the ecosystem towards a specific, and often desired, stable state. Restoration goals may take many years to reach thus it is essential to frequently assess the trajectory of the restoration path on the basis of the systems current performance. Predictive ecosystem models allow this level of assessment through the synthesis of bottom-up, field-level research with theory-driven, top-down conceptions.

Oral; Student; Aquatic Ecosystem Science

CAUSES OF SEX RATIO VARIATION IN THE TRINIDADIAN GUPPY, *POECILIA RETICULATA*

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The sex ratio is an important demographic characteristic that can significantly affect population and mating dynamics. Primary (at conception) and secondary (at birth) sex ratios may be determined by environmental, social or genetic factors. Tertiary (adult) sex ratios are influenced by the previous factors, but can also vary with differential mortality of the sexes. In the Trinidadian guppy (*Poecilia reticulata*), differing sex ratios are known to have considerable effects on mating behaviour, thus influencing the balance between sexual selection and sexual coercion. Interestingly, significant variations in sex ratio have been documented between different natural guppy populations, despite most evidence pointing towards a stable, genetically determined 1:1 sex ratio at birth. Differential mortality of the sexes is therefore likely responsible for this trend. It is generally assumed that female-biased ratios prevail in low-predation environments where the gape-limited *Rivulus hartii* is the sole predator that preferentially consumes juveniles and adult males. Predators of high-predation sites are thought to consume males and females equally. However, these trends are not always clear-cut, as low-predation sites may be male-biased, and vice versa. Other factors, such as resource availability, may vary between sites with differing sex ratios. By surveying sex ratios at a variety of Trinidadian streams and quantifying the different abiotic and biotic properties of these habitats, I will further elucidate the mechanisms responsible for sex ratio variation in guppies. In addition, I will perform controlled laboratory experiments to outline specific factors responsible for differential male and female mortality.

Oral; Student; Contributed

SPECIES DIFFERENCES IN EARLY MARINE MORTALITY OF JUVENILE PACIFIC SALMON ARE LARGELY ATTRIBUTED SIMPLY TO DIFFERENCES IN BODY LENGTH AND MIGRATORY DISTANCE

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The first three years of the Pacific Ocean Shelf Tracking Project (POST) have documented considerable variation in mortality among populations of juvenile salmon, both by the end of their downstream (8-87%, weighted mean 59%) and early ocean (42-95%, mean 88%) migrations. Steelhead and sockeye smolts tended to migrate rapidly through the inshore Strait of Georgia system and leave with relatively high survival rates. Coho and chinook smolts suffered higher mortality during the downstream migration, and either high rates of mortality or inshore residency after ocean entry. We used a binary logistic regression model incorporating fish from all species in all years to explain the variation in survival by multiple factors including body length, tag size, migration distance, and latitude. Hatchery-reared smolts suffered higher mortality during the downstream migration compared to wild-caught smolts when other factors were taken into account. Fish with smaller body sizes and longer distances to migrate were also more likely to die during both downstream and early ocean segments of their migration. Of all factors, body length had the strongest effect on the variation in mortality, especially by the end of the early ocean migration. When length and other factors were accounted for, there were small mortality differences between species during the downstream migration but these differences essentially disappeared by the end of the early inshore ocean migration. This finding was surprising considering the wide variation among Pacific salmon species in migratory patterns and life-history strategies after ocean entry.

Oral; Student; Contributed

SELECTION OF DIURNAL REFUGES BY THE NOCTURNAL SQUIRRELFISH, *HOLOCENTRUS RUFUS*

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The distribution and abundance of many species of fish is associated with habitat complexity and the presence of refuges. In coral reefs, fish occupy naturally occurring refuges such as crevices, holes and ledges. However, there is little information on the importance of specific characteristics for refuge selection. We examined diurnal refuge occupancy in the nocturnal squirrelfish, *Holocentrus rufus*, to describe refuge use and to determine which, if any, refuge characteristics were selected. We tagged 21 *H. rufus* on two sites on a fringing reef in Barbados, West Indies, monitored their refuge use for a month, identified the refuges they used (n = 57) and measured 10 characteristics of each refuge and the surrounding microhabitat. To build a model of refuge selection, we measured the same characteristics on a comparable number of unused potential refuges (n = 67). Each fish showed exclusive use of 1 - 9 refuges, which they defended against intrusion by conspecifics and some heterospecifics. For individuals that used more than one refuge, there was a significant positive relationship between the maximum distance between their refuges and their total length. The width, height and length of the refuges used by each fish were all positively related to their length, but not the number of refuges they used. Selected refuges differed significantly from unused potential refuges mainly in characteristics related to vertical position. Currently, we are investigating whether different species of Holocentridae use different refuge types and whether refuge availability limits their densities.

Oral; Student; Aquatic Conservation

A HIGH-RESOLUTION FOSSIL DIATOM RECORD OF CLIMATE AND ENVIRONMENTAL CHANGE IN EAST AFRICA SINCE THE LAST GLACIAL MAXIMUM

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Existing climate-proxy records from low-latitude regions demonstrate that tropical climate has fluctuated throughout the Holocene, and suggest links between tropical atmospheric processes and global climate dynamics. However, the exact mechanical relationship between tropical and temperate climate variability, as well as the regional synchrony of temperature and humidity variations within the tropics, are still poorly understood due to the scarcity of suitable high-resolution climate archives from tropical continental regions. Lake Challa is a 5 km^2, 97m deep freshwater crater lake located at 880m elevation on the southeast slope of Mount Kilimanjaro (Kenya-Tanzania). It has no surface inflow or outflow, and is maintained by precipitation on the lake surface, and groundwater seepage from the shallow aquifer fed mainly by precipitation on the forest zone of Mount Kilimanjaro. A 22m sediment core recovered in 2005 has well preserved diatoms throughout its length. Diatom species diversity was found to be extremely low in this core, however, the relative abundance of species is highly variable from 25-11 ka BP, compared to the relatively stability during the Holocene. Diatom concentrations fluctuate throughout, suggesting that diatom biovolume in this lake is responsive to climate change. Our paleoecoloogical interpretations are supported by spatial analysis of modern diatom assemblages throughout the lake to provide information on the distribution and abundance of planktonic, benthic and periphytic species in relation to present-day limnology. In conjunction with other biological and geochemical paleoproxy indicators, this high-resolution diatom record will help us better understand climate-driven environmental change in the vicinity of Mount Kilimanjaro, site of the only African ice-core record.

Oral; Student; Climate Change

SCIENCE-BASED AQUATIC ECOSYSTEM MANAGEMENT: A PROGRESS REPORT

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Using science for aquatic ecosystem management has a long history in Canada, particularly in freshwaters. As attention to management of marine ecosystems is more recent, a comparison of history, issues, approaches, and progress in freshwater and marine ecosystems will help highlight priorities for future progress. In freshwaters, efforts to manage ecosystems mainly evolved from efforts, in the 1960/70s, to control pollution impacts. Long-term programs investing in science to increased understanding, monitoring to measure success, and infrastructure and legislation to limit stressors, yielded considerable improvements in places like the Great Lakes. The easier specific problems were tackled but the harder systemic problems driven by human population numbers and activities and by land use changes were unresolved. Events in the Bay of Quinte provide a model history for freshwaters. In marine waters, efforts largely evolved in the 1990s to grapple with the perturbations arising from fishery collapses. Recent emphasis on ecosystem-based fisheries management has largely been centred on sustaining what many think are unsustainable fisheries, thinking also present in freshwaters. Marine ecosystem management investments have been limited. Support for science-based decision-making has been faltering everywhere as successive governments have given way to economic pressures and acceded to more dispersed forms of governance. Future success depends on recognizing: (a) the total dependence of humans on aquatic ecosystems; (b) that it is humans and their activities that need to be managed, and (c) the need for science-based adaptive management for all decision-making.

Oral; Aquatic Ecosystem Science

PROVINCIAL WATER CLASSIFICATION: LINKING AQUATIC RESEARCH WITH RIVER MANAGEMENT

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Effective management of river systems requires a detailed understanding of the effects of natural and anthropogenic stressors on the diversity and structure of instream biotic communities. The New Brunswick *Water Classification Regulation – Clean Water Act* (2002) requires the assessment of watercourses within the province against legal standards for instream benthic macroinvertebrate communities. By incorporating an understanding of the natural biodiversity of instream community structure in the development of an interpretive model, it has been possible to provide an accurate measure of the biodiversity of the watercourses within the province. This model utilises a site classification method based on a combination of instream community structure and larger scale environmental variables of pre-selected reference sites. Preliminary results of sample method compatibility and testing of the interpretive model are presented. Important issues relating to data compatibility are discussed in relation to the range of methods and sources for both biological and environmental data collection within this project. The results will form the basis for the development of standards for collecting and analysing benthic macroinvertebrate data and will provide a method for assessing the baseline status for watercourses within New Brunswick.

Oral; Aquatic Conservation

THE ROLE OF COLONISTS AND INVADERS IN THE RECOVERY OF SUDBURY'S ACIDIFIED LAKE FISH COMMUNITIES

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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 (*Perca flavescens*) tends to dominate the fish community in many lakes occupying the trophic roles of planktivore, benthivore and piscivore. The relative biomass of plantivorous perch affects large zooplankton biomass and increases intraspecific competition delaying the shift to benthivory until the fish reach a larger size. Over the last decade the invasion of predatory fish species such as the smallmouth bass (*Micropterus dolomieu*) and the walleye (*Sander vitreus*) has caused profound changes in yellow perch dynamics and trophic pathways. In the presence of these predatory species yellow perch abandon the pelagic zone at a small body size and occupy the littoral zone. This shift in habitat is accompanied by a shift to benthic feeding at a much smaller size. Yellow perch also alter their body shape and proportions in the presence of predators. In addition to the survey and monitoring data, some preliminary results of a prey manipulation project are presented, involving the effect of transferring smallmouth bass on yellow perch life history characteristics.

Oral; Contributed

REVIEW OF THE LIFE HISTORY AND ECOLOGY OF SHORTJAW CISCO (*COREGONUS ZENITHICUS*): A PROPOSED SPECIES AT RISK

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This review was designed to compile the available information on the life history and ecology of shortjaw cisco (*Coregonus zenithicus*) into a single, operational knowledge base. The primary purpose of the review was to scope and identify the key uncertainties regarding the ecology and life history of the species for use in species at risk evaluation. The shortjaw cisco is a deepwater coregonine found in Lakes Superior/Huron of the Laurentian Great Lakes, and scattered across approximately 30 lakes in central Canada. The abundance and distribution of shortjaw cisco has declined since the 1930s, and the species has been placed on the IUCN Red List as "vulnerable" since 1996. In Canada, COSEWIC has recommended shortjaw cisco be listed as "threatened" throughout the species' range. One of the primary uncertainties associated with shortjaw cisco status is the ability to reliably identify and discriminate this species from other closely-related cisco species. We adopted a life-history approach to organize information and to generate competing hypotheses about important ecological mechanisms that could affect shortjaw cisco distribution and abundance. We employed NVivo knowledge base software that allowed us to organize the quantitative, qualitative and multi-media data that were extracted from the literature, databases, and expert opinions. We propose that these uncertainties and associated hypotheses feature prominently in the current COSEWIC and pending SARA re-evaluation of the status for shortjaw cisco.

Oral; Student; Aquatic Conservation

IMPACT OF CLIMATE CHANGE ON THE INVASION OF LARGEMOUTH BASS IN LAKE TAHOE, CALIFORNIA- NEVADA

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Largemouth bass were introduced into Lake Tahoe, California-Nevada in the 1980s. Currently restricted to warmer parts of the lake (e.g. enclosed areas and lagoons); they may become widely distributed as a result of climate change. Once established, these invaders can potentially disrupt nearshore productivity and could threaten the persistence and reestablishment of native fishes. The objective of this project is to identify current and future invasion hot spots for largemouth bass within Lake Tahoe. Identifying invasion hot spots could help prioritizing focal sites for future management planning to prevent further expansion of bass. Based on cluster analysis of surface water temperature data collected in Lake Tahoe (2001, 03 and 06), several thermally distinct regions were identified and regional-specific models were then constructed. These models utilize daily air temperature to estimate daily surface water temperature. In recent years, air temperatures around Lake Tahoe have shown elevated mean annual values and shorter winter durations. This trend is expected to continue as climate change progresses. Using available information from several climate change scenarios in combination with our region-specific models, we forecast how climate change may elevate lake water temperature. These predicted water temperatures are used in bioenergetic models to assess largemouth bass survival and reproductive potential in various regions of the lake, thus identifying potential invasion hot spots.

Oral; Student; Climate Change

COMPARISON OF CISCO SPECIES SPATIAL AND DEPTH DISTRIBUTIONS ALONG THE NORTH SHORE OF LAKE SUPERIOR

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The shortjaw cisco (*Coregonus zenithicus*) is one of five deepwater ciscoes known in Canada. Ciscoes have been extensively fished commercially in the Great Lakes since the 1800's, with the shortjaw cisco preferred dues to its large size and relative ease of capture. Overexploitation, invasive species, and habitat impairment have been responsible for the decline of this once abundant species. The shortjaw cisco is currently listed as Threatened by COSEWIC; however, little is known about the biology of this species making the setting of recovery, critical habitat, and allowable harm targets difficult. Separating this species from other co-occurring ciscoes is critical for determining their distribution, abundance, and life history. Gillnet surveys were conducted along the north shore of Lake Superior in 2006, in areas were shortjaw cisco were historically fished. Sites were randomly selected across depth strata (<65m, 65 – 105 m, >105m). We examined the distribution of the four cisco species collected in the gillnet surveys to determine if it was possible to separate the species by spatial and depth distribution. The data was then compared to a historical gillnet survey conducted by Koelz (1929) to compare the current distribution of cisco spp. to their earliest published range.

Oral; Aquatic Conservation

DISTRIBUTION OF JUVENILE FISH IN THE COASTAL ZONE OF NOVA SCOTIA

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Despite recent legislation from federal agencies to enable marine conservation, no coordinated national or regional plan has been formally adopted to develop national networks of marine protected areas (MPAs). Most studies undertaken in this field have concentrated on offshore waters – typically greater than thirty meters in depth. As such, very little work has been done to define representative or distinctive sites within the inshore zone. My project attempts to define relationships between the distribution of larval and juvenile fish, with topographic and geomorphological features in the coastal zone. The intent is to derive a classification of inshore waters based on easily measured and mapped features, from which candidate protected areas can be selected. Questions I am attempting to answer include: 1) can we define areas with greater abundance or diversity of fish from topographic features, 2) how many areas of different habitat types do we need to protect, and 3) how large of an area do we need? To date, numerous habitat types have been surveyed around the coast of mainland Nova Scotia for juvenile and larval fish. Preliminary analysis depicts an increase in species number with decreasing substrate particle size (e.g. from boulder to mud substrate types). As well, juvenile fish species number increases northwards along the Atlantic coast of Nova Scotia. This study will contribute to information leading to the environmentally defensible selection of both priority and representative areas for MPAs.

Oral; Student; Aquatic Conservation

TEMPORAL PATTERNS OF LAKE-WATER CHEMICAL CHANGE IN SOUTH-CENTRAL ONTARIO: LOCAL CONTROL OF REGIONAL DRIVERS

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Lakes in south-central Ontario have been subject to a number of potentially detrimental anthropogenic stressors over the last decades, principally reductions in undeveloped riparian zones, climatic warming, and varying nutrient inputs and acidic deposition levels. To quantify regional-scale lake-water chemical response to these stressors, we compared temporally discrete datasets for 37 lakes chosen to encompass a representative range of lake morphometry, acidity, trophic status, shoreline development and terrestrial watershed. These lakes have been used extensively to characterize "minimally-impacted" Precambrian Shield lakes. Our results indicate acute lake-water chemical change over time (doubly-multivariate repeated measures $F = 34.55$, $p<0.0001$), specifically decreases in conductivity, sulphate, calcium, magnesium, iron, manganese, conductivity, phosphorous and chlorophyll *a*, and increases in alkalinity, pH, sodium, chloride, inorganic nitrogen and dissolved inorganic carbon (paired t-tests $p<0.05$). As expected, correlation analysis shows a high degree of synchrony within lakes for related variables, for example declines in sulphate correspond to increases in alkalinity and pH. However, although temporal trends are relatively consistent suggesting regional drivers of change, there are some inconsistencies. As well, there is great variability between lakes as to the amount of change detected. We found that much of this variability can be explained by localized factors (i.e. catchment and lake properties) suggesting that studies designed to assess large-scale change must take into account individual lake characteristics when interpreting patterns. Such drastic changes in lake chemistry across south-central Ontario suggest there may be corresponding shifts in limnetic communities and we are currently assessing zooplankton response to these chemical changes.

Oral; Student; Land-Water Interactions

LINKING ENVIRONMENTAL FORECASTING, HABITAT CHANGE, AND FISH MORTALITY TO THE MANAGEMENT OF FRASER RIVER SOCKEYE SALMON

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Every year a variable proportion of adult Fraser River sockeye salmon (*Oncorhynchus nerka*) die during their remarkable upstream migration (100 to 1200 km). The best estimate of this en route loss is the annual discrepancy between river mouth counts and the upstream spawner enumeration. Estimates of annual losses, exceeding half a million fish in 8 of the last 15 years, are significantly correlated to the migratory freshwater habitat conditions, specifically water temperature and discharge. These correlations are consistent with the current research on the causal links between environmental conditions and physiology/behaviour associated with migratory failure. Therefore, if environmental conditions can be forecasted prior to fishing, managers can meet escapement targets by adjusting harvest levels to account for expected en route losses. We evaluated different models for generating long range forecasts of the environmental conditions experienced by different aggregate populations of migrating sockeye salmon. Predictor variable (e.g. precipitation, air temperature, snow pack and climate trends) choice was dependent on seasonal availability of data, model fit, and uncertainty in environmental input variables. A range of temperature and discharge forecasts, representing environmental uncertainty, were inputted into en route loss models to generate mortality estimates. A cumulative distribution of expected losses was generated to allow fishery managers to select an appropriate trade-off between maximising fishing opportunities and the probability of achieving desired escapement targets. The application of long range environmental forecasting to fish-habitat mortality models will be crucial for future Fraser sockeye management given recent climate trends.

Oral; Habitat-Fish Mortality Linkages

DIATOM-INFERRED HOLOCENE CLIMATE CHANGE IN TWO CANADIAN SUBARCTIC LAKES

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Trends in subfossil diatom assemblages were investigated in a sediment core from Lake TK-54, a shallow, ultra-oligotrophic lake located in the forest-tundra ecozone of Canada's Subarctic. A focus was made on the most recent sediments to determine whether, and to what extent, the diatom community has responded to recent climate change. Very few paleolimnological studies in the Canadian Subarctic have thus far examined in detail this recent timeframe, and none has assessed diatom assemblage responses in a lake as shallow as TK-54. Throughout most of the core, the assemblages were overwhelmingly dominated by benthic taxa, and exhibited only minor fluctuations, with the only notable changes occurring in the top 5 cm (ca. 1872 to present). These included marked shifts in the composition of the benthic taxa, and a striking increase in small planktonic *Cyclotella* species. These changes are consistent with a 19th-century climate warming and resultant changes in aquatic habitat availability from decreased ice cover. Lake TK-2, on the other hand, is located in the Arctic tundra approximately 200 km north of the forest-tundra ecozone. A 2 m-long sediment core is being examined for changes in the diatom assemblages over the Holocene. To date, the vast majority of Arctic paleolimnological studies have been conducted on sites located in or near the sensitive forest-tundra, or in the High Arctic. TK-2 provides an interesting opportunity for studying how the diatom response in this intermediate region compares to those in studies from both the High Arctic and the lower Subarctic, including that of TK-54.

Oral; Student; Climate Change

HYDROELECTRIC DAMS ARE NOT NECESSARILY BAD FOR FISH: ECOLOGY OF A THRIVING POPULATION OF LAKE STURGEON DOWNSTREAM OF A GENERATING STATION ON THE WINNIPEG RIVER

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Hydroelectric generating stations are commonly implicated as having negative impacts on downstream fish habitat, and this is particularly the case for large migratory species such as lake sturgeon (*Acipenser fulvescens*). While there is no doubt that some facilities have had negative impacts, the assertion that all dams are bad for all fish is based on very little quantitative data. We present data on abundance, habitat use, and feeding in a population of lake sturgeon downstream of a hydroelectric generating station on the Winnipeg River, an area that was considered to contain marginal habitat. In spite of this, we found a large population of juvenile fish that inhabited flat-bottomed, sandy areas with a detectable current, in the deepest available water from the face of the dam to about 10 km downstream. Fish were concentrated in these areas and appeared to segregate themselves from other sympatric species. Although we are in the process of aging these fish, year-class strength appeared to be strong. In spring, most fish stomachs contained large amounts of Dipteran larvae; however, as summer progressed, gut contents became more diverse and stomach fullness declined. Growth rate in age-0 fish appeared to be very fast, with fish reaching 20 cm in length by fall. Growth in older fish was much slower, and stable isotope data suggest growth is very slow (or absent) for all fish during the winter months. In general, results indicate that a hydroelectric generating station can contain suitable spawning and nursery habitat for lake sturgeon.

Oral; Hydroelectric Power and Aquatic Ecosystems

IS DEMERSAL SPAWNING A VIABLE ALTERNATE REPRODUCTIVE STRATEGY FOR CAPELIN (*MALLOTUS VILLOSUS*) IN COASTAL NEWFOUNDLAND?

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In the past decade, capelin (*Mallotus villosus*), the focal forage fish in the Northwest Atlantic, has undergone dramatic changes in its biology and behaviour. Capelin spawn both on and off beaches throughout their circumpolar distribution but are thought to spawn primarily on beaches in Newfoundland. Persistently used demersal spawning sites, however, have recently been discovered in coastal Newfoundland. The objectives of my research were to investigate the early life history stages of demersally spawning capelin (*Mallotus villosus*) on the Northeast coast of Newfoundland. Egg abundance at demersal sites was similar to or higher than at a nearby beach site and egg mortality was higher at the beach in both years of this study. Developmental rates observed at demersal sites in this study do not support previous findings on egg development at the beach. Egg development was slower than at the beach, resulting in demersally spawned eggs hatching 8-10 days later than predicted. Environmental cues that stimulate the release of larvae from the sediment at beaches in Newfoundland occur at demersal spawning sites, but do not appear to stimulate larval emergence. Instead, larvae in good condition appeared to emerge continuously from the sediment. Results from this study suggest that demersal spawning is a viable reproductive strategy on the Northeast coast of Newfoundland.

Oral; Student; Contributed

TROPHIC DYNAMICS OF MACRO-INVERTEBRATES IN LAKES OF VARYING DISSOLVED ORGANIC CARBON CONCENTRATION

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We are only beginning to decode complexities within the zooplankton community which may exist along key environmental gradients such as dissolved organic carbon. Hence we investigated whether there are differences within the macro-invertebrate community among lakes of varying DOC concentration. Specifically, we used $\delta^{13}C$ and $\delta^{15}N$ isotopic signatures, along with crop content analyses to evaluate whether diet and feeding behaviour among macro-invertebrate species vary among lakes of different DOC concentration. We surveyed 15 lakes in Central Ontario with a wide range of DOC (2.7-14.1 mgL^{-1}) after dark in July and August, 2004 for *Chaoborus* larvae and *Leptodora kindtii*. Among species, *C. trivitattus* consistently had the most depleted $\delta^{13}C$ signatures and highest trophic status across the DOC gradient. In contrast, *L. kindtii* and *C. punctipennis* were more enriched in ^{13}C and had lower but variable trophic statuses among lakes. $\delta^{13}C$ of the two *Chaoborus* species were highly correlated with cyclopoid $\delta^{13}C$, whereas *L. kindtii* $\delta^{13}C$ was correlated with *Daphnia* and calanoid $\delta^{13}C$. Crop content analyses supported the dietary importance of copepods for *Chaoborus*. Together these results indicate that there are differences in carbon transfer and trophic status among macro-invertebrates which can potentially influence food web structure and function. Therefore studies examining food web patterns along environmental gradients, such as DOC, in temperate lakes should take these differences into account.

Oral; Student; Land-Water Interactions

ABILITY OF THE WHITE SUCKER, *CATOSTOMUS COMMERSONI*, TO COLONIZE LAKES OF THE CANADIAN SHIELD AND IMPACTS ON BROOK CHARR, *SALVELINUS FONTINALIS,* POPULATIONS

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Many studies have shown that the presence of white sucker, *Catostomus commersoni,* can induce significant declines in the biomass, abundance and sport fishing yields of brook charr, *Salvelinus fontinalis,* in Canadian Shield lakes. Since the abundance of brook charr was low in many Québec lakes, a mass removal experiment of white sucker was done in five lakes between 1995 and 2001. The objective of the present study was to quantify the long-term responses in white sucker and brook charr after the end of the mass removal in two of these lakes. The responses of the two species were determined by comparing their abundance, biomass, growth, as well as age and length at maturity, before and after the mass removals. No significant responses were observed in the abundance and biomass of the two species after the end of the white sucker mass removals. Varying responses were observed for the age and length at maturity of white sucker, while an increase in the age and length at maturity was observed for brook charr. Finally, the end of the white sucker mass removals induced an increase in the growth of white sucker, but not of brook charr. These results suggest that there might be a lag in the responses of the fish species after the end of the white sucker mass removals.

Oral; Student; Aquatic Conservation

THE EFFECT OF THERMAL STRATIFICATION ON LAKE TROUT (*SALVELINUS NAMAYCUSH*) HABITAT USE DURING TWO CLIMATICALLY DIFFERENT YEARS

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Acoustic telemetry was used to continuously (24 h/d) monitor the depth distribution of lake trout over two climatically different years (2003 and 2004). Large differences in air and water temperatures between the two study years (~ 3.8°C) allowed for testing of individual responses to thermal stratification patterns. The objectives were to determine habitat preferences and investigate the link between the thermal stratification of lakes and lake trout distribution. All data were collected in a small boreal shield lake (Lake 373, Area = 27.3 ha, Max depth = 20.8 m) at the Experimental Lakes Area in northwest Ontario, Canada. Based on daily medians, lake trout were distributed over a broad range of temperatures (2 – 18 °C) during the period of thermal stratification, suggesting that the "classic" thermal habitat boundary (8 – 12 °C) does not adequately define the vertical distribution of lake trout. Seasonal and annual variations in median daily depths of fish were primarily associated with temperature-mediated changes in the timing and depth of thermal stratification. This analysis controls for individual-specific differences with respect to environmental conditions, and presents the first empirical estimates of lake trout behavior and habitat occupation over a relatively broad range of climate and thermal stratification patterns.

Oral; Student; Climate Change

COMPARING THE PREDICTIVE SUCCESS OF SPECIES OCCURRENCE MODELS FOR THE IMPERILED SPECIES THE REDSIDE DACE (*CLINOSTOMUS ELONGATUS*) AND ITS HABITAT

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Current regression-based approaches for modeling imperiled species are limited in their explanatory power by the statistical limitations of non-normal (i.e. Gaussian) populations, low sample sizes, and inflated coefficients of variation. Without consideration of the effect of these violations, regression approaches can become biased. Robust alternatives to regression-based approaches may allow for better selection of habitat variables correlated with the probability of occurrence. Here, we compare alternative statistical methods for identifying environmental variables linked with the occurrence of imperiled species, such as multiple logistic regression, artificial neural networks (ANN), and classification and regression trees (CART). The objective of this study was to determine: 1) the adequacy of alternative modeling approaches for predicting imperiled species, and 2) whether the spatial extent of the identified habitat variables can be used to identify areas of conservation concern. We employed a case study approach using the redside dace (*Clinostomus elongatus*) in the Greater Toronto Area. This species was an ideal candidate for such a comparison because its decline has been thought to be closely linked with landscape variables related to urbanization. Species data were combined with habitat factors such as substrate size, land-cover and flow. Areas with high conservation value were produced from the resultant habitat variables and overlaid using geographic information systems. We demonstrate the applicability of such alternative modeling approaches in evaluating important habitat features, identifying areas of concern for species conservation, and predicting the response in species occurrence with changes in habitat features.

Oral; Student; Aquatic Conservation

ANGLER NUMERICAL RESPONSE ACROSS LANDSCAPES, POLICY OPTIONS, AND THE COLLAPSE OF FRESHWATER FISHERIES

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We used empirical data on the spatial pattern of fishing effort and fish abundance to model the numerical response of anglers in rainbow trout fisheries in the southern interior of British Columbia. The model includes a distance dependent attrition of effort term and incorporates population size-dependent fishing participation rates. This empirical model was concatenated to a simple fish production function from which we calculate spatial patterns in fishing effort, catch rates and yield. We use this model to assess the ability of traditional recreational fishing regulations to sustain fisheries. In addition we use this dynamic simulation model to assess the utility of various active management schemes of effort controls to sustain fisheries across landscapes. Finally we use contemporary patterns and processes to assess both historical patterns in recreational fisheries, and to project future scenarios given extant time series and projections of human population growth.

Oral; Aquatic Conservation

MESURE DE LA DENITRIFICATION DANS UN MARAIS COTIER DE

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En milieu marin côtier, la dénitrification est un processus bactérien de première importance qui contribue à épurer les eaux côtières de leur charge de nutriments azotés fixés (NO_2^- + NO_3^-) pour former de l'azote gazeux (N_2) non biodisponible. À l'heure actuelle, très peu d'information est disponible concernant le rôle des marais côtiers sur le bilan d'azote de l'estuaire du St-Laurent. Bien qu'il soit généralement reconnu que les milieux littoraux de type marais côtier sont des sites importants pour la régénération des nutriments azotés, l'aspect quantitatif des processus biochimiques impliqués dans ce biogéocycle demeure méconnu. Au cours de l'année 2005, nous avons mesuré, à l'aide d'une technique d'enrichissement isotopique éprouvée, les taux de dénitrification associés aux changements saisonniers de température d'un marais côtier nordique, (Pointe-Au-Père, Rimouski, QC). Ces mesures, réalisées en laboratoire sur trois séries de 16 carottes sédimentaires incubées à 2, 6 et 12^{o}c pour une période de 8h, nous ont permis de calculer des taux moyens de dénitrification de 9.6, 17.7 et 25.5 µmol n_2 m^{-2} h^{-1} respectivement. Outre l'obtention de données uniques et novatrices sur la dénitrification des marais côtiers froids, cette étude aborde des aspects complémentaires concernant les flux associés d'oxygène dissous, de nitrites, de nitrates, d'ammonium ainsi qu'une caractérisation de la composition géochimique des sédiments incubés. Sachant que les marais côtiers sont menacés de disparition dans les prochaines décennies, cette étude démontre l'importance de préserver et de restaurer ces milieux humides qui nous prémunissent contre l'eutrophisation croissante des zones côtières.

Oral; Wetlands

RELATIONSHIP BETWEEN FERTILIZATION SUCCESS AND THE NUMBER OF MILT DONORS IN RAINBOW SMELT (*OSMERUS MORDAX* MITCHELL): IMPICATIONS FOR POPULATION GROWTH RATES

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A series of artificial fertilizations using rainbow smelt (*Osmerus mordax* Mitchell) were conducted, each designed to assess the fertilization success of a female's eggs with milt from one to five males. Mean egg fertilization success increased and variance in fertilization success decreased when more males contributed to a constant volume of milt. This may indicate the presence of an Allee effect. The results suggest that potential changes in egg fertilization success due to a decrease in the number of males, in addition to changes in egg production due to a decrease in the number of females, can affect estimates of maximum sustainable harvest rates, and recovery of depleted populations.

Oral; Aquatic Conservation

LINKS BETWEEN HABITAT QUALITY AND FISH MORTALITY – CHALLENGES, APPROACHES, SCIENCE PROGRESS AND APPLICATION

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Preliminary results of an ongoing literature survey of research on the link between habitat quantity and quality and fish mortality are summarized. Although mortality was the primary response variable of interest, other vital rates leading to production were also included in the search (growth and reproduction). Significant challenges to research in this area include: 1) confounding stressors on populations (habitat alteration versus other); 2) the magnitude of habitat change needed to detect a population response; 3) the appropriate spatial scale for study; and 4) understanding loss rates (mortality versus fish re-distribution). Approaches include empirical observation, experimentation, and models. Work on habitat-fish mortality is increasing and advancing in all ecosystem types, including freshwater, estuarine and coastal marine areas. Research on habitat-mortality links is timely, as it provides science support for management of aquatic resources, both for specific issues such as species-at-risk and impacts of development, but also more generally for ecosystem-based methods for management. Research on habitat-mortality links provides a functional and explicit link between fish habitat and fish population dynamics.

Oral; Habitat-Fish Mortality Linkages

IS THE PRESENCE, TIMING AND INTENSITY OF POPULATION REGULATION DETECTABLE ACROSS 37 WILD UNSTOCKED RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) POPULATIONS?

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Are there consistent features in the timing and intensity of population regulation in the life cycle among 37 wild unstocked rainbow trout populations from central British Columbia? Age-specific density and habitat quantity estimates in stream (juvenile) and lake (adult) habitats were made in all populations in between 1 and 3 years. We discovered that: (1) Population regulation was detectable prior to age-1 in the streams. Although there was obvious interannual variance, it did not account for all of the inter-population variance or conceal the effects of population regulation in the early life history. (2) Populations with the most limited stream (relative to lake) space were most strongly regulated. (3) Among populations with particularly high estimated stream egg densities, 'snapshot' estimates of stream age-0 disappearance rates were extremely high, and resulting age-0 stream densities extremely low. This may reflect an intense population regulatory process, although alternate viable explanations exist. (4) Populations that did *not* have limited stream (relative to lake) space appeared to have the greatest potential for high stream age-0 densities. (5) These generalizations about age-0 stream densities could not be used to understand or predict adult densities in the lake. (6) There were no *clear* effects of population regulation during the adult phase of the life cycle. Yet, a less obvious second period of population regulation may limit indices of age-2 lake densities (the age at 50% maturity, and the first age of full occupation of the adult (lake) habitat).

Oral; Student; Habitat-Fish Mortality Linkages

BETWEEN- AND WITHIN-TRIBUTARY VARIATION IN RIVERINE FISH ASSEMBLAGES: THE ROLE OF MACROPHYTES AND WATER TRANSPARENCY

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We quantified the variation of fish assemblage structure between- and within-tributaries of the Outaouais River (Québec, Canada), and determined which environmental variables were most strongly associated with each type of variation. Fish samples were collected by beach seining in 170 sites distributed among 11 tributaries. Nine environmental variables were considered for inclusion in the analysis: river width, bank slope, water transparency, water velocity, dissolved oxygen concentration, pH, width of the macrophyte bed, macrophyte taxonomic richness, and dominant substrate. Partitioning of variation by means of partial redundancy analyses indicated that assemblages were more variable within tributaries (61.3% of the total variation) than between tributaries (38.7%). Width of the macrophyte beds strongly influenced the structure of fish assemblages within tributaries, along a longitudinal (upstream to downstream) gradient, whereas water transparency was the only environmental variable significantly related to variation among tributaries. Analysis of ecomorphological relationships showed that assemblages associated with high macrophyte cover were dominated by individuals with larger body size and pectoral fins, suggesting that functional performance in this habitat may be related to capacity for manoeuvring.

Oral; Aquatic Ecosystem Science

MOVEMENT AND HABITAT USE IN TWO ECOTYPES OF BROOK CHARR: INFERENCES FROM BODY SIZE AND STABLE ISOTOPES

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In the Lake Superior drainage basin, Canada, two forms of brook charr (*Salvelinus fontinalis*) have been observed, small fish (78 to 249 mm total length) assumed to be resident in tributary streams and larger fish (206 to 574 cm fork length) assumed to inhabit Lake Superior for most of year, but migrate and spawn in tributaries in fall. These populations of brook charr are becoming a conservation concern because of declines in the larger, lake ecotype. We used field sampling surveys and stable isotope analysis to test three competing hypotheses regarding the habitat use of the two ecotypes of brook charr: (i) the small and large ecotypes spend significant amounts of time in the stream and lake habitats, respectively, (ii) the small ecotype is stream resident while the large ecotype has an expanded range that entails switching between the stream and lake habitats extensively, and (iii) the small ecotype switches between stream and lake habitats, while the large ecotype uses the lake habitat exclusively. We first demonstrate that stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) signatures from adipose fin clips (non-lethal sampling) are good predictors of signatures from muscle tissue (lethal sampling). We then demonstrate that body size distributions and distributions of $\delta^{13}C$ and $\delta^{15}N$ signatures from adipose fin clips of fish caught in streams and the lake during the summer exhibit very little overlap and, therefore, no evidence of switching. Our analyses support the hypothesis that during the summer purported stream resident and migrant trout spend significant amounts of time in the streams and lake, respectively.

Oral; Student; Aquatic Conservation

THE ECOLOGICAL CONSEQUENCES OF HYBRIDIZATION BETWEEN NATIVE WESTSLOPE CUTTHROAT TROUT AND INTRODUCED RAINBOW TROUT IN SOUTHERN ALBERTA

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The introduction of exotic species has long been recognized as a major factor contributing to the reduction of the ranges of native species. The stocking of rainbow trout (*Oncorhynchus mykiss*) into the native range of westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) has resulted in introgressive hybridization between these naturally allopatric species. Although introductions began in the early 1900's this topic has only recently begun to receive substantial attention with its ecological consequences still receiving little study. In May 2005, *O. clarkii lewisi* populations of British Columbia and Alberta were listed as threatened by COSEWIC. This study will identify metabolic differences between *O. clarkii lewisi*, *O. mykiss* and hybrids to determine their relative competitive abilities. We hypothesize that hybrids will have a higher maximum metabolic capacity enabling them to outcompete *O. clarkii lewisi*. To support this we will compare growth rates of both genotypes through scale back-calculations both within a site and along an elevational gradient. We will also analyse stomach contents to determine if the presence of hybrids forces a diet shift in *O. clarkii lewisi*. By mapping the extent of hybridization and surveying entire streams we will identify any potential mechanisms involved in limiting the upstream spread of hybridization. Finally, we will assess the degree to which morphological characteristics can be used to distinguish between hybrids and pure strains.

Oral; Student; Aquatic Invasive Species

PRE-FLOODING ASSESSMENT OF AQUATIC ECOSYSTEM C CYCLING

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Large portions of the boreal landscape in Québec have been altered for the creation of hydroelectric reservoirs. The direct impact of reservoirs in terms of C cycling and greenhouse gas accounting has seldom been studied and is a matter of current debate. Lakes are a major component of boreal landscapes, representing nearly 7% of the total surface, and most likely key players in regional carbon budgets. We present here the first study to address in detail the pre-impoundment status of aquatic ecosystems in a boreal region. In the summer of 2005, we studied a suite of 40 lakes that were later inundated for the creation of the Eastmain-1 reservoir during the winter of 2005-2006. All lakes studied were super-saturated in CO_2 and showed positive fluxes of CO_2 to the atmopshere. Carbon dioxide concentrations were generally highest in small shallow lakes with high DOC and TN content. At departures from saturation above approximately 20 µM, CO_2 and O_2 tended to decouple, with high CO_2 super-saturation and low O_2 under-saturation. This decoupling may be due to abiotic external inputs of CO_2 such as groundwater or surface water. Additionally, both measured (floating chambers) and calculated fluxes were well correlated to the DOC:TP ratio, indicating that lakes receiving higher allochthonous carbon inputs and supporting higher bacterial respiration tend to also produce greater CO_2 fluxes to the atmosphere. The empirical patterns in lake CO_2 generated in this study will be used to estimate the net impact of the replacement of a network or lakes and streams by one large reservoir on the regional C budget of this boreal region of Québec.

Oral; Hydroelectric Power and Aquatic Ecosystems

HYDRAULIC GEOMETRY AS A PHYSICAL TEMPLATE FOR THE RIVER CONTINUUM: APPLICATION TO OPTIMAL FLOWS AND LONGITUDINAL TRENDS IN SALMONID HABITAT

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The River Continuum Concept lacks a quantitative physical model to represent downstream trends in habitat. We evaluate whether hydraulic geometry relationships can be used as a physical template to predict longitudinal trends in habitat availability and optimal flows for different life-history stages of Rainbow trout. Optimal flows based on hydraulic geometry indicate that: 1) optimal flows are higher for larger fish, 2) optimal flows proportionally increase as streams became smaller and decrease downstream, and 3) maximum predicted habitat suitabilities for fry and juveniles are in small streams, and are displaced progressively downstream for later life history stages. These patterns are an emergent property of downstream increases in channel depth and velocity and changes in habitat suitability curves associated with increased swimming performance of larger fish. Non-linear downstream trends in habitat imply that fixed flow percentages recommended by the Tenant method may significantly underestimate optimal flows in small streams. Despite oversimplifying complex channel structure, hydraulic geometry relationships should serve as a useful physical model for testing downstream trends in habitat-related processes along the river continuum.

Oral; Hydroelectric Power and Aquatic Ecosystems

METHYL MERCURY EXPORT FROM BEAVER DAMS ON THE CANADIAN SHIELD

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Beaver populations and beaver dams are currently increasing in many Canadian regions. Since natural and anthropogenic impoundments have historically been identified as sources of the potent neurotoxicant methyl mercury (MeHg), beaver dams could also increase MeHg levels in streams. During the summer of 2006, we collected water samples from twenty beaver dams of the Laurentian region, between St-Jérôme and the Mont-Tremblant Park. At each site, we sampled the inlet, the pond, the outlet and 150 meters downstream from the dam. Samples were analysed for total Hg, MeHg and other chemical variables including DOC, TP, TDP, TN, cations and anions. Beaver impoundments increased in average [MeHg] by 3,4 fold (0,7-9,4) and [total Hg] by 1,6 fold (0,7-4,4). Multivariate analyses identified the key determinants of spatial variability in the ratio of [MeHg] in the dam outlet *vs.* its inlet. Overall, our results suggest that beaver dams may considerably increase MeHg levels in downstream ecosystems due to physical or biological/chemical alteration of the interface between terrestrial and aquatic systems. The impact of beavers on the cycling of contaminants in watersheds should be considered in the management of their populations.

Oral; Student; Land-Water Interactions

CORAL REEF FISH LARVAL RETENTION VERSUS DISPERSAL: MEASURING CONNECTIVITY USING MOLECULAR GENETICS

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Estimates of connectivity, or gene flow within and among coral reef fish populations is of critical importance for both conservation and for our understanding of reef ecosystems. The bicolor damselfish, *Stegastes partitus*, is a benthic, non migratory reef fish with a pelagic larval phase lasting about a month. Adults (n=549, ~270 per site) and recently settled juveniles (n=384, 192 per site) were sampled from two reefs located on the eastern and western side of Turneffe atoll, Belize, and were genotyped at 11 microsatellite loci. The two adult samples were genetically similar (F_{st}= 0.0016 to 0.0003), but not the same (exact test X-sq = 85.2844, d.f.= 22, p<0.0001). Using genotype assignment, 102 of 384 juveniles were significantly assigned to (P > 0.95), or rejected from the adult populations. There is a similar degree of retention in the two reefs; a total of 77 juveniles were identified as coming from those adult populations, and 25 juveniles were from some site we did not sample. Overall, there is a higher level of larval retention than dispersal in the target reefs, indicating that connectivity between other sites and Turneffe atoll may be small. However, the possibility of temporal and spatial variability in larval retention rates must be considered.

Oral; Student; Aquatic Conservation

DOES WATER VELOCITY INFLUENCE MORPHOLOGICAL VARIATION AND SWIMMING PERFORMANCE IN BROOK CHARR?

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The diversity in body shapes and ecology among individuals within a species may be influenced by differential selective pressures in response to habitat variation. A shift into a new habitat may induce plastic responses in a variety of traits, creating opportunities for habitat-dependent pressures to select individuals that are better adapted to the new environment. In complex environments, where several or many contrasting habitats are available, it is likely that selection will not drive convergence to an optimum phenotype but will instead tend to promote phenotypic plasticity. Streams and lakes provide a unique opportunity to study plastic responses because they are spatially complex and offer contrasting habitats both between and within systems (e.g., riffles *versus* pools, pelagic *versus* littoral zones). These contrasting habitats are expected to exert different swimming demands due to differences in hydrological conditions related to water velocity. In this study, we tested whether differences in water velocity between habitats have resulted in differences in swimming performance in brook charr. We compared sustained swimming between individuals caught in lakes (pelagic zone) and streams (riffles and pools). We found that riffle individuals swim more efficiently than pool and pelagic individuals, which suggests that water velocity is an important selective pressure on locomotor performance. We also discuss how differential swimming demands match with morphological variation and integration across habitats.

Oral; Student; Aquatic Ecosystem Science

SEASONAL VARIATION IN THE EFFECTS OF NUTRIENTS AND DISSOLVED ORGANIC MATTER ON THE RESPONSE OF PHYTOPLANKTON COMMUNITY STRUCTURE TO ULTRAVIOLET RADIATION

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The seasonal variation in the effects of nutrients and dissolved organic matter (DOM) on the response of phytoplankton community structure to ultraviolet radiation (UVR) was studied using natural phytoplankton assemblages from Lake Giles (Northeastern Pennsylvania), a temperate, oligotrophic, highly UVR-transparent lake. Microcosm experiments were conducted in 1-L bags in the spring and summer. A factorial design was used, with two UVR treatments (ambient and reduced), four nutrient treatments (control with no nutrients added, nitrogen addition, phosphorus addition, and nitrogen and phosphorus addition), and two DOM treatments (control of 1 mg L^{-1} and doubled). In April, there was a strong effect of UVR on the overall phytoplankton community structure, causing a shift in the dominant species. The nutrient and DOM additions did not cause a shift. In July, however, there was a much weaker effect of UVR on the community. Instead, the community responded more strongly to the nutrient additions, but not to the DOM addition. The initial communities were different in April and July, but *Synura sphagnicola* and *Chroomonas* sp. were present in both seasons. *Synura sphagnicola* responded positively to the addition of DOM in April and the reduction of UVR in July. *Chroomonas* sp. responded positively to the reduction of UVR in April and the addition of nutrients in July. The differential sensitivity of these two species suggests that changing environmental factors between the seasons, such as temperature and/or nutrient concentrations, led to the difference in the relative importance of UVR in changing phytoplankton community structure.

Oral; Student; Climate Change

THE 'NATURAL FLOW PARADIGM' AND ATLANTIC SALMON: MOVING FROM CONCEPT TO PRACTICE

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The 'Natural Flow Paradigm' is becoming an important first principle in the setting of managed flow regimes throughout the world, including Canada. This principle simply states that managed flow regimes should consider including elements of natural hydrological variability, both seasonally and inter-annually, in prescribed flow regimes in order to maintain the ecological integrity of the river system. This principle, while laudable, is in direct conflict with development interests and both developers and regulatory agencies are struggling to identify what elements of hydrological variability are critical to maintain ecological health of rivers. In this paper these issues are explored in the context of wild anadromous Atlantic salmon populations. The life history patterns of salmon are linked to natural hydrological variability in two examples: (i) a large river (mainstem) system where the life history requirements are primarily linked to migration (upstream to habitat above the impoundment, downstream to the ocean), and (ii) a smaller river where freshwater production (spawning, rearing of juveniles, over-wintering) is occurring. A conceptual managed flow regime is examined that may provide the necessary flow variation to support Atlantic salmon life history requirements, while permitting flow modification, for the above 2 examples. These are examined for both a water storage and water abstraction scenario. The issues are further discussed in the context of regional differences in salmon life histories and hydrological variability.

Oral; Hydroelectric Power and Aquatic Ecosystems

MID TO LATE HOLOCENE TRENDS IN NORTHERN PACIFIC SALMON PRODUCTION

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Modeling projections suggest drastic reorganization of Pacific salmon (*Oncorhynchus* spp.) distribution and production with future climate warming (Welch et al. 1998, *CJFAS*). Recent developments in paleolimnology have enabled the assessment of long-term trends in sockeye salmon (*O. nerka*) production. Such data illustrate natural variability on ecologically-relevant timescales relative to short and sparse monitoring data, and have demonstrated the broad range and cyclical nature of northeast Pacific salmon production. Climate proxy records suggest the mid-Holocene was a warmer period in this region (Heusser et al, 1985, Nature). As such, analysis of past salmon production during this period offers an interesting and unique analog for the understanding and the influences of climate warming on salmon production. Evidence from Karluk Lake, Kodiak Island, Alaska, spanning the past ~ 2,200 yr (Finney et al, 2002, *Nature*), revealed multi-centennial regimes in salmon production. Using sedimentary $\delta^{15}N$, diatoms, organic C/N and other proxy data archived in lake sediments, we explore production variability in sockeye salmon from Karluk Lake over the mid to late Holocene. Our record demonstrates the persistence of multi-centennial to millennial cyclicity in salmon production trends from ~ 6500 cal. BP to present. A comparison with other records in NE Pacific illustrates both regional coherence and inter-regional variability in salmon production, likely in relation to spatial variation in influences of large-scale environmental drivers.

Oral; Climate Change

STATUS OF THE WESTERN SCOTIAN SHELF ECOSYSTEM

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We examined time series of biological and oceanographic indices derived from the western Scotian Shelf over the past 30+ years. Striking changes were evident in the fish community: four heavily exploited predator species declined (white hake, cod, cusk, thorny skate) while an assemblage of small demersal and pelagic species increased, including spiny dogfish. Landings of commercially exploited macro-invertebrates and formerly "under-utilized" species have increased. Indices of ecological health revealed stressed populations/ communities. For instance, a decline in body size was evident among members of the groundfish community, in part due to lower-than-normal growth rates of haddock, pollock and silver hake. Condition indices were also relatively low. Changes were also observed in nutrients and productivity at the lower trophic levels. Silicate decreased in the 1990's, nitrate and the primary producers increased while large copepods have decreased. Variation in the volume transport of the Gulf Stream onto the WSS may be related to the observed increases in nitrate, bottom temperature and saturated oxygen. The declining trends in health and other indices on the WSS are a cause for concern because of their similarity to the adjacent eastern Scotian Shelf, where the groundfish stocks collapsed in 1993.

Oral: Aquatic Ecosystem Science

PREDICTING SMALLMOUTH BASS INCIDENCE USING CLIMATE DATA ACROSS NORTH AMERICA

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Smallmouth bass, *Micropterus dolomieu*, is a warmwater fish species that is native to central U.S.A. Lake stocking, unauthorized introduction by anglers, and dispersal through drainage networks have contributed to the range expansion of the species across Canada and U.S.A. Climate change scenarios predict further extension of smallmouth bass into Canadian lakes potentially negatively affecting native fish species, such as the lake trout (*Salvelinus namaycush*). We collected 4,181 geo-referenced records of smallmouth bass in North America. Climate data based on 1961-1990 averages were matched with smallmouth bass presence. Data were summarized into 13,719 locations for which 567 locations contained at least one incidence of smallmouth bass. This dataset was further divided into training and validation datasets. We compared four statistical approaches in their efficacy at predicting smallmouth bass incidence: multiple logistic regression, classification tree, linear discriminant analysis and artificial neural networks. Artificial neural networks indicated that winter air temperatures were the most important predictors of smallmouth bass incidence. The remaining approaches indicated that summer air temperatures were the best predictors of bass. Of the four statistical approaches compared, artificial neural networks performed the best with the highest sensitivity (correctly predicting presence) and specificity (correctly predicting absence), followed by linear discriminant analysis. Multiple logistic regression and classification trees exhibited very low sensitivity, but very high specificity. The analyses revealed the climatic conditions required for smallmouth bass to sustain viable populations. As temperatures increase due to climate change, smallmouth bass will experience a northerly shift in its range, potentially negatively impacting native fishes.

Oral; Student; Contributed

LIMITED BIOLOGICAL RECOVERY OF KILLARNEY PARK LAKES (ONTARIO) FROM HISTORICAL ACID DEPOSITION DESPITE CHEMICAL RECOVERY: 1971-2005

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Forty-five lakes in Killarney Provincial Park and the surrounding area in south-central Ontario, Canada, were sampled for crustacean zooplankton, water chemistry and phytoplankton biomass (chlorophyll *a*) in the summer of 2005. For each of the lakes we had historic data from peak-acidification in the 1970s and post-acidification periods in 1990 and 2000. Situated in and around the orthoquartzite ridges of the La Cloche Mountains in and near Killarney Provincial Park many of these lakes were acidified during the mid-1900s owing to extensive mining and smelting activities in nearby (40-60 km) Sudbury, Ontario. There is large variation in the geochemistry of the soils and the bedrock within the park. As a result, varying degrees of acidification of these freshwater lakes were seen ranging from being heavily acidified (pH < 4.5) to others that were buffered from the effects of acidic deposition. However, with reductions in smelter emissions (SO_2) of 90% over the past 30 years and the present, many lakes in the Sudbury region are starting to show strong evidence of chemical recovery. However, despite significant chemical recovery (pH), there is limited evidence of biological recovery. Some lakes show increases in zooplankton richness while others are showing decreases compared to richness during peak acidification. Potential factors affecting biological recovery include the invasion by predatory zooplankton *Bythotrephes*, biological resistance, or other stressors such as climate change.

Oral; Student; Aquatic Ecosystem Science

ENVIRONMENTAL SITE EFFECTS ON THE PERFORMANCE OF NATIVE AND HYBRID BLUE MUSSELS (*MYTILUS* SPP.) ON THE PACIFIC COAST OF CANADA

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The *Mytilus* species complex consists of three closely related mussel species, which are known to hybridize where they come into contact. Stable hybrid zones have developed in areas where one or more species have been introduced, making the invasion process doubly complex. On the East coast of Vancouver Island, British Columbia (BC) Canada, the native (*Mytilus trossulus*) introduced (*M. edulis* and *M. galloprovincialis*) and their hybrid offspring occur sympatrically. This study used a common garden experiment to determine the potential for performance differences between native, introduced, and hybrid mussels on Vancouver Island. Mussels were collected from Ladysmith, an area of known hybridization, and reared in cages locally at Ladysmith and remotely at Quadra Island (approximately 150km apart) from May to August 2006. Shell length and mortality were monitored and differences between native, introduced, and hybrid individuals were compared between and within sites to determine whether growth and mortality are independent of site and mussel type. Overall, remotely deployed mussels performed better than locally deployed mussels, while hybrid mussels performed better than both introduced and native mussels. Differences in survival and growth among the native, introduced and introgressed mussels may serve to explain the complex hybridization patterns and dynamics characteristic of this contact zone.

Oral; Student; Aquatic Invasive Species

EFFECTS OF WETLAND INUNDATION ON HYDROLOGICALLY CONNECTED AQUATIC ECOSYSTEMS

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Wetland ecosystems are sinks of organic carbon, nutrients such as nitrogen and phosphorus and metals stored in both vegetation and soils. The inundation of wetland systems increases the decomposition of vegetation and leaching of these substances into adjacent and hydrologically connected ecosystems. The temporal and spatial patterns of the fate and transport of the released nutrients can result in adverse effects on water quality in terms of increased colour, metals, algal biomass, and contaminants; in terms of resource management issues it is important that these patterns are deciphered. Begbie Lake ($48^{O}35'105''N$, $123^{O}41'016''W$) is part of a small wetland-dominated ecosystem on Vancouver Island, British Columbia, Canada. The lake is hydrologically connected to Sooke Lake reservoir, the main supply of drinking water to Greater Victoria. In 2002 the dam on Sooke Lake reservoir was upgraded, raising the maximum water level by 6 meters. During the winters of 2005 and 2006 the reservoir approached near capacity, flooding the wetland around Begbie Lake and will continue to occur each subsequent winter. The introduction of this inundation regime provided an excellent chance to quantify the effects of seasonal flooding in terms of the temporal patterns of changes in release of organic carbon, nitrogen, phosphorus, and metals for wetland-dominated systems and their transport and fate in adjoined aquatic ecosystems. The data is used to determine effects on water quality in Sooke Lake and may provide insight into the timing and extent of water level regulation.

Oral; Student; Wetlands

THE EFFECTS OF RAMPING AND FLOW ON INVERTEBRATE DRIFT IN A REGULATED RIVER

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Regulation of rivers by waterpower facilities results in flow regimes with marked changes to the magnitude, duration, frequency, timing, and rate of change of flow (ramping, $m^3 \cdot s^{-1} \cdot hr^{-1}$) compared to natural conditions. As flows and depths increase downstream of a dam, so does sheer stress on the substrate and associated organisms. We conducted an experiment to measure the effect of abrupt flow changes on invertebrate drift in a river regulated for hydropower generation. The peaking waterpower facility operates with a minimum flow level restriction, but with no restriction on ramping rate. Drifting macroinvertebrates and other organic and inorganic material were measured at low flow, up ramping, high flow, and down ramping, simultaneously at three sites ranging from 3 to 9.5 km from the dam. For comparison, drift was measured at two flows along a similar longitudinal distance on an unregulated river. Overall density of drift was greater on the regulated river. Invertebrate richness was higher during up ramping than the other flow categories. At the site closest to the dam, hydra dominated counts, but were largely absent from the control system. The lowest densities were observed during down ramping. Without hydra, invertebrate density was greatest during up ramping. Both the inorganic and ash-free-dry-weight of other matter was greater during up ramping, suggesting the rapid increase in flow is causing sheer stress and disturbing substrate. Changes in patterns of drift in response to flow could affect the behaviour and consumption rates of drift feeding fishes.

Oral; Hydroelectric Power and Aquatic Ecosystems

RECOVERING FRESHWATER SPECIES AT RISK IN CANADA'S PRIORITY WATERSHEDS

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The watersheds of south-western Ontario have been identified as priority watersheds for the conservation of freshwater biodiversity in Canada. These watersheds of the Great Lakes basin support the highest diversity of species at risk in the country, including several globally rare fishes and mussels. To ensure the preservation of aquatic biodiversity in the region, an aquatic ecosystem approach to recovery planning is underway within the Sydenham, Thames, Grand and Ausable Rivers as well as the Essex-Erie region. The implementation of recovery strategies addressing priorities for stewardship, research & monitoring, and public awareness approaches is occurring throughout these drainages. Progress on recovery actions by the Ausable River Recovery Team will be highlighted with particular emphasis on the establishment of a quantitative monitoring program for freshwater mussels in 2006. The results of the monitoring program will provide a baseline to track changes in the mussel community over time and help measure the success of the recovery program.

Oral; Contributed

DEVELOPMENT AND SENSITIVITY ANALYSIS OF FUZZY HABITAT SUITABILITY INDICES FOR INSTREAM FLOW ESTIMATION

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Canadian rivers can support a variety of needs, including habitat for fish, hydropower generation, outdoor recreation, and navigation. Instream Flow Incremental Method (IFIM) has been applied to a number of hydroelectric projects in order to determine the quantity of water to remain downstream of hydroelectric dams for the preservation of ecosystem functions. In this study, the potential of a fuzzy approach for modeling habitat preferences for Atlantic salmon (*Salmo salar*) is explored. Instead of developing a single Habitat Suitability model for a given life cycle (e.g. spawning or parr rearing), fuzzy sets and fuzzy preference rules were developed for these habitats by several (6) experienced fish biologists and technicians. Fuzzy sets were defined for water depth, velocity and substrate composition. Fuzzy preference rules for the two life stages were then defined as sets of IF–THEN rules relating the physical variables to habitat suitability. The fuzzy suitability indices were used to calculate weighted usable area at different discharges on the Romaine River (Québec North Shore, Canada) and to estimate the ecologic flow required to preserve the habitat. A preliminary sensitivity analysis was performed on the choice of rule consequences and fuzzy set boundaries. It is concluded that fuzzy models are suitable for representing the readily available expert knowledge of fish-habitat relationships, but that a limited number of rules are determinant. A modification in the consequence of these rules can significantly alter Weighted Usable Area estimations. Two methods of combination of expert fuzzy rules and sets are proposed and results are compared.

Oral; Hydroelectric Power and Aquatic Ecosystems

HABITAT-SPECIFIC EFFECTS OF CLIMATE WARMING ON ALPINE ZOOPLANKTON

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The impact of climate warming on alpine lakes is expected to be influenced by specific habitat characteristics. Benthic communities benefit from a close interaction with sediment as an additional food source in comparison with pelagic zooplankton, but can also suffer from mechanical interference caused by sediment suspension. We hypothesised that lower food availability in pelagic environments interacts synergistically with warming to reduce zooplankton survival and reproduction. We also predicted that the nutritive advantage of sediments in benthic communities would primarily favour grasping feeders over filter-feeders as they are less susceptible to mechanical difficulties caused by suspended particles. To test this hypothesis, we conducted a two-factor microcosm experiment with a planktonic alpine community over a 34-day period, which consisted of a temperature treatment (8˚C vs. 14˚C) and a habitat treatment, determined by the presence or absence of sediments. The addition of sediments amplified the negative effects of warming on cladoceran survival and reversed the positive impact of warming on cladoceran fecundity. Warming did not affect copepods, but the presence of sediments triggered an increase in fecundity. Our results suggest that shallow littoral habitats are more sensitive to climate warming than deep pelagic systems as a result of the community shifts caused by interactions between temperature and sediment suspension.

Oral; Student; Climate Change

REGIONAL DISPERSAL OF ZOOPLANKTON MAY DAMPEN THE EFFECTS OF AN INVASIVE PREDATOR, *BYTHOTREPHES*, ON LOCAL COMMUNITIES

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The rapid spread of invasive species into ecosystems around the world is of great concern, with hypothesized declines in the biodiversity and functioning of these systems. *Bythotrephes longimanus* is an invertebrate predator that is spreading rapidly in the Great Lakes basin, into Ontario, Quebec, and the upper United States. As the invader occupies greater numbers of habitats and reduces crustacean zooplankton species richness, there are fewer locations that can act as sources to maintain regional species richness and function. Using 7000L enclosures, we performed a 2x2 factorial experiment to test the effects of regional dispersal on zooplankton communities which had been: 1) invaded by *Bythotrephes*, 2) invaded, but invader was removed from treatments, and 3) never invaded by *Bythotrephes*. Dispersal had little effect on abundance or biomass of zooplankton which were never invaded, suggesting that the local community may have excluded new species from entering. Dispersal had a slight positive effect on zooplankton biomass and abundance in communities invaded by *Bythotrephes*, but a large positive effect when the invader was removed, suggesting that the effect of *Bythotrephes* is not permanent and can create niches for regional species that would otherwise be unable to colonize the community. This suggests that in cases of failed invasions and in time periods when the invader is not present, regional dispersal may provide a mechanism for the continued functioning of zooplankton communities.

Oral; Student; Aquatic Invasive Species

EVALUATING THE RESPONSE OF CLADOCERA TO RECENT ENVIRONMENTAL CHANGES IN LAKES FROM THE CENTRAL CANADIAN ARCTIC TREELINE REGION

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Arctic and Subarctic ecosystems have undergone considerable environmental changes in recent years as the result of climate warming. Fossil records of freshwater diatoms in lakes throughout the circumpolar Arctic, including the central Canadian Arctic treeline region, have revealed marked directional shifts in diatom assemblages in recent lake sediments. These changes have been linked to longer growing seasons, decreased duration of ice cover, increased thermal stability, as well as related limnological shifts. The effects of these recent environmental changes on higher trophic levels, such as the Cladocera, are still unclear. Using cladoceran remains preserved in the sediments of 50 lakes, which were previously examined for changes in diatoms, we show that significant changes in cladoceran species composition have occurred from pre-industrial times to the present. However, these changes are considerably muted compared to the more substantial changes observed in the diatom record. We found no consistent patterns of change in planktonic cladocerans (i.e. Daphnia, Bosmina) within our study lakes, and the response of the Cladocera to environmental changes does not appear to be strongly coupled to recent changes in diatom communities, thus further confirming that the previously observed diatom changes were related to bottom-up limnological controls. These results highlight the complex response of Arctic freshwater food-webs to climate change, and the need for incorporating multi-trophic studies into climate change investigations.

Oral; Student; Climate Change

EFFECTS OF THE ANANLYSIS SCALE SIZE ON MODELS OF ICHTHYOLOGICAL HABITAT QUALITY

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With the goal of conserving littoral lake ecosystems, it is important to be able to qualify the habitats that compose them. Indeed, habitats of the littoral zone neither answer equally to anthropogenic pressures nor possess the same value within an ecosystem (Boisclair 2001). Thus, it is essential to identify the most important zones at the ecological level, in order to reduce human impacts on these natural habitats. The modelling of habitats quality is a solution quite appropriate for those cases. This allows to identify the key factors of a healthy littoral zone and to predict the abundance or biomass of the present biological communities. My research focus on the littoral zone fish communities and aim to model the quality of those species' habitats in particular. The data used for this study come from the Lake Purvis, located in the Laurentians. Sampling of the environmental and biological elements was carried out visually by snorkelling observers during the summer of 2005. Since models can vary tremendously according to the analytical scale used (Brind'Amour and Boisclair 2006), I tested the predictive power of many scales. The results show that the analysis scales determined by habitat patches provide the most powerful models on fish habitat quality. The analysis of a total of nine visits, distributed over three lakes of the region, should allow for confirmation of this phenomenon.

Oral; Student; Aquatic Ecosystem Science

EFFETS DE LA TAILLE DES GRAINS D'ANALYSE SUR LES MODÈLES DE LA QUALITÉ D'HABITATS ICHTYOLOGIQUES

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Dans le but de conserver les écosystèmes littoraux lacustres, il importe de pouvoir qualifier les habitats qui les composent. En effet, les habitats de la zone littorale ne répondent pas tous également aux pressions anthropogéniques, ni ne possèdent la même valeur au sein d'un écosystème (Boisclair 2001). Il est donc essentiel d'identifier les zones les plus importantes au niveau écologique pour réduire les impacts humains sur ces habitats naturels. La modélisation de la qualité des habitats est une solution toute appropriée pour ce genre de cas. Cela permet d'identifier les facteurs clés d'une zone littorale saine et de prédire l'abondance ou la biomasse des communautés biologiques présentes. Mes recherches se concentrent sur les communautés de poissons de la zone littorale et visent à modéliser la qualité des habitats pour ces espèces en particulier. Les données utilisées proviennent du lac Purvis, situé dans les Laurentides. L'échantillonnage des éléments environnementaux et biologiques des habitats a été effectué visuellement par des observateurs en plongée avec un tuba durant l'été 2005. Étant donné que les modèles peuvent varier énormément selon le grain d'analyse utilisé (Brind'Amour et Boisclair 2006), j'ai testé le pouvoir prédictif de plusieurs grains d'analyse. Les résultats démontrent que les grains d'analyse déterminés par taches d'habitats fournissent les modèles les plus puissants à l'élaboration de modèles sur la qualité des habitats de poissons. L'analyse d'un total de neuf visites, distribuées sur trois lacs de la région, permettra de confirmer ce phénomène.

Oral; Student; Aquatic Ecosystem Science

IMPACT OF AN INVASIVE MACROPHYTE, *TRAPA NATANS* ON NITROGEN TRANSFORMATIONS IN THE HUDSON RIVER

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Aquatic plants can play a significant role as ecosystem engineers altering chemical dynamics. In the tidal Hudson River a native aquatic plant species (*Vallisneria americana*) and a non-native species (*Trapa natans*) vary dramatically in how they alter the oxygen concentrations in the water. *Vallisneria*, a submersed macrophyte, adds DO to the aquatic system while free-floating leaved *Trapa* vents oxygen to the atmosphere causing hypoxia within large beds. To assess the contrasting effect of native and introduced macrophytes on nitrogen (N) processing and denitrification (anaerobic reduction of nitrates into gaseous nitrogen) particularly, we measured N_2 and N_2O fluxes in both macrophytes beds. Here we show that high depletion of nitrates with respect to phosphorus observed within *Trapa* beds can be explain entirely by denitrification rates measured. This N loss represents approximately 20% of the average daily summertime export of N from the tidal freshwater Hudson. Therefore, denitrification in *Trapa* beds represents a significant and permanent N sink compared to plant uptake. However, we hypothesize that *Trapa* beds could also be hot spots of nitrous oxide, a green-house gas, byproduct of denitrification. Thus hypoxia caused by *Trapa* has significant geochemical consequences and these nutrient changes can result in eutrophication problems, including toxic algal blooms and loss of habitat.

Oral; Aquatic Invasive Species

BACTERIAL RESISTANCE TO ELEVATED PH LEVELS IN HIGHLY PRODUCTIVE, MACROPHYTE DOMINATED LAKES OF THE MACKENZIE DELTA, NORTHWEST TERRITORIES

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Shallow lakes are known to represent, globally, a large proportion of total lacustrine area. However, they tend to be understudied relative to larger waterbodies, despite the fact that small lakes may function much differently than their larger counterparts. For example, small, shallow lakes can experience elevated pH levels caused by high levels of macrophyte production, the effect of which has been largely unstudied. These pH rises are particularly striking in some lakes of the Mackenzie Delta, where pH can increase to as high as 10.5 in the late summer. We examined the effects of these naturally occurring pH increases on the bacterial community of Delta lakes in both short- and long-term incubations. Over the short term (48 hour experiments), bacteria taken from lakes that did not experience high pH levels consistently showed severe, significant decreases in production and respiration when pH was raised. In contrast, bacteria from lakes that became more strongly alkaline as the summer progressed showed similar depressions in response to elevated pH only early in the ice-free season. Over the long term (30 day mesocosm experiments), bacteria from a lake unaffected by alkalization acclimated to high pH levels within 20 days. Survey results of Delta lakes across a gradient of pH levels shows that bacterial production tends to be comparatively high in high-pH lakes, suggesting that these bacterial communities can adapt to, and even prosper in macrophyte-rich, high pH lakes.

Oral; Student; Aquatic Ecosystem Science

THE ROLE OF THE ROUND GOBY (*NEOGOBIUS MELANOSTOMUS*) IN THE BAY OF QUINTE, LAKE ONTARIO, ECOSYSTEM

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In the past decades the Bay of Quinte ecosystem has undergone a series of changes due to reduction in phosphorus loading, and invading species. The most recent invader, the round goby, was first sighted in the Bay in 1999, and has become an important component of the nearshore community. We evaluate the trophic relationships of the round goby in the Bay of Quinte. From May to October 2005 we conducted intensive sampling in two areas of the bay that were subjected to goby invasion two years apart. Goby densities were estimated in 2005 using underwater camera. Round goby diet was qualitatively and quantitatively described. Scales and otoliths were used for age estimation. Samples of top predators were analyzed to provide estimates of goby predation rates. Results of the bioenergetics assessment of the round goby in the Bay of Quinte will be presented.

Oral; Aquatic Invasive Species

REEF FISH GENETIC POPULATION STRUCTURE AND OCEANOGRAPHIC PATTERNS ALONG THE MESOAMERICAN BARRIER REEF

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Overfishing and exploitation of marine resources have led to the decline of many commercially and ecologically important reef fish. To establish effective marine reserves and protected areas, we must be able to define the spatial bounds of the populations and determine levels of connectivity. Many marine fish species exhibit a pelagic larval phase in which their potential for long distance dispersal is high, leading to the expectation that populations will be highly connected. Recent evidence, however, has shown that there may be significant levels of local retention in some reef systems brought about by interactions of larval behaviour with oceanographic features such as eddies and gyres. In this study, we assess population structure in *Stegastes partitus* (Bicolor damselfish) at seven sites spanning the reefs of southern Mexico to central Belize using 12 highly polymorphic microsatellite loci. We sampled both adult and newly recruited juvenile fish at each site. We tested for population structure among the adult fish (N=100/site) and preliminary results indicate strong genetic structure consistent with expected seasonal oceanographic currents. Although the juvenile fish analysis was not complete at the time of writing, we predict that, based on the dispersal capabilities of the larval fish, the juvenile fish will not show the same genetic structural pattern. High resolution population genetic studies, such as this one, are critical to developing conceptual hypotheses concerning connectivity of reef fish populations.

Oral; Student; Aquatic Conservation

NET IMPACTS OF CLIMATE WARMING AND NITROGEN DEPOSITION ON PLANKTON IN ALPINE LAKES

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The combined effects of multiple ecological stressors determine the net impact of global change on environmentally sensitive alpine environments. For example, climate warming and nitrogen deposition are both increasingly affecting aquatic ecosystems at high elevations. We hypothesized that the net impact of warming on alpine plankton would be altered by the presence of added nitrogen and vice versa. These hypotheses were tested by applying temperature (8 vs. 15˚C) and nitrogen (200 vs. 1000 μg N L^{-1}) treatments to a planktonic alpine community using aquaria in a laboratory setting. A significant nitrogen-temperature interactive effect on phytoplankton abundance occurred because the expected positive effect of fertilization depended on warming. Furthermore, both temperature and nitrogen treatments caused reductions in phytoplankton community diversity with phytoflagellates becoming more prevalent over green algae and cyanobacteria. Warming and nitrogen in combination increased survival and reproduction in herbivores while warming suppressed the fecundity of omnivores. The observed prevalence of non-additive effects on plankton highlights the strong potential for global change causing future ecological surprises in alpine environments.

Oral; Student; Climate Change

NET GHG EMISSIONS FROM A HYDROELECTRIC RESERVOIR: EASTMAIN-1

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Carbon dioxide and methane are the world's main greenhouse gases (GHG) and are emitted from both natural aquatic ecosystems (lakes, rivers, estuaries, wetlands) and man-made reservoirs. The role of greenhouse gas emissions from freshwater reservoirs and their contribution to increasing atmospheric GHG concentrations is a focus of much discussion globally. Knowledge of Net GHG emissions is crucial for determining the true impact of reservoirs on the dynamics of carbon at a watershed scale. This is currently being done for the first time, on the Eastmain-1 project situated in the boreal forest region (Quebec, Canada). The impoundment of this reservoir started en November 2005 and ended in May 2006. This communication presents both the results of GHG flux measurements and other parameters taken for 3 years over both aquatic and terrestrial systems prior to the flooding and the approach taken to model the net carbon budget.

Oral; Hydroelectric Power and Aquatic Ecosystems

IMPACT OF FOREST HARVESTING ON BROOK TROUT SELECTIVE FORAGING IN BOREAL SHIELD LAKES

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The aim of this study is to determine the impact of logging on zooplankton and zoobenthos communities, on brook trout (*Salvelinus fontinalis*) selective foraging and on trophic structure of six lakes of the Canadian Boreal Shield. Three lakes had an undisturbed watershed while the three others had at least 35 % of their catchment area logged. Lakes have been sampled once in June-July 2005. Littoral (n=18) and pelagic (n=18) zooplankton and benthos samples (n= 30) have been sorted and sub-samples of specimens have been counted and identified at the family level when possible. There is no difference of abundance, species richness, Shannon diversity indices and evenness between logged and undisturbed lakes for zooplankton and zoobenthos. Stomach content analyses have been performed on 30 brook trout in each lake. Diet composition results show that brook trout feed more on zooplankton in logged lakes. Chesson's alpha has been used to determine brook trout selectivity on zooplankton and benthos preys in logged and undisturbed lakes. Brook trout select positively the larger organisms such as *Chaoborus* sp., *Leptodora kindtii*, ephemeroptera and trichoptera. Nitrogen and carbon stable isotopes have be used to determine if logging has an impact on trophic level and carbon sources respectively for particulate organic matter (POM) and fish. Those analyses show that POM in logged lakes is more depleted in carbon stable isotope and that brook trout in logged lakes are more depleted in nitrogen stable isotope.

Oral; Student; Land-Water Interactions

DENSITY- AND HABITAT-DEPENDENT TERRITORY RELOCATION IN A CORAL REEF FISH: IMPLICATIONS FOR THE DESIGN OF MARINE PROTECTED AREAS

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Marine protected areas (MPAs) allow local fish populations to increase in abundance and attain larger body sizes, but little is known about what influences movements of fishes from MPAs to surrounding unprotected areas. 'Spillover' (movement of adult fish from the MPA to the fished area) is expected to be density-dependent when high density reduces fitness through decreased resource availability or increased agonistic interactions. We are studying whether territory relocation shows density-dependence and whether it is affected by habitat quality. We gradually reduced the density of longfin damselfish at four apparently saturated sites on a Barbados fringing coral reef to mimic fishing pressure in creating vacant habitat. Prior to removal, we developed a model to describe habitat use as a function of fish size. During the removal, we recorded territory relocation and changes in territory size for damselfish that did not move. Overall, damselfish were more likely to colonize vacant territories formerly occupied by large individuals (higher habitat quality) than those occupied by small individuals (lower habitat quality). A predictive model of relocation showed that local density, distance from high quality territories, and habitat quality in relation to fish size act synergistically to influence the probability that a damselfish would relocate. Current research is examining the role of habitat connectivity in this process. The design of MPAs needs to consider habitat quality of both the protected and the fished area, whether the goal is to promote or prevent density-dependent movement of fishes.

Oral; Student; Aquatic Conservation

TEMPORAL AND SPATIAL PATTERNS IN THE RECRUITMENT OF CORAL-REEF FISHES ON BARBADOS, WEST INDIES

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Monitoring replenishment of demersal fishes is fundamental to identify processes underlying variability in their distribution in space and time, helping improve conservation and management practices. In the present study, we monitored continuously over one year the recruitment of 8 taxa of coral-reef fishes at five sites distributed over 15 km along the west coast of Barbados, West Indies. We used standard monitoring units of recruitment to coral rubble (SMURFs) designed to minimize predation to collect newly settled fishes at 10-d intervals. SMURFs were deployed directly in reef habitat to assess the role of the benthos in setting patterns of recruitment within and among sites. We found that temporal patterns of recruitment differed among taxa, but were concordant across sites for each taxon, indicating coast-wide synchronous settlement. There were also differences across taxa in spatial patterns of recruitment within and among sites. Within sites, three taxa seemed to respond to specific benthic features, although in different ways. Among sites, overall recruitment was lower to the central site of the west coast, and highest to the southern and northern ends. This pattern was driven by four taxa and is consistent with a water-flow regime identified in previous studies. Four other taxa, however, did not comply with such pattern, indicating taxon-specific settlement dynamics that require alternative bio-physical models. Overall, our study highlights the value of monitoring several taxa concurrently using SMURFs to identify potential processes underlying recruitment variability in time and space and to assess the generality of these potential processes across taxa.

Oral; Student; Aquatic Conservation

TOP DOWN EFFECTS ON ZOOPLANKTON COMMUNITIES IN LAKES RECOVERING FROM ACIDIFICATION AND METAL CONTAMINATION

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We now know a good deal about how top down forces structure zooplankton communities, however, lakes that are industrially damaged offer new challenges to understanding. Although 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 90 lakes in the Sudbury area along gradients of nutrient levels, DOC, metal contamination, and planktivorous fish abundance. Many of these lakes exhibited unusual patterns in zooplankton community structure, namely an absence or reduction of cladoceran zooplankton. Preliminary analysis of geographic patterns of zooplankton communities failed to reveal any strong relationships between zooplankton metrics (total biomass, cladoceran biomass, and size structure) and physico-chemical lake characteristics, including metal contamination. Instead, strong top-down effects seem evident. With the extirpation 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 these 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; Student; Aquatic Ecosystem Science

TRACKING EFFORT DYNAMICS IN SMALL LAKES: PATTERNS AND EVALUATIONS

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Evaluating angler effort in areas with multiple fishing opportunities presents many difficulties. Angler dynamics are driven by many factors, including, but not limited to fish size-structure, catch rates and harvest regulations. Changes in management can stimulate these factors to change in all or many sites in a region, and can cause angling effort to redistribute to other sites nearby. A key in preventing over-harvesting in many of these small, spatially separated sites is to track movements in angler effort in order to prevent anglers from targeting and over-exploiting any particular site. We evaluate a new, inexpensive method for providing an index of angler effort on small, spatially discrete angling sites. Angling effort is monitored using stationary time-lapse cameras to photograph lakes and record numbers of boats over hours, days and months. Our findings are contrasted with those of weekly fly-over boat counts, which is a common method currently in place to estimate angler effort in small lakes in British Columbia. We demonstrate patterns of angler effort over various time-scales and discuss the implications of tracking effort and how this technology can help. Finally, the potential uses for this new technology will be discussed.

Oral; Student; Aquatic Conservation

MONITORING LAKE TROUT AND ROUND WHITEFISH AT A DIAMOND MINE IN THE SUBARCTIC

Vecsei, P., Macthans, H. and R. Schryer

De Beers Canada Inc. has developed a comprehensive aquatic effects monitoring program for the Snap Lake Project. Primary project related changes expected for the Project are a gradual increase in total dissolved solids and nutrient levels in Snap Lake. The fisheries component of the Snap Lake monitoring program consists of effects monitoring of adult fish health, and a special study to evaluate non-lethal methods for measuring effects to population structure and health of juvenile fish. The lakes sampled have included Snap Lake, 3 unnamed candidate reference lakes, Reference Lake, and Northeast Lake. Using a combination of gill nets, Nordic nets and angling gear, a total of 261 lake trout and 145 round whitefish were captured in 1999, 2004, 2005 and 2006. Individual fish were examined and a set of morphometric and health indices were recorded. The standard fish health indicators reveal healthy populations among the sampling locations but with considerable intra and interspecific variation among lake trout and round whitefish. Information collected will be used in future statistical comparisons to detect and interpret Project related changes in Snap Lake.

Oral; Aquatic Conservation

A QUANTITATIVE APPROACH TO ASSESS ALLOWABLE HARM IN SPECIES AT RISK: APPLICATION TO THE LAURENTIAN BLACK REDHORSE (*MOXOSTOMA DUQUESNEI*)

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The Species at Risk Act (SARA), intended to protect species at risk of extinction or extirpation in Canada and to promote their recovery, determines population resilience to human-induced harm by conducting an allowable harm analysis (AHA). After a species is listed by COSEWIC as threatened or endangered its protection is granted and the function of AHA is to provide scientific advice about the levels of harm a species (or population) could sustain during the time period comprised between the species listing and the implementation of a recovery plan. Based on the framework revised by Fisheries and Oceans Canada (Canadian Science Advisory Secretariat 2004), a particular kind of AHA has been applied mainly to commercial marine species for which catch or bycatch time series are available. Based on an initiative to work on AHA for freshwater species at risk we developed a methodology to estimate quantitatively allowable harm within a demographic framework. After defining harm as a negative perturbation that can target one or more vital rates and life cycle stages simultaneously, allowable harm results a function of (a) the vital rate(s) impacted by the involved human action(s), (b) the elasticities of impacted vital rate(s), (c) the population growth rate before allowing the harm, and (d) the minimum population growth rate that will not jeopardize the survival and future recovery of the population. Additional characteristics of our approach are that it requires minimal data but it uses all available data, links population dynamics with habitat supply, is flexible enough to assess complex life histories, and it follows the precautionary approach. We apply this methodology to a Canadian population of black redhorse, which has been chosen as one of seven species to be used as case studies to produce potential survival/recovery targets, and to identify and quantify critical habitats for species at risk.

Oral; Aquatic Conservation

RICKER REVISITED: EFFECTS OF FISHING AND FEMALES ON RECRUITMENT DYNAMICS OF WALLEYE (*SANDER VITREUS*)

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Models of stock size and recruitment are often used to establish fishing regulations that will protect the long-term viability of a population. These models assume that the survival of offspring is independent of parentage, despite overwhelming evidence from laboratory and hatchery experiments to the contrary, and recent simulations that suggest that parent-offspring relationships affect the dynamics of a population. Relying on results from benign (and short-term) experiments to model recruitment is problematic, however, because parental effects might be different in nature. Here we quantify a strong, positive effect of maternal quality (namely egg size) on juvenile survival under field conditions. When results were incorporated into an age-structured matrix model to evaluate the population-level consequences of these mechanisms, the shape of the stock-recruitment relationship depended strongly on stock structure. This result is inconsistent with the critical assumption that stock-recruitment relationships are fixed in stable environments, and brings into question the reliability of sustainable rates of harvest from which they are derived. Our results suggest clearly that fisheries managers should consider the size- or age-structure of a population when deciding policy, and assess explicitly effects of harvest strategies on recruitment dynamics.

Oral; Student; Contributed

IMPACTS OF RECENT EXTREME CLIMATE CHANGE ON ALPINE LAKES OF THE CANADIAN ROCKY MOUNTAINS

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Climate is the primary factor affecting alpine environments around the world. Thus, alpine lakes can function as sentinels of the impacts of global warming, which are forecasted as being most pronounced at high elevations. The main objective of our study was to determine how extreme climatic variability affects alpine lakes along the eastern front range of the Canadian Rocky Mountains in central Alberta. We performed a multivariate analysis of the meteorological database for the Bow Valley to identify climatically extreme years. Warmer, drier, and shorter ice-free seasons have become more frequent over the past 15 years. Concomitantly, non-chromophoric dissolved organic carbon (DOC) concentrations have increased significantly in several lakes while other limnological variables have remained relatively unaffected, including total phytoplankton biomass. However, increasing DOC levels significantly explained a striking taxonomic shift in which fast-growing chrysophytes have replaced larger dinoflagellates. A potential explanation for this phenomenon is that climate warming increases microbial processing of labile autochthonous organics, which then stimulates heterotrophic chrysophytes. Our findings highlight how the impacts of global change on inland coldwaters are becoming more widespread, extending from the Arctic to high-elevation sites at lower latitudes.

Oral; Climate Change

EFFECTS OF NUTRIENTS ON AQUATIC PLANTS IN STREAMS AND RIVERS: A COMPARISON OF SESTONIC ALGAE, BENTHIC ALGAE AND MACROPHYTE BIOMASS-NUTRIENT RELATIONSHIPS

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The response of suspended and benthic algae and macrophytes communities to increasing nutrients was compared for streams and rivers in the Mixedwood Plains Ecozone of southern Ontario and Quebec. Based on existing data from the literature and provincial monitoring programs, we found differing responses to increasing total phosphorus (TP) and total nitrogen (TN) amongst the various plant communities. Suspended algae responded positively to increasing nutrients (TP and TN), with the slope of the relationship influenced by drainage area. Benthic algae showed increasing biomass with increasing TP up to 40 µgP/L after which biomass decreased, yet showed a continually increasing response to TN. In contrast, macrophyte communities had no significant relationship with water column nutrients; these plants only occurred in predominantly low P (<100 µg/L), high N (>2.0 mg/L) systems. Analyses of percent cover data in relation to nutrients for benthic algae, filamentous algae and macrophytes gave patterns similar to those for biomass. Analysis of relationships between biomass and N:P showed opposite responses for suspended algae and benthic algae: suspended algal biomass was more strongly controlled by P whereas benthic algae responded more strongly to N, regardless of whether nutrient concentrations were excessive or not. Our results indicate that for the Mixedwood Plains Ecozone, biomass-nutrient relationships can be used to predict which plant communities will dominate under various nutrient scenarios.

Oral; Wetlands

BAYESIAN SUMMARY STATISTIC SELECTION FOR AQUATIC COMMUNITY MONITORING

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Aquatic ecologists often wish to assess hypotheses about the diversity and compositional similarity of communities. One approach has been to calculate summary statistics of species presence/absence data matrices and calculate p-values associated with these statistics under various null hypotheses. The statistics are chosen to reflect the diversity and similarity implied by presence/absence matrices. Unfortunately, this choice can be subjective as many summary statistics exist. Alternatively, it is easy to justify the use of a particular statistic when most statistics lead to the same conclusion. However, this does not work when conclusions depend on the choice of statistic. A naïve approach is to use many statistics and see which sets of statistics agree with each other. Unfortunately, this leads to multiple comparison issues that cannot be easily corrected because most summary statistics are correlated. Via a case study of fish communities from a set of Central Ontario lakes, we demonstrate the potential of a Bayesian approach for addressing these issues. Bayes' theorem can be used to calculate the probability that a set of summary statistics are consistent with a particular hypothesis given a presence/absence matrix. When this probability is high, we are justified in claiming that our conclusions are not influenced by the choice of statistic. We can also calculate the probability that a set of summary statistics is inconsistent with another set. This will often lead us to a deeper understanding of the communities of interest, and of our summary statistics, while avoiding problems associated with choosing a statistic.

Oral; Student; Aquatic Conservation

WHITEFISH RECRUITMENT DYNAMICS SPANNING THE MID-1990s REGIME SHIFT IN LAKE ONTARIO: EVALUATING LONG-TERM STOCK-DEPENDENCE, REPRODUCTIVE INVESTMENT, AND ENVIRONMENTAL DRIVERS

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In eastern Lake Ontario, lake whitefish (*Coregonus clupeaformis*) have exhibited suppressed levels of abundance, condition, and recruitment since the mid-1990s. During this period the Lake Ontario food web underwent a remarkable shift in ecological processes – production of lower trophic levels declined dramatically, and zooplankton, benthic macroinvertebrate, and fish community composition were restructured. This shift was observed amidst a suite of environmental changes, including the introductions of two benthic filter feeders (*Dreissena* sp.) and a series of unusually warm winters. Since 1979, age-3 whitefish recruits have shown strong correlations with age-0 summer abundance, suggesting that year class strength may be set during early life stages. Factors of potential importance to survival during early life include the amount of surplus energy available to females for reproductive investment, ice cover duration during egg incubation, prey availability to recently hatched larvae, and summer zooplankton availability. Using data collected between 1979 and 2006, we use change point analysis to test for structural shifts in whitefish and environmental data. We take an information theoretic approach to evaluate the structure of stock-dependence on age-0 abundance prior to and following the regime shift. Using a proxy of reproductive investment, we assess whether a decline therein shifted the stock-recruit equilibrium to a point where replacement recruitment was unlikely. Finally we evaluate whether residual variation in age-0 abundance is correlated with environmental drivers prior to the mid-1990s, and whether recruitment became more strongly correlated with lower food web production and winter climate following the regime shift.

Oral; Student; Contributed Papers

VARIANCE IN MALE REPRODUCTIVE SUCCESS AND CORRELATES OF MULTIPLE PATERNITY IN A NATURALLY SPAWNING ATLANTIC SALMON POPULATION

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Maintenance of genetic variability within fish populations can be achieved when multiple male males mate with a single female. Atlantic salmon, *Salmo salar*, have two distinct male maturation phenotypes. Males of this species can mature at a young age and small size as parr, or as significantly larger migratory individuals. Simultaneous spawning by both male maturation phenotypes can result in a high incidence of multiple paternity, thereby increasing the genetic variability of the offspring. We undertook a field study in Catamaran brook, New Brunswick, Canada to determine the number of males that fertilise eggs in single spawning events and how this may vary within a system. In autumn, 2003, redd surveys were conducted along a 12 km stretch of the brook. Approximately fifty eggs from 18 of a total of 60 redds were sampled, with almost equal numbers of redds sampled from three major spawning sections of the brook. Kinship analysis was performed using microsatellite markers to assign offspring to parents. Redds were significantly clumped in space, suggesting that there are areas of preferred spawning habitat in the brook. Not surprisingly, spawnings involving many males occurred most frequently in areas of high female activity. There was a large range in the number of fathers within a redd, whereby between one and 16 males successfully fertilised eggs. In addition, there was high skew in fertilisation success among males, which has consequences for estimating the effective number of breeding males and effective population size.

Oral; Student; Aquatic Conservation

ÉTUDES EMPIRIQUES ET MODÈLE DU CYCLE DU CARBONE DU COMPLEXE HYDROÉLECTRIQUE DE LA BAIE JAMES, QUÉBEC

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La création de réservoirs hydroélectriques modifie le cycle de carbone des milieux aquatiques. L'augmentation de la superficie inondée et des temps de séjour, la modification de l'hydrologie, des conditions de stratification, de pénétration de la lumière et de la physico-chimie ainsi que les apports des sols inondés sont autant de facteurs qui influencent l'activité biologique et le cycle de carbone dans ces milieux. Des émissions de CO_2 de la surface des réservoirs, ainsi que mesurées dans un grand nombre de réservoirs des zones boréales, tempérées et tropicales en sont le résultat observable. Ces émissions sont en partie attribuables à la dégradation de matière organique dans les sols inondés, mais également à la minéralisation d'une fraction de la matière organique d'origine terrigène des bassins versant. Nous avons ici créé un modèle du cycle du carbone pour le complexe de réservoirs de la Baie-James, couvrant 15000 km^2 dans le moyen-nord québécois. Ce modèle se base sur des mesures de carbone organique dissous et de biomarqueurs de la lignine et intègre les résultats de plusieurs études empiriques menées sur les différents compartiments du cycle du carbone dans les réservoirs de la région d'étude, en particulier les échanges entre la colonne d'eau et les sols inondés ainsi que l'atmosphère. À l'aide de ce modèle, il est possible d'évaluer le devenir du carbone d'origine terrigène provenant des sols inondés et du bassin versant dans le réseau hydrique et ainsi l'impact climatique net sur sa durée de vie d'un complexe hydroélectrique.

Oral; Hydroelectric Power and Aquatic Ecosystems

THE EFFECT OF HYDROELECTRIC RESERVOIR DRAW-DOWN ON BENTHIC MACROINVERTEBRATE COMMUNITIES OF STONY LITTORAL HABITATS: AN APPLICATION OF THE REFERENCE CONDITION APPROACH

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Due to increasing power demands and the general desire to pursue renewable energy opportunities, future hydroelectric power generation is expected to increase: resulting in the creation of more hydroelectric reservoirs across the globe. The Ontario Water Level Lake Series (OWLLS) was established to address the paucity of data concerning natural water level fluctuations (WLF) in large lakes (>1000ha) along with its associated influences on stony littoral benthic macroinvertebrate communities. Twenty-one reference lakes having similar influences relative to a set of hydroelectric reservoirs were instrumented with water level data loggers in 2005, each recording water level and temperature at hourly intervals 365 days a year. In August 2006, nearshore stony littoral benthic macroinvertebrate communities were sampled using the kick and sweep method at each of the twenty-one reference lakes and thirty-two hydroelectric reservoirs; all having a characteristic WLF depending on the reservoirs operating management plan (i.e. peaking, run of the river, winter draw-down, exaggerated natural). A modified reference condition approach (RCA) was used to determine differences in community structure between the reference lakes and each of the thirty-two hydroelectric reservoirs. This modified approach focuses on one habitat type, west facing nearshore stony littorals, rather than sample the full range of habitats that most RCA studies aim to accomplish. The results demonstrate that the stony littoral benthic macroinvertebrate communities of hydroelectric reservoirs differed significantly from reference-lake communities. The difference in community structure is primarily a function of the WLF regime used in the different reservoirs.

Oral; Student; Hydroelectric Power and Aquatic Ecosystems

EPIPHYTIC MACROINVERTEBRATE COMMUNITIES ON EURASIAN MILFOIL AND NATIVE MILFOILS IN EASTERN NORTH AMERICA

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Aquatic plants play an important role in the survival and proliferation of invertebrates in freshwater systems. Exotic freshwater plants are now common in North America, where they often displace native plants, thereby potentially altering epiphytic invertebrate communities. This research compared macroinvertebrate communities on native and exotic plants of similar leaf morphology. We sampled the exotic Eurasian milfoil (*Myriophyllum spicatum)* and either the native *M. sibericum* or *M. alterniflorum* from four bodies of water in southern Quebec and upstate New York throughout the summer of 2005. Within each waterbody, we compared the community composition, diversity, density and biomass of epiphytic invertebrates on exotic and native *Myriophyllum*. We found differences in invertebrate communities on native and exotic *Myriophyllum* that varied with season and across sites. Both *M. sibericum* and *M. alterniflorum* had higher invertebrate diversity and supported more gastropods than *M. spicatum*. In late summer, both native *Myriophyllum* species generally supported greater invertebrate biomass than *M. spicatum*. Invertebrate density was higher on *M. sibericum* than *M. spicatum*, but lower on *M. alterniflorum* than *M. spicatum*. The results show that the exotic *M. spicatum* supports invertebrate communities that differ from those on structurally-similar native plants. Thus, the replacement of native *Myriophyllum* by *M. spicatum* may have indirect effects on aquatic food webs.

Oral; Student; Aquatic Invasive Species

LANDSCAPE EFFECTS ON FISH NUTRIENT EXCRETION IN TEMPERATE STREAMS

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Fish can be an important source of nutrients (N, P, DOC) to freshwater ecosystems. We examined the rates and ratios of nutrient excretion by freshwater fish in 12 temperate streams for two years (2005 and 2006). These streams were selected based on the contrasting agricultural land use in their watersheds (10% to 90% cropland). We found strong effects of taxonomic identity, body size and stoichiometry on fish excretion rates. In 2006, body size strongly predicted variations in excretion rates for most species, exhibiting negative relationships for all nutrients measured, with the strongest relationships exhibited for phosphorus excretion. From a landscape perspective, % cropland in the watershed was as a strong predictor of both N and C excretion for many fish taxa (e.g., *Rhinichthys sp.* NH_4 r^2= 0.81, DOC r^2= 0.62) but these effects changed from 2005 to 2006. We hypothesise that changes in the strength of excretion-land use relationships are a result of varying elemental composition of the food consumed by these fish. We found a wide range of N and P concentration among streams in 2005, which strongly related to the amount of cropland in the watershed. In 2006, these relationships were absent. Our results indicate that taxonomic differences in body size and stoichiometry and environmental variation all regulate the role played by temperate stream fishes in nutrient recycling.

Oral; Student; Land-Water Interactions

ENVIRONMENTAL CONTROLS OF FOOD WEB STRUCTURE AND ENERGY FLOW IN SALINE PRAIRIE LAKES

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Salinity excerpts unique effects on food web dynamics in addition to other key parameters, such as nutrients, DOC, and lake morphometry. As the onset of osmotic stress varies among trophic levels, the complexity of food webs in saline lakes is highly variable and more diverse than in freshwater lakes. To evaluate the effects of salinity on food web composition, we analyzed lake depth, water chemistry, algae, and zooplankton from 70 prairie lakes, with salinity ranging from fresh to hypersaline. In regard to water chemistry, all major ions, DOC, and N were highly correlated with salinity, while lake depth, TP, and Ca were controlled otherwise. Zooplankton species richness dramatically declined from fresh to hyposaline waters, and in hypersaline lakes only two species were present. Freshwater lakes had “typical” zooplankton species compositions; but at intermediate salinities, salt-tolerant species such as Daphnia similis and Diaptomus nevadensis were common, followed by large conspicuous invertebrates (e.g. isopods), and finally artemiidae at highest salinities. Additionally to salinity, CCA identified lake depth and Ca as variables that significantly influenced zooplankton species composition. Phytoplankton biomass was low relative to nutrient concentrations and species composition was not strongly affected by salinity, but cyanobacteria were more frequent in freshwater lakes. Climate change scenarios predict that the Canadian plains (and other regions worldwide) will experience more droughts in the future. As saline lakes are known to be very sensitive to hydrologic changes, these systems are critically important to detect early signs of climate change, and to predict the consequences for lake food webs.

Oral; Aquatic Ecosystem Science

COHERENT LAKE WATER RESPONSES IN NOVA SCOTIA TO CHANGES IN ACID DEPOSITION

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Acid rain has had adverse effects on aquatic and terrestrial ecosystems. Consequently, the government of Canada has introduced national emission reduction programs and participated in international control agreements to address the trans-boundary nature of these emissions. As the control programs are costly, it is crucial to determine whether the emission reductions are facilitating system recovery. Statistical techniques were used in this study to determine the effectiveness of emission reductions on surface water quality in Nova Scotia, by first grouping lakes with similar temporal responses and then examining temporal trends within these groupings for improvements. Coherence analysis on time series of water quality data for acid sensitive lakes identified several lake groupings with synchronous temporal responses. Representative of each lake cluster time series for sulphate were examined for monotonic trends to determine if recovery is occurring. Finally, simple indices of deposition and climatic variables were used to determine the drivers explaining the largest percentage of variability in the water quality temporal changes.

Oral; Student; Contributed

REBOUND OF STREAM INVERTEBRATE COMMUNITIES DURING URBAN DEVELOPMENT

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Urbanization results in the conversion of cropland, pasture and forest into urban and suburban environments. Urbanization is a global phenomenon that leads to dramatic and most often negative changes in aquatic systems. We assessed the effects of urbanization on invertebrate communities over the course of three years in streams flowing through the town of Milton, Ontario. We show consistent differences in habitat quality between reference and impacted sites suggesting that the urbanization has a negative impact on downstream waters. Although construction is still ongoing, we found evidence to suggest a rebounding effect at impacted sites after three years of study. This rebound was suggested by a convergence of five community indices (mean total number of species, mean total EPT species, mean Simpson Diversity Index, mean Shannon-Weaver Diversity Index, and mean EPT: Chironomid ratios) for reference and impacted sites during the third year of monitoring. We also found improvements to water quality measures in the impacted sites over the three years as suggested by the general decrease in alkalinity and concentrations of calcium, magnesium, strontium, uranium and total dissolved solids. The rebound in benthic macroinvertebrate communities likely reflects these general improvements in water quality, high dispersal abilities of the taxa found, and the relatively impoverished state of the stream communities pre-development. Our results imply the greatest effects of development on stream invertebrate communities may be short-term and insignificant in some landscapes.

Oral; Aquatic Ecosystem Science

Poster Presentation Abstracts
(alphabetical order by first author by session)

AQUATIC CONSERVATION

P1. POPULATION GENETIC DIVERGENCE AMONG DETROIT RIVER BROWN BULLHEAD: POSSIBLE LOCAL ADAPTATION TO ENVIRONMENTAL CONTAMINANTS

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The brown bullhead (*Ameiurus nebulosus*) is a bottom-dwelling fish that is commonly used as a biomonitor of toxicological stress associated with sediment. The Detroit River is known for particularly high levels of insoluble contaminants in the sediments that previous studies have shown impact the resident brown bullhead. Observed differences in response to contaminant exposure in brown bullhead from different parts of the river have been postulated as a result of local adaptation. However, local adaptation requires limited gene flow to allow the evolution of local genetic adaptations. Although tagged bullhead are frequently re-caught at, or near, the release site, no population genetic analysis has been published. In this study, brown bullhead were collected from six sites within the Detroit River, and DNA was extracted from each fish. Microsatellite markers were PCR-amplified and the fish were genotyped at multiple polymorphic loci. We tested for population divergence using exact tests of allele frequency distribution differences, as well as through F_{ST} calculation. This data will be used to determine whether the populations are genetically isolated or if frequent migration is occurring, and thus local adaptation could be used to explain local differences in contaminant response among the Detroit River bullhead.

P2. DRIFTING INTO THE LIGHT: OPENING THE BLACK BOX ON MARINE LARVAL DISPERSAL

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Worldwide collapse of commercial marine species and the resultant failure of recovery efforts suggest large gaps in our understanding of marine ecosystem dynamics. Though the role of dispersal and connectivity in structuring and stabilizing terrestrial systems is well recognized, it has received far less attention in marine environments. The last decade has seen several technological developments directed towards measuring marine dispersal, nonetheless most studies fail to fully consider the inherent assumptions and biases associated with differing approaches or habitats. Our review of existing dispersal estimates indicates a bias towards low latitude species with limited dispersal. To determine whether current dispersal estimates are broadly representative, we use a database of dispersal potential (planktonic larval duration (PLD), 145 species) and realized dispersal (genetic differentiation F_{ST}, 212 species). We observed significant differences in realized dispersal (P<0.001) and dispersal potential (P<0.001) between taxonomic (e.g., fish, cnidarians, mollusks, etc) groups as well as a weak association between realized and potential dispersal (R=0.4) across groups. Within marine fish, significant increases in dispersal were associated with increases in latitude, body size, and maximum depth. Latitude was identified as the predominant factor, and similarly the proportion of fish species with pelagic eggs significantly increased with increased latitude ($P<0.001$, $r^2=0.76$). Because current estimates of dispersal in marine species are significantly biased towards low dispersal taxa, extrapolating from tropical systems or low dispersal species to other geographic regions and species may have serious management and subsequent evolutionary implications.

P3. LONG-TERM VARIABILITY OF CLADOCERANS IN BOREAL SHIELD LAKES UNDER NATURAL AND HUMAN DISTURBANCES

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Watershed perturbations such as forest harvesting or wildfires induce significant modifications on lake chemistry and ecology, thus causing an additional source of inter-annual variability in zooplankton communities. In order to assess the ecological importance of these short-term disturbances, it is important to acquire a better understanding of the natural variations of zooplankton communities in lake over long periods of time. Long-term studies of these variations can be achieved using paleolimnological methods, particularly the examination of cladoceran remains. Our objective was to compare the short-term variability due to natural and human watershed disturbance to the long-term variability of cladocerans in Boreal Shield lakes. Sediment cores were taken from three lakes in the Boreal forest, north of Lake St-Jean. All lakes experienced wildfires and logging activities on their watershed at one time or another over the last decades. Cores from each lake were brought to laboratory for preparation and dating before analyses of cladocerans remains were conducted. Our results showed a cyclic long-term variability patterns in the abundance of almost all of the 37 species observed. The genera *Bosmina* and *Daphnia* showed clear cyclic patterns throughout the entire core length. *Holopodium gibberum* displayed a drastic increase in abundance during the last decade. Links will be made between the natural variability of every species studied and the short-term disturbances observed on the watersheds over the years.

P4. TEMPORAL DIFFERENTIATION: CONTINUOUS VS. DISCONTINUOUS SPAWNING RUNS IN ANADROMOUS RAINBOW SMELT (*OSMERUS MORDAX*)

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While the importance of spatial separation to population divergence has often been studied, the influence of temporal separation has received much less attention. We assessed temporal genetic differentiation within three spawning locations for anadromous smelt (*Osmerus mordax*). At one location, spawning activity occurs continuously over a two-month period; at the other two locations spawning occurs over a similar period, but with a 3-4 week break in spawning activity between two distinct runs of fish. At all locations, 'early' and 'late' spawning smelt were sampled about 1-2 months apart. F_{ST} values indicated that significant genetic divergence exists between runs separated with a 'break' in spawning activity (0.0056-0.0067), while no significant effect of structuring was present across the two sampling periods of the continuous run (0.0027). This demonstrates the importance of spawning time as well as degree of connectivity between temporally separated individuals in contributing to population differentiation. By removing the spatial effect, we can assess temporal effects which may often be obscured when they occur in the context of geographically separated populations. In smelt, the magnitude of genetic differentiation associated with temporal effects appears to be comparable in magnitude to genetic differentiation seen on regional scales when there are little or no temporal differences in spawning. The level of temporal differentiation in smelt is similar to that seen in some anadromous salmonids (e.g. *Oncorhynchus nerka*) and suggests a general importance for 'isolation by time' in the maintenance of intraspecific diversity.

P5. ECOLOGY OF THE REDBREAST SUNFISH *LEPOMIS AURITUS* IN YOHO LAKE, NEW BRUNSWICK

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In Canada, the redbreast sunfish, *Lepomis auritus*, is only located in south western New Brunswick which is the northern limit of the species. In 1989, The Committee on the Status of Endangered Wildlife in Canada (COSEWIC), listed it as a species of concern due to its limited distribution. In 2005, the New Brunswick Cooperative Fish and Wildlife Research Unit, was commissioned by COSEWIC, to provide an updated status report on the redbreast sunfish. During this process it became apparent that there was a void in data on Canadian populations of redbreast sunfish, making an appropriate assessment difficult. The purpose of this research is to begin to build an ecological data base for the redbreast sunfish in New Brunswick. Snorkeling surveys were conducted during spawning to assess habitat use during spawning. Nests averaged 51.1 cm in diameter and average depth of 46.5 cm. Nest substrate was always a sandy with small gravel and 41 % of the nests observed were associated with some structure. Mark recapture sampling was carried out using fyke nets and windemere traps. The average total length and weight were 12.6 cm and 43.4 g respectively. The population estimate for 2006 was 447 individuals. The length frequency distributions were consistent over years and seasons. Overall the population of redbreast sunfish in Yoho Lake appears to be healthy and stable.

P6. CALIBRATING QUEBEC AND ONTARIO METHODS OF INDEXING THE ABUNDANCE OF LAKE TROUT (*SALVELINUS NAMAYCUSH*)

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Management agencies in the provinces of Quebec and Ontario share common problems in managing lake trout (*Salvelinus namaycush*) fisheries. Jointly, these provinces have a large responsibility in lake trout conservation because they steward approximately 2/3 of the world's lake trout lakes. Management agencies in each province have witnessed the decline of lake trout populations in human impacted areas and implemented actions to reduce stress caused by exploitation, habitat degradation and species invasions. To monitor lake trout abundance and evaluate the success of these actions, each agency has independently developed index fishing standards and invested in research to calibrate indices of abundance they supply. These calibration exercises are expensive because they require intensive mark-recapture studies to estimate lake trout population size in a sample of lakes. The cost of calibrating each standard can be reduced substantially if the two provinces collaborate and test each provincial standard on lakes where lake trout abundance has been estimated. Recently, Quebec and Ontario have combined research efforts to calibrate their index fishing methods. This poster demonstrates the progress that has been made as a result of this collaboration and calls for a closer working relationship among provincial and state agencies where lake trout exist. We believe this action would be beneficial for the conservation of this species.

P7. BULL TROUT DISTRIBUTION IN THE NORTHWEST TERRITORIES - POTENTIAL OVERLAP WITH DOLLY VARDEN?

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Bull trout (*Salvelinus confluentus*) populations have been confirmed in four watersheds from the central and southern Northwest Territories during field studies conducted since 2000. Most river-dwelling char captured in the NWT previously were incorrectly identified as Dolly Varden (*S. malma*); however, genetic and morphometric analyses have confirmed that most of the char caught south of Great Bear River are actually bull trout. Growth patterns corresponding to adfluvial, fluvial, and stream-resident life histories were observed in the NWT and individuals from these populations mature late and spawn in alternate years. Recent field surveys in 2006 confirmed the presence of bull trout approximately 160 km northwest of the previous northernmost known distribution centered at N 65° 17.892' W 129° 21.340' in the Gayna River. Further upstream, apparently isolated beyond a large set of rapids, Dolly Varden were also captured. This is the first record of sympatric Dolly Varden and bull trout populations in the NWT and provides preliminary information on geographic overlap for these two species. Further work is required to clearly delineate the distribution for both species and determine if other sympatric and/or hybrid populations exist in this area. Understanding the distribution and biology of Dolly Varden and bull trout in the NWT will be critical for appropriate management and protection as industrial development progresses

P8. PHENOTYPIC AND BEHAVIOURAL CORRELATES OF INDIVIDUAL VARIATION IN ATLANTIC COD REPRODUCTIVE SUCCESS

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Census estimates of mature individuals (Nc) may be considerably greater than the number of individuals that contribute genes during reproduction. For broadcast-spawning marine fishes, effective population size (Ne) may be 2-5 orders of magnitude lower than Nc because of unusually high variance in individual reproductive success. We tested the hypothesis that variability in reproductive success in Atlantic cod (*Gadus morhua*) is random with respect to morphology, condition, and behaviour. Allowing four groups of 52-93 cod from three Northwest Atlantic populations to breed undisturbed in a very large (684 m^3) tank, we quantified individual variation in male reproductive success, based on parentage assignment of 8913 offspring. Reproductive success was highly variable with most eggs being fertilized by a very small percentage of available males. The number of offspring sired was positively associated with male body size and aggression. Our results suggest that intrasexual competition and/or mate choice are constituents of the mating system, and that this can have a significant influence on individual fitness. Consequently, reductions in the mean and variance of body size concomitant with size-selective harvesting may have greater negative consequences for population recovery than previously thought. These findings have important implications for the conservation of marine fishes, particularly those with mating systems similar to Atlantic cod.

P9. IMPACTS OF DRAIN MAINTENANCE ON FISH AND BENTHIC INVERTEBRATE ASSEMBLAGES IN AGRICULTURAL DRAINS

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The effects of agricultural drainage on fish and benthic invertebrate communities are of increasing interest as attempts are made to mitigate anthropogenic effects on natural populations. A recent study concluded agricultural drains in southwestern Ontario are functioning as fish habitat and that there are no differences between the assemblages in drains and reference water courses of comparable size. However, this study had no time-constraints with respect to time since last maintenance action, and consequently drains sampled ranged in time post maintenance from 1 to 36 years, suggesting that fish assemblages are recovering following drain maintenance. The current study will look at the short term maintenance effects on both fish and benthic invertebrate assemblages. Drains scheduled for maintenance will be paired with reference water courses of similar size. A BACI design will be employed to quantify recovery of both assemblages in sample drains. Drains and their references will be sampled immediately following drain maintenance and at predetermined intervals up to 1 year post maintenance. Sampling will include species richness and relative abundance for fish and benthic invertebrate assemblages, as well as gross habitat characteristics. A greater understanding of recovery time will be of use to managers in determining maintenance practices.

SESSION: LAND-WATER INTERACTIONS

P10. LOGGING-INDUCED VARIATIONS IN DOC AFFECT YELLOW PERCH RECRUITMENT IN CANADIAN SHIELD LAKES

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There is an increasing interest on the effects of allochthonous carbon on lake food webs. By temporarily increasing levels of dissolved organic carbon (DOC) in lakes, logging can help us understand how carbon from the watershed could affect lake biota. The goals of this study were to determine (i) if logging has a significant effect on the abundance of young-of-the-year (YOY) yellow perch (*Perca flavescens*) in Canadian Shield lakes and (ii) if any changes in yellow perch recruitment could be related to increases in nutrients (N and P) and (or) DOC following logging. To do this, we examined 22 Canadian Shield lakes; the watersheds of 12 were not impacted while 10 underwent logging (1-78% of the watershed area). We found that the relative abundance of YOY yellow perch increased after logging in proportion to the ratio between the area of the logged watershed and the lake volume. We show that this effect is likely explained by an increase in DOC following logging. This might be related to (i) an increase in secondary productivity due to a positive effect of terrestrial carbon on the microbial loop and (or) (ii) an increased hatching success due to a greater protection from UV by DOC.

P11. TRACKING THE HISTORY OF PACIFIC SALMON POPULATIONS AND RELATED TROPHIC DYNAMICS OVER THE PAST ~5,000YRS USING MULTI-PROXY PALEOLIMNOLOGICAL TECHNIQUES

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Sockeye salmon (*Oncorhynchus nerka*) play an important role in both natural ecosystem and social-economic communities across the North Pacific. Understanding of long-term salmon population dynamics, beyond the period of commercial harvest, can help evaluate the magnitude of natural changes and identify potential driving factors for sockeye populations. With this project we are interested in looking both at external factors (i.e. climate forcing on ocean production) and internal factors (i.e. nursery lake conditions). Our main study site is Lake Nerka, Alaska, an important salmon nursery lake within the Bristol Bay region and site of recent paleolimnological investigation (Schindler *et al.*, 2005). We now have a ~5,000 yr core from this lake and will define the changes in sockeye salmon population dynamics by conducting $\delta^{15}N$. We will characterize the limnetic response to changes in salmon by conducting diatom, fossil pigment and zooplankton analyses (e.g. Finney *et al.*, 2000; Schindler *et al.*, 2005). To explore the role of external factors we will draw comparison with other salmon reconstructions, as well paleoclimatic and paleoceanographic time series. To identify the role of rearing conditions we will conduct analysis of zooplankton density and size structure.

P12. TRACKING FISH TISSUE MERCURY BURDENS: A DATA MINING APPROACH

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Tissue mercury (Hg) concentrations in many fish species, particularly those in higher trophic levels, are elevated in many lakes and rivers across Ontario, Canada. The Ontario Ministry of Environment (OME) has been collecting data on fish tissue Hg burdens in lakes and rivers across Ontario since the mid-1970s to the present. It is estimated that 165,000+ fish from 86 species and 1,600+ sites have been tested for Hg, with this equating to about 1.5 million database records across Ontario. While Hg burdens in fish have reportedly been declining since the mid-1970s, many species still often exceed Health Canada guidelines for human consumption. The OME uses their data primarily for the production of the biennial *Guide to Eating Ontario Sport Fish* and for the identification of Hg sources. We are pioneering the use of applying "Geographic Knowledge Discovery" (GKD) using "spatial data mining" techniques to the database. GKD is an emerging field of study providing powerful analysis techniques for discovering patterns in large electronic databases. Restricted previously to mostly business/commercial applications, evidence is becoming increasingly clear that these methods are relevant to investigating spatial and temporal trends in heterogeneous, long-term environmental datasets, and will be used here to uncover internal spatial / temporal patterns and associations with surrounding biogeochemistry. We present our analysis results and discuss the relevance of the trends observed to date.

P13. EFFECTS OF LAND-USE AND RIPARIAN BUFFER ZONES ON WATER QUALITY INDICATORS OF A LOTIC ECOSYSTEM WITHIN AN AGRICULTURAL WATERSHED

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There is a significant body of research documenting the negative environmental impact that industrialized agricultural production causes to surrounding aquatic ecosystems. This research has led to better control of point sources of agricultural pollution. However, non-point sources continue to degrade natural habitats and affect ecosystem processes. We are conducting a watershed-scale study within the Salmon River watershed to determine the patterns of water quality impacts along an increasing gradient of agricultural intensity and variable riparian buffer zones (a common best management practice). This approach is unique, as most research to date has focused on categories of land-use rather than gradients of intensity within a particular land-use. Furthermore, the investigation of the potential for buffer zones to mitigate the impacts of agricultural pollution is necessary as this is a strategy commonly employed by land managers. We will present the preliminary results on nutrients and algal biomass along the river transects to test our objective.

P14. THE PROCESSES OF NICKEL PARTITIONING IN THE WATER COLUMN OF A RECOVERING LAKE IN THE SUDBURY, ONTARIO REGION

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In the context of limnological and biological recovery, nickel (Ni) is still found at toxic levels in the water of lakes in the Greater Sudbury area. It is known that pH, redox potential (ORP) and organic matter (OM) concentration are three major factors that affect metal partitioning in fresh water. There has been little investigation of the processes of partitioning of nickel in the water column of Clearwater Lake – a recovering dimictic lake. Limited knowledge on Ni fate in Sudbury waters suggested that Ni occurs as free ion or labile complexes, and that the sediments act as a sink for Ni (& Cu), suggesting that removal does occur via the sediments. Furthermore, with relatively low organic carbon and free sulphide concentrations in Clearwater Lake, the actual mechanism of partitioning and removal of Ni is still unknown.
Conventional water column and hypolimnetic close interval sampling (a first in these lakes) were performed in the summer of 2005 and 2006 and produced some preliminary data to suggest that Ni behaviour is unique in that: 1) Ni is the only one of the metals studied (Fe, Cu, Mn, Al, Co) with a significant downward diffusive flux (to the sediment). 2)Ni in the hypolimnion (using the Close Interval Sampling) correlates significantly with <0.45um operationally-defined dissolved Mn, and Al (Mn_D & Al_D) and particulate Mn (Mn_P), and to a lesser extent with redox potential (ORP) and particulate iron (Fe_P), with insignificant correlation with [TOC]. 3)Log-transformed particle-water coefficients (log K_{P-W} (L/kg)) versus log-transformed particle concentrations (log Cp (kg/L) of the metals correlated with Ni(Mn, Al), showed relationships symptomatic of Brownian Pumping – a two step process: 1. Relatively fast colloid metal-complexation, followed by 2. Slower coagulation of colloids and particulate formation. Future laboratory experiments testing the effects of sulphide, organic matter availability, and other metals (e.g. Fe, Cu, Mn, Al, and Co) on particulate Ni formation will be combined with a detailed analysis and speciation modelling of conventionally-sampled water and Close Interval Sampled hypolimnion water.

P15. FOREST FIRES AND PLANKTONIC RESPIRATION IN BOREAL LAKES

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Wild fires annually decimate up to 0.4% of the total forested area in the boreal regions of Québec. Fire is a major structuring factor in the region and creates a mosaic of watersheds characterized by large variations in vegetation structure and composition. How does this watershed heterogeneity affect carbon dynamics in boreal lake ecosystems? Previous studies have shown that watershed perturbations alter the water, nutrient and carbon transport to lakes and streams. Here we first explore how the terrestrial plant succession resulting from fire influences the chemical characteristics in the adjacent lakes. We then explore if epilimnetic respiration is influenced by the shifts in organic carbon and nutrients in watersheds that are at different stages of recovery from fire. Finally, we attempt to establish the link between watershed properties, planktonic respiration and lake air-water CO_2 fluxes. Epilimnetic water samples were collected from 70 lakes in the Eastmain River region of boreal Québec. Lakes were selected to represent distinct watershed types, in terms of post-fire succession, including mature forest watersheds as well as watersheds at different successional stages. Plankton respiration was determined from changes in oxygen concentration during *in vitro* incubations. Preliminary results suggest that planktonic respiration may in part reflect watershed characteristics, and may thus potentially constitute an integrative index of the impact of wild fires on lacustrine environments. Our preliminary results contribute to a better understanding of the impact of terrestrial ecosystem disturbances on aquatic ecosystem C and nutrient cycling.

P16. TRACKING THE EFFECTS OF CLIMATE AND LAND-USE CHANGES ON WATER QUALITY OF BOREAL AND GRASSLAND LAKES IN ALBERTA

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Nutrient concentrations of Albertan lakes are among the most elevated in Canada. Both natural and anthropogenic factors may explain why these waters are so nutrient-rich, but there has been no systematic investigation to address the relative importance of these factors at a landscape level. Studies have shown that natural geology and topography are significantly related to the amount of nutrients exported from watersheds. As Alberta is composed of nutrient-rich soils and low-lying topography, we believe that lakes in this region may have a tendency to be naturally productive. Anthropogenic disturbance such as agriculture, however, can lead to further increases in nutrient exports via increased erosion of fertilizer-enriched soils. To elucidate the significance of these factors in influencing water quality, we have adopted a spatial and temporal approach. We believe that our study is particularly novel as we are interested in comparing how different lake types respond to these drivers.
Our regression analyses have demonstrated a significant relationship ($p = 0.039$, $df = 5$) between % open land and water quality for dimictic lakes, but no significant relationship was detected for polymictic lakes ($p = 0.361$, $df = 20$). Our complementary paleolimnological analyses, which examined changes in sedimentary chironomid headcapsules through time, showed that dimictic basins have undergone an increase in bottom water anoxia, while polymictic basins have undergone an increase in recent times. Our presentation will discuss how climate and land use may cause the different responses observed across lake types. These findings will better inform water-quality management decisions in this region of rapid development.

SESSION: HYDROPOWER

P17. WATER BUDGET AND WATER QUALITY COMPARISON OF NATURAL LAKES AND HYDROELECTRIC RESERVOIRS

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Hydrologic modelling of lakes provides an understanding of system functions and is essential in predicting anthropogenic or natural influences on lake ecology. Naturally occurring stable isotopes of oxygen and hydrogen have become a useful tool in hydrologic modeling. Utilizing water budget estimates and water quality parameters, we conducted a comparative study between natural lakes and hydroelectric reservoirs across Ontario's Boreal Shield region. Four reservoirs and eight natural lakes were sampled. Oxygen-18 (^{18}O) and deuterium (^{2}H) levels in lake water were compared to values in regional precipitation to estimate lake evaporation as part of the calculation of lake water budgets. Dissolved organic carbon (DOC), nutrients, and other abiotic parameters were collected to characterize water quality. Isotope sampling can be problematic in stratified waters, thus affecting the evaporation estimate. We show whether sample location within a lake affects the predicted water budget and assess whether estimated evaporation from hydroelectric reservoirs differs from that of natural lakes in the same region. This study will contribute to the understanding of environmental impacts as a result of the operation of hydroelectric reservoirs.

P18. FISH RESPONSE TO FLUCTUATING FLOW IN REGULATED RIVERS: RESEARCH METHODS, EFFECTS AND OPPORTUNITIES

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Globally, rivers are increasingly being subjected to various levels of physical alteration and river regulation to provide humans with services such as hydropower, freshwater, flood control, irrigation, and recreation. Although river regulation plays an important role in modern society, there are potential consequences which may negatively affect fish and fish habitat. While much effort has been expended examining the response of fish to fluctuating flow regimes, there has been little in the way of a comprehensive synthesis. In an effort to better understand the effects of river regulation on fish and fish habitat, we conducted a systematic review of available literature with three distinct goals. First, we summarized the various research tools, strategies, and experimental approaches used (or available) for studying the consequences of variable flows on fish and fish habitat. Second, we conducted a meta-analysis to determine if variable flows had negative effects on fish and fish habitat. Finally, we used the information derived from the analysis to identify future research priorities and provide a framework for enhancing regulated river science.

SESSION: ECOSYSTEM SCIENCE

P19. EXPLORING THE APPLICATION OF MIMS WHOLE-REACH ESTIMATES OF DENITRIFICATION: FURTHER RESTRICTIONS ON USE

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Development of a whole-reach method for measurement of denitrification, without the use of expensive isotopic tracers, has generated considerable interest among researchers attempting to quantify N loss from lotic systems. Membrane inlet mass spectrometry allows measurement of small changes in N_2 concentrations, allowing calculation of whole-reach denitrification using an N_2 mass balance corrected for gas exchange. While the method has been successfully applied within several systems, its application has so far been limited to streams with relatively high denitrification rates. Previous model-based analyses suggest that broader application is feasible, and specifically that shallow streams are well suited for the method. Within this study we revisit this model-based analysis using alternate models of gas exchange, and demonstrate that benthic turbulence-induced reaeration may further restrict the suite of suitable study streams.

P20. CLADOCERA CULTURING IN THE F.L.A.M.E.S MEDIUM: A NEW SOFT WATER MEDIUM FOR TOXICITY TESTING IN CANADIAN SHIELD WATERS

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The vast majority of daphniid bioassays are performed in hard waters, yet most Canadian lakes are soft. We developed a chemically-defined, soft water medium suitable for the culture of Canadian Shield daphniids, basing the medium's composition on the chemistry of two Dorset-area lakes with thriving and diverse daphniid assemblages. The new FLAMES medium was tested against others commonly used in toxicity testing in 21 day bioassays at 20ºC, with one hundred neonates of each of *Daphnia pulex* and *D. minnehaha.* The FLAMES medium fostered 97.83% and 94.97% survival of *D. pulex* and *D. minnehaha*, respectively, better survival than in Soft Combo (88.86% and 90.83% survival, respectively), and much better survival than in the soft water media recommended by Environment Canada, ASTM and EPA (8.33% and 6.75% survival, respectively, for the two species), which we will term the ASTM medium. Primaparity was reached on day 9 in the FLAMES and Soft Combo media by *D. pulex* and *D. minnehaha*; 2 days earlier than in the other media. *D. pulex* that survived the experiment produced an average of 32 neonates in the FLAMES medium, much higher than the 6.28 in Soft Combo and 6.10 in ASTM. In contrast, surviving *D. minnehaha* averaged 6.8 neonates in the FLAMES medium, vs. 4.9 in Soft Combo and 14 in ASTM. We are currently maintaining reproducing and long-lived populations of *Daphnia mendotae, D. pulex, D. minnehaha, D. ambigua, D. catawba, D. dubia, D. pulicaria, D. magna,* and *Bosmina freyi* in FLAMES medium.

P21. LONG-TERM TEMPORAL CHANGES IN CRAYFISH ABUNDANCES IN SOUTH-CENTRAL ONTARIO LAKES

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Ongoing monitoring of crayfish populations in 18 south-central Ontario lakes has identified significant temporal changes in crayfish relative abundances. In a related survey between 1989 and 1994, the Dorset Environmental Science Centre assessed the geographic (spatial) distribution and relative abundance of crayfish in 100 Precambrian Shield lakes. Each summer, crayfish were collected with over-night sets of baited traps. As many as 4 crayfish species were caught in any lake, although no crayfish were caught in 29% of the spatial-survey lakes. When the survey lakes were grouped by tertiary watershed, over 40% of the lakes sampled in two watersheds supported no crayfish populations. In the summers of 2005 and 2006, 60 of the original 100 lakes were re-sampled to determine whether crayfish relative abundances had changed in the spatial-survey lakes. Results of the re-sampling indicate declines in the relative abundances of many crayfish populations, as well as an overall decrease in the spatial distribution of several species. We propose that these findings are consistent with recent concerns associated with observed declines in calcium concentrations in Shield lakes, plus the potential impacts of multiple stressors such as lake-warming, diseases, predation, and the effects of introduced species.

P22. TEMPORAL CHANGES IN MERCURY BIOACCUMULATION OVER 30 YEARS IN SOUTH-CENTRAL ONTARIO LAKES

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Mercury (Hg) accounts for over 90% of the sport fish consumption restrictions in Ontario inland lakes. Since the late 1970s, fish from South-Central Ontario have been collected and analyzed for Hg by the Ontario Ministry of the Environment (OMOE). We examined fish Hg bioaccumulation in several lakes with consumption advisories. Smallmouth bass (*Micropterus dolomieui*) and lake trout (*Salvelinus namaycush*) have similar trends; significant decreases in the rate of Hg bioaccumulation between 1977 and 2004. However, this trend was not significant in all lakes. Temporal patterns in Hg bioaccumulation and biomagnification are hypothesized to be complicated by the interaction of multiple stressors or drivers. For example, decreased atmospheric Hg deposition, changes in water chemistry (e.g., pH, SO_4, DOC) and changes or shifts in lake food web structure (e.g., invasion and/or extirpation of fish or zooplankton species) may all play a role in the decreased Hg concentrations observed. Various changes and admittedly scant sport fish data for these lakes make it difficult to tease apart the drivers in these systems. Fish were collected from these lakes and other South-Central Ontario lakes in 2006 to aid in filling the data gaps and increase our ability to compare historic (1970s) and contemporary Hg data. Also, it is anticipated that ongoing research will give insights into the significance of the invasion of *Bythotrephes* (spiny water flea) on Hg bioaccumulation in these lakes.

P23. COMPARATIVE ECOSYSTEM MODELLING IN THE BAY OF QUINTE AND ONEIDA LAKE

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The Bay of Quinte (Lake Ontario) and Oneida Lake (New York) have undergone a series of ecological changes including increased phosphorus loadings leading to eutrophication, followed by phosphorus control, reduced phosphorus concentrations, increased water clarity, increased benthification and macrophyte abundance, invasion by exotic species (e.g. zebra mussels, *Dreissena polymorpha*), arrival and increased abundance of double-crested cormorants (*Phalacrocorax auritus*), and declining walleye (*Sander vitreus*). Ecosystem modelling provides a context for synthesizing data from all trophic levels to obtain an integrated ecosystem perspective. We use the Ecopath with Ecosim approach to build models for three time periods: pre- and post- phosphorus control and post-zebra mussel invasion. Comparisons are made across time periods to learn about changes to the structure and function of these two ecosystems. Ecosim scenarios were run to evaluate alternative explanations for the decline of walleye. These models suggest that the Bay of Quinte and Oneida Lake have responded similarly to productivity changes and invasion by exotic invertebrates, resulting in ecosystems that are more benthic with a combination of top-down and bottom-up explanations for the decline of walleye.

P24. ACOUSTICAL ASSESSMENT OF OFFSHORE FISHES IN HAMILTON HARBOUR, 2006

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As a Great Lakes Area of Concern, a Remedial Action Plan (RAP) was developed for Hamilton Harbour promoting an ecosystem approach. Numerous remediation projects were undertaken to improve water quality and enhance habitat. One of the goals of the RAP is to have a naturally reproducing warm water fishery while a long-term goal is to restore the cold water fishery. In 2006, DFO conducted several programs on the Harbour, including nearshore and offshore fish sampling. Offshore fishes were sampled in non-industrialized areas along 15 transects ranging in depth from 6 to 20 m. A BioSonics DTX with a 200 kHz split-beam transducer was used concurrently with a 20' ground line bottom trawl. Dissolved oxygen and temperature profiles were measured on each transect prior to sampling. A total of 3539 fishes were caught in the trawls with a mean of 44 fish per transect in the spring, 9 in the summer and 61 in the fall. Dissolved oxygen levels less than 4 mg/l were found from 5 to 14 m in the summer which may account for the low summer trawl values. A total of 13 species were caught with emerald shiner (48%), alewife (21%), round goby (17%) and white perch (7%) the most abundant of the fishes captured. The acoustical data recorded during the trawls will be analyzed and used to estimate species biomasses to parameterize an ecosystem model being developed for Hamilton Harbour.

P25. BACTERIAL C TRANSFORMATIONS AND C QUALITY IN LAKE ST PIERRE A LARGE FLUVIAL LAKE OF THE ST LAWRENCE RIVER

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Carbon dynamics of aquatic ecosystems, particularly large rivers are strongly influenced by bacterial respiration and production. The efficiency of bacterial C transformations or bacterial growth efficiency (BGE) influenced by a difference in C quality where growth is more efficient on labile substrates and less when C is more recalcitrant. Lake St-Pierre has a unique hydrology and can be separated into 3 general water masses with distinct chemical characteristics: 1) North draining the Ottawa River, 2) Central, the Great Lakes and 3) South, 3 tributaries heavily impacted by agriculture. A study carried out in 2005 demonstrated that BGE was typically higher in the South and North masses and lower in the Central. However, using a spectrofluorescence approach, we determined that the dissolved organic C (DOC) was more labile in the Central challenging the current paradigm. Regrowth experiments and an evaluation of the presence of the animo acid tryptophan using spectrofluorescence were subsequently carried out to verify this discrepancy. It is concluded that there is a greater total amount of labile C and tryptophan present in the South and North mass, but this represents a smaller proportion of the bulk DOC as compared with the Central mass. Therefore general spectrofluorescence measures must be interpreted with caution when applied to evaluate the suitability of bacterial substrates in the DOC pool.

P26. EFFECT OF FOOD ELEMENTAL COMPOSITION AND TEMPERATURE ON NUTRIENT EXCRETION IN BLUNTNOSE MINNOW (*PIMEPHALES NOTATUS*)

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Fishes actively recycle and transport nutrients within and among aquatic habitats. Subsequent to ingestion of food items by fish, nutrients such as carbon, nitrogen, and phosphorus, are excreted from the gills in a dissolved form, which are immediately available for uptake by primary producers. Theoretically, the ratios of nutrients excreted are a function of the elemental composition of an individual fish and its food. To test this relationship, the excretions of bluntnose minnow (*Pimephales notatus*) were analysed (n=30) for elemental ratios derived from four distinct feeding treatments, collectively representing a gradient of carbon, nitrogen, and phosphorus concentrations. Preliminary results indicate the mean rate of phosphorus excretion of a bluntnose minnow fed commercial fish food in water with an ambient temperature of 14°C is 1.41 μg P g^{-1} h^{-1}. Excretion rates appear to be correlated with body size, where larger fish excrete more nutrients over a given period. Additional testing will examine excretion rates along a temperature gradient. Future analysis will illustrate the relationship between body elemental composition and the ratio of nutrients excreted. The role fishes play in nutrient liberation and mobility in freshwater ecosystems may provide additional insight into the methods with which ecosystems should be managed and rehabilitated.

P27. INFERRING OF PAST FISH ABUNDANCE FROM *DAPHNIA* EPHIPPIA SIZE IN SOUTH CENTRAL ONTARIO

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Fish predation is important in structuring aquatic communities, such as zooplankton community structure and size spectra. Identifiable residuals (e.g. scales, bones) of fish assemblages preserved in lake sediments are often rare, and require a large volume of sediment for analysis. Using paleolimnological approaches to reconstruct past changes in lake environments, an indirect approach using sub-fossil zooplankton might provide a reliable indicator of past fish abundance. Lake sediments are rich in cladoceran sub-fossils of diverse origins. This research will utilize *Daphnia* ephippia as an indicator to reconstruct past fish abundances in south-central Ontario. The zooplankton community structure in these lakes is highly influenced by size-selective predation by fish. Previous research in shallow productive Danish lakes has shown that mean size of subfossil *Daphnia* ephippia decreases with increasing density of fish, expressed as catch per unit effort, CPUEn. Therefore, the available *Daphnia* ephippia preserved in sediment cores could be a useful paleo-indicator to quantify the past abundance of fish. However, it is important to know whether this methodology is also valid for deep and unproductive Canadian lakes. This study will further help provide new paleo-environmental tools to reconstruct the history of lakes.

P28. CONTROLS OF THE ELEMENTAL COMPOSITION OF BENTHIC INVERTEBRATES ALONG THE NUTRIENT GRADIENT OF A CENTRAL ONTARIO STREAM

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Ecological stoichiometry has the potential to improve our understanding of trophic interactions and nutrient cycling in freshwater streams. While a few studies have examined the elemental composition of benthic macroinvertabrates in streams, little remains known about how this intra- and interspecific variation relates to consumer food quality. In this study, we examined the elemental composition of benthic macroinvertebrates as it relates to water nutrient chemistry and elemental food quality in a river network flowing through central Ontario (Canada). We sampled study streams in the same watershed but flow through different land cover and are known to have contrasting water nutrient concentrations. We examined the elemental composition (C:N:P ratios) of 11 taxonomic groups having different feeding strategies and in different tropic levels collected from 18 distinct locations. Water samples from each site were analyzed for dissolved organic carbon (DOC), total dissolved nitrogen (TDN) and total phosphorus (TP). Preliminary results show a relatively limited C:N range of 4.8 to 6.4 for leeches (Hirudinea) and of 4.8 to 8.4 for mayflies (Ephemeroptera). The C:P ratios and the C:N ratios of remaining taxa will be measured and compared with nutrient concentrations of the water samples. The findings from this study will be used to estimate the extent of elemental homeostasis exhibited by benthic invertebrates and will contribute to the understanding of the stoichiometric relationship between consumers and their food sources in stream ecosystems.

P29. EFFECTS OF METAL CONTAMINATION AND FISH PREDATION ON THE RECOVERY OF ZOOPLANKTON IN SUDBURY LAKES

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In recent decades, lakes in the Sudbury area have shown significant improvements in water quality due to decreases in sulphur emissions from area smelters and more distant sources. However, evidence shows that biological recovery is lagging behind water quality improvements. The objective of this project is to examine the roles of two local factors, residual metal contamination and altered predation from fish communities, on zooplankton recovery in five Sudbury area lakes for which we have the longest records. Over three decades of physico-chemical and zooplankton data were collected for Joe, Laundrie, Nelson, Wavy, and Whitpine Lakes. This dataset offers a unique opportunity to examine the relative importance of large changes in habitat quality (decreases in both acidity and metal concentrations) and dramatic changes in fish communities on crustacean zooplankton communities. In this preliminary analysis we search for correlations between changes in the time series for zooplankton biomass, body length, and species composition and changes in pH, metals, and fish.

P30. FACTORS AFFECTING MERCURY CONCENTRATIONS IN FISH FROM ACIDIFIED FOOD WEBS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA

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Mercury (Hg) contamination of the environment has been an issue since the 1950's; however, acid rain and Hg emission reductions have not always been successful in reducing the concentrations of this pollutant in freshwater organisms. Although fish from acidified lakes are known to contain high mercury concentrations, it is not known whether ecosystem processes such as food web length or atypically high biomagnification contribute to these high concentrations. This study has two main objectives: 1) to characterize the food webs of four acidic (pH of 4.4 to 5.3) lakes in Kejimkujik National Park, Nova Scotia to assess whether trophic structure and the biomagnification of mercury is enhanced in acidic systems supporting yellow perch as compared to circumneutral ones; 2) to revisit lakes sampled in the mid-1990s to determine whether mercury concentrations in yellow perch have decreased over the past decade. Littoral, pelagic, and profundal invertebrates and yellow perch, golden shiner, banded killifish, and brown bullhead were captured in 2006 from each of the four food web lakes. Yellow perch and golden shiner were also caught in 6 additional lakes for the temporal comparisons. Stable carbon and nitrogen isotope concentrations are being measured in these biota to determine their food sources and relative trophic positions, respectively, and to assess whether food webs in these lakes are longer than those of circumneutral systems. Total Hg concentrations of yellow perch in the ten lakes are being measured and contrasted against the mid-1990 concentrations. Results from the above-mentioned analyses will be presented and discussed.

SESSION: WETLANDS

P31. ENVIRONMENTAL VARIATION AND PREDATOR-PREY INTERACTIONS: BENEFICIARIES OF A CHANGING AQUATIC ENVIRONMENT

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Aquatic ecosystems within Delta Marsh, Manitoba are highly variable throughout the summer months. Temperatures reach above 29°C and dissolved oxygen (DO) levels fall below 1 mg/L. This variability, along with changes in turbidity can affect not only species composition within the marsh, but also the interactions between large piscivorous fish and their piscine prey. The activity of both piscivorous fishes and their prey was monitored in Delta Marsh from May to August of 2006. YSI data sondes recorded temperature, dissolved oxygen and turbidity for the duration of the study. As the success of avian predation is also likely related to the abovementioned environmental factors, the activity of avian piscivores was also monitored. Preliminary results indicate that temperature and hypoxia sensitive species such as the northern pike reduce their activity in response to increased temperature and decreased DO levels. However, other piscivores such as the freshwater drum and bullhead species remained in the marsh; the number of small drum present increased as the summer progressed. Fathead minnows, the dominant prey species in the marsh and a temperature and hypoxia tolerant species, decreased in number as the temperature and DO level increased and decreased respectively, suggesting that while suitable habitat remains, predation pressure may increase with increasing temperatures. It is expected that the risk of avian predation will increase with increasing temperature and decreasing DO, however it is also expected that this relationship will be affected by the change in fathead minnow population.

P32. SHELTER USE IN THE NORTHERN REDBELLY DACE, *PHOXINUS EOS*: EFFECT OF PREDATION RISK AND FISH ASSEMBLAGE?

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It is well known that prey use structurally complex habitats as shelter to reduce predation risk. Northern redbelly dace (NRD) perform diel onshore-offshore migrations between the littoral and pelagic zones of small lakes and use preferentially vegetated areas of the littoral zone during the day. It is suggested that NRD use this behaviour to reduce predation risk by brook trout, Salvelinus fontinalis. However, no studies have measured the predation risk by brook trout on NRD in situ. The objective of this study was to determine the effects of predation risk on NRD behaviour at the lake level (pelagic vs. littoral zones), and within the littoral zone (open vs. vegetated areas). We predicted that NRD will be more abundant in (i) the littoral zone and (ii) vegetated areas, in lakes with higher predation risk. Minnow traps were set in both vegetated and open habitats of the littoral zone in 14 lakes, and predation risk of NRD was estimated through tethering experiments. We found that the abundance of NRD in the littoral zone increased with predation risk, and that the proportion of NRD captured in the vegetated habitats (i) decreased with an increase of predation risk and (ii) was higher in richer fish assemblages (lakes with vs. without creek chub, Semotilus atromaculatus, and white sucker, Catostomus commersoni). Our results suggest that the littoral zone is used as a refuge by NRD to counter predation by brook trout but do not allow to conclude that vegetated habitats are associated with shelter within the littoral zone.

P33. DENSITY-DEPENDENT HABITAT SELECTION IN MARINE FLATFISH: THE DYNAMIC ROLE OF ONTOGENY AND TEMPERATURE

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Changes in habitat use with increasing conspecific density are well-documented, but such patterns are likely dynamic over the lifespan of the organism and responsive to changes in the environment. In the laboratory, we examined how habitat selection was mediated by ontogeny (6, 8, 12-mo) and temperature (4°C, 9°C) in two juvenile, marine flatfish species— Pacific halibut (*Hippoglossus stenolepis*) and northern rock sole (*Lepidopsetta polyxystra*). At 9°C, groups of same-aged juvenile flatfish (6, 8 or 12-mo) of either halibut or rock sole were given the choice of two habitats, fine sand (preferred) and coarse gravel (unpreferred), at one of six densities (0.4-12.2 fish m^{-2}). A second set of trials was conducted at a colder temperature (4°C) using 8-mo juvenile fish of both species over the same range of densities. At 9°C, density-dependent habitat selection was observed among all treatment groups. As juveniles increased in age in the 9°C treatments, both species began occupying the less-preferred gravel at lower densities. However, density-dependent habitat selection varied between species at cold temperatures. Sand habitat supported higher densities of juvenile Pacific halibut at colder temperatures whereas no change was observed in northern rock sole. Juvenile Pacific halibut activity was also lower than rock sole at cold temperatures, suggesting that the physiological demands of halibut are sufficiently reduced at these temperatures to increase the carrying capacity of their preferred habitat. Together, these results indicate that interactions between temperature, ontogeny and density yield unique habitat selection patterns in fish, mechanisms that may be important in area-abundance relationships.

P34. EFFECTS OF SEDIMENTS FROM POTATO AGRICULTURE ON FISH POPULATIONS AND COMMUNITY STRUCTURE

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Agriculture land-use has an impact on the amount of suspended sediments input into adjacent streams. The severity of effects on fish has been modeled for southern USA streams based on duration and intensity of the sediment event, i.e., suspended sediment where effect is scored from no impact to mortality of fishes. We are testing this severity of effects (SEV) impact assessment model in northern New Brunswick, Canada's third largest potato production region. A preliminary field season of electrofishing in August 2006 sampled seventeen streams of similar watershed size across a gradient of increasing potato production. We compared fish population parameters and communities and found lower abundance in streams within the most intense potato production. Continuing research will establish the link between SEV, suspended sediment loading from increased pressure of agriculture and the impacts on fish in Canadian waters.

SESSION: ST-LAWRENCE

P35. CONSEQUENCES OF THE HYPOXIA PHENOMENA ON MACROBENTHIC BIODIVERSITY AND ON BIOTURBATION RATES IN THE ESTUARY AND GULF OF ST. LAWRENCE

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Studies have shown that the oxygen concentration in the deep water of the Lower St. Lawrence estuary (LSLE), Quebec, Canada, is getting constantly lower since the 1930's. The head of the Laurentian Channel is hypoxic and has a concentration of dissolved oxygen lower than 65 μmol L^{-1}. It as been shown that hypoxia has the effect of decreasing biomass, abundance and benthic biodiversity. Eutrophication is a potential cause to this phenomenon in the LSLE. These changes can be important for benthic organisms and for the bioturbation of the sediment. The main objective of this project is to study the influence of the hypoxia phenomenon on the epibenthic megafauna communities and on changes in bioturbation rates. Pictures have been taken at 15 stations in the Gulf of St. Lawrence and estuary in August and September 2006. The pictures were taken using a "Benthos" underwater camera system. Primary analyses suggest the predominance of two species of the phylum Cnidaria, *Pennatula aculeata* and *Pennatula borealis* (filter feeders), and two species of the phylum Echinodermata, *Ophiura sarsi* (deposit feeder) and *Amphiura filiformis* (mud-dweller). Similarity indices and multivariate analyses will be used to determine the potential link between community structure, concentration of dissolved oxygen and bioturbation rates.

P36. AN ASSESSMENT OF STOCKING CONTRIBUTION OF RAINBOW SMELT LARVAE IN THE ST. LAWRENCE MIDDLE ESTUARY AND IN LAKE ST-JEAN

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Rainbow smelt (*Osmerus mordax*) is an important forage fish in many aquatic ecosystems but recent population declines have been observed recently in the St. Lawrence middle Estuary (STL) and in Lake St-Jean (LSJ). In order to re-establish stocks of smelt in both ecosystems, incubators were established in de l'Église brook (STL) and Metabetchouan River (LSJ), producing respectively 20 and 12 millions of yolk-sac larvae annually. To evaluate the contribution of the stocked larvae to the wild populations, all embryos were marked with alizarin red S in 2005 and 2006 at a concentration of 150 mg L^{-1} for a period of 24h. The marking success was 100% in both ecosystems and there was no significant difference in the survival between marked and unmarked larvae, with a hatching rate of 93%. In the STL, our results showed that stocked larvae represented less than 5% of the individuals caught during the drift, indicating that the production of wild larvae was important. In LSJ, our results showed that the captured larvae during the drift came exclusively from the incubators in the southern part of the lake. Larvae produced by the incubators were not detectable one month after hatching in the STL and in LSJ. We conclude that the actual level of production of yolk-sac larvae by the incubators do not contribute significantly to the restoration of rainbow smelt populations in the STL and in LSJ.

P37. MERCURY ACCUMULATION, METHYLATION AND DEMETHYLATION BY EPIPHYTES : WHAT IS GOING ON?

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In aquatic environments, one critical gap in our understanding of mercury (Hg) fate is that we still are uncertain about which organisms methylate and transfer Hg to the food chain. Our objective is to verify the importance of epiphytic biofilms growing on aquatic plants in Hg accumulation and net methylmercury production. Epiphytic biofilms were sampled in Lake St.Pierre (Qc, Canada) from May to September in order to: 1) determine total mercury (THg) and methylmercury (MeHg) accumulation; 2) measure epiphytes methylation/demethylation rates (Me/Deme). 3) determine which groups of microorganisms contribute to mercury Me/Deme processes. [THg] were analysed with a DMA-80 and [MeHg] by CVFAS. Me/Deme were measured by *in situ* incubation of epiphytic biofilms and macrophytes with stable isotope ^{199}Hg and $Me^{200}Hg$. Our main findings were: 1) High [THg] and [MeHg] in epiphytes were found, ranging from 30 to 207 ng/gDW and from 0,5 to 22 ng/gDW, respectively. 2) Higher [MeHg] were found in summer (June to August) and decreased in fall. 3) Demethylation rates were driving MeHg net production, which vary from -0,71 to 3,72 ng/g DWepiphytes/day. 4) SRB are not the principal Hg methylators in our biofilms .

P38. CARACTERISATION OF BENTHIC MEGAFAUNA INVERTEBRATE POPULATION ASSOCIATED TO ENVIRONMENTAL CONDITIONS AND DEMERSAL FISH ASSEMBLAGE IN THE GULF OF ST-LAWRENCE.

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The Gulf of St-Lawrence (GSL) is a broad dynamical ecosystem with oceanographical and estuarie's properties. The variability of morphological and hydrographical conditions of this part of St.Lawrence proposed a diversified habitat for its fauna. The commercial species are well monitored fifteen years, but the epibenthic invertebrate population of GSL are poorly known. Annually the groudfish population of the GSL is evaluated by trawl survey. During the mission of summer 2006, the sampling of invertebrates occuring along the seabed have been carried out through 220 stations. With this survey, it will be possible to characterise the composition and the distribution of the mega-epibentic invertebrates, in relation with environmental variables such as salinity, depht, oxygen, temperature and chlorophyll a concentration. Relationship with demersal fish assemblage will also be examined. The distribution of epibenthic megafauna will be illustraded by using geographical infomatic system (GIS). Moreover, multivariate analysis will be used to analyse the biodiversity and the association of benthic invertebrates as well as to determine the major factors influencing their distribution. Correlation measured between environmental parameters, demersal fish assemblage and the epibenthic organisms observed during this study will help to develop somes indicators, that could have had some effects on the spatial and/or temporal population of epibenthic megafauna. Furthermore, these indicators could be used to some extent to reconstruct the past picture of the epibenthic megafauna and link them to major changes that happen in the Estuary and Gulf of St. Lawrence, such as the decrease of oxygen observed at the head of the Laurentian Channel.

P39. ROLE OF GAS EVASION FROM CONTAMINATED SEDIMENTS AS A MECHANISM OF MERCURY TRANSFER TO AQUATIC BIOTA

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The St. Lawrence River near Cornwall, ON has been designated an Area of Concern (AOC) due to the past deposition of mercury (Hg) from several industries for nearly a century. Hg contamination of important sport-fish such as the walleye (*Sander vitreus vitreus*) continue to remain above the health limits designated safe for consumption by Health Canada. Recent studies have demonstrated paradoxically high concentrations of Hg in yellow perch (*Perca flavescens*) from one contaminated zone, in contrast to background concentrations in the same species at a second zone where sediment Hg is highest. One explanation may be enhanced gas evolution from contaminated sediments combined with elevated concentrations of methylmercury (MeHg) in porewater at this site. Mechanical mixing of the sediment and porewater as a result of gas production and release may increase the bioavailability of MeHg to biota. *In situ* exposure experiments with caged invertebrates and fish were carried out in proximity to these areas of gas formation. Preliminary results from one method of collecting native invertebrate species show significant differences in Hg concentrations in invertebrates between high bubbling in the contaminated site versus low bubbling in the non-contaminated site.

P40. MERCURY BIOACCUMULATION IN AQUATIC FOOD WEBS: CASE STUDY - CORNWALL, ON

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After decades of exposure to industrial pollutants, sediments along depositional zones in the St. Lawrence River at Cornwall, Ontario are highly contaminated with mercury (Hg). The popular sport-fish species, walleye (*Sander vitreus*) and yellow perch (*Perca flavescens*), are significantly more contaminated on the Cornwall waterfront relative to other St. Lawrence River sites. Hg concentrations in walleye along the Cornwall waterfront and Lake St. Francis (downstream from Cornwall) between 1998 and 2000 have exceeded the Ministry of Environment guideline of 0.45 μg/g wet weight. As a result of Hg contamination in walleye and yellow perch, anglers in this region who consume sport-fish from Cornwall will have elevated Hg in their blood, which may place them at risk. Preliminary evidence indicates that prey selection, but not food chain length, may be an important factor in explaining variation in Hg burdens in yellow perch. There is also an indication that amphipods may be an important conduit of Hg to sport-fish. Presently, research is being conducted to investigate the role of amphipods and other aquatic invertebrates in the biomagnification of Hg in the food web. In addition to THg and MeHg analyses, trophic level assignment through the use of stable nitrogen and carbon isotope analysis will also be performed.

SESSION: AQUATIC INVASIVES

P41. AQUATIC INVASIVE SPECIES MONITORING IN GREAT LAKES' AREAS OF CONCERN

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Early detection of aquatic invasive species (AIS) and rapid response have been identified as critical components in the line of defense against AIS. Results from the first year of a Fisheries and Oceans Canada (DFO) monitoring project in the Great Lakes will be presented from two Areas of Concern (AOC), Hamilton Harbour and the St. Marys River. Monitoring programs in these two areas were designed to determine if additional fishing gears were required to detect AIS alongside a DFO electrofishing monitoring and research program. In 2006, AOC boat electrofishing was supplemented with gill and trap nets, minnow traps, and beach seines for both Hamilton Harbour and St. Marys River, with the addition of hoop net sampling in Hamilton Harbour. Supplemental sampling gears collected 10 additional species in Hamilton Harbour and two in the St. Marys River. The capture of a bigmouth buffalo (*Ictiobus cyprinellus*) and a rudd (*Scardinius erythrophthalmus*) were the first records for these species in Hamilton Harbour. The rudd is an invasive species and the bigmouth buffalo is designated as a Species at Risk of "special concern". After correction for effort, sampling gears performed differently in the AOCs. In Hamilton Harbour, species richness was highest from trap net (27), boat electrofishing (25), and hoop net (24) samples. In the St. Marys River, species richness in electrofishing samples (38) far exceeded other gear types. Cumulative species catch curves were used to evaluate the gear types for AIS monitoring. Results will be applied to other AOCs in the Great Lakes.

P42. A 300 LAKE BYTHOTREPHES SURVEY: OBJECTIVES, METHODOLOGIES AND NEW INVASION RECORDS

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During the summers of 2005 and 2006, 311 lakes were surveyed for *Bythotrephes* in watershed 2EB located in the Muskoka District of Ontario. The watershed contains ~1600 lakes >1ha, 23 known to be invaded by *Bythotrephes* as of 2004. The plethora of lakes and the number of recorded invasions created an ideal study area to examine the pathways and regulators of *Bythotrephes* spread. The objectives of the survey were: a) to quantify the actual current distribution of *Bythotrephes* in the watershed; b) to determine whether the distribution of *Bythotrephes* could be predicted by human-mediated vectors alone, and c) to determine whether chemical, physical, morphometric or ecological conditions regulate propagule introduction rates and establishment success. Lakes were selected by size and spatial distribution in 2005 (N = 87; 46 re-sampled in 2006). In 2006, lakes were randomly selected along three gradients which might influence the probability of invasion: a) hydrological connectivity to an invaded lake (N=101), b) an analogue of human propagule pressure (N = 93), and c) lake size (N=76). To detect *Bythotrephes*, duplicate hauls were taken at 5 stations along the fetch of each lake using a 63µm tow net. A 6th, single, horizontal haul was also taken at windward end of the lake. Physical (Secchi depth, temperature and O_2 profiles) and chemical (pH, alkalinity, DOC, colour, silica, Ca, TP, Mg, Na, K) parameters were assessed for each lake. During the survey 20 new invasions were detected, increasing the number of known invaded lakes in watershed 2EB to 43.

P43. THE INTEGRATION OF GEOGRAPHIC INFORMATION SYSTEMS IN LARGE-SCALE SURVEY FOR INVASIVE SPECIES; BYTHOTREPHES

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There are inherent challenges with designing and implementing large-scale surveys across wide spatial distributions such as watersheds due partially to the availability of reliable, accurate, and up to date datasets. During the summer of 2006, the Canadian Aquatic Invasive Species Network (CAISN) set out to conduct a lake survey of watershed 2EB, located in the Muskoka District of Ontario, for the presence of *Bythotrephes*. When working with approximately 1600 lakes, Geographical Information Systems (GIS) allow for multiple variables to be assessed simultaneously. The challenge of the project was the translation of theoretical methods for random lake selection of 300 lakes into a usable GIS. A human propagule pressure analogue, hydrologic connectivity to an invaded lake, and lakes size were examined in order to interrelate each variable to form a model on the presence of *Bythotrephes*. A GIS was developed in order to manipulate geospatial data and allow for the selection of lakes that fulfilled each of the project criteria for site selection. Lakes were identified and selected for random sampling based on the project criteria, utilizing available geospatial data, as well as creating, correcting, and collecting new spatial data. The GIS now serves as a tool for displaying collected data spatially. Future work is needed to process samples collected in 2006 and further develop the GIS into an interactive model for visualization of data and prediction of further *Bythotrephes* invasion.

P44. BAITFISH AS AN INVASION PATHWAY: A CASE STUDY OF THE LAKE OF THE WOODS WINTER FISHERY

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The use of live bait for angling has resulted in the transfer of baitfish outside of their natural range. We examined the potential for aquatic invasive species (AIS) to enter Lake of the Woods through the baitfish trade. Lake of the Woods (3850 km^2) lies at the intersection of the Ontario, Manitoba and Minnesota borders, has an extensive watershed and a sizeable recreational fishery. Our surveys of baitfish suppliers and anglers occurred during the winter of 2006 and included both a questionnaire and examination of baitfish species. A small fraction (20%) of baitfish dealers surveyed (n=15) claimed they had “Good” or “Excellent” awareness of invasive fish species in the area. No AIS were identified in our examination of dealer holding tanks (n=924 fish). Our survey of anglers (n=480 fishing parties) showed that most (98%) used live bait and few (8%) dumped their remaining live bait into the lake upon completion of fishing. Angler knowledge of AIS in the area was similar to that of dealers. Most bait used by anglers was purchased locally (within 10 km), with the maximum transportation distance being 174 km. Some fishing parties (<3%) had illegally brought live bait into Ontario from Manitoba and the United States. No AIS were present in our examination of angler bait buckets (n>3000 fish). The habits of winter anglers differ markedly from past studies of summer baitfish use and are discussed in relation to the potential risk for AIS introductions into Lake of the Woods.

SESSION: CLIMATE CHANGE

P45. FIRE-CLIMATE RELATIONSHIPS ON THE FOREST-PRAIRIE ECOTONE IN ALBERTA, CANADA

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High-resolution climatic reconstructions, based on diatom analyses from lake sediment cores from the Canadian prairies, show that shifts in drought conditions on multi-decadal to millennial scales have prevailed in this region for at least the past six millennia. However, the relationships between these drought shifts and fire frequency and intensity remain unknown. Similarly, the vegetative response to these climatic shifts and fire regimes are not well understood. In order to determine these relationships, a paleolimnological approach will be used to analyze both pollen and charcoal remains in a sedimentary core taken from Chauvin Lake (Alberta, Canada) in the summer of 2003. Along with using total charcoal analysis, charcoal morphological classification will be used to provide insights on the fire regimes on the forest-prairie ecotone over the past six millennia. Pollen remains will also be enumerated according to species in order to track changes in vegetation over time. The relationship between drought, vegetation and fire on the forest-prairie ecotone has large implications in the field of environmental management, as the detection of cyclical patterns in drought may help predict future fire events in this area.

P46. TEMPERATURE EFFECTS ON ZOOPLANKTON DISTRIBUTION WITH POTENTIAL CONSEQUENCES FOR SPECIES INTERACTIONS

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The potential effects of climate change on species interactions have not been investigated. We performed a comparison of the mid-summer (July and August) vertical distribution of zooplankton and chlorophyll *a* concentrations between six warm years and six cool years in Swan Lake near Sudbury, ON. Generally, in cool years, air and water surface temperatures were low and the lake was stratified with a cool hypolimnion. In warm years, air and water surface temperatures were higher and stratification was weak with no coldwater habitat. Aquatic biota may be directly affected by temperature, or experience indirect effects through altered trophic interactions. Direct temperature effects should produce small-bodied zooplankton with low richness and abundance in warm years, and larger bodied zooplankton species with high richness and abundance in cool years. However, if trophic interactions drive zooplankton dynamics we arrive at different predictions. A downwards shift in zooplankton depth distribution to avoid surface-dwelling macroinvertebrate predators may result in higher species richness and abundance in warm years. In contrast, zooplankton will be restricted to epilimnetic regions in cool years when the lake is stratified and both food resources and predators are concentrated near the surface. Therefore, predatory trophic interactions in cool years may result in lower species richness and abundance. This research will help understand the relative contribution of both direct and indirect temperature effects on zooplankton community composition in small boreal lakes.

P47. A HOLCENE-LEVEL FOSSIL DIATOM RECORD OF CLIMATE CHANGE AND ARIDITY AT THE EXPERIMENTAL LAKES AREA: NORTHWESTERN ONTARIO

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Boreal freshwater ecosystems are one of the most abundant freshwater environments found on Earth, but are also the least studied. Knowledge of past cycles of aridity and drought in these areas will provide information necessary to predict future changes, as well as providing a foundation to understand the potential impacts of human-induced stressors on these cycles. Using a 13-m sediment core, collected from Lake 239 ELA (Experimental Lakes Area) in the summer of 2004, diatom assemblages were enumerated to better understand diatom community changes throughout the Holocene. Results indicate the lake is climate sensitive, with changes to more benthic diatom forms during pollen-inferred arid periods such as the mid Holocene. Certain species (*Aulacoseira subarctica*) also indicate periods of greater wind-driven turbidity. Results thus far indicate millennial to centennial scale variations between wet and dry periods throughout the Holocene. The direct importance of this research includes: 1) the extension of diatom paleoclimate data into the early Holocene for ELA; 2) a better understanding of millennial to centennial scale climate fluctuations and the occurrence of arid periods in NW Ontario; and 3) predictions of how global warming and climate change will affect the area based, in part, on understanding of past fluctuations.

P48. A DYNAMIC OPTIMIZATION MODEL TO EVALUATE THE DEPTH, GROWTH, AND SURVIVAL OF LAKE TROUT (*Salvelinus namaycush*) OVER CHANGING THERMAL CONDITIONS

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I employ a state-dependent individual-based population model that is predicated on the assumption that lake trout will seek depths based on both food and temperature niche axes in order to maximize net energy gain (i.e., growth) by fall spawning, which is assumed to maximize fitness. Growth and fitness are closely linked to the water temperatures that fish occupy; therefore, the model is confronted with daily thermal-depth profiles recorded in a small Precambrian shield lake (Lake 373 at the Experimental Lakes Area, northwestern Ontario) during two years of contrasting thermal stratification patterns. The model is also confronted with thermal profiles projected over a series of climate change scenarios (i.e., increases of 2, 4, and 9°C). These scenarios were projected from observed weather ('warm' and 'cool') and stratification patterns ('long' and 'short') during two climatically extreme base years. The in situ depths of acoustically-tagged fish were also recorded concurrently with lake thermal-depth profiles, and comparison of fish behaviour to model output provided a qualitative assessment of model performance. The depths and temperatures occupied by tagged fish closely resembled the depths and temperatures of simulated fish, indicating that the model may incorporate the underlying mechanisms behind individual, seasonal, and annual patterns in lake trout behavior. Annual differences in model runs showed reduced growth and fitness during climatically warm conditions, and results of climate change scenarios suggested persistent increases in temperature and longer stratification patterns could challenge the fitness of many lake trout populations.

P49. LONG-TERM PATTERNS IN HYPOLIMNETIC OXYGEN IN SOUTHERN CANADIAN SHIELD LAKES

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Few long-term monitoring programs exist that include measurement of oxygen profiles. Compared to other limnological variables, long-term dynamics and variability of hypolimnetic oxygen concentrations are not well known. Long-term records (1976-2005) of volume-weighted hypolimnetic oxygen (VWHO) in 25 south-central Ontario shield lakes were analyzed for trends and temporal coherence amongst lakes. Temporal coherence patterns in VWHO were identified using Brien's test for equal correlations. Results indicate that the study lakes, with varying limnological characteristics, such as mean depth, trophic status (TP), DOC, lake surface area, show remarkably coherent trends, which consist of two major patterns: Group 1) a group of small, shallow lakes with anoxic hypolimnia display a pattern where they synchronously experience intermittent years with relatively high VWHO levels; Group 2) the remainder of the lakes show moderately synchronous patterns of high year-to-year variability in VWHO. There was little or no long-term increase in VWHO in response to observed long-term declines in lake TP. Individual time series in both Group 1 and Group 2 lakes showed strong correlations with climate parameters, such as date (DOY) of ice-off, number of ice-free days, or Southern Oscillation Index values; however there were no consistent patterns amongst lakes. Coherence analyses also identified 1990 as a year of anomalously low VWHO in nearly all Group 2 lakes. These results suggest that regional-scale parameters, such as climate (temperature, rate of temperature change, ice cover dynamics), and not local-scale parameters such as lake TP, more strongly influence long-term dynamics of VWHO in small shield lakes.

SESSION: CYANOBACTERIA

P50. WATER-SEDIMENT BOUNDARY IMPLICATION IN N_2-FIXING CYANOBACTERIAL BLOOMS, BROME LAKE (QC) EXAMPLE

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Cyanobacterial blooms, identified in lacustrine ecosystems in most regions of the world, seem to have increased in the last 20 years in Eastern Canadian lakes. By developing into blooms and producing toxins, these algae have negative consequences on ecosystems and can adversely affect public health as well as recreational activities. However, little is know about the mechanisms controlling the massive proliferation of this toxic algae. The objective of this research is to study the past 30 years of sedimentary algal record to trace their abundance in relation to nutrient concentrations measured in the water column. The approach to trace the cyanobacteria record will be the analysis of: 1) specific fossil pigments; and 2) algal records, particularly for the N_2 fixing cyanobacteria. Many toxic cyanobacteria have the capacity to develop into resistant forms (ex. akinetes) which can persist in the water-sediment interface and in sediments. The importance of the benthic zone as a seed bank for the toxic cyanobacteria will also be investigated. We will develop this project in the lake Brome using physico-chemical data collected by GRIL teams during the past 30 years.

P51. PHOTOSYNTHETIC ACTIVITY AND TOXIN PRODUCTION OF A TOXIC AND NON-TOXIC STRAINS OF CYANOBACTERIA EXPOSED TO LIGHT STRESS

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Blooms of cyanobacteria are a major problem in eutrophic aquatic ecosystems. One of the cyanobacteria responsible for these bloom events is *Microcystis aeruginosa*. Their occurrences are frequently, but not always, accompanied by the presence of toxin in water but the factors controlling cyanobacterial population dynamic and microcystin production at the cellular level are not well understood. In this study we assessed the effect of different light treatments on the photosynthetic activity and toxicity of 2 strains of *Microcystis aeruginosa* (UTCC 299 and UTCC 632) by comparing the results obtain by Pulse-Amplitude-Modulated (PAM) fluorometry and phosphatase inhibition assay.
We have determined the effect of short term exposure (30 to 120 minutes) to 1000 $\mu E\ m^{-2}\ s^{-1}$ on low light (20 $\mu E\ m^{-2}\ s^{-1}$), medium light (50 $\mu E\ m^{-2}\ s^{-1}$) and high light (150 $\mu E\ m^{-2}\ s^{-1}$) acclimated cells. We have also studied the effect of successive low light-high light cycles over a period of 7 days. These two sets of experiments showed that the toxic strain of *M. aeruginosa* is more resistant to fluctuation in light intensity when comparing the PSII operational quantum yield, energy dissipation pathways and P/E curves. These differences in energy dissipation processes may be involved in the regulation of toxin production by these cyanobacterial strains. This study provides additional information on the role of light in *M. aeruginosa* population dynamic and toxin production.

P52. TOXICITY AND ABUNDANCE OF MICROCYSTIS IN THE BAY OF QUINTE, LAKE ONTARIO

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Microcystin producing cyanobacterial blooms occur in freshwater ecosystems around the world; however, bloom toxicity is difficult to predict based on taxonomy alone. This is due to the genetic and environmental modulation of toxin production. Environmental factors include irradiance, temperature, and nutrient availability. One area where toxin producing cyanobacterial blooms (containing Microcystis sp.) occur annually is the Bay of Quinte, Lake Ontario. The nutrient and biomass gradients in the Bay of Quinte make this an ideal study site to investigate the complex factors affecting cyanobacterial blooms and toxin production.

In biweekly surveys of 4 stations, we tested the hypothesis that the concentration of microcystins (MC) varies with Microcystis sp. biomass, temperature and PAR. The concentration of MC was measured as MC-LR equivalents for surface and composite samples using ELISA test kits (Envirologix). Both particulate (p) and total (t) MC concentrations were determined. Increasing MC concentrations were observed for all four sample types through August and September at all sites. MC concentrations then declined through October. MC and chlorophyll a concentrations were generally highest at the mid-bay sites, Hay Bay and Napanee, but preliminary data show no consistent relationship between MC concentrations and chlorophyll a, temperature or transparency. The calculation of toxin concentrations relative to Microcystis abundance will be used to reveal the presence or absence of environmental modulation of toxin production in the Bay of Quinte, testing our above hypothesis.

P53. EFFET DE L'EXTRAIT D'ORGE SUR LA CROISSANCE DES CYANOBACTÉRIES

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Certaines études font part d'un effet inhibiteur de la paille d'orge sur les cyanobactéries, dont la prolifération devient de plus en plus problématique au Québec. Une série d'expériences ont été menées afin de déterminer si des extraits d'orge en décomposition avaient effectivement un effet inhibiteur sur la prolifération d'une souche de cyanobactéries toxiques, *Anabaena flos-aquae*, et, si tel était le cas, d'identifier l'origine de l'effet. La première expérience a montré que les extraits de l'orge, faits maison ou achetés commercialement, n'avaient pas d'effet dans un incubateur de cultures sous les conditions de croissance normales. Des expériences subséquentes ont démontré que la lumière jouait un rôle crucial pour la manifestation de l'effet inhibiteur de l'extrait d'orge : à faible intensité lumineuse, aucun effet n'est décelé, alors qu'à forte intensité lumineuse, l'effet inhibiteur de l'extrait d'orge apparaît clairement. L'extrait d'orge pouvait inhiber fortement la souche d'*Anabaena*, mais à condition que l'intensité lumineuse soit égale ou supérieure à 50% du plein soleil. L'effet n'est pas dû à la photoproduction de radicaux libres car il n'y a pas plus de production de radicaux libres ($OH^{\bullet}$) en présence d'extrait d'orge qu'en son absence. Finalement, une expérience permettant de démontrer si le peroxyde d'hydrogène était en plus grande concentration en présence d'extrait d'orge a été menée, afin de déterminer si ce produit était à l'origine de l'effet inhibiteur. La concentration en peroxyde n'étant apparemment pas plus importante en présence ou en absence d'extrait d'orge, celui-ci n'est pas à l'origine de l'effet inhibiteur observé.

P54. CHARACTERIZATION OF PERIPHYTIC ALGAE FROM THE MACHETA AND PAIPA THERMAL SPRINGS OF COLOMBIA

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Live and preserved samples of periphytic mats, from natural and artificial substrates, muds and water of thermal springs from Paipa (Pozo Azul – La Playa region, Boyaca department), and Machetá (Los Volcanes region, Cundinamarca department), were examined to characterize the taxonomy and ecological habit of the constituant algae. Some of the mats were cultivated on solid Bristol and Complex Thermomineral media, in order to isolate specimens for taxonomical characterization. Forty-five different species of algae were found in these springs, of which 40 belong to the Cyanobacteria. The prevailing genera were *Phormidium*, *Oscillatoria*, *Synechococcus* and *Chroococcus*, among others. Twenty-seven of them were exclusive to the thermal environment. Moreover, it was possible to determine that some of these species are bound to particular conditions of temperature, pH and salt content within each studied thermal environment (especially within Paipa), while others can have wide ranges of tolerance against variations of mineral ion concentration and composition (especially within Machetá). Growth habits or forms of growth in the thermal springs and in cultivation media were related to the cellular forms (filamentous, unicellular, etc.) as well as to possible associations among some species. It was found that some ethanolic and hydrolytic extracts of mats and muds from the thermal springs possess antibiotic effects against bacteria (*Staphylococcus aureus*) and yeast (*Candida albicans*). These threatened habitats may possess untapped bioresources.

P55. IRON REGULATION OF BLOOM FORMING CYANOBACTERIA ABUNDANCE

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High nutrient loadings are important risk factors for the formation of cyanobacterial blooms in eutrophic systems. Despite considerable research, the mechanism that accounts for the displacement of eukaryotic algae by large cyanobacteria at high nutrient loading is unclear. Cyanobacteria have higher Fe requirements than eukaryotic algae, hence, cyanobacteria may be Fe-limited in oligotrophic systems while eukaryotic algae are P-limited. We hypothesized that reducing the biological availability of Fe in eutrophic systems will reduce the absolute and relative abundance of cyanobacteria. We tested this hypothesis in eutrophic Lake 227 (ELA) which is fertilized weekly with P. Oxine (a strong Fe chelator) was added twice weekly to three enclosures for 2 weeks beginning mid May in 2006 and then variably for 4 weeks. Oxine significantly reduced the biomass and the relative abundance of cyanobacteria during the bloom period ($p = 0.01$ and < 0.001, respectively). Near surface concentrations of total reactive Fe and Fe^{+2} (measured with a modified triazine method) were ~1-6 and ~2-11 times higher in the oxine treated enclosures than the controls. Experiments indicated that triazine reagents removed Fe^{+2} from oxine and thus Fe^{+2} appeared detectable as 'free' Fe^{+2}, however, oxine-bound Fe^{+2} is probably unavailable to phytoplankton. The results are consistent with the hypothesis that cyanobacteria have higher Fe requirements than eukaryotic phytoplankton and that the relative abundance of cyanobacteria is regulated in part by iron availability.

SESSION: CONTRIBUTED

P56. RELATIONSHIP BETWEEN NOCTURNAL HYPOXIA AND FISH ABUNDANCE IN FILAMENTOUS ALGAE OF LAKE SAINT-PIERRE, ST. LAWRENCE RIVER (QUÉBEC)

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Nitrogen and phosphorus loading originating from agriculture and waste waters are responsible for the proliferation of filamentous algae at some periods of the summer in the littoral zone of Lake Saint-Pierre (Québec). During the night, algal respiration could induce localized hypoxia. The impact of these oxygen variations on the dynamics of fish populations is still unknown. The goal of this study was to determine the oxygen concentrations and the abundance of fish at different periods of the day in three types of plant cover: filamentous algae, macrophytes and sites without vegetation (with artificial macrophytes used to control for the effect of cover). Dissolved oxygen measurements were made at dawn, noon, dusk and midnight over four days in August 2005 in a bay of Lake Saint-Pierre. Minnow traps were used to estimate the mean abundance of fish in each habitat. A striking variation in oxygen concentration was observed between dawn and dusk in the three habitats. The oxygen concentration was lower at dawn and higher at dusk in filamentous algae compared to the other two habitats. At dusk and dawn, the abundance of juvenile fish tended to be lower in filamentous algae than in macrophytes and habitats without vegetation. These results suggest that the decrease in fish abundance in filamentous algae at night is not associated with a decrease in oxygen concentration.

P57. SCALED CHRYSOPHYTES AS PALEOECOLOGICAL INDICATORS OF ENVIRONMENTAL CHANGE IN FOUR ACID-SENSITIVE LAKES IN THE MUSKOKA-HALIBURTON REGION OF ONTARIO

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While previous work has shown that long-term changes in chrysophyte species composition have occurred since pre-industrial times in the Muskoka-Haliburton region of Ontario (Canada), there exists little information regarding the timing of these changes relative to major environmental stressors. For this study, four freshwater lakes from this region have been selected to elucidate the timing of changes in the algal chrysophyte community over the past several decades. Chrysophytes (Classes Chrysophyceae and Synurophyceae) have been used in previous paleolimnological studies because their siliceous stomatocysts and scales preserve well in lake sediments and they have known ecological optima and tolerances. In many central Ontario lakes, these algae also comprise the largest component of the phytoplankton, and thus are important ecological indicators. Sediment cores were obtained from four intensively studied lakes in 2001 (Dickie, Harp, Blue Chalk and Plastic Lake). A detailed stratigraphic analysis reveals that a decrease in *Mallomonas duerrschmidtiae*, with the exception of Harp L., is clear in three of the study lakes. Moreover, the relative abundance of colonial scaled chrysophytes increased in all lakes since the pre-industrial period (ca. 1850s), including an increase in the taste- and odour-causing taxon *Synura petersenii* in three of the lakes. Interestingly, the increase in colonial taxa was not coincident across lakes, with changes occurring at an earlier date in more acid-sensitive lakes. This suggests that acid deposition, and/or correlated variables, may be the primary cause of the observed floristic changes.

P58. HOW LAKE RECREATIONAL DEVELOPMENT AFFECTS INVERTEBRATES LIVING ON DIFFERENT NATURAL SUBSTRATA

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We sampled benthic invertebrates in the littoral zone of 7 lakes of the Laurentian region of Quebec to understand the response of these communities to lakeshore anthropogenic development.. We examined total biomass, size structure, and taxonomic composition of invertebrates living on distinct natural substrata (sediments, rocks, woods and macrophytes). Four of the lakes were relatively pristine while 3 were experiencing intense recreational development. Sediments and rocks were present in all lakes whereas wood was found only in undeveloped lakes and macrophytes only in the perturbed lakes. In less developed lakes, total biomass and individual size were greatest on sediments, lowest on rocks, and somewhat intermediate on wood. Invertebrate taxonomic composition was similar on rocks and woods with a clear dominance of *Chironomidae*. Sediments dwelling invertebrates were more diverse and represented by Anisoptera, *Coleoptera*, *Ephemeroptera* and *Gasteropoda*. In more perturbed lakes, total biomass was again the highest in sediments but differences among substrata were more subtle than in the undeveloped lakes. Size structure was not different among substrata but taxonomic composition clearly varied. The biggest difference was observed between macrophytes (*Gasteropoda, Hydra* and *Ceratopogonidae*) and sediments (*Oligochaeta* and *Nematoda*). Rocks were again dominated by *Chironomidae*. With increasing lakeshore development, total invertebrate biomass and size structure became similar on all substrata but the presence of macrophytes contributed a distinctive fauna to the lakes.

P59. SURVIVAL OF RAINBOW SMELT LARVAE IN RELATION TO PREY CONCENTRATION, SALINITY AND TEMPERATURE IN THE SAGUENAY FJORD

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Rainbow smelt (*Osmerus mordax*) is an important forage fish in the Saguenay Fjord which is the most important tributary of the St. Lawrence Estuary. Recent observations showed the existence of two distinct cohorts, one in June and one in July. Our objective was to assess the influence of prey concentration and abiotic environmental conditions on the survival of rainbow smelt larvae from the two cohorts produced in the Saguenay Fjord. Rainbow smelt larvae were sampled once a month from May to October in 2004 and 2005 using a Bongo net and a Tucker trawl. Sagittal otoliths were extracted on 300 and 230 larvae in 2004 and 2005 respectively. Daily increments were counted and measured in order to estimate hatching dates and growth rates. Preliminary results showed that high densities of rainbow smelt larvae were associated with salinity ranging from 2 to 10 PSU and with high concentrations of the estuarine copepod, *Eurytemora affinis*. Moreover, our results suggested a density-dependent relationship between larval growth and abundance, probably due to food limitation. Further analyses will document the links between growth and survival of rainbow smelt larvae from the two cohorts and environmental conditions in the Saguenay Fjord.

P60. DIATOMS AND SCALED CHRYSOPHYTES AS INDICATORS OF RECOVERY FROM ACIDIFICATION IN LAKES NEAR WAWA, ONTARIO

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Diatom valves and chrysophyte scales are being studied in five lakes recovering from severe acidification near Wawa, Ontario. Little Soulier, Otter, Talbot, Lagarde and Blueberry lakes represent a unique opportunity for studying rapid recovery patterns in lakes damaged by acidification. Despite very high buffering capacities, these lakes were greatly acidified (pH 3.1 - 4.1) during a period of iron sintering, which ended with the closure of the Algoma Ore Division sintering operation in 1998. Within five years of the closure, remarkable chemical recovery (pH 6.8 – 7.5) was measured in all five lakes. In June, 2006, short sediment cores were collected from the five acid-recovering lakes and four nearby reference lakes. Cores were sectioned at 0.25 cm intervals for high resolution analysis of diatom and chrysophyte community shifts during the periods of acidification and recovery. Important questions that this research will address include: 1) Is there any evidence of biological recovery in the benthic diatom or planktonic chrysophyte communities since the closure of the smelter in 1998? 2) If so, were the responses similar across algal groups, or did one community show a greater sensitivity to pH changes? 3) Are the communities returning to pre-industrial conditions or might other factors be causing a permanent shift in community structure? Preliminary data will be presented.

P61. RISKY HABITATS: THE EFFECTS OF PERCEIVED PREDATION RISK ON POPULATION DENSITIES OF JUVENILE ATLANTIC SALMON IN THE WILD

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Manipulations of predation risk have striking effects on the short term behaviour of individuals including juvenile salmonids in both laboratory and field conditions. However, the long term consequences of differences in predation risk on animal populations have rarely been examined. To examine the potential long term effects of perceived predation risk on the population density of juvenile Atlantic salmon, we established three contiguous sections differing in predation risk in each of seven reaches of relatively uniform habitat in Catamaran Brook, New Brunswick. Each reach consisted of a low predation site (stream water as a control) and a high predation site (alarm cue as a treatment) separated by an undisturbed buffer zone. We manipulated the perceived predation risk over 17 days by releasing chemical alarm cue in the high predation treatment (skin extracts from juvenile Atlantic salmon) and stream water as a control during the settlement period, when young salmon emerge from gravel nests and begin defending territories. As predicted, juvenile density in high predation risk sites decreased whereas the density in control sites increased slightly during the settlement period. After the settlement period however, an increase in predation risk had little influence on the juvenile density. Our study shows that increasing perceived predation risk reduces the local population density of juvenile Atlantic salmon during the settlement period. However, once settled, the cost of relocating may outweigh the benefit of avoiding a risky habitat.

P62. QUANTIFYING THE EFFECTS OF GENE FLOW ON ADAPTATION IN PAIRS OF LAKE AND STREAM THREESPINE STICKLEBACK

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Habitat heterogeneity should favor the evolution of local variants. However, gene flow will homogenize gene pools and prevent local adaptation, which can lead to negative fitness consequences. The extent to which gene flow prevents adaptation in natural population is still poorly understood. Yet, understanding its effect is crucial if we are to predict the fitness consequences of translocation of individuals among habitats. We studied parapatric pairs of threespine stickleback (*Gasterosteus aculeatus*) differentially adapted to lake and stream environments. In the Misty Lake system (Vancouver Island, BC) two streams are connected to the lake, each containing sticklebacks. While the inlet stream is morphologically and genetically divergent from the lake, the outlet stream displays intermediate morphology attributed to elevated amounts of gene flow. We combine morphological, habitat and molecular (microsatellites) data to quantify the effects of gene flow on adaptation in the outlet. More precisely, we make the assumption that the inlet population is optimally adapted to stream conditions, and using habitat data to compare the selective environments of the outlet and inlet, we predict what the expected phenotype would be in the outlet in the absence of gene flow. We find that gene flow from the lake leads to a proportional deviation of 80% between the observed outlet phenotype and its expected optimal phenotype. We compare this estimate to theoretical predictions by parameterizing a quantitative genetic model with our data. We discuss the potential consequences of gene flow for population persistence in the Misty system.

P63. SUCCESSFUL CREATION OF FISH REARING HABITAT AS COMPENSATION FOR LOSS IN THE SUB-ARCTIC

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A diversion channel (Panda Diversion Channel, PDC) was constructed in 1997 as compensation for loss of stream habitat during development of the EKATI Diamond Mine (EKATI), located approximately 300 km northeast of Yellowknife, NWT. It was designed to replicate a natural stream in its physical dimensions and substrate type. The PDC receives water from North Panda Lake, Grizzly Lake and a few ponds, which all drain into Kodiak Lake. Like all streams in the EKATI area, it freezes solid in winter and is only used by fish during the open-water season (late May to October). A 10-year monitoring program was established beginning in 1999 in order to assess the effectiveness of the PDC in providing productive fish habitat. This was done, in part, by comparing productivity of the PDC with productivity of two nearby natural streams (Pigeon and Polar-Vulture). Over the last 8 years of monitoring, the channel has proven to be successful in providing fish habitat, including spawning, egg incubation and rearing habitat for Arctic grayling (*Thymallus arcticus*), the predominant species of the PDC. In order to demonstrate the channel's success in providing good rearing habitat for Arctic grayling fry, data obtained from 2003 to 2006 will be presented for the PDC and two natural streams, focussing on the yearly outmigration. During this outmigration period, fyke nets were installed in all three streams to capture fry. Numbers and biological information (length and weight) were collected in order to estimate yearly fry production. Fry were also sacrificed over 2 sampling occasions in 2006 in order to compare the relative preparedness of outmigrants for overwintering by assessing their lipid content. Preliminary estimates indicate that outmigrant fry of the PDC have a similar and/or higher size-adjusted lipid content than the other streams, depending on the sampling occasion. Both in-stream and between-stream outmigration patterns will be discussed.

P64. WHAT DO THE EMPTY STOMACHS OF NORTHERN PIKE REVEAL? INSIGHTS FROM CARBON ($\delta^{13}C$) AND NITROGEN ($\delta^{15}N$) STABLE ISOTOPES

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Stomach emptiness has been suggested to occur more frequently in piscivorous than non-piscivorous fish. While some inter-specific comparisons gave support to this hypothesis, the question has not been addressed at the intra-specific level. Here we test the hypothesis that stomach emptiness is related to the degree of piscivory in northern pike, *Esox lucius*. Although northern pike is considered to be a specialized piscivore, it can also feed on invertebrates throughout its ontogeny. Here, we compare the short-term (i.e., stomach contents) and long-term (i.e., trophic positions) feeding behaviours of northern pike in 16 populations composed of individuals feeding on either fish or invertebrates, as well as individuals with empty stomachs. Carbon ($\delta^{15}C$) and nitrogen ($\delta^{15}N$) stable isotope signatures were used to estimate the long-term trophic position of individuals. Individuals with fish in their stomachs were expected to have a higher trophic position and be in better condition than northern pike feeding on invertebrates. Moreover, northern pike with empty stomachs were expected to have a trophic position similar to piscivorous individuals. Unexpectedly, no differences were found in the trophic position nor the condition among the three groups, with a relatively high average trophic position. This suggests that prey fish are the main source of energy for most individuals, regardless of their stomach content. Our results also suggest that northern pike have opportunistic feeding habits at the individual level, but there is no gradient of piscivory among individuals. Thus, stomach emptiness can not be related to the degree of piscivory in this study.

P65. FROM THE MOUTH TO THE GUT – VARIATION IN YELLOW PERCH FEEDING APPARATUS

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Yellow perch (*Perca flavescens*) dominate the fish communities in many Sudbury and area lakes. Stomach content analysis suggests that yellow perch undergo an ontogenetic diet shift from planktiviory to benthivory at approximately 100 mm in total length. Detailed measurements of yellow perch between 100 and 120 mm suggest that fish of this size vary in mouth gape size, gill raker density, maximum raker length, and gut length in response to type of available food (zooplankton, benthos, fish) and the presence of potential predators such as smallmouth bass (*Micropterus dolomieu*) and walleye (*Sander vitreus*). Raker density was negatively correlated with gape size and positively correlated with large zooplankton abundance. In lakes with predatory fish species yellow perch had longer rakers. Longer gut length was found in yellow perch captured in the pelagic zone and also in lakes with piscivores. Our results suggest that the feeding and digestion apparatus of yellow perch is highly optimized for different types of diet.

P66. PALEOECOLOGICAL ASSESSMENT OF WATER QUALITY CHANGES IN URBAN LAKES FROM HALIFAX (NS, CANADA).

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Aquatic ecosystems are susceptible to various natural and anthropogenic stressors such as acid precipitation, climate change, land-use modifications, industrial development, and nutrient enrichment. While many studies focus on these environmental stressors, few have been conducted on urban systems, and very few are able to determine the extent of ecosystem changes due to lack of data on pre-impact conditions. However, pre-impact environmental conditions are essential to assess the magnitude and extent of water quality changes. By comparing diatoms present in recent sediments to those deposited before significant human impact (i.e. pre-1850), a snapshot of background and present day conditions in lake water quality can be reconstructed, which can be used to assess changes in water quality. The current study (part of a 5-year, multi-disciplinary, NSERC Strategic Grant assessing water quality in Nova Scotia and Southern New Brunswick) examines the extent of changes in diatom floras from 45 Halifax Region lakes. The primary objectives and relevance of this research are to: 1) Examine the pre- and post-industrial water-quality status of Halifax region lakes using sub-fossil diatom assemblages and water chemistry characteristics; (2) evaluate the anthropogenic impact, including urbanization and other environmental stressors, on the observed changes; (3) provide relevant information on water quality changes in Halifax region, and thereby stimulate further research in the area. Observed trends in sub-fossil diatom assemblages from ca. 1850 to present, along with overall increase in TP and conductivity levels from 1980 to 2006, for most of the study lakes indicate large-scale environmental changes in nutrient enrichment, acid precipitation, and climate change since pre-disturbance lake conditions.

P67. RECOVERY OF BENTHIC INVERTEBRATE COMMUNITIES IN PREVIOUSLY ACIDIFIED LAKES

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Much of the area surrounding Wawa, Ontario was severely damaged by a century of iron mining and smelting with exceptional acidification of lakes (pH 3-4) and the accumulation of arsenic and other toxins. No formal restoration occurred following cessation of mining and smelting operations in 1998. In the summer of 2005 we sampled the benthic macroinvertebrate communities of 18 lakes and two former mine pits within and around the former fume-kill area with the goal of estimating the state of community recovery. Despite the short time available for recovery the macroinvertebrate communities showed significant recovery with community composition being well within the range found in nearby reference lakes. There has also been significant chemical recovery of the lakes with all of the lakes having a pH higher than 6.7. We attribute the rapid recovery firstly to the underlying calcium-rich geology, which apparently led to a quick decrease of acidity, thus facilitating re-colonization of the lakes. Secondly, lake location relative to the acidic deposition zone may have facilitated rapid re-colonization from source populations in the surrounding areas. Even invertebrates that are dispersal limited (no airborne adult stage), such as gastropods and crustaceans, were found in the fume-kill area lakes and in the former mine pits.

P68. THE USE OF DISTURBANCE CUES IN CONVICT CICHLIDS AS AN ADDITIONAL SOURCE OF CHEMOSENSORY RISK ASSESSMENT

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A wide variety of taxonomically diverse prey fishes rely on chemical information to assess local predation risk. In addition to the widely studied damage-released chemical alarm cues, recent evidence suggests the existence of an additional source of chemical information, the disturbance cues. Disturbance cues are thought to be released by stressed or disturbed individuals early on during the predation sequence. In this study, we attempt to: 1) verify the existence of disturbance cues in juvenile convict cichlids (*Archocentrus nigrofasciatus*), 2) characterize the behavioural response to these cues, and 3) test the hypothesis that these cues are comprised of nitrogenous-waste products (ammonium) released by stressed individuals. Preliminary results suggest that convict cichlids do indeed possess disturbance cues and that these cues elicit reliable, but subtle increases in antipredator behaviour (reduced foraging, time spent moving and area use). Using colourimetric analysis, we found no change in the presence of ammonium in disturbed tanks. This was followed by a behavioural assay of fish given a synthetic ammonium analogue in which no significant response was detected, suggesting that ammonium may not be a component of the disturbance cue in cichlids as was previously believed.