Abstract	Theme Name	Talk #
Rigler's Gift and Lake 227: When will we learn their lessons? R.E. Hecky, United Nations University Chair in African Great Lakes and Rivers, Biology Department, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada. N2L 3G1. email: rehecky@sciborg.uwaterloo.ca At the 1974 SIL meeting in Winnipeg, Frank Rigler shocked the limnological world by limiting the role that reductionism can play in our science, thereby rejecting a research approach that he had championed for 20 years. He strongly embraced empiricism applied to whole ecosystems as the surest path to a predictive freshwater science and especially in understanding the relationships between inorganic nutrient supply and biological production. Experimental treatments of whole lakes led by Schindler and others have illustrated the power of Rigler's insight and, in particular, greatly advanced our understanding of the role of nutrients in controlling biological production and defining aquatic communities. Given the power of this insight and the whole ecosystem experimental approach, why are large lakes and seas around the world (including the developed world) still turning green due to phosphorus enrichment. A number of reasons can be identified that include cultural and economic factors, but surprisingly some of the strongest resistance arises from scientists who question the applicability of whole ecosystem results to systems different than the experimental system itself. I will try to demonstrate that the lessons of Rigler and tiny Lake 227 at ELA are applicable to some of the largest lakes in the world including the Baltic Sea. I will also examine the scientific reluctance to accept the applicability of the 227 lesson embodied in arguments about how system size, biogeochemistry and food webs make 227 irrelevant to large systems. Rejection of 227 and Rigler's epiphany is leading to continued damage of aquatic systems and unnecessary economic costs coastal states around the world.	Rigler	Rig.
The use of sub-lethal physiological indicators in fish for environmental management; from the Salton Sea, California, to Lake Qinghai, China. Colin Brauner, Department of Zoology. University of British Columbia The Salton Sea is the largest lake in California (1000 km^2). It is below sea level, has no outflow, and high evaporative water loss. The salinity is currently 43 g/L, and increasing at a rate of 0.3 g/L per year. This hypersaline lake supports a recreational fishery, consisting of several marine fish species and the California Mozambique tilapia (Oreochromis mossambicus x O. urolepsis hornorum), which is the most abundant fish species. Lake Qinghai is the largest lake in China (4000 km^2) and resides on the Tibetan plateau at 3200 m. This lake also has no outflow and high evaporative water loss, and significant inflow is diverted away from the lake for agricultural purposes. The lake salinity is presently 9 g/L, but increasing as the lake water levels continue to fall. Lake Qinghai is home to the lake Qinghai scale-less carp (Gymnocypris przewalskii), a Tibetan cultural icon and the species that historically supported a commercial fishery that has since collapsed. In both systems, lake salinity is progressively increasing, largely due to anthropogenic factors, and will eventually surpass salinity tolerance of resident fish species. We are conducting experiments to investigate the physiological mechanism(s) and threshold(s) of salinity tolerance (based upon changes in gill Na+,K+ ATPase activity, gill morphology, drinking rate, plasma ion levels and osmolality, metabolic rate, and growth, among other parameters) of these fish to gain insight into their ability to acclimate to increasing salinity. In each system, tilapia and carp appear to be on the edge of their salinity tolerance, necessitating large changes to water use and water management strategies, if these species are to persist.	Steven.	Stev.

A framework for broad scale definition of water resources on the Boreal Plain: should topography be considered last? K. Devito1, I. Creed2, T. Gan3, C. Mendoza4, R. Petrone5, U. Silins6, B. Smerdon4 1. University of Alberta, Department of Biological Sciences, Edmonton, Alberta, T6G 2H1, Canada 2. University of Western Ontario, Department of Biology, London, Ontario, Canada 3. University of Alberta, Civil and Environmental Engineering 4. University of Alberta, Department of Earth & Atmospheric Sciences 5. Wilfrid Laurier University, Department of Geography, Waterloo, Ontario, Canada 6. University of Alberta, Department of Renewable Resources We present a framework for defining effective hydrologic response units in landscapes at both local and regional scales. This framework summarizes research conducted at the Utikuma Research Study Area (URSA), Alberta, Canada, where sub-humid climate (P ≤ PET), low relief and deep glaciated substrates result in the dominance of vadose zone storage, evapotranspiration and vertical, rather than lateral water exchange in hillslope water balances. Furthermore, heterogeneity in the scale of surface-water and groundwater interactions is associated with heterogeneity of glacial landforms (e.g., sand outwash, clay-silt moraines, and low-lying lacustrine clay with peatlands) that precludes the use of topographic watershed boundaries to define water sources. We present a comparative analysis of hydrologic cycling in different regions of the Boreal Forest that forms the basis for a hierarchy of factors to classify hydrological systems. The hierarchy moves in the direction of decreasing spatial scale when considering the relative importance of controlling factors in water cycling. This analysis shows that regional sampling and mapping to select representative landscape units that reflect climate, bedrock and surficial geology, and soil type and depth controls on hydrological systems, prior to topography, are imperative for effective generalizations of water and energy cycles in the Western Boreal Forest. This framework is designed to aid in the regionalization of catchment hydrology, direct the effective use of instrumentation, monitoring and modeling approaches, and direct adaptive management of water resources in both simple and complex landscapes.	Joint	1
ON THE LIMNOLOGICAL BACKWATERS OF CANADA: RIVER ECOSYSTEMS AND THEIR DRIVERS Pick, F.R. Department of Biology, University of Ottawa, Ottawa, Ont. K1N 6N5 Historically, river research has not been as popular with Canadian limnologists as lake research. The size and temporal variability of rivers has perhaps been too daunting but also the teaching of limnology has focused largely on lakes. Similarly river management has been less successful than lake management because of overlapping jurisdictions and a lack of stewardship. Yet aside from cities on the Great Lakes, most urban centers in Canada are located on rivers that supply critical drinking water and recreational opportunities. Since the formulation of the River Continuum Concept, the physical characteristics related to stream order (i.e. discharge) have been considered the major drivers of river ecosystems, but chemical drivers and in particular nutrient levels are just as important as they are in lakes. Nutrients rather than discharge or water residence time control the biomass of algae in most Canadian river systems, although physical features related to morphology (channel depth, backwaters or dead zones) can affect the relative importance of planktonic versus benthic biomass. In terms of community structure and in contrast to lake systems, nanoplankton appear to dominate the plankton of rivers in Ontario and Western Quebec regardless of nutrient concentrations. This pattern may stem from the overriding influence of turbulence on cell size in flowing waters, and/or less grazing compared to lake systems.	Joint	2

USING RIVER-SIDE MICROCOSMS TO ASSESS ECOLOGICAL RISK Culp*, J.M. Environment Canada (NWRI) and Canadian Rivers Institute, University of New Brunswick, Fredericton, NB. (joseph.culp@ec.gc.ca) Pollution effects in riverine environments are seldom the result of single stressors. This is because flowing waters receive multiple, and potentially, interacting effluent discharges from municipalities and industries, and from non-point sources (e.g., agriculture). This reality makes it difficult to establish cause and effect relationships through standard field biomonitoring of rivers, particularly given that the duration and concentration of effluent exposure is often poorly described. Although enclosure experiments have provided substantial benefits to establishing causal mechanisms in lakes, this approach is less successful in rivers due to the difficulties of creating and maintaining enclosures in an environment of frequent flow variation and continual downstream transport of suspended particles. One approach that provides a partial solution to this problem is the integration of field bioassessments with artificial stream experiments. This integrated approach provides the advantage of using field observations to focus hypothesis generation for experimental studies which identify cause and effect relationships. In contrast to field biomonitoring, artificial stream experiments can control relevant variables and help isolate potential agents, such as nutrients or contaminants, which cause the biological response. This research tool incorporates greater ecological complexity than is possible to include in laboratory tests, and can generate important information on the chronic effects of pollutants on riverine communities. Case studies from several Canadian rivers will be discussed (e.g., Fraser, Wapiti, Saint John) to illustrate how field-based artificial streams can be used to separate the effects of multiple stressors in field situations (e.g., nutrient-contaminant interactions).	Joint	3
The sedimentary link concept: key valley-scale landscape structures that determine Atlantic salmon habitat. The case of the Sainte-Marguerite River, a salmon river in the Saguenay region, Quebec. Michel Lapointe, Department of Geography, McGill University (michel.lapointe@mcgill.ca) The segmenting of gravel-bed rivers into a number of discrete 'sedimentary links' is a relatively recent concept. Each successive link is initiated at a node where coarse sediments are recruited (for example from tributaries, bedrock canyons, glacial deposits), followed by a segment marked by downstream fining of alluvium and reduction of channel slope. The sedimentary link concept offers promise to model the large scale spatial organisation of many types of aquatic habitat (spawning, feeding, refuge, etc) that happen to be strongly dependent on local bed sediment calibre, associated flow strength and channel stability conditions. So far, the ecological application of this concept has mainly focused on benthic invertebrates. Here we illustrate its application to fish (Atlantic Salmon; Salmo salar). The sedimentary link concept focuses on easily identifiable landscape structures that reflect the key role played by bed substrate grain size in salmon ecology, at the level of spawning, feeding and winter refuge habitats. We argue that sedimentary links represent key riverine landscape structures to understand salmon habitat organization and demonstrate its application to the Sainte-Marguerite River (SMR), a salmon river in the Saguenay region, Quebec. The selection of the appropriate spatial scale to conduct research on Atlantic salmon freshwater ecosystem structure is a well recognized problem. We will show that along the SMR the structure of sedimentary links reveals the basin-scale organisation of Atlantic salmon spawning activity. We also show that large-scale patterns in abundances of juvenile salmon (parr) are directly related to link structure. Our results suggest that the link structure of a particular salmon river can shed light on the location of the most productive valley segments.	Large Rivers	1
BENTHOS OF LARGE, GRAVEL-BED RIVERS: WHY DO WE KNOW SO LITTLE? Richardson*, John S.1 and Laura L. Rempel2. 1. University of British Columbia, Dept of Forest Sciences. 2. Department of Fisheries and Oceans Canada, Vancouver, BC. John.Richardson@ubc.ca	Large Rivers	2

Noel Hynes once noted that benthos of large rivers, i.e., those that are not wadeable, were poorly known. The situation has not dramatically improved, particularly for gravel-bed rivers where modified oceanographic sampling gear used in soft sediments is ineffective. The shore-zone margin of gravel-bed rivers, sampled using gear designed for small streams, shares some similarity in community composition to small streams. Sampling also shows that the shore-zone community is adapted to seasonal water level changes as it tracks the shore margin. But benthos in the deep, main channel of these rivers is mostly inferred based on more easily collected drifting specimens that often differ from those along the margins. These include particular species of flies (e.g. chironomids, blepharocerids, simuliids, etc.), but whether these animals contribute to overall river productivity, or are scarce and with low growth rates, is uncertain. The uniqueness of these assemblages has not been assessed. These issues are relevant to understanding the consequences of flow regulation, where flows are reduced on average and formerly productive shore zones are often dry. Benthos of near-shore environments suggest that these assemblages may be resilient to physical disturbances, such as gravel mining, but this may be a scaling artefact of the very large source area available for colonisation. Understanding the environmental basis of fish production may also be enhanced by further assessments. Despite the technical challenges of research in large, gravel-bed rivers, ongoing work continues to show that these dynamic environments do support benthic organisms.		
MULTI-DIMENSIONAL ASSESSMENT OF HUMAN IMPACTS ON WATER QUANTITY AND QUALITY IN THE SOUTH SASKATCHEWAN RIVER BASIN Leland J. Jackson1*, Edward McCauley1H, Laureen Lamb1†, Ken Jeffries1I & Bernhard Mayer2 1Department of Biological Sciences, University of Calgary, 2500 University Dr., NW, Calgary, AB, Canada T2N 1N4 (phone: (403) 220-6790; fax: (403) 289-9311; email: *ljackson@ucalgary.ca; Hmccauley@ucalgary.ca; Ikmjeffri@ucalgary.ca) †Present address: TERA Environmental Consultants, Suite 1100, 815-8th Ave., SW, Calgary, AB T2P 3P2 (llamb@teraenv.com) 2Department of Geology and Geophysics, University of Calgary, 2500 University Dr., NW, Calgary, Alberta, Canada T2N 1N4 (mayer@ucalgary.ca) Human activity and development in Western Canada has ecological and socio-economic impacts on aquatic ecosystems. Besides being the major water source for »4 million people, theses systems are important for hydroelectric generation, drinking water supplies, irrigation and recreation, and disposal of municipal sewage and industrial wastes. These rivers also cross multiple regulatory jurisdictions. Given multiple stakeholder interest in these drainages, the potential for future development and the need for environmental decision-making tools, water management models must be developed for environmental policy makers to make critical decisions regarding sustainable development while still supplying abundant, clean water. We are attempting to understand the relationship between water quantity and quality, and economic development in the South Saskatchewan River basin. One of our end goals is to develop an expert system that couples ecology and economics to guide integrated watershed management in these systems. We will present analyses of factors that affect water quantity and quality in the SSRB, which follows the amalgamation of water quantity and quality data bases, land cover and watersheds into a GIS. Our initial goal is to understand how water quantity and quality is linked to changes and spatial locations of land uses, and the relative importance of non point-source versus point-source inputs, which we have quantified through assessment of biological responses and stable isotope tracing downstream of major urban centres.	Large Rivers	3
Lotic periphyton biomass response to experimental phosphorus enrichment Davies, J-M.1 and M.L. Bothwell2. 1 Department of Biology, University of Victoria. Current address: Saskatchewan Watershed Authority, #330 - 350 Third Avenue North, Saskatoon SK S7K 2H6, Tel: (306) 933-8250. john-mark.davies@swa.ca	Large Rivers	4

2Environment Canada, Pacific Biological Station, 3190 Hammond Bay Rd, Nanaimo, BC Canada. V9R 5K6. (250) 756-7037. bothwellm@pac.dfo-mpo.gc.ca River periphyton growth is impacted by water velocity, nutrient concentration and invertebrate grazing. While high velocity is known to scour periphyton and reset community growth, at lower flows it carries a continuous supply of nutrients. Thus, nutrient limitation of periphyton growth is linked with both flow and concentration emphasizing the need to examine nutrient fluxes. This study, using water from the Thompson River, BC, examines initial colonization and post log-growth in experimental flumes at several nutrient concentrations. At higher nutrient concentrations the periphyton community shifted to filamentous forms capable of maintaining greater community biomass. An in-river study examining periphyton accrual demonstrated the importance of nutrient flux. The flume and in-river studies provide insight into ecosystem spatial and temporal sensitivity and suggest that management practices, such as timed waste water release, might be effective in reducing nuisance algal growth.		
Some thoughts about fish communities and the function of Arctic and Tropical Rivers. Ross F. Tallman1 and Spencer Jack2 1Department of Fisheries and Oceans, Central and Arctic Region, 501 University Crescent, Winnipeg, Manitoba. R3T 2N6 (tallmanr@dfo-mpo.gc.ca) 2Canadian Cichlid Association, 704 Muriel Street, Winnipeg, MB. R2Y 0Y2 (spenjack@shaw.ca) Fish communities in large rivers have some unique features to their habitat that cannot be understood using borrowed concepts from studies of lake or streams communities. Large tropical and Arctic freshwater river systems and their biota are typically considered to be at opposite ends of a spectrum from each other. It is true that species diversity is much greater in tropical than Arctic systems . For example 1400+ species are described from the Amazon River while the lower Mackenzie River, NWT has 38 and the Slave River, NWT 31 species, respectively. As well, species in tropical areas tend to be highly specialized while those from Arctic areas may have many forms within one species and a rather generalized niche. However, in other ways large rivers of the tropics and the Arctic function in similar ways. We discuss the nature of fish communities in rivers in terms of the theories of riverine function such as the Flood-Pulse concept and Riverine Productivity Model.	Large Rivers	5
AN EVALUATION OF VISUAL SURVEY PROGRAMS FOR MONITORING COHO SALMON (ONCORHYNCHUS KISUTCH) ESCAPEMENT Holt*, K. and S.P. Cox. School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC (email:krh@sfu.ca) Canada's Wild Salmon Policy requires that quantitative survey designs be used to monitor annual trends in Pacific salmon (Oncorhynchus spp.) escapement. Visual survey methods, in which periodic counts of spawning fish are made throughout a season, are often applied for this purpose. The power to detect trends for most visual survey methods depends mainly upon consistency in (i.) the ability of observers to detect fish and (ii.) the annual timing of fish presence in the survey area. We developed a Monte Carlo simulation procedure to evaluate the power of Peak Count, Mean Count, and Area-Under-the-Curve (AUC) methods to detect 30% declines in coho salmon (O. kisutch) escapement over 10 years, which is the magnitude of trend that would warrant listing a coho population as threatened under the Canadian Species at Risk Act. Spawner run-timing distributions were parameterized based on 121 existing visual count datasets from British Columbia coho salmon streams. Variability in observer detection probability and spawner lifetimes were obtained from literature sources. In our baseline scenario, the Mean Count method achieved 80% power or greater at 5 or more survey counts per year, while both Peak and AUC methods only achieved a maximum of 60% power at 8 or more survey counts per year. Sensitivity analyses showed that the AUC method required nearly perfect information about spawner lifetime to achieve 80% power or greater. Our results suggest that a simple Mean Count method could be applied extensively to monitor coho salmon abundance in relation to conservation guidelines.	Large Rivers	6

GROWTH RATE AND MORPHOLOGICAL CHARACTERISTICS OF CLEARWATER BROOK ATLANTIC SALMON (SALMO SALAR) SPRING SMOLTS AND AUTUMN PARR Mathews*, M., Cunjak, R. and G. Chaput. Department of Biology, University of New Brunswick, Fredericton, New Brunswick (email: megan.mathews@unb.ca) We examined growth rate and morphological characteristics of wild Atlantic salmon (Salmo salar L.) spring smolt and autumn parr of Clearwater Brook, New Brunswick, Canada. Growth rate of each growing season was inferred from scale circuli counts and size and age data were collected. Two age classes of migrants exist; majorities are 2+ parr / 3 year old smolt (~70%), remainder are 1+ parr / 2 year old smolt. Autumn parr are found to have slower growth rates in the fry year and last parr year prior to migration than spring migrants for the older age class; younger age class are found to all have fast growth rates. Stable isotope analysis indicates both groups rear in similar locations of the stream. Extremely high fry densities (maximum of 120 / 100m2) are thought to cause competition for habitat, especially winter substrate, and initiate dominance which later determines density dependent displacement of autumn migrants.	Large Rivers	7
INFLUENCE OF ABIOTIC FACTORS ON CUTTHROAT TROUT IN SOUTHWESTERN ALBERTA: A POPULATION-LEVEL ASSESSMENT OF AN EXTREME FLOOD EVENT Paul*, A J., C. G. S. Dormer and C. Greenway. Department of Biological Sciences, University of Calgary, Calgary, Alberta (email: ajpaul@ucalgary.ca) Variability in annual maximum daily discharge for streams in southwestern Alberta is among the greatest observed anywhere in Canada. High variability in these streams suggests fish populations may be influenced strongly by rare, relatively large-magnitude flood events. Such flooding occurred along the foothills of southern Alberta in June 2005, with an estimated recurrence interval for the flood of >100 years. We assessed the effect of this flood on an isolated population of native westslope cutthroat trout (Oncorhynchus clarkii lewisi) in a small third-order watershed. A two-stage assessment protocol was used to estimate population abundance of age-1 and older cutthroat trout in 2004 (1 year before the flood) and 2005 (1 month after flooding). The assessment protocol consisted of electrofishing 100-m sections of stream to estimate either: a) capture efficiency (stage one) or b) catch per unit effort (CUE; stage two). Basin-wide population estimates were obtained by first fitting a nonparametric spatial model to CUE data (corrected for capture efficiency) and then integrating the spatial model over the entire stream network. Uncertainty in population estimates was evaluated through parametric bootstrapping of both capture efficiency and CUE correction. Population estimates for 2004 did not differ significantly from 2005, showing floods had little if any affect on age-1 and older cutthroat trout. In contrast to fish populations, habitat measurements taken in 2004 and repeated at the same locations in 2005 showed flooding significantly deepened the channel, reduced accumulations of fine sediments and exposed cobbles—conditions likely to be beneficial for trout. We conclude with the hypothesis that, despite high variability in annual maximum discharge, fish populations in southern Alberta foothill streams are not likely to be affected adversely by extreme floods alone.	Large Rivers	8
SEASONAL MOVEMENT AND HABITAT SELECTION BY FLUVIAL BULL TROUT (Salvelinus confluentus) IN SOUTHWESTERN ALBERTA Popowich*, R. C.(1), and A. J. Paul(2). (1)Department of Biological Sciences, University of Alberta, Edmonton, Alberta (email:rcp1@ualberta.ca), (2) Department of Biological Sciences, University of Calgary, Calgary Alberta. Population declines of bull trout have prompted considerable effort toward defining key habitat requirements (e.g., type and location) deemed necessary for their recovery. A fundamental problem in assessing these requirements, however, is observed patterns of movement and habitat use by individuals can be emergent properties of either population or landscape dynamics. To address this, we used radio telemetry to track 83 fluvial	Large Rivers	9

bull trout from three rivers in southwestern Alberta. The rivers offer unique research opportunities because: i) they differ in population structure (two rivers contain 'healthy' bull trout populations and the third is on the verge of extirpation), and ii) the rivers transect a variety of landscapes ranging from pristine sub-alpine forests to highly developed urban centers (e.g., Calgary). We combined six river-years of bull trout location data with habitat mapping (aerial photos) and GIS spatial layers to determine if movement and habitat use were related to characteristics of the individual (fish size or sex), population (abundance), or landscape (extent of development). The outcome of this work identifies large-scale habitat features (e.g., type and location) used by fluvial bull trout and identifies how use is influenced by individual, population and landscape differences. Understanding processes that drive habitat use is an important step in defining habitat requirements for bull trout.		
WHAT STRUCTURES PARR DENSITIES ALONG A RIVER? Bouchard*, J. and D. Boisclair, D. Université de Montréal, Département de sciences biologiques, C.P. 6128, Succursale Centre-ville, Montréal, Québec Canada H3C 3J7 (e-mail : judith.bouchard@umontreal.ca). Numerous models have been proposed to describe the processes that structure abiotic and biotic components in rivers. Hynes (1975) emphasized the effect of the valleys on stream characteristics. Vannote et al. (1980) proposed the river continuum concept which focuses on the longitudinal (upstream-downstream) gradient of physical and biological properties of rivers. Rice et al. (2001) developed the link discontinuity concept which suggests that sudden input of sediments (from tributaries or lateral sources) create a series of sedimentary links that structure the properties of rivers. More recently, notions of landscape ecology suggested that the spatial organisation of habitats found in rivers may influence fish distribution (Wiens 2002). Our objective was to determine the processes that influence the distribution of parr of Atlantic salmon along a river. We sampled 32 segments of 200 m along 86 km of the Sainte-Marguerite River. At each segment sampled, we estimated parr densities and described local, lateral, and longitudinal environmental conditions. Local variables described conditions within segments (substrate composition, water depth, flow velocity). Lateral variables described the condition on the shore (sandy shore, bend tree, cliff, slope, and area of watershed). Longitudinal variables described the spatial position of segments relative to other river features such as river mouth, spawning sites, tributaries, and sedimentary links. We used multiple regressions to predict parr densities using local, lateral, and longitudinal variables as independent variables. Our work suggests that parr densities along a complete river are affected by sedimentary links and more specifically by the percentage of boulder within segments.	Large Rivers	10
TEMPERATURE AND FISH BIODIVERSITY IN ONTARIO STREAMS Chu*, C.1, Jones, N.E., Mandrak, N.E.2 and A. R. Piggott3. 1Watershed Ecosystem Graduate Program, Trent University, 1600 West Bank Drive, Peterborough ON, K9J 7B8, 2Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington ON, L7R 4A6, 3Aquatic Ecosystem Impacts Research Branch, Environment Canada, 867 Lakeshore Road, Burlington ON, L7R 4A6. The distribution of individual fish species and composition of fish communities in Ontario's streams are shaped, in part, by the availability of suitable thermal habitat. Temperature drives life history events such as spawning, effects the growth and survival of aquatic organisms and influences the productive capacity of stream systems. An assessment of fish biodiversity in Ontario therefore requires an understanding of stream temperatures and the potential factors influencing those temperatures. In this study we developed a new biodiversity index that incorporates the thermal preferences of each species in the community, examined how much variance in biodiversity could be explained by air temperature and groundwater; the principle predictors of stream temperature, and present the potential impacts of climate change on the thermal diversity of stream communities in Ontario. These findings identify which watersheds and their associated fish communities may be sensitive to climate change in the future.	Large Rivers	11

SAMPLING THE RED RIVER, MANITOBA FOR SPECIES AT RISK (SAR) - LISTED AND EXOTIC FISH SPECIES USING STRATIFIED RANDOM BOAT ELECTROFISHING. Franzin*, William G. and Douglas A. Watkinson, Fisheries and Oceans, Central and Arctic Region, 501 University Crescent, Winnipeg, MB, R3T 2N6 Email: franzinw@dfo-mpo.gc.ca We sampled the 242 kilometre length of the Red River in Manitoba from the International Border at Emerson to the end of the mainstem at the delta near Lake Winnipeg. Fishing was done using a Smith Root SR 20 electrofishing boat equipped with a GPP 5 electrofisher in a stratified random sampling scheme that sampled 3 individual kilometers out of each of 24 10-km blocks such that the entire river was sampled in each of Fall 2002, Spring and Summer 2003. Each 1-km site was sampled in three equal portions on the two banks and the center of the channel. A total of 639 samples were collected from 213 individual kilometers. The total fish catch of 7,376 comprised 37 of the 57 species known to occur in the mainstem of the river. Fishing effort and catch averaged 32 minutes and 36 fish per kilometer respectively. Species diversity and abundances in catches averaged 2.9 and 6.2 respectively but variances were very high. Issues associated with electrofishing a large turbid river are discussed.	Large Rivers	12
THE UPPER ATHABASCA RIVER BASIN: ASPECTS OF WATER QUALITY AND BASIN CHARACTERISTICS *Irving, E.C. (1), Cooley, P. (1), Cooley, H.M.(1), McEachern P (2), and Scrimgeour G. (3) (1) North/South Consultants Inc. Suite 500, 805 - 8th Ave. S.W. Calgary, Alberta, T2P 1H7. (2) Alberta Environment, Northern Region, 111 Twin Atria Bldg. 4999 - 98 Ave. Edmonton, AB, T6B 2X3. (3) Limnos Aquatic Ecosystems Consulting and Research, Edmonton, Alberta. Alberta Environment is currently working towards developing a watershed management plan for the upper Athabasca River basin and has identified surface water quality in the upper Athabasca River mainstem as a priority. The occurrence of low dissolved oxygen (DO) events along the river and the cumulative decrease in DO upstream of Grand Rapids during winter months is central to the concern regarding water quality. This study aimed to provide an overview of basin characteristics (i.e., the Upper Athabasca River Information System [UARIS]), as well as an overview of nutrient, total suspended solids (TSS) and biological oxygen demand (BOD) loadings to the upper Athabasca River mainstem. Water quality data relating to relative loadings of nutrients, BOD and TSS to the Athabasca River upstream of Grand Rapids were compiled and assessed; as well as data relating to tributary water quality, and data relating to climate, land use, and water allocation within the entire upper drainage basin. An integral component of the study was the creation of a comprehensive GIS-based digital atlas (UARIS) that incorporated all relevant point and non-point source information to describe the many thematic elements of the drainage basin. Uncertainties and data gaps regarding the overview of basin characteristics, water use and the assessment of nutrient, BOD and TSS loading to the upper Athabasca River mainstemwere identified. These information sources were then used as a basis for making recommendations to facilitate the development of a watershed management plan for the upper Athabasca basin.	Large Rivers	13
FRAGMENTATION OF BOREAL STREAM HABITATS IN ALBERTA AS A CONSEQUENCE OF HANGING CULVERTS Park, D.1,2*, M. Sullivan2,3 and E. Bayne1 1University of Alberta, Dept. of Biological Sciences, 2Alberta Fish and Wildlife Division; 3Alberta Cooperative Conservation Research Unit (email: dave.park@gov.ab.ca) Fishes such as Arctic grayling and northern pike in Alberta's boreal forest streams must migrate within watersheds in response to life history needs and typical harsh and variable hydrological conditions in tributaries and mainstem rivers. Extensive industrial development in Alberta is resulting in an	Large Rivers	14

extensive and growing network of roads and their associated culvert stream crossings. Culverts may be installed properly, but almost invariably become fish barriers (i.e., hanging culverts) after outfall erosion. A survey of 509 culvert road crossings in 4 watersheds in northern Alberta showed that 42% were hanging. Hanging culvert occurrence was found to develop over time, at a rate regulated by landscape gradient. We estimate that there are 44,000 hanging culverts in Alberta's boreal forest. Simply replacing these culverts could cost $550 million. At current rates of road building and culvert failure, an additional 14,000 hanging culverts develop each year, resulting in enormous levels of habitat fragmentation. Mitigating fragmentation on this scale is a daunting task. We developed a dynamic simulation model of hanging culvert-induced fragmentation of boreal stream habitat over time to investigate potential outcomes of different stream crossing strategies in simulated high and low gradient boreal landscapes. Management scenarios that consisted of replacement of hanging culverts, combined with a reduction in annual road build rates and increase in avoidance of stream crossings, were most cost-effective at reducing watershed fragmentation in low gradient areas facing road development, however, in high gradient areas, maximum cost-effectiveness was achieved through the alternative use of temporary bridges.		
BULL TROUT (SALVELINUS CONFLUENTUS) OCCURRENCE AND ABUNDANCE INFLUENCED BY CUMULATIVE INDUSTRIAL DEVELOPMENTS IN A CANADIAN BOREAL FOREST WATERSHED Ripley, T.,* G. Scrimgeour, and M. S. Boyce, Fish and Wildlife Division, SRD, Calgary, AB (email: Travis.Ripley@gov.ab.ca) We examined relations between cumulative levels of forest harvesting and density of road networks on the occurrence and abundance of bull trout (Salvelinus confluentus) in the Kakwa River Basin, Alberta. Logistic regression models showed that bull trout occurrence was positively related to stream wetted width but negatively related to percent fines, percent cobbles, reach slope, and the cumulative area of the subbasin harvested and road density. Results from zero-inflated Poisson regression models typically showed that bull trout abundance was positively related to elevation and negatively related to stream width, percent fines, percent cobble, slope, and levels of forest harvesting. Using the negative relation between bull trout occurrence and percentage of subbasins harvested derived from the most parsimonious logistic regression model, we forecasted that forest harvesting over the next 20 years is projected to result in the local extirpation of bull trout from 24% to 43% of stream reaches that currently support bull trout in the Kakwa River Basin.	Large Rivers	15
INFLUENCE OF DAMS AND HABITAT CHARACTERISTICS ON MOXOSTOMA SPECIES DISTRIBUTION IN THE GRAND RIVER, ONTARIO Reid, S.M1.*, C.C. Wilson2 and L.M.Carl3. (1) Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON (email:scott.c.reid@mnr.gov.on.ca). (2) Aquatic Biodiversity and Conservation, Ontario Ministry of Natural Resources, Peterborough, ON. (3) Great Lakes Science Center, United States Geological Survey, Ann Arbour, MI. The development of species at risk recovery plans is limited by a lack of knowledge regarding species ecology, population size and limiting factors. Recovery plans for the Grand and Thames rivers and COSEWIC status assessments contend that dams have negatively affected redhorse (Moxostoma sp.) populations. This has not been tested for Canadian populations, however. From 2002 to 2004, 151 sites throughout the Grand River (a highly fragmented watershed in southern Ontario) were sampled to identify the factors influencing the distribution of redhorse species. Individual redhorse species were captured from 3 to 31% of the sites. The most widespread species were golden redhorse (M. erythrurum) and greater redhorse (M. valenciennesi), while river redhorse (M. carinatum) was only collected from the lower Grand River. The nationally threatened black redhorse (M. duquesnei) was restricted to the middle of the watershed. Redhorse were absent from the Speed River sub-watershed, which has the highest density of dams, and upstream of major barriers along the Conostogo and Grand rivers. Generalized additive models (GAMs) were applied to explore the influence of dams and habitat characteristics on redhorse species distribution. Principal component analysis reduced habitat data to three axes representing: channel structure, substrate, and pool, riffle and run habitats (PC1); gradient and drainage area (PC2); and cover	Large Rivers	16

(PC3). GAMs indicate that PC2 was important for predicting black redhorse and greater redhorse site occupancy and PC1 was important for golden redhorse. River fragment length was important for predicting site occupancy for shorthead redhorse, but not other Moxostoma species.		
INFLUENCE OF FLOW REGIME ON BENTHIC INVERTEBRATE COMMUNITIES: MAGPIE RIVER, WAWA, ONTARIO Jones, Nick*, River and Stream Ecology Unit, Ontario Ministry of Natural Resources-Trent University, 1600 West Bank Drive, Peterborough ON, Canada K9J 7B8 nick.jones@mnr.gov.on.ca The ecological integrity of flowing waters depends on their natural flow regime. Deviations from a natural flow regime may result in new constraints on community structure of river-dwelling fishes and invertebrates and loss of productive fish habitat. In this study benthic invertebrate communities are compared from the Magpie River and a natural reference river. The Magpie River has a water power facility with a ramping constraint of 1 m3•s-1 with a minimum flow of 7.5 and a maximum flow of 45 m3•s-1. This flow regime results in a variable wetted perimeter with a frequency and duration wetting set by market energy prices and energy demands. Benthic samples were collected in mid-July 2004 using a Surber sampler fitted with a 500 µm mesh net. Samples were collected along three transects on each river leading from the shore to mid-channel. Differences were evident in the distribution and abundance of invertebrates in relation to the distance from the dam and shore. Transects close to the dam (<8 km) had much higher densities of lotic and lentic derived invertebrates, whereas areas close to shore in the Magpie contained invertebrates (e.g., oligochaetes, flatworms, gastropods) capable of withstanding harsh environmental conditions. More environmentally sensitive invertebrates belonging to the groups Trichoptera, Diptera, Ephemeroptera, and Coleoptera were scarce in nearshore areas but common in deeper offshore samples of the Magpie. Similar trends in invertebrate abundance and composition could not be found in the reference river. The implications for benthic fish production are discussed.	Large Rivers	17
MAGPIE RIVER RAMPING RATE STUDY: TESTING THE EFFECTS OF RAPID FLOW CHANGES ON DOWNSTREAM ECOLOGY. Smokorowski, K.E.*, Metcalfe, R., Jones, N., and Finucan, S.D * Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Sciences, 1 Canal Dr., Sault Ste. Marie, Ontario (email: smokorowskik@dfo-mpo.gc.ca) Fisheries and Oceans Canada, Ontario Ministry of Natural Resources, and Brascan Power Corporation are collaborating on a long-term, adaptive management experiment to test whether regulating the rate of change of water flow (ramping rates) through hydroelectric facilities can provide a more favourable environment for fish, while optimizing energy production. Baseline phase results (2002-2004) will be presented, summarizing physical and biological measures taken from an experimental (Magpie) and reference (Batchawana) river to quantify conditions under highly restricted ramping. The magnitude of flow change on the Batchawana was greater; flow on the Magpie fluctuated more frequently and ramping was higher even under rate restrictions. Permanent transects will be resampled to determine whether any significant differences have occurred between the impact and control sites in changes in morphological characteristics. Electrofishing biomass varied by river, habitat type, and valley segment, but was more consistent on the Batchawana than the Magpie. Brook trout muscle contraction rate reflected flow change: large increases in flow resulted in spikes in muscle contractions, while steady or low flow resulted in slower contraction rates. Cross-sectional transects revealed a gradient in invertebrate density by taxa on the Magpie (wet-dry vs. permanently wet) but not on the Batchawana. Ramping restrictions were removed October 2004 and flow can now fluctuate as rapidly and frequently as desired by the power generator. Monitoring will continue to assess the effect of unrestricted ramping through 2007, and results will be incorporated into provincial and federal waterpower guidelines and policy.	Large Rivers	18

WHISKEY'S FOR DRINKIN' AND WATER'S FOR FIGHTIN': CLIMATE CHANGE AND WATER SUPPLY IN THE WESTERN CANADIAN PRAIRIES *Donahue, W.F.(1), and Schindler, D.W.(2) (1) Freshwater Research Ltd., Edmonton, AB T6C 0R6 (2) Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9 Development in the Canada's prairies during the last century has coincided with a century of relatively stable climate that is among the wettest in the last thousand years. Consequently, our society relies on water-intensive industries dependent upon rivers flowing from the Rocky Mountains. We assume that future water supplies will reflect historical averages, that our consumption may grow without limit, and that our economic engines will continue to function in the long term. Our mistakes have been not recognizing the increasingly obvious changes in water supplies and climate, or the costs we have already begun to bear. Rapid growth in human populations, agriculture and industry already affect water quality and quantity in the western prairies. Climate has warmed by 1-4 C since the mid-20th century, summer river flows have decreased by 30-80%, lake levels have declined, and wetlands have disappeared. Unlike other major East Slopes rivers, the Athabasca River has not yet been dammed, making it the primary candidate for large-scales studies of water supply and climate change. Recent changes in water yields in different parts of the Athabasca basin suggest differing regional impacts of and susceptibility to climate change. Using new water yield models, I will highlight the effects of future climate change on water supply in the Athabasca Lowlands as an example of what will likely be a widespread and significant problem in western Canada. Climate warming will exacerbate our already evident problems with water quantity and quality in the western prairies in the years ahead.	Alpine-Prairie	1
CLEARING THE WATERS: THE EFFECTS OF BROOK TROUT REMOVAL ON AN OLIGOTROPHIC, SPECIES-POOR ALPINE LAKE Parker*, B.R. and Schindler, D.W. Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9. (brparker@ualberta.ca) Non-native Brook Trout were gillnetted from originally fishless alpine Bighorn Lake to test whether strong cascading trophic interactions (CTI) can occur in oligotrophic species-poor lakes. Fishless alpine Pipit Lake was used as a reference ecosystem. Zooplankton response to trout removal varied with taxon: adult Diacyclops density increased 1200-fold within a few weeks while the reappearance of Daphnia, after a 3 decade absence, required 13 months. The calanoid copepod Hesperodiaptomus, last observed just after fish stocking, failed to return, due to exhaustion of its resting egg bank. Hesperodiaptomus was deliberately reintroduced after trout were extirpated. Total zooplankton biomass, initially 11% of that observed in reference Pipit Lake, increased 4-fold following trout removal. Total phytoplankton biomass declined 70-fold to become similar to that of Pipit Lake. However, phytoplankton biomass response lagged Brook Trout removal and the return of Daphnia by 3-4 years. Mid-late summer Secchi disc depth increased from a mean of 3.1 m prior to fish removal to maximum lake depth (9.2 m) thereafter. Removal of non-native Brook Trout resulted in massive CTI responses in the planktonic community of oligotrophic, species-poor Bighorn Lake.	Alpine-Prairie	2
REGIONAL VERSUS LOCAL FACTORS OF MOUNTAIN ZOOPLANKTON DIVERSITY: IMPLICATIONS FOR ADAPTABILITY OF GLOBAL CHANGE Vinebrooke, R.D. (1), Holzapfel, A.M. (1), Donald, D.B. (2), and Anderson, R.S. (3) (1) Freshwater Biodiversity Laboratory, Department of Biological Sciences, University of Alberta, Edmonton, Canada, T6G 2E9 (2) Environment Canada, 2365 Albert Street, Regina, Saskatchewan S4P 4K1 (3) P.O. Box 127, New Sarepta, Albert T0B 3M0 Global change increasingly pressures species to migrate in response to habitat loss. For example, climate warming tests the ability of coldwater	Alpine-Prairie	3

species to disperse across insular lakes and ponds. We hypothesized that zooplankton assemblages in mountainous regions are poorly adapted to environmental change because of dispersal-limitation imposed by topographic barriers (i.e. high mountain ranges). A significant positive relationship between mean (local) and cumulative (regional) alpine species richness, along with high species turnover, across 13 lake regions in mountain parks of Alberta suggested dispersal-limitation of zooplankton inhabiting high-elevation sites. We tested whether warming increases invasion of alpine lakes by species actively imported from warmer low-elevation waterbodies by conducting a two-factor (2 temperature x 2 invasion treatments) growth-chamber experiment. Warming significantly suppressed total consumer biomass owing to the decline of large alpine species, resulting in greater autotrophic abundance. Large native omnivores suppressed smaller invaders, while imported herbivores suppressed functionally similar native alpine species. Warming did not significantly affect invader biomass because introduced species thrived under both ambient and warmed alpine conditions. Therefore, our findings demonstrate that the adaptability of remote alpine communities to global change is limited by species dispersal from lower montane and prairie ecosystems.		
A QUANTITATIVE ANALYSIS OF LAKE RELATIVE SENSITIVITY TO VARIATIONS IN CLIMATE AND LAND-USE PRACTICES Dietrich, S. V. (1), McGowan, S. (2), Leavitt, P. R. (1) (1) Department of Biology, University of Regina, Regina, SK, S4S 0A2 (2) Department of Geography, University of Nottingham, Nottingham, United Kingdom Evaluation of the impacts of climatic change and human activities on lakes requires improved understanding of how stressors interact and the degree to which individual sentinel lakes represent broad patterns of ecosystem response to disturbance. To address these issues, we surveyed modern water chemistry (ions, conductivity, salinity, lake level) and sediments (algal pigments, stable isotopes) in 20 lakes that surround Humboldt Lake, Saskatchewan, site of a 2000-year climate reconstruction. Lake sensitivity to climate was identified by the degree to which lakes exhibited evaporative concentration during 2003, 2004, and 2005. Variations in nitrogen cycling arising from terrestrial nutrient inputs were quantified as changes in sedimentary and soil stable isotopes (N), and pigment signals between ca. 1850 and 2003. Evaporative concentration was recorded in most lakes as increased salinity during lake-level decline, although the extent and timing of sensitivity varied among sites, and among years. Similarly, lakes with known inputs of N revealed substantial (>3 per mil) increases in N isotopic ratios during the past century. When placed in a landscape context, there was no spatial relationship between lake sensitivity to climate and human activities, nor was there an apparent interaction between stressors.	Alpine-Prairie	4
A COMPARISON OF LANDUSE IMPACTS ON RIVER WATER QUALITY WITHIN THE SOUTH SASKATCHEWAN RIVER BASIN. Nadorozny, N.D. and Jackson, L. J., Department of Biological Sciences, University of Calgary, AB, T2N 1N4 A regional-scale study of three South Saskatchewan River Basin headwater rivers was conducted to attempt to link land cover and land use to the chemical signature of the rivers. Because the systems are approximately the same size and share similar geological templates (headwaters in the mountains, flowing through foothills and ending in the prairies), the underlying chemical signatures for these systems should be similar. However, land use within each basin differs, (e.g., agriculture, urban and cattle farming are dominant for the Oldman River Basin, Bow River Basin and Red Deer River Basin respectively), and might generate local variability in the chemical signatures across the three rivers. To further complicate matters, the advective nature of rivers might smear land use signatures or displace them downstream of their terrestrial source. To account for instream processes and the unique properties of the chemical constituents (e.g., solubility), we chose to compare conservative and non-conservative chemical elements. Our objectives were to determine if all conservative or non-conservative elements responded similarly within and among basins and secondly, if the same chemical elements responded similarly among the three drainage basins by assessments of: i) the extent to which land cover correlates to water quality at a regional scale, and, ii) the spatial scales and landscape metrics that influence chemical constituents. The results have implications to landscape management strategies that might influence river water quality, thus giving managers guidance regarding land use management.	Alpine-Prairie	5

HEAVY METALS IN PACIFIC OCEAN PERCH FROM BRITISH COLUMBIA: CONCERNS FOR PUBLIC HEALTH? Edwards, A.*, Trudel, M. and Mazumder, A. Water and Watershed Research Program, Department of Biology, University of Victoria, Victoria, British Columbia (email: alied@uvic.ca) Metals such as mercury, cadmium and arsenic occur naturally in the marine environment, but the high concentrations in edible fish tissues can have significant adverse health effects. Elevated levels of these metals in fish are the result of bioaccumulate processes, which are more pronounced in long-lived, large, predatory species. Pacific Ocean Perch, Sebastes alutus, has the highest landed catch of any commercial rockfish from the bottom trawl fishery in the eastern North Pacific. They are known to be carnivorous and live up to 100 years. This study explores the patterns of heavy metal bioaccumulation in Pacific Ocean Perch, by investigating biological variables such as age, length, body mass and feeding habits in relation to concentrations of Hg, As and Cd. This study also explores spatial variability by analyzing samples from several different commercial fishing areas on the West Coast, including Hecate Strait, Queen Charlotte Sound and the West Coast of Vancouver Island. Muscle tissue from more than 250 fish has been analyzed for Hg, Cd and As, as well as for stable isotopes of carbon and nitrogen. The data indicates significant differences in both the concentrations and the amount of variation in concentration in all three metals based on location. Samples from the West Coast of Vancouver Island appear to contain higher concentrations of all three metals. In particular, total mercury concentrations ranged from 0.03 to 3.32 ppm and total arsenic concentrations ranged from 0.8 to 44.6 ppm. We are currently investigating various processes that could be potentially linked to the alarmingly high levels.	Env. Effects	6
APOPTOSIS AS A BIOMARKER FOR CONTAMINANT GENOTOXICOLOGICAL EFFECTS IN DETROIT RIVER BROWN BULLHEAD (AMEIURUS NEBULOSUS). Busch, C.R.1, Hubberstey, A.1 & Heath* D.D.2 1Department of Biological Sciences, University of Windsor, 401 Sunset Avenue, Windsor, Ontario. 1Great Lakes Institute for Environmental Research and Department of Biological Sciences, University of Windsor, 401 Sunset Avenue, Windsor, Ontario. (e-mail: dheath@uwindsor.ca) The persistent loading of Polycyclic Aromatic Hydrocarbons (PAHs) into rivers, lakes, and marine ecosystems is demonstrated by elevated PAH concentrations observed in sediment samples. Exposure of fish species to contaminated sediment is known to cause elevated neoplastic growth, alterations to biochemical pathways, and reduced reproductive success. However, very few studies have evaluated the impact of PAHs on apoptosis – a key mechanism involved in the formation of tumours and regulation of cellular homeostasis. We used a combination of immunohistochemistry techniques (TUNEL) and novel molecular biomarkers to evaluate differences in the level of apoptosis and transcription of apoptotic regulatory genes among brown bullheads (Ameiurus nebulosus) in the Detroit River system at 3 sites with various levels of contamination. Bullhead experiencing elevated PAH concentrations demonstrated higher apoptosis (based on TUNEL) occurring in dorsal muscle tissue biopsies, relative to the control site. Furthermore, significant differences in the transcription of apoptotic regulatory genes were observed; specifically; transcription of p53 was enhanced while an inhibitor of apoptosis (IAP) gene was suppressed in the contaminated sites. Two genes thought to be associated with the apoptotic pathway demonstrated a dose-dependant transcriptional alteration among the study populations. Thus, the apoptotic pathway of feral populations of brown bullheads is measurably changed when exposed to complex mixtures of xenobiotic compounds, containing elevated PAH concentrations. Our results provide potential mechanisms behind previously reported correlations between tumorigenesis and sediment PAH contamination in bottom dwelling fish. Furthermore, future applications of the brown bullhead apoptosis genes as biomarkers for monitoring ecotoxicological responses are validated.	Env. Effects	7

RESPONSE OF NATIVE FISHES TO SALMONID CAGE AQUACULTURE IN NORTHERN LAKE HURON Johnston, T.A.1*, D. M. Whittle 2, and M. Power 3 1 Ontario Ministry of Natural Resources, Cooperative Freshwater Ecology Unit, Sudbury, ON (* e-mail: tjohnston@laurentian.ca) 2 Department of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington, ON 3 Department of Biology, University of Waterloo, Waterloo, ON Aquaculture production in central Canada comes primarily from cage culture of rainbow trout (Oncorhynchus mykiss) and much of this industry is concentrated in northern Lake Huron. The industry is currently small (8 cage sites in the Manitoulin Island region) but, there is potential for growth. Environmental effects of this industry are being investigated to ensure that further expansion is carried out in an environmentally sustainable fashion. Cage culture sites in Lake Huron represent relatively large point sources of organic inputs into an oligotrophic ecosystem. These inputs may change current trophic relationships and alter the distribution and relative abundances of native fishes. We compared the abundance and species compositions of native fish assemblages near and far from existing cage culture facilities. Standardized, multimesh gill net surveys were carried out at five cage culture sites and at five representative reference sites in a paired-comparisons design during the spring and fall of 2004 and 2005. The cage culture sites appear to be net attractants to native fishes. In most cases, abundances were significantly higher near the cage sites than at reference sites for both small- and large-bodied fishes. Species composition did not appear to vary between cage and reference sites. Stable isotope compositions (C, N, and S) of various native species are being compared to those of the feed, domestic fish, and faecal material from the cage culture facilities in order to determine if farm waste is directly or indirectly entering the food webs of the native fishes. This analysis is continuing.	Env. Effects	8
LAKE TROUT AND ROUND WHITEFISH MONITORING AT A DIAMOND MINE Machtans, H.*1, K. Murchie1, R. Schryer2 and R. Johnstone3 1)Golder Associates Ltd., Yellowknife, NT, 2) Golder Associates Ltd., Saskatoon, SK 3)De Beers Canada Ltd., Yellowknife, NT. (hmachtans@golder.com) Adult lake trout and round whitefish were sampled in three sub-arctic lakes (Snap Lake, Reference Lake, and Northeast Lake) in August 2004, as part of the baseline inventory required for future monitoring at the Snap Lake Project, NT. Fork length, weight, and age information were collected from all sampled fish. Sacrificed lake trout were additionally sampled for sex, state of maturity, liver weight, gonad weight and fecundity. The gonads were sectioned for histological examination to confirm the state of maturity. In addition, parasite load and stomach contents were also examined. Lake trout were generally old, slow growing and late to mature. Growth rates were similar between lakes. Age class distribution was similar between the Northeast Lake and Snap Lake lake trout populations; however, the population in the Reference Lake was, on average, represented by younger individuals. The presence of resting female and males is indicative of the low productivity of these lakes. Females may be spawning in alternate years. More baseline data collections from sub-arctic lakes are required for a better understanding of the general ecology of lake trout populations at northern latitudes if they are to be considered for monitoring potential effects due to development.	Env. Effects	9

LAKE STURGEON MONITORING PROGRAM TO ASSESS IMPACTS IN REPSONSE TO A TREATED MINE WATER EFFLUENT OUTFALL IN A NORTHERN ONTARIO RIVER Pullen, C(1)*, R. Mellow(2), A. Langhorne(3), B. Chapman(4), D. Schmidt (4) and S. Lendrum (5) Golder Associates, Ottawa (cpullent@golder.com)(1) and Sudbury(2) Ontario, Saskatoon Saskatchewan(3), Castlegar B.C.(4), and Falconbridge Montcalm Project, Timmins Ontario (5). We investigated a relatively abundant population of lake sturgeon (Acipenser fulvescens) on the Groundhog River near the Montcalm copper-nickel mine, near Timmins in northeastern Ontario. A lake sturgeon spawning area in the vicinity of the mine's treated water outfall was monitored to determine any detectable (direct or indirect) effects of chronic exposure to treated mine water effluent on the population. This report addresses the component of the investigations that assesses the impact of the effluent on the proportion of sturgeon eggs hatched by using a before after control impact (BACI) design. The study is designed to provide a rapid response indicator for adaptive management of the mine effluent. Eggs collected from spawning sturgeon were fertilized and placed in incubators. The incubators were installed in the river at reference (control) and exposure (impact) areas within physically similar habitats. Incubators were checked daily and a subset of eggs were sampled and preserved to determine the stage of embryo development phases. The number of surviving larvae were enumerated and any abnormalities noted. Pre-effluent spawning data were collected in 2003 and 2004, and pre-effluent egg incubation was conducted in 2005. Results indicate that incubators are viable monitoring tools to monitor future effluent impacts with successful hatching occurring at all monitoring locations.	Env. Effects	10
TEMPORAL STABILITY IN THE ANALYSIS OF THE RELATIONSHIPS BETWEEN FISH COMMUNITIES AND THEIR ENVIRONMENT Gibeau, Pascale * and Daniel Boisclair. Département de Sciences Biologiques, Université de Montréal, Montréal, Québec (pascale.gibeau@umontreal.ca) Habitat patchiness in the littoral zone of lakes contributes to the irregular distribution of fishes. Numerous environmental attributes may influence fish distribution around the perimeter of a lake and this influence may vary in time. The objective of our study was to assess whether the responses of fish communities to their environment changed according to the year of sampling. We quantified the abundance, the size composition, and the specific composition of the fish community in four lakes of the Laurentides region of Québec. In each lake, the fish community was described by sampling fifteen 200 m2 stations located in the littoral zone. The data were collected during visual surveys in July and in August 2004 and 2005. We also estimated several physical and biological variables such as depth, macrophyte cover, substrate composition (local scale) and altitude and number of habitation found around the lakes (lake scale). Canonical analysis and analysis of variance were used to study the relationships between the fishes and their environment and the temporal stability of these relationships. Preliminary results show that more than 60% of the variation of the densities of functional groups of fish is explained by the combination of 23 environmental variables observed at the local and lake scale. Moreover, the same associations between groups of fish and specific environmental variables occurred in 2004 and 2005, suggesting habitat modelling may be temporally stable.	Env. Effects	11
TESTING A FISH INDEX OF BIOTIC INTEGRITY FOR GREAT LAKES COASTAL WETLANDS STRATIFIED BY PLANT ZONES Bhagat*, Y.1, J.J.H. Ciborowski2, V.J. Brady3, L.B. Johnson3, D. Breneman3, J. Schuldt3, T.B. Hrabik4, C. Richards5 (yakutabhagat@trentu.ca) 1Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario 2Department of Biological Sciences & Great Lakes Institute of Environmental Research, University of Windsor, Windsor, Ontario	Env. Effects	12

3Natural Resources Research Institute, University of Minnesota 4Department of Biological Sciences, University of Minnesota 5Minnesota Sea Grant College Program, University of Minnesota Fish community composition often varies across ecoregions and hydrogeomorphic types within ecoregions. However, attempts to develop an Index of Biotic Integrity (IBI) for environmentally homogeneous sites of the Great Lakes have had only limited success. We evaluated 2 recently-proposed vegetation-specific indices of biotic integrity (IBIs) developed for Great Lakes coastal wetlands dominated (> 50% cover) by Typha (cattail) and Scirpus (bulrush) vegetation. Thirty-three coastal wetlands meeting the criteria of dominant Typha or Scirpus vegetation were sampled for fish using overnight sets of fyke nets. These sites had been selected to span gradients of population density, road density, urban development, point source pollution, and agriculture, measured using a GIS-based analysis of Great Lakes coastal margin land use. Sites subject to low levels of anthropogenic influence had high IBI scores. The Typha-specific IBI was most highly negatively correlated with a disturbance variable that combined population density, road density and urban development, whereas the Scirpus-specific IBI negatively correlated most strongly with agricultural intensity. Furthermore, relationships between IBI and disturbance scores were non-linear particularly for Scirpus dominant sites, suggesting that beyond a certain disturbance level, a sharp change occurs in fish community composition and function, symptomatic of a degraded site. The proposed indices appear to effectively indicate the effects of some but not all classes of anthropogenic disturbance on fish communities at Great Lakes coastal margins.		
UNDERSTANDING THE ECOLOGY OF SLIMY SCULPIN AND THEIR USE IN ENVIRONMENTAL EFFECTS MONITORING Keeler*, R. Gray, M., and R. Cunjak. Canadian Rivers Institute and Department of Biology, University of New Brunswick, Fredericton, NB (rachel.keeler@unb.ca) The use of small-bodied fishes (i.e. cottids and cyprinids) for environmental monitoring has increased in recent years. However, a lack of basic ecological information has been a limitation to the usefulness of these species. The main objective of this research was to gain a better understanding of slimy sculpin (Cottus cognatus) ecology. A total of 337 sculpin were implanted with 12 mm PIT (passive integrated transponder) tags at six sites in five tributaries of the Kennebecasis River, New Brunswick. Sites were searched, approximately biweekly from June 2003 to July 2004, with a remote PIT tag antenna capable of reading the PIT tags without removing the sculpin from the stream. Many of the sculpin were detected again during the study (85%) and the data set was used to consider two main areas of sculpin ecology: movement and reproduction. Annual movement of PIT tagged sculpin was extremely low (median home range <10 m) and no significant differences were observed among the sites studied. Sculpin nests were located in the spring (May 2004) and examination of the nest sites suggested that slimy sculpin prefer cobble habitat in shallow areas of the stream. This study further demonstrates that sculpin have the ability to reflect local conditions, given their limited mobility. In addition, given the lack of site specific differences, these ecological findings are expected to apply to small streams in other regions.	Env. Effects	13
DEVELOPMENT AND COMPARISON OF FISH AND BENTHIC MACROINVERTEBRATE BIOASSESSEMENT MODELS FOR WADEABLE STREAMS OF THE YUKON RIVER BASIN Bailey*, J. L., R. C. Bailey and R.J. Scott. Department of Biology, The University of Western Ontario, London, Ontario (email:jbaile3@uwo.ca) We sampled fish and benthic macroinvertebrates in wadeable streams in the Yukon River basin in Yukon Territory, Canada during July 2004 and 2005, to establish reference conditions for Yukon River basin stream communities. Water quality (eg. temperature, dissolved oxygen, conductivity, pH), stream flow, substrate characteristics and riparian vegetation were also measured at each site. In addition, catchment area, catchment land cover, and distance of each site to major water bodies and stream barriers were determined using Geographic Information System and satellite	Env. Effects	14

imagery analysis. Bioassessment models were developed based on the fish, benthic macroinvertebrate and their combined communities, and the relationships of these communities with the multi-scale descriptors of the stream environment. These models were applied to data from stressor-exposed test sites and their effectiveness at detecting environmental impacts were compared.		
EFFECTS OF NITROGEN AND SALINITY ENRICHMENT ON ALGAL COMMUNITY COMPOSITION AND BIOMASS IN SHALLOW POND MESOCOSMS. *McGowan, S. (1), Barker, T., (2), Hatton, K. (2), Leavitt, P.R. (3) Moss, B. (2) and O'Connor, M. (2). (1) School of Geography, University of Nottingham, Nottingham, NG7 2&D, UK. (2) School of Biological Sciences, University of Liverpool, Liverpool, L69 3BX, UK. (3) Department of Biology, University of Regina, Regina, SK, S4S 0A2, Canada. There is a growing realization that nitrogen from diffuse agricultural sources may be important in eutrophication, particularly in lowland lakes in northwestern Europe. In such agricultural regions, pumping of surface water for land drainage or groundwater abstraction may cause lakes near coasts to salinize as sea-water is drawn into the groundwater. Fifteen years of monitoring on one such shallow lake, Hickling Broad (UK) showed that when nitrogen and salinity increased, changes in food web structure and increases in the toxic bloom-forming alga Prymnesium parvum were observed. Despite this evidence, the relative effects of nitrogen, salinity and their interactions on phytoplankton are thus far poorly defined. Therefore, we conducted an experiment in 48 x 3000 litre mesocosms at the University of Liverpool's experimental facility that were designed to mimic shallow ponds. We applied four levels of nitrogen and salinity to mesocosms inoculated with sediments from Hickling Broad in a fully factorial experiment arranged in a randomized block design. The experiment lasted for one year and pigments (chlorophylls and carotenoids) from phytoplankton were sampled to assess algal responses. Preliminary analyses suggest that nitrogen and salinity additions caused significant increases in diatom/ chrysophyte groups, green algae, prymnesiophytes and total algal biomass, but that cryptophytes succeeded best at intermediate nitrogen concentrations. Cyanobacteria were uncommon in all treatments. Single effects of nitrogen and salinity more important their interactions throughout the year. Responses to the treatments were greatest during winter and spring months, but tended to weaken during the summer, possibly because of the divergent development of complex grazer and periphytic communities. These results suggest that continued use of nitrogen fertilizers coupled with salinization from excessive land drainage or sea level rise will cause elevated algal biomass in shallow lowland lakes and favour the growth of toxic bloom-forming species.	Env. Effects	15
AQUATIC RESPIRATION AND PHOTOSYNTHESIS IN EUTROPHIC HAMILTON HARBOUR AND OLIGOTROPHIC LAKE ONTARIO. Bocaniov* S.A., R.E.H. Smith, and S. Schiff, University of Waterloo, Ontario, Canada, (sbocanio@scimail.uwaterloo.ca) Rates of aquatic photosynthesis (P) and respiration (R) as well as their ratio (P:R) are useful indicators of the effect of nutrient loading, and therefore, can be used to evaluate the impact of human activities on water quality and fisheries. They can also be applied to formulate and evaluate management policies and water resource conservation strategies. In the present study, we measured photosynthetic and respiration rates to quantify the differences between the rates of P and R, and P:R ratios in two systems: a eutrophic system largely affected by human and industrial activities (Hamilton Harbour) and an oligo-mesotrophic system affected to a lesser degree (western Lake Ontario). The stations were sampled biweekly through the summers of 2003 and 2004. We measured P and R rates by two methods, oxygen light & dark bottle incubations and the 14C method. We also measured the natural abundance of the stable oxygen isotopes (18O/16O) of dissolved oxygen (DO). The δ18O values of DO were below the atmospheric equilibrium value of 24.2 ‰ indicating the presence of the photosynthetic oxygen in both systems with a stronger signal for Hamilton Harbour. The study revealed large seasonal variations in P and R rates as well as in P:R ratios coherent with corresponding signals in 18O/16O enrichment of DO. Also, while rates of P and R were found to be significantly different between two systems, inter-seasonal P and R rates of the same system show no significant differences.	Env. Effects	16

LANDSCAPE LEVEL INFLUENCES ON WATER QUALITY IN THE BOREAL REGION OF MANITOBA: A LAKES SURVEY *Jacobs, K. (1), Goldsborough, G. (1), and Kotak, B. (2) (1) Department of Botany, University of Manitoba, Winnipeg MB, Canada R3T 2N2, (2) Miette Environmental Consulting Inc. P.O. Box 268 Pine Falls, MB Canada There has been increased emphasis on modeling forest harvesting practices after natural disturbance. The assumption, which remains unverified, is that ecosystem integrity can be maintained if harvesting patterns imitate fire. Forest harvesting and fire is expected to increase rates of erosion and nutrient export into lakes. In Canada, the majority of research examining the effects of forest disturbance on lakes has occurred in Alberta and Quebec so the relevance to forest lakes in other regions is unknown. Preliminary research appears to indicate that lake water quality can be maintained if timber harvesting disturbance is limited to a low percentage of a watershed. Lakes in Manitoba, especially those on the sparsely populated east side of Lake Winnipeg, suffer from a chronic lack of baseline data and water quality monitoring infrastructure. This project is intended to address this knowledge gaps with a survey of approximately 100 lakes, with varying levels of watershed disturbance (harvested, burned, and reference), in the boreal forest of eastern Manitoba. Lakes were selected using aerial reconnaissance and remote sensing. A suite of physical and chemical water quality parameters, as well as basic bathymetry, were measured in mid-summer 2004. In 2005 a subset of approximately 30 lakes were sampled at three locations in spring, summer, and fall to gain an understanding of temporal and spatial variation within each lake. Relationships between water quality, historical patterns of land use, and landscape features will be examined. Final results from the 2004 and 2005 field season will be presented examining the relationship between landscape features and limnological trends across the region.	Env. Effects	17
ONTOGENY OF PHENOTYPIC PLASTICITY IN ICELANDIC ARCTIC CHARR ECOMORPHS RESPONDING TO TWO DIET TREATMENTS Parsons*, K.J.1, M.M. Ferguson 1, and S. Skúlason 2. * (email: parsons@uoguelph.ca) 1 Department of Integrative Biology, University of Guelph, Guelph, Ontario 2 Hólar University College, 551 Sauðárkrókur, Iceland To understand the evolution of resource polymorphism requires knowledge of the genetic and environmental factors that affect organisms over ontogeny. The environmental control of phenotypes likely plays a central evolutionary role as organisms colonize novel habitats and utilize new resources. Longitudinal studies of ontogeny in the context of resource polymorphism are rare but when conducted they typically involve a single environment whereby allometric relationships of characters are shown to change over the growth of an organism in ways unique to each ecotype. The use of a single environment limits the ability to reveal additional genetic variation among ecomorphs that may exist in the form of evolved plastic responses. Here, we test for differences in plastic ontogentic responses among ecomorphs of Icelandic arctic charr experiencing two dietary treatments. Arctic charr in Iceland exhibit large amounts of phenotypic variation that is associated with different benthic and limnetic habitats. We raised full-sib families of charr ecomorphs under benthic and limnetic diet treatments and sampled them at two life stages to test the following predictions: 1) rearing environment can both increase and decrease morphological 'gaps' among ecomorphs dependant upon the comparison made, 2) relatively lower levels of plasticity exist in more divergent or specialized populations, and 3) more specialized populations will exhibit a greater environment by ecomorph interaction, indicating genetic variation for plasticity.	Env. Effects	18
COMMUNITY CLOSURE FOLLOWING ACIDIFICATION: BIOLOGICAL RESISTANCE TO RECOVERY * Arnott, S.E. and D. Hasek (1) Department of Biology, Queen's University, Kingston, ON, K7L 3N6 Regional acidification of aquatic habitats has caused severe reductions in biodiversity and changes in community structure. However, reduced	Env. Effects	19

sulphur dioxide emissions over the past several decades have resulted in increased pH and alkalinity in some areas in North America and Europe. Despite this, biotic recovery has lagged increases in lake pH. We propose that acidification-induced changes in aquatic assemblages can provide 'biological resistance' to recovery of crustacean zooplankton assemblages. We tested this hypothesis using two field mesocosm experiments in Swan Lake, a historically acidified but now circumneutral, fishless lake in Sudbury, ON. Potential zooplankton colonists from 4 nearby circumneutral lakes were added to enclosures of three treatments: 1) Control with no Swan Lake residents; 2) Swan Lake zooplankton at ambient densities; and 3) Swan Lake zooplankton plus macroinvertebrate predators at ambient densities. One experiment was conducted in July when Notonectids and Graphoderus liberus, a pelagic diving beetle larvae, were abundant. The second experiment was conducted in August when densities of notonectids and G. liberus were lower and Chaoborus spp. was the dominant predator. Preliminary results suggest that while there are some negative effects of the local Swan Lake community on colonist success, the impact of predation by macroinvertebrates is far greater. Species richness, diversity, and total zooplankton abundance were lowest in the predator treatments. This suggests that active intervention, i.e., restoration of fish populations and subsequent reduction of macroinvertebrate predation, may be necessary for recovery of zooplankton communities in lakes recovering from acidification.		
STABILITY OF ECOSYSTEM FUNCTION IN ACID-STRESSED LAKES *Ramcharan, C.W.(1), Keller, B.(2), and Yan, N.D.(3) (1) Dept. Biology, Laurentian University, Sudbury, ON P3E 2C6 (2) Cooperative Freshwater Ecology Unit, Ontario Min. Environment, Sudbury, ON P3E 2C6 (3) Dept. Biology, York University, Toronto, ON M3J 1P3 In many damaged habitats, ecosystem functions seem to be preserved despite the effects of stressors on species diversity and community composition. Acidified lakes in Ontario provide an ideal opportunity to test the stability of ecosystem functions. During acidification and recovery, zooplankton communities underwent substantial changes in community composition and average body size, as well as fluctuations in overall density. The long-term datasets collected from these lakes include over a million measurements of the body lengths of individual zooplankters. With these body lengths, we used published allometric models to estimate both body weight and the grazing rates of herbivores and omnivores. The most complete data were available for nine Ontario lakes located near Dorset and two near Sudbury. Our analyses show that long-term variation in the function of the grazer community (i.e., clearance rate) is less than would be inferred from fluctuations in zooplankton density. Clearance rate was also unrelated to species diversity, but was strongly correlated with biomass. Our results suggest that the ecosystem function of the zooplankton community is set by factors such as overall system productivity, rather than species composition.	Env. Effects	20
INTERACTIONS AMONG WARMING, DROUGHT AND ACIDIFICATION DETERMINE THE RESPONSE OF BOREAL ZOOPLANKTON TO GLOBAL CHANGE *Christensen M.R.(1), Graham, M.D.(1), Vinebrooke R.D.(1), David L. Findlay(2), Michael J. Paterson(2) and Michael A. Turner(2) (1) Department of Biological Sciences, University of Alberta, Edmonton Alberta, T6G 2E9 (2) Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba, Canada R3T 2N6 Cumulative impacts of global change on freshwater ecosystems involve interactive and direct effects of multiple stressors; however, little is known about the ecological impact of their interactions. To determine the importance of interactions among ecological stressors, we analyzed the 25-yr history of a lake (Lake 302S, Experimental Lakes Area) while it had experienced the triple-whammy impact of acidification, climate warming, and drought. Interactions among temperature, dissolved organic carbon (DOC) and acidity, rather than their direct effects, best explained variation in zooplankton abundance. We corroborated these correlative findings with evidence from an in situ experiment in which a 3-factor (temperature, DOC,	Env. Effects	21

pH) design was replicated three times for a total of twenty-four 1500-L mesocosms. The stressors exerted significant synergistic effects on total zooplankton biomass and community composition owing to the stimulation of a stress-tolerant herbivore (Daphnia catawba). Our empirical evidence demonstrates for the first time that multiple anthropogenic stressors exert unpredictable, non-additive ecological effects, highlighting the high degree of uncertainty in predictions of the future impacts of global change on freshwater ecosystems.		
INCREASED ECOSYSTEM VARIABILITY FOLLOWING IMPOUNDMENT AND LAND-USE CHANGES: EVIDENCE FROM SEDIMENT GEOCHEMICAL RECORDS Das, B., Nordin, R., and Mazumder, A. Water and Watershed Research Program, Department of Biology, University of Victoria, P.O. Box 3020, Station CSC, Victoria, B.C. Canada V8W 3N5 Although stable isotopes (d13C and d15N) and biogenic silica (BSiO2) have been used for many years as proxy indicators of paleoproductivity in lake sediments, none of them have been employed in order to reconstruct productivity changes due to water level changes in drinking water reservoirs. We explored the use of d13C, d15N and BSiO2 as paleoproductivity indicators in sediments from Sooke Reservoir located in Vancouver Island, British Columbia, Canada. Sediment core trace metal concentrations (Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Na, V and Zn) were also compared to detect anthropogenic inputs with contrasting land-use activities. The d13C and d15N as well as BSiO2stratigraphy showed a clear isotopic enrichment following impoundments. In comparison, sediment records in Shawnigan Lake, a nearby lake with similar limnological regime but with contrasting land-use activities, also shows an enrichment of isotopic signatures in post-disturbance periods. It seems likely that both types of anthropogenic disturbances (regulated water-level and land-use changes) have had similar impact on lake productivity reconstructed from stable isotope signatures. In contrast, higher sediment accumulation rate resulting in higher trace metal accumulation following impoundments compared to land-use changes. Results from current study can help to better assess trophic history and trace metal accumulation in lake and reservoir systems that have been affected by elevated loadings due to frequent water-level and land-use changes.	Env. Effects	22
A MESOCOSM STUDY ON THE EFFECTS OF FISH AND MACROINVERTEBRATE PREDATORS ON ZOOPLANKTON COMMUNITIES IN RELATION TO BIOLOGICAL RECOVERY FROM ACIDIFICATION LINLEY*, R.D.; RAMCHARAN, C.W. Department of Biology, Laurentian University, Sudbury ON, P3E 2C6 Years of atmospheric deposition of sulfur from industrial activity has resulted in the acidification of thousands of lakes around the world, one of the most affected areas was Sudbury, Ontario, Canada. Beginning in the 1970's, emission control programs were put in place which lead to impressive chemical recovery of the Sudbury area lakes. More recently the study of biological recovery of lake ecosystems has provided evidence that there are many factors which govern the trajectory of zooplankton recovery. A major influence restricting recovery is an altered predation regime. Often a single acid tolerant planktivorous fish species or a macroinvertebrate species becomes the top predator in a lake, strongly affecting community structure and limiting the ability of zooplankton species to successfully colonize. To study the effects of predation regimes on the zooplankton community we undertook a mesocosm experiment with a factorial design that featured the extremes of predation that might be found in recovering lakes (High Fish x Low Fish x Chaoborus sp.). Initial results suggest that the reintroduction of both planktivorous and piscivorous fish to lakes that are recovering from acidification may actually enhance zooplankton communities by reducing the predation pressure from both vertebrate and invertebrate predators. Establishing a more normal fish community may enhance the restoration of a normal zooplankton community which has been a major objective of remediation programs.	Env. Effects	23

SELECTION AND SAMPLING GUIDANCE FOR THE USE OF FISH SPECIES IN ENVIRONMENTAL MONITORING PROGRAMS. Galloway*(1), B.J., and K.R. Munkittrick(2). (1) Golder Associates Ltd., Calgary, AB (2) Canadian Rivers Institute, University of New Brunswick, Saint John, NB. Fish species used as sentinels in monitoring programs are selected based on a number of criteria, such as; perceived stakeholder value, relative abundance, and knowledge of basic life history information. Fish species should not be excluded from use when life history characteristics are not fully understood. In many large rivers, multiple wastewater effluents (e.g., pulp and paper mill and municipal sewage effluents) are often discharged in close proximity. Attributing responsibility for the existing impacts within a river responding to multiple stressors to a specific industry can be difficult. It is important that the fish species selected should offer the greatest potential for defining the relative impacts of individual anthropogenic stressors in sections of rivers receiving multiple stressors. In Canada, there has been a shift from using large-bodied fish species (e.g., sucker spp.) to small-bodied fish species (e.g., cyprinids and cottids) for monitoring the impacts of stressors. The use of small-bodied fish for monitoring programs has increased because they are relatively easy to capture, many species exhibit site fidelity, and they are relatively abundant. The main disadvantage of using small-bodied fish for monitoring programs is the lack of basic life-history information, which can hinder study design and data interpretation. Some species may not be suitable as sentinel species, given the high variability seen in reference populations during the reproductive season. The Canadian North is an active area of exploration and development related to the petroleum and mining industries. Many rivers and lakes in these areas have species for which basic life history information is lacking. General guidelines for factors to consider when selecting sentinel species will be discussed.	Env. Effects	24
USING NINESPINE STICKLEBACK AS AN ENVIRONMENTAL MONITORING TOOL B. Tibble*1, H. Machtans1, R. Connell2, and R. Schryer3 1)Golder Associates Ltd., Yellowknife, NT, 2)Miramar Con Mine Ltd., Yellowknife, NT, 3)Golder Associates Ltd., Saskatoon, SK Ninespine stickleback (Pungitius pungitius) were used as a study species in an environmental monitoring program on Great Slave Lake, Northwest Territories in fall, 2004. Ninespine stickleback are not a species commonly used in environmental monitoring programs. They were selected because they were the only suitable fish species present in an area exposed to a saline mine effluent, and in a reference area. Fish were collected using beach seines and Gee minnow traps and were measured for length and weight. Fish abundance and catch rate was also calculated. A target sample size of 20 adult males, 20 adult females, and 20 juveniles was processed and examined for age, liver pathology, visceral tissue arsenic, and gonad histopathology. Ninespine stickleback proved easily attainable, in high abundance, and relatively straightforward to process and analyze. Based on the field logistics and results of this study, ninespine stickleback can be an appropriate study species in select situations.	Env. Effects	25
ENVIRONMENTAL CHANGES ACROSS THE GREAT LAKES AND THEIR AFFECT ON WALLEYE HABITAT AND ABUNDANCE Dobiesz*, N.E., University of Toronto (dobieszn@zoo.utoronto.ca) and Lester, N.P, Ontario Ministry of Natural Resources During the 1970s, reductions in phosphorus loadings and other pollution sources dramatically increased water clarity throughout the Laurentian Great Lakes. Filtration by invading exotic mussels beginning in the late 1980s further contributed to improve water clarity. Although the Great Lakes form an interconnected system, the initial state of each lake varied and changes in environmental conditions occurred during different time periods. We document changes in water clarity and water temperature across Lakes Huron, St. Clair, Erie, and Ontario over time and explore the potential effects on walleye (Sander vitreus) populations, a species with a known sensitivity to light. Across the lakes, mean percent light transmission through the	Env. Effects	26

water column increased from 47% to 78% from 1968-2002. Surface temperature during this time increased 2oC in the deepest lakes, Huron and Ontario, with increases of less than 1 oC in the much warmer shallower Lakes Erie and St. Clair. The depth at which the preferred walleye temperatures (18-22oC) occurred decreased in all lakes, with a marked decrease of 2m in Lake Ontario. During this same time period, commercial production of walleye increased 1.3 fold in the cooler Lakes Huron and Ontario and 12 fold in warmer Lake Erie.		
AGRICULTURAL DRAINS AS FISH HABITAT IN SOUTHWESTERN ONTARIO Stammler, K.L.*, Mandrak, N.E., McLaughlin, R. *Department of Zoology, University of Guelph, Guelph, Ontario (email:kstammle@uoguelph.ca) Growing human populations and activities are greatly affecting our natural environment. It is important to acknowledge humans as part of the ecosystem and to determine ways for ecosystems to serve human functions while conserving biodiversity. Open agricultural ditches (drains) represent an ideal ecosystem in which to conduct these investigations because they provide necessary drainage for crop land and may also provide habitat supporting native fish assemblages. This study tested whether warm water agricultural drains in southwestern Ontario provide fish habitat similar to that of natural watercourses. Fish assemblage and habitat characteristics were examined in 24 pairs of agricultural drains and natural watercourses. Pairs were matched by similarity in size, order and location within the same watershed. Sampling effort was standardized for each pair using electrofishing and/or seining to collect fishes and standard protocols to collect habitat data. Drains and natural watercourses did not differ significantly in species richness, total fish abundance and composition, occurrence of reproductive life stages within species, or habitat attributes expected to be altered by drain maintenance. These findings suggest that drains in southwestern Ontario provide fish habitat of similar quality to that of natural watercourses. The findings will be used by fishery and drain managers to develop drain management guidelines that consider the needs of agriculture, while preserving fish biodiversity and habitat.	Env. Effects	27
A LIGHT AT THE END OF THE TUNNEL, USING GAIT TRANSITION TO DETERMINE CULVERT WATER VELOCITY. Johnson*, A.J. and S. Peake. Department of Biology, University of New Brunswick, Fredericton, New Brunswick (email:Alison.johnson@unb.ca) Urbanization of an area often involves the construction of roads and a method for crossing pre-existing waterways often becomes necessary. Culverts or bridges are almost always used and have become a common fixture in our landscape. Improperly designed and installed culverts can pose barriers for fish spawning, migration and feeding in a number of ways: they may become blocked by debris; be elevated relative to the river bed; have insufficient water depth or elevated water velocities. The latter is of particular importance to this study. Current culvert water velocity guidelines are historically based on swimming performance experiments but there has been evidence to suggest potential problems in the methods used to gain this data. This study examines a new and potentially more accurate method of establishing culvert water velocity guidelines using gait transition. Like us, fish employ a variety of gaits which use different types of muscle in an effort to maximize efficiency. As with humans, gait transition in fish is automatic with changes in speed. It is for this reason that gait transition data is potentially more accurate for basing culvert water velocities than prior methods using swimming performance.	Env. Effects	28
HAS A PREDATOR ARRIVED?: ASK THE PREY SPECIES. Lippert, K.,* J. Gunn and G. Morgan. Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Ontario. (email: KLippert@laurentian.ca) Lakes in the Sudbury Region recovering from acidification are now at the frontline of a northern movement of warm-water invasive species, the	Introd. Spp.	6

smallmouth bass (Micropterus dolomieu), and a recolonization of walleye (Sander vitreus) and northern pike (Esox lucius). This study tests the effects of invaders on stunted yellow perch (Perca flavescens) populations that are abundant in these recovering lakes. The international NORDIC biodiversity assessment technique was used to evaluate fish communities in 17 Sudbury study lakes of three predator-regimes: perch only; perch with recent predators; perch with established predators. Additional fall netting at the end of their growing season was conducted to target perch between 100mm to 120mm in total length for the collection of samples relating to life history characteristics in males and females (i.e. gonad weight, fecundity, and egg lipid content), metabolic enzyme activities (e.g. LDH, CS, and NDPK), and body shape morphometrics. Results suggest that recent introductions of predators cause dramatic decreases in yellow perch biomass (g of perch per net) and decreased maximum size of perch in the population. Metabolic activity analysis suggests that both burst (LDH) and continuous (CS) swimming activity is decreased when predators first arrive to the system and that growth potential (NDPK) is elevated after establishment. Female perch in lakes recently invaded by predators show similar gonad weights, but are producing an increased number (fecundity) of low quality (lipid content) eggs. Male gonad weight decreases significantly after invasion. This study suggests that the introduction of predatory fish into simplified fish communities can cause rapid responses from perch in terms of community structure, physiological parameters, and life history characteristics.		
DISRUPTION OF ENERGY FLOW IN BOREAL SHIELD LAKES: IMPLICATIONS OF THE INVASION OF AN INVERTEBRATE PREDATOR, BYTHOTREPHES *Strecker, A.L. and Arnott, S.E. Department of Biology, Queen's University, Kingston, ON, K7L 3N6 The invasion of exotic species into novel habitats is an emerging stressor to ecosystems. The predacious zooplankter, Bythotrephes longimanus, has invaded >100 freshwater lakes in North America, but its impacts on food web dynamics and energy flow are poorly understood. Our objectives were to determine if predation by Bythotrephes on zooplankton prey translated into reduced energy flow to higher trophic levels. Four invaded and four reference lakes on the boreal shield were visited from May to September 2003, sampling for crustacean zooplankton, water chemistry, and Bythotrephes. Secondary production of biomass by zooplankton was calculated every two weeks for each thermal stratum using the egg-ratio method. While large reductions in zooplankton abundance and production were observed in the epilimnion of invaded lakes, there appears to be some compensation, such that total zooplankton abundance and secondary production were higher in the metalimnetic strata of invaded lakes. Although this compensation may help to reduce the negative effect of Bythotrephes on the flow of energy to upper trophic level consumers, the reductions observed in the epilimnion are expected to have serious consequences for other macroinvertebrates, planktivorous fish, and juvenile piscivores. Because zooplankton are a key link in pelagic food webs, higher trophic levels may suffer from decreased body size, reduced growth, and increased competition for scarce resources because of Bythotrephes predation in the warm epilimnion of the lake.	Introd. Spp.	7
RE-INTRODUCTION OF THE CRAYFISH ORCONECTES VIRILIS TO A RECOVERING ACIDIFIED LAKE: RESTORATION OR INVASION? *Phillips, I.D. (1), Vinebrooke, R.D. (1), and Turner, M.A. (2) (1) Department of Biological Sciences, University of Alberta, Edmonton, AB, T6E 2E9 (2) Department of Fisheries and Oceans, Freshwater Institute, 501 University Crescent, Winnipeg, MB, R3T 2N6 Re-introduction of a keystone species has been proposed as a strategy for reversing catastrophic ecosystem shifts and facilitating recovery. However, the sudden reappearance of an extirpated species may have adverse ecological impacts that are analogous to the effects of an invasive species. Therefore, we experimentally re-introduced the resident crayfish species Orconectes virilis into a recovering acidified boreal lake (Lake 302S, Experimental Lakes Area, Canada) following a 17-yr absence to determine the magnitude of its effects on the abundance and composition of zoobenthos and periphyton. A single factor experiment consisting of two treatment levels (crayfish-less control vs 2 crayfish/square meter) was replicated five times for a total of 10 2 x 2 m aquaculture cages deployed in a shallow littoral area in June 2004. During the 50-day experiment, O.	Introd. Spp.	8

virilis significantly suppressed total zoobenthos (RM-ANOVA, $p<0.05$) by 70% primarily due to declines in anisopteran and chironomid abundances. Similarly, O. virilis significantly reduced ($p<0.001$) periphyton biomass by approximately 90% respectively. Stable isotopic data and gut-content analyses showed that these crayfish were omnivorous, feeding on both invertebrates and periphyton. Our findings suggest that the re-introduction of O. virilis must be controlled carefully because this keystone species can function as an invader in the absence of fish predation, exerting pronounced negative effects on the productive capacity of boreal lake for harvestable fish.		
INTRODUCED WILD RICE (ZIZANIA PALUSTRIS) IN LAKES IN WEST CENTRAL MANITOBA: WHAT ARE THE IMPACTS ON THE INVERTEBRATE COMMUNITY? Lowdon*, M., K. Kidd1, and D. Bodaly. Department of Zoology, University of Manitoba, Winnipeg, Manitoba. (email:lowdonm@dfo-mpo.gc.ca) 1 Biology Department, University of New Brunswick, Saint John, New Brunswick With the intentional introductions of wild rice (Zizania palustris) to the west-central region of Manitoba there have been many concerns about the impacts this introduced species will have on invertebrate and fish communities. To examine this, I compared invertebrate abundance, diversity, and community composition between bays with wild rice and bays with native macrophytes in three lakes (Barry, Cacholotte and Naosap) in west-central Manitoba. Environmental variables, including water quality, temperature and dissolved oxygen concentrations, were also compared. Bottle trap, emergence trap, and bucket volume samplers were used to capture invertebrates within both habitats. Paired t-test results showed that the abundance and diversity of the invertebrate community was not significantly different between the wild rice and native macrophyte bays ($P>0.05$). However, invertebrate community composition differed between wild rice and native macrophyte bays. Principal Component Analysis (PCA) showed that Amphipoda, Physidae, and Ostracoda were more abundant within the wild rice bays while Haliplidae, Chironomidae, and Gyrinidae were more abundant within native macrophyte bays. Dissolved oxygen concentrations were consistently lower in the wild rice bays of two of the three lakes when compared to native macrophyte bays, whereas water quality was similar between bays. Water temperatures were variable across bays and were not consistently higher or lower in wild rice bays. Although invertebrate communities in wild rice and native macrophytes bays appeared to be equally abundant, community composition varied between the wild rice and non wild rice bays in this study.	Introd. Spp.	9
INTRODUCED WILD RICE (ZIZANIA PALUSTRIS L.): IMPACTS TO LITTORAL FISHES AND FISH HABITAT IN NORTHWESTERN MANITOBA BOREAL LAKES. Lavergne*, C. and D. Bodaly. Department of Zoology, University of Manitoba, Winnipeg, MB, and Department of Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, MB. (email: clavergne@nscons.ca) The recent introduction of annual wild rice (Zizania palustris) to boreal lakes in northwestern Manitoba has developed into an environmental concern to regional fishery and fish habitat managers, citing specifically the effects this emergent grass may have on littoral fish populations. An exploratory survey was conducted during the summer of 2003 to compare water temperature and dissolved oxygen, as well as fish community compositions, in a littoral bay with, and another without, wild rice (wild rice bays and non-rice bays, respectively) in each of three northwestern Manitoba boreal lakes. Data comparisons revealed that water temperature was similar in the wild rice and non-rice bays during June and August. Dissolved oxygen was also similar during June, but was on average 2.0 mg L-1 lower in the wild rice bays than in the paired non-rice bays during August. These lower oxygen levels were likely due to the decomposition of wild rice straw on the lake bottom. All fish species were captured in higher numbers in the wild rice bays than in the paired non-rice bays during June. These differences in abundance were significant for white sucker, small (≤300 mm) northern pike, and three Notropis shiner species. This finding may be attributed to higher estimates of macrophyte habitat complexity in the wild rice bays than in the paired non-rice bays. Conversely, fish species abundances were inconsistent in the non-rice and wild rice bay pairs during August. This result may be related to increased macrophyte habitat complexity in the non-rice bays following the maturation of several native plant species. Only the Notropis	Introd. Spp.	10

shiners were shown statistically to avoid the wild rice bays during August. This finding may be related to their preference for other lake habitats higher in dissolved oxygen and/or lower in vegetation density.		
DISPERSION, MICROHABITAT SELECTION AND SPECIES ASSOCIATIONS OF INTRODUCED PUMPKINSEED SUNFISH (Lepomis gibbosus) IN TWO SMALL ENGLISH STREAMS, AND COMPARISONS WITH NATIVE BROWN TROUT (Salmo trutta) Villeneuve, F.*1. M.G. Fox2, S. Stakėnas3 and G.H. Copp3. 1Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario (email: francoisvilleneuve@trentu.ca). 2Environmental and Resource Studies Program and Department of Biology, Trent University, 3Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, England. Introduced fishes often colonize waterbodies via the stream systems of alien environments, but little data exist on the distribution, microhabitat selection and native species associations of these fish in stream environments. In the case of pumpkinseed introduced into southern England, habitat selection was of particular concern because a previous macrohabitat study found that pumpkinseed and native brown trout frequently co-occurred and were exploiting similar habitat features. To investigate their habitat use at a finer scale, two small streams in southern England were surveyed by electrofishing from May to August 2004 and from May to June 2005, and habitat variables (depth, channel width, focal substrate, water velocity, shelter) were measured every 5 metres along the surveyed reaches as well as at all specific locations where a pumpkinseed or a brown trout was captured. Numbers of other species were also recorded every 25 m, and were also used to determine associations with pumpkinseed and brown trout. Our preliminary analysis shows that pumpkinseed were most abundant near the outlets of source ponds, and that their downstream distribution was greatly diminished, but aggregated in sites where they were found. Pumpkinseeds were generally found in relatively deep pools, or among submerged root systems formed by riparian trees. Brown trout were also found mostly in pools, but usually closer to fast-flowing water. We tentatively conclude that the habitat overlap between pumpkinseed and brown trout is minimal when considered at a microhabitat scale, illustrating the importance of scale selection in habitat assessment.	Introd. Spp.	11
SEASONAL GROWTH AND REPRODUCTIVE ALLOCATION OF INTRODUCED POPULATIONS OF PUMPKINSEED SUNFISH (Lepomis gibbosus) IN SOUTHERN ENGLAND Villeneuve, F.*1. M.G. Fox2, S. Stakėnas3 and G.H. Copp3. 1Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario (email: francoisvilleneuve@trentu.ca). 2Environmental and Resource Studies Program and Department of Biology, Trent University, 3Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, England. Introduced fish species that are in a ‘lag phase’ (i.e. not yet considered invasive) can be difficult to study due to limited published data. However, these populations represent a ‘natural experiment’ for studying biological invasion processes. One such example is the pumpkinseed (Lepomis gibbosus) in the UK, where populations are currently restricted to southern England. As part of a larger study to examine life history variability in introduced pumpkinseed, populations from three English waterbodies were sampled biweekly from early June to mid-August 2004 to examine female reproductive traits, population growth parameters and productivity indicators, which were compared with previous studies on the species both in its native and introduced range. Preliminary analysis suggests that in Southern England, pumpkinseed populations have a shorter reproductive season, lower gonad to body weight ratios and a lower annual reproductive allocation relative to native populations and those introduced into warmer European waterbodies. Despite a variation in population density of more than two orders of magnitude, the degree of variation in reproductive traits among these populations is low relative to those in other geographic areas. Factors influencing the reproductive potential of pumpkinseed in the UK will be discussed.	Introd. Spp.	12

ROUND GOBY AND LAKE ERIE BEACH FISH COMMUNITIES. Reid, S.M.1*, J. Barnucz2, and N. E. Mandrak2. 1. Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario. email:screid@trentu.ca 2. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, Ontario. In western Lake Erie (Ohio) and Lake St. Clair (Michigan), large increases in the abundance of round gobies (Neogobius melanostomus), concurrent with reductions in the abundance of native benthic species (e.g. logperch, Percina caprodes) have been reported. However, it is not known whether such changes have occurred in Canadian Great Lakes waters. During the late spring and early fall of 2005, we sampled 33 beaches across the north shore of Lake Erie in order to document the nearshore fish community, and to evaluate beach seining as a monitoring tool. Beaches were sampled during day and night with multiple 50 m long seine hauls parallel to shore. Round gobies were collected at all beaches sampled and comprised more than 93% and 53% of the benthic fishes captured in the spring and fall, respectively. Overall, eight of the 41 species captured were non-native. Compared to past surveys, the distribution of darter species along the north shore of Lake Erie has contracted with the nationally threatened channel darter (P. copelandi) found at only four locations along Point Pelee. Trawling data from the Inner Long Point Bay and the western basin of Lake Erie further indicate that reductions in the abundance of johnny darter (Etheostoma nigrum) and logperch are occurring.	Introd. Spp.	13
MORPHOLOGICAL VARIATION IN NON-NATIVE PUMPKINSEEDS INTRODUCED INTO IBERIAN LAKES AND RESERVOIRS; ADAPTATIONS TO DIET AND LAKE MORPHOMETRY? Fox*, M.G.1, A. Vila-Gispert2, L. Zamora2 and R. Moreno-Amich2. 1 Environmental and Resources Studies Program and Department of Biology, Trent University, Peterborough, ON. 2Department of Environmental Sciences, University of Girona, Girona, Spain. The pumpkinseed (Lepomis gibbosus) was introduced into Spain in 1910, and is now widely distributed throughout the Iberian Peninsula, where it has become a dominant species in streams, lakes and reservoirs. To assess its adaptations to the introduced environment, we examined the morphology of pumpkinseed populations in five Catalonian waterbodies (northeastern Spain) that vary in morphometry, and compared these to a native North American reference site that contains two morphological variants of this species. The external and internal morphological traits examined in this study were those known to have functional significance with regard to foraging mode and prey type. Study populations exhibited significant differences in morphometric measures related to fin location, body depth, caudal peduncle length, gillraker spacing and pharygeal molar size. Discriminate Function Analysis provided significant separation of all populations on the basis of both external and internal morphology, with the main axis of separation being geographical rather than functional. However, the secondary DFA axis did separate populations that fed primarily on zooplankton from those that were primarily benthic invertebrate feeders. In this regard, a pumpkinseed population that occupied a steep-sided reservoir with an unstable littoral zone showed similar morphological adaptations to the native limnetic morphological variant, supporting previous studies showing that fish morphology is strongly affected by prey type and feeding mode. The study demonstrates that pumpkinseeds have a high degree of morphological plasticity, and this may partially explain why they are so successful in areas where they have been introduced.	Introd. Spp.	14
EVALUATING CHANGES IN LAKE WHITEFISH LIFE HISTORIES AFTER AQUATIC INVERTEBRATE INVASIONS *Rennie, M.R.(1), Sprules, W.G. (1), and Johnson, T.B.(1,2) (1) Department of Biology, University of Toronto at Missisauga, Mississauga, ON L5L 1C6 (2) Ontario Ministry of Natural Resources, Glenora Fisheries Station, R.R. #4, 41 Hatchery Lane, Picton, Ontario K0K 2T0	Introd. Spp.	15

Agencies on the Great Lakes have reported declines in lake whitefish (Coregonus clupeaformis) growth and condition over the past two decades, and these declines have been widely speculated to result from disruptions in food web structure associated with the invasion of dreissenid mussels. Recent work has shown that changes in the Great Lakes benthic invertebrate community structure after dreissenid invasion may have substantially reduced average energy densities in lake whitefish diets (compared to whitefish diet before dreissenid invasion), and thus play some part in observed whitefish growth declines. According to life history theory, changes in growth are often related inversely to mortality and reproductive schedules. Thus, declines in food quality resulting in reduced somatic growth would be expected to cause a delay in lake whitefish maturity schedules, and potentially result in increased lifespan/reduced mortality. Using a variety of techniques, we examine a time series of the lake whitefish population from South Bay, Lake Huron to evaluate differences in life history parameters (pre- and post-maturation growth, age and length at maturity, maximum size) before and after the invasion of zebra mussels in 1997. Additionally, we discuss how these changes considered within the context of Beverton Holt life history invariants may better inform our understanding of the impact zebra mussels may have had on Great Lakes lake whitefish populations.		
PATTERNS IN PREY AVAILABILITY AND DIET OF AGE-0 LAKE WHITEFISH FOLLOWING THE INTRODUCTION OF A PREDATORY ZOOPLANKTER TO LAKE ONTARIO Ward*, C.L.1, O.E. Johannsson2, J.A. Hoyle3, K.S. McCann1, B.J. Morrison3, and D.L.G. Noakes4. 1Department of Integrative Biology, University of Guelph, Guelph, Ontario. 2Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, Ontario. 3Lake Ontario Management Unit, Ontario Ministry of Natural Resources, Picton, Ontario. 4Fisheries & Wildlife Department, Oregon State University, Corvallis, Oregon. (email: wardc@uoguelph.ca) In the eastern basin of Lake Ontario, adult and juvenile lake whitefish (Coregonus clupeaformis), respectively, have exhibited dramatic declines in growth and abundance since 1995 and 1998. Declines among age-0 whitefish may be attributed to reduced parental investment in reproduction, altered lake thermal regime, and/or reduced availability of zooplankton or benthic macroinvertebrate prey during a period of extensive ecological change in Lake Ontario. Among these changes was the invasion of a predatory cladoceran, Cercopagis pengoi, in 1998. C. pengoi are thought to have reduced the abundance and production of small zooplankton in Lake Ontario in 1999 and 2000, and have been observed in the stomachs of age-0 and planktivorous fishes; as such C. pengoi may have altered the structure and function of the lower food web in Lake Ontario. Here we evaluate one hypothesis for declines in growth and abundance of juvenile whitefish related to zooplankton prey availability and diet quality following the invasion of C. pengoi. We use zooplankton density collected between 1995 and 2004, juvenile whitefish stomach content data collected in 2003 and 2004, and prey electivity indices to test whether C. pengoi restrict the availability of suitable (small) zooplankton prey to juvenile whitefish, and discuss potential impacts of observed patterns on juvenile whitefish growth and year-class strength.	Introd. Spp.	16
LIFE HISTORY VARIATION AMONG NATURALIZED RAINBOW TROUT POPULATIONS ALONG LAKE SUPERIOR'S NORTHERN SHORELINE. Addison, P. A. A.1*, B. J. Shuter1, and. C. C. Wilson2. 1 Zoology Department, University of Toronto, Toronto, Ontario; 2 Ministry of Natural Resources and Trent University, Peterborough, Ontario. (email:paddison@zoo.utoronto.ca) Introduced species are often exposed to strong selective pressures in their new environments, resulting in rapid evolutionary responses and contemporary evolution. Naturalized potadromous rainbow trout (Oncorhynchus mykiss) in tributaries between Thunder Bay and Sault St. Marie, Ontario, have had at least 85 years since initial colonization, with limited influence from subsequent supplemental stocking. These naturalized populations provide an ideal opportunity for studying local selection and adaptive divergence in life history traits among naturalized populations. Adult rainbow trout from 17 tributaries are being used as a model system to study life history variation and habitat-related inter-population divergence of an	Introd. Spp.	17

introduced species. Life history data (length and sex data and scale samples) and DNA were collected via non-lethal sampling of individuals during spring spawning runs between 1991 and 2005. Scale pattern analysis was used to determine smolting age, age at maturity and total age for 90 to 500 individuals from each tributary, and genetic structuring among tributaries was assessed using 11 microsatellite loci for 40 to 50 individuals per site. Preliminary results show limited genetic structuring and inter-population divergence, but substantial inter-population life history differences in age at smolting and age at maturity both within and among genetic neighbourhoods. These contrasting data suggest that life history differences among populations may be driven by local selective pressures, and are causing more rapid divergence than is readily detectable using neutral genetic markers. These data have strong implications in the context of rates of local adaptation of invasive or introduced species, and may provide insights into adaptive potential and rates of evolutionary response in native species as well.		
MERCURY CONCENTRATIONS IN NORTHERN PIKE AND WALLEYE FROM RESERVOIRS AND LAKES ON THE LOWER NELSON RIVER (MANITOBA) BEFORE AND AFTER THE INVASION OF RAINBOW SMELT *Jansen, W.A., Remnant, R.A. North/South Consultants Inc., 83 Scurfield Blvd.,Winipeg, MB, R3Y 1G4 Over the past 10-15 years, rainbow smelt (Osmerus mordax) has invaded Lake Winnipeg and the lower Nelson River (Manitoba), including several riverine reservoirs which have been flooded over the last 15-35 years. Mercury concentrations, particularly in northern pike (Esox lucius) and walleye (Sander vitreus), have consequently increased in these systems and are now declining to pre-impoundment levels. Because rainbow smelt may be trophically elevated relative to common forage fish such as cisco, spottail shiner, and yellow perch, and are known to increase bioaccumulation rates of pollutants in predatory fish by lengthening the food chain, it can be hypothesized that this recent invader will increase mercury concentrations and prolong the return times to safe consumption levels. Between 1999 and 2004 we assessed the importance of rainbow smelt to the fish community of two lakes and three reservoirs on the lower Nelson River, their contribution to the diet of northern pike and walleye, and determined mercury concentrations of rainbow smelt, other common forage species, and of northern pike and walleye. Our results indicate that rainbow smelt are well established in the study area and contribute prominently to the diet of northern pike and, particularly, walleye. However, there is little evidence that mercury concentrations of the two predatory species have increased since the invasion of rainbow smelt. Results from one lake indicate that this is likely because mercury concentrations in rainbow smelt are relatively low compared to other forage species.	Introd. Spp.	18
PRELIMINARY OBSERVATIONS OF A RECENT INVADER, RAINBOW TROUT (ONCORHYNCHUS MYKISS), IN TROUT RIVER, NEWFOUNDLAND AND IT'S POTENTIAL TO AFFECT NATIVE SALMONIDS. Clarke*, K. D., D. A. Scruton and T. R. Porter. Science Branch, Fisheries and Oceans Canada, PO Box 5667, St. John's NL. A1C 5X1. (clarkekd@dfo-mpo.gc.ca). Rainbow trout have successfully established a self sustaining population in Trout River, located on the west coast of Newfoundland. Due to the many similarities of rainbow trout to the native salmonids, Atlantic salmon (Salmo salar) and brook charr (Salvelinus fontinalis), it's affect on their populations has been questioned. Habitat utilization of the three species has been evaluated via under water observations. Data to be presented will investigate the overlap in the utilization of water depth, holding velocity, substrate and cover. These observations will be compared to previously published data where these species coexist, including other Newfoundland streams with sympatric brook charr and rainbow trout. In addition the relative abundance of the three species within Feeder Brook, a tributary of Trout River, and a preliminary assessment of each species' swimming ability will be presented.	Introd. Spp.	19

TROUT STOCKING AND BIODIVERSITY: AMPHIBIANS AND TROUT IN SMALL LAKES OF THE SOUTHERN INTERIOR OF BRITISH COLUMBIA McGarvie-Hirner*, Joanna L. and Sean P. Cox. School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia (email:jlmcgarv@sfu.ca) Many lakes in British Columbia (BC) are stocked with rainbow trout (Oncorhynchus mykiss) to encourage recreational fishing. Although native to the region, when rainbow trout are stocked in lakes previously barren of trout, these fish are an introduced species in the sense of being nonnative to the individual lakes. Evidence from studies in the western United States suggests that introduced trout may cause substantial decreases in abundance of lake breeding amphibians. In this study, we are examining the association between rainbow trout presence and amphibians in small (<30 ha) lakes of BC's Southern Interior region. We sampled amphibian populations in lakes with and without rainbow trout (n=19 for each lake type, 38 lakes total) during the spring/summer of 2004. Analysis of presence/absence and aquatic trap catch data suggests that trout presence is associated with reduced probability of presence and reduced relative abundance for the long-toed salamander (Ambystoma macrodactylum), Columbia spotted frog (Rana luteiventris), and Pacific treefrog (Hyla regilla). However, this result was statistically significant only for the long-toed salamander (p=0.02, using a randomization test of difference in mean catch between lakes with and without trout). In contrast, for the western toad (Bufo boreas), probability of presence and relative abundance was higher in the presence of trout, although the results of statistical tests are inconclusive. Further analysis will include using generalized linear models to examine how lake habitat characteristics other than trout presence/absence influence the observed relationship between the presence of trout and amphibian relative abundance.	Introd. Spp.	20
DETERMINING EFFECTS OF INTRODUCED TROUT AND AERATION ON COMMUNITIES IN BOREAL FOOTHILLS LAKES Tonn, W., C. Paszkowski, C. Schank*, L. Nasmith*, and G. Scrimgeour1. Department of Biological Sciences, University of Alberta, Edmonton, Alberta. 1 Alberta Conservation Association. (*emails: cschank@ualberta.ca; lnasmith@ualberta.ca) The Alberta Conservation Association and Alberta Sustainable Resources Development stock salmonids into small lakes where sport-fishing opportunities are otherwise lacking. Introduced salmonids are known to cause serious negative effects in some freshwater ecosystems, especially naturally fishless unproductive alpine lakes. Stocking effects in productive and/or fish bearing lakes are not well known. The University of Alberta in partnership with ACA recently initiated a study of 11 lakes in the boreal foothills to document the effects of trout stocking and aeration on forage fish, invertebrates, and amphibians. The 11 lakes receive one of three treatments: stocked (n=3), stocked and aerated (n=2), and unstocked (n=6). To determine forage fish distribution and abundance, we used transect trapping and mark- recapture respectively. Perimeter, transects, and drift fence surveys were used to assess adult and young-of-the-year amphibian abundances. Ten benthic-littoral sweep samples were taken for macroinvertebrates on each lake. Water chemistry samples were taken to determine total and dissolved nitrogen, total and dissolved phosphorous, pH, conductivity, chlorophyll-a, and vertical profiles of temperature and dissolved oxygen. Preliminary results show that our lakes contained six species of forage fish (fathead minnow, brook stickleback, Iowa darter, pearl, northern redbelly, and finescale dace, and dace hybrids) and three species of amphibians (wood and boreal chorus frog, and western toad). Dace species and wood frogs are the most abundant fish and amphibian taxa present at our study lakes respectively. Intensive sampling will continue in 2006 and continue in 2007 to document community responses to sports fish.	Introd. Spp.	21

PHYSIOLOGICAL AND BEHAVIOURAL EFFECTS OF INTROGRESSION OF SALMONID FAST-GROWING DOMESTIC GENOTYPES INTO NON-SELECTED GENETIC BACKGROUNDS Tymchuk*, Wendy1,2, Carlo Biagi1, Ruth Withler3, and Robert Devlin1,2. 1 Fisheries & Oceans Canada, Centre for Aquaculture and Environmental Research, 4160 Marine Dr., West Vancouver,BC 2 Department of Zoology, University of British Columbia, Vancouver, BC, Canada 3 Fisheries & Oceans Canada, 4160 Hammond Bay Road, Nanaimo, BC Canada Domestication in fish often involves direct selection for improved growth rates as well as other correlated traits, and can therefore have a significant impact on life history. Many fitness-related traits, such as growth, competitive ability and anti-predator behaviour, have been found to have a genetic component. Due to an altered selection regime, the cultured fish may not be as adapted to the natural environment as wild fish. This research summarizes the growth, behaviour and physiology of fast-growing (domesticated aquaculture), slow-growing (non-selected), and hybrid (F1, F2 backcross, and F3 backcross) strains of coho salmon (Oncorhynchus kisutch) and rainbow trout (O. mykiss). Growth of the strains was compared under both culture and semi-natural rearing conditions. Under all environments, there was a strong correlation between growth and the proportion of domestic genes within the genotype. Comparisons of anti-predator behaviour and hormone profiles illustrated similar trends. Assessment of the expression of fitness-related phenotypes in the hybrid strains can provide information on the genetic changes that have evolved during the domestication process. Knowledge of the genetic changes responsible for altered growth rates in fish is crucial information needed to increase our ability to predict the consequences of introgression between fast and slow-growing strains of fish.	Introd. Spp.	22
INFLUENCE OF LIGHT INTENSITY ON ACTIVITY AND HABITAT UTILIZATION OF WALLEYE (SANDER VITREUS) IN TWO NORTHWESTERN ONTARIO LAKES Metcalfe*, B.1, N. Lester2, R. Mackereth3, B. Jackson4 1Centre for Northern Forest Ecosystem Research, Lakehead University, Thunder Bay, Ontario (email: bwmetcal@lakeheadu.ca); 2Harkness Laboratory of Fisheries Research, Ontario Ministry of Natural Resources, Peterborough, Ontario; 3Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources, Thunder Bay, Ontario, Atikokan Area Office, Ontario Ministry of Natural Resources, Atikokan, Ontario A recent habitat suitability model (HSM) for walleye (Sander vitreus) hypothesises that light is the primary controlling variable influencing the spatial and temporal dimensions of walleye feeding habitat. To test the HSM and evaluate the optical and thermal characteristics of walleye habitat we used telemetry to estimate foraging activity of 23 walleye in two lakes during periods of changing light intensity. The water clarity in the lakes differed (mean Secchi = 2.5m and 4.6m); however, the thermal environment, although variable, did not differ consistently between the lakes. Walleye in the stained lake were located in warmer (mean temperature = 17-19oC), shallower (mean depth = 3–7m) water, close to the depth range predicted by the HSM. In contrast, walleye in the clear lake were generally located at depths (mean depth = 6–8.5m) shallower than predicted by the model (14–19m), likely because predicted optimal light levels occurred at depths where the temperature was too cold (7–9oC). The individual activity of walleye was highly variable but the general patter of behaviour was similar between the two lakes. Walleye activity tended to be low in the afternoon and increased as light levels declined at dusk (e.g. mean change in displacement rate = 35% between 3–5 pm, and 550% between 7–9 pm). Our results support the hypothesis that light conditions are a key element of walleye habitat; however, other factors, such as temperature, also strongly influence walleye behaviour.	Introd. Spp.	23

FISHERY MANAGEMENT AT THE INTERSECTION OF COMPETING ENVIRONMENTAL CONCERNS: SEA LAMPREY CONTROL USING BARRIERS, TRAPS, AND FISHWAYS McLaughlin*, R. L. Department of Integrative Biology, University of Guelph, Guelph, Ontario (email:rlmclaug@uoguelph.ca) Increasingly, our environment is consisting of human influenced ecosystems that require resource managers to make decisions in the face of multiple, and sometimes competing, environmental concerns. In-stream barriers provide such an example. On one hand, they represent a valuable ecosystem tool for controlling the spread and reproduction of invasive species. On the other hand, they can fragment streams and rivers, and the populations of native fishes inhabiting these systems, which has heightened interest in dam removal. This talk will describe a rigorous and directed research framework supporting and fostering innovation in the design, implementation, and operation of barriers, traps, and fishways used in the control of sea lamprey (Petromyzon marinus) in the Laurentian Great Lakes. A primary responsibility of the Great Lakes Fishery Commission (GLFC) is to provide a sea lamprey management program that is ecologically and economically sound and socially acceptable. The GLFC has pledged to increase its reliance on barriers and traps to achieve its control targets for sea lamprey, thereby creating a need for barrier and trap designs selectively blocking and capturing sea lamprey while passing non-target fishes. The research framework develops a explicit, transparent research strategy, identifies 14 broad research needs, and advances a work plan to help the GLFC achieve sea lamprey suppression while minimizing effects on non-target species. It also provides a foundation for cultivating the Great Lakes basin as an international research centre for fish migration and passage, and the development of environmentally friendly barriers.	Introd. Spp.	24
A NEW APPROACH TO PREDICTING METAMORPHOSIS IN LARVAL SEA LAMPREY. Andrew Treble12*, Michael Jones1, Todd Bradley Steeves2 (*Email: treblean@msu.edu) 1 Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 2 Sea Lamprey Control Centre, Department of Fisheries and Oceans, Sault Ste Marie, ON Control of the invasive sea lamprey (Petromyzon marinus) in the Great Lakes relies on the application of lampricide to nursery streams prior to the metamorphosis of larvae and their subsequent migration to the lakes as parasitic juveniles. Control agents use a length-based model to predict metamorphosis in larval sea lamprey populations, in combination with stream population surveys, to select streams across the basin for lampricide treatment. Unfortunately, the length-based model contains uncertainty that reduces its accuracy as a tool for stream selection. Much of this uncertainty derives from the use of back-calculated length data from lamprey collections made during previous treatments, which requires assumptions about larval growth rates immediately prior to the onset of metamorphosis. We conducted mark-recapture studies on nine Great Lakes tributaries using coded wire tags to measure actual growth and transformation rates over a whole year and thus avoid the assumptions of the back-calculated method. We also developed a model to non-invasively predict lipid content within sea lamprey larvae, based on measures of length, weight and condition factor, and combined this with other biotic and abiotic measures in a logistic regression framework to improve our ability to predict metamorphosis. Finally, using data from mark recapture and treatment collections, we compared the ability of the back-calculated method with that of the logistic model to predict metamorphosis in larval sea lamprey. Improvements in our ability to predict metamorphosis will be used to refine the stream selection process and lead to better control of sea lamprey in the Great Lakes.	Introd. Spp.	25
VARIATION IN GROWTH AND RECRUITMENT DYNAMICS OF LARVAL SEA LAMPREYS (PETROMYZON MARINUS): IMPLICATIONS FOR MANAGEMENT Anderson*,G.J. and M.L.Jones. Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI (email: ande1125@msu.edu)	Introd. Spp.	26

Sea lampreys (Petromyzon marinus) are invasive to the Great Lakes and have negatively impacted the native fish community. Sea lampreys are managed largely through the application to Great Lakes tributaries of a lampricide that targets the non-parasitic larval stage. Some tributaries are highly regular in their cycles of lamprey production and need for lampricide treatment, while others vary widely, indicating the presence of greater natural variability in recruitment and larval growth rates in the latter group. Understanding the sources of this variation could allow for better prediction of treatment schedules, help to shape an effective assessment procedure, and increase understanding of lamprey ecology. We analyzed survey data from 1959-2004 for differences in recruitment and growth to age 1 between regularly and irregularly treated streams. Preliminary results show that no difference exists in mean length at age 1 among the stream types, but regular producers have lower levels of variability in growth to age 1 than irregular producers, indicating that consistent growth rates could be associated with consistent treatments. Regular producers have higher mean recruitment levels and higher variability in recruitment than irregular producers, indicating that once a threshold level of recruitment is passed variation above that level does not influence regularity of treatment. This knowledge of population level processes that influence the dynamics of sea lamprey production can help to shape future assessment and control procedures by directing assessment to the appropriate life stage and by facilitating the integration of historical data into the stream selection procedure.		
DEMOGRAPHIC ANALYSIS OF SEA LAMPREY (Petromyzon marinus) IN THE GREAT LAKES: MANAGEMENT IMPLICATIONS Luis A. Vélez-Espino and Robert L. McLaughlin. Department of Integrative biology. University of Guelph. Ontario (lespino@uoguelph.ca) Control of sea lamprey in the Great Lakes has been dependent primarily on the treatment of tributaries with lampricides. Resilience of sea lamprey to this control measure and public concern for collateral effects of chemicals poured into tributaries have motivated the use of alternative strategies to reduce the abundance of sea lamprey. Nonetheless, the effects that these control strategies have in the population dynamics of this species are largely unknown. In this paper we use perturbation analysis to gain insights into the demographic properties of this pest and assess the response of sea lamprey population growth to management alternatives. Our perturbation analysis consisted on projections of population dynamics from stage-structured matrix modeling incorporating variation in life-history traits. The demographic impact of both variation in sex ratio adjudicated to management and sea lamprey's wide variation in age at metamorphosis are specifically addressed. Our results showed that 1) sea lamprey maximum intrinsic rate of increase is achieved when metamorphosis occurs at age 8, 2) plasticity in age at metamorphosis increases population fitness, 3) it is possible to produce a long-term decline in sea lamprey population with lampricide applications alone causing simultaneous 50% reductions in survival rates of pre-juvenile lampreys in a Great Lakes-wide scale, and 4) the contribution of alternative methods although modest still can help to reduce the intensity of lampricide treatments necessary to produce a long-term decline in the abundance of sea lampreys. It is recommended to develop alternative methods that target vital rates other than those currently impacted, because our demographic analysis indicates that it is possible to reduce the use of lampricides and still have effective sea lamprey control.	Introd. Spp.	27
SUCTION STRENGTH AND ATTACHMENT BEHAVIORS OF SPAWNING-RUN SEA LAMPREYS Ulrich G. Reinhardt*, Robert Adams, Eastern Michigan University, Biology Department and Tom Binder. University of Guelph, Department of Integrative Biology e-mail: ureinhard@emich.edu Despite its importance throughout the sea lamprey life cycle, little is known about sea lamprey oral disk attachment behavior. The goal of this study was to quantify suction creation and attachment behavior, and then assess whether adult sea lamprey use suction to climb over low-head migration barriers. We measured suction pressures exerted by lamprey upon surfaces ranging from smooth to notched. Through increased oral pumping frequency, the lampreys were able to maintain suction on slightly notched surfaces, but no seal was maintained when notches were deeper than	Introd. Spp.	28

2mm. In a behavioral preference experiment, lamprey showed some preference for surfaces that facilitated attachment. In a third lab experiment, lamprey were observed trying to scale a vertical barrier with varying inclination angles and water flows. Lamprey were incapable of climbing a ramp of 30cm regardless of the angle. Lamprey were not capable of climbing wetted surfaces once their dorsal fin had left the water. A 50% probability of successful passage was found for a barrier height of only 30-40% of body length. Attachment to the barrier by suction was observed, but did not help the lamprey climb. Jumping as a strategy to pass the barrier was not observed. Our findings suggest that lamprey attachment behavior may be exploitable for trap design or lamprey fish ladders, but not in situations when lamprey encounter near-vertical surfaces.		
IS THE PAIN WORTH THE GAIN? – EFFECTIVENESS OF A PROTECTED SLOT SIZE LIMIT FOR WALLEYE (SANDER VITREUS) ON THE FRENCH RIVER, ONTARIO Morgan*, G.E. Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, Ontario (email: gmorgan@laurentian.ca) The French River is a popular recreational fishery destination in northeastern Ontario. Responding to angler concerns over the decline in the quality of the walleye (Sander vitreus) fishery, the Ontario Ministry of Natural Resources conducted over 30 creel surveys and 40 netting assessment between 1942 and 1992. However no changes were made to the fishing regulations. A public partnership was initiated in 1992 to steer a management process to change the fishing regulations. Using the results from creel surveys, angler attitude surveys and standard index netting methods, the group instituted a very wide protected slot size limit of 380 to 640mm total length in 1995. Assessment has continued to evaluate the effectiveness of this regulation. Walleye abundance has increased over 40% and males are growing faster. Other biological parameters have exhibited no change. Implications for recovery time and rational for size limits will be discussed.	Rec. Fish.	6
THE FREQUENCY DISTRIBUTIONS OF COMMERCIAL CATCH RATES: BEHAVIOURAL BIASES AND STATISTICAL REPRESENTATIONS Gillis, Darren M.* Department of Zoology, University of Manitoba, Winnipeg, MB, R3T 2N2 (email: dgillis@umanitoba.ca) Commercial catches provide a fundamental source of data for hypothesis tests in fisheries research and management. However, unlike planned surveys, these data are not based upon principles of randomized designs. The deliberate pursuit of specific species (targeting), through selection of fishing location and methodology, can make catch rates weakly responsive to changes in abundance relative. Additionally, harvesting behaviours can theoretically influence the statistical distribution of catch rates. A number of catch rate distributions have been employed in fisheries research: lognormal, negative binomial, gamma, delta-lognormal, and more recently the tweedie distribution. In reviewing data from a marine mobile-gear and a freshwater fixed-gear fishery relationships can be seen between species values and both fishing success (non-zero sets) and the quantitative distribution of successes. This implies that the statistical analysis of commercial data, especially our choice of error distributions, can be influenced by the behaviour of harvesters. Changes in fishing conditions driven by economics or regulations should be examined for their impact on the distribution of catch rates, not just the distribution's central tendency. Developing statistical methods allow more realistic data and error distributions that incorporate both zero catch rates and skewed distributions of positive catch values. Both aspects of the data are likely influenced by harvester behaviour.	Rec. Fish.	7
COMPARING LAKE TROUT (SALVELINUS NAMAYCUSH) AND WALLEYE (SANDER VITREUS) ANGLING EFFORT IN NORTHEASTERN ONTARIO: WHEN, WHO, AND HOW? Kaufman*, S. D.1, Morgan, G.E.1, Malette, M.D.1, Lowman, D.2, and Sellinger, W.2	Rec. Fish.	8

1 Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, ON. 2 Ontario Ministry of Natural Resources, Espanola Area Office, Espanola, ON. (sdkaufman@laurentian.ca) Aerial pressure counts from 710 lakes in northeastern Ontario were conducted between 2001 and 2003, covering both winter and open water seasons. Angling effort increased with lake surface area during both for walleye and lake trout fisheries, however open water angling for lake trout was proportionally higher on larger lakes. When controlling for lake surface area, there was significantly more winter effort on lake trout and mixed (both lake trout and walleye) fisheries than walleye fisheries. The major user group to affect both walleye and lake trout effort were cottagers; angling during both seasons was higher on lakes with cottages. The type of road access also showed seasonal differences between the fisheries. For walleye, effort was higher during the open water season on lakes more easily accessed, but was equal between open water and winter on more inaccessible lakes. Lake trout effort declined with increasingly difficult access during both winter and open water seasons, but winter effort was actually higher on more remote lakes. The overall results suggest that angling effort for lake trout in the winter may warrant special attention, with cottagers and road accessibility the driving forces behind observed seasonal patterns of angling effort.		
LINKING ANGLING QUALITY AND LEARNING UNDER CATCH AND RELEASE REGULATIONS: WHY ARE THE FISH NOT BITING? Paul J. Askey1*, John R. Post1, Eric A. Parkinson2 and Shane Richards1 1) Ecology division, University of Calgary, Calgary, AB email: pjaskey@ucalgary.ca 2) Ministry of BC Environment, University of BC, Vancouver, BC Many recreational fisheries are subject to varying degrees of catch and release fishing through regulations and conservation minded anglers. Clearly releasing a proportion of the catch improves the conservation of the fishery, yet it is less clear how the released catch contributes to angling quality. If fish change their behavior to lower their individual catchability after they have been caught then angling quality may not be proportional to fish density. Therefore, even catch and release fisheries could exhibit poor angling quality if there is sufficiently high angler effort. We tested this idea on a 1.2 hectare lake containing rainbow trout (Onchorynchus mykiss) in the interior of British Columbia. We found that with sustained effort of 8 angler hours per day catch rates quickly dropped within 7-10 days. The individual catch histories of the fish were analyzed using a Jolly-Seber multiple mark-recapture approach and Akaike Information Criterion was used to compare models describing catcahbility. The most parsimonious model given the data (lowest AICΔ), incorporated learning and heterogeniety in intrinsic catchability. The best fit parameter values suggest that the population contained a group of highly catchable fish that were quickly caught and then learned to avoid hooks. Thus their catchability soon dropped to a level similar to the rest of the population. Our results indicate that angling quality may decline due to high angling effort even when fish number remains constant. Therefore management goals that go beyond conservation issues and attempt to maximize angler satisfaction must account for effort density on a recreational fishery.	Rec. Fish.	9
ANTICIPATING ANGLING EFFORT RESPONSE IN OPTIMIZING STOCKING PROGRAMS. Parkinson, Eric A. and J. Post. BC Ministry of Environment. Vancouver, BC. eric.parkinson@gov.bc.ca Recreational fisheries managers rarely attempt to anticipate angler effort response to management activities even though this response is a key factor in the success or failure of many management policies. In particular, alternative policies for stocking hatchery fish are frequently evaluated in terms of fish production rather than angling activity. This is especially true in situations where there are a variety of options for size and density at release, which ultimately affect the density and size of fish available to anglers. We use a simulation model for rainbow trout stocked into small monoculture lakes to illustrate the process of estimating effort responses to changes in management policies. Our model integrates empirical data on: hatchery production cost as a function of size, growth and survival of stocked fish in the lake as functions of size and density at release, harvest rates as a	Rec. Fish.	10

function of angler density and angling quality as a function of lake accessibility. Although our focus is on hatchery populations, similar techniques can be used to anticipate the effort response to changes in management policies (e.g. regulation changes) in wild populations.		
ARE ALBERTA'S WALLEYES SHRINKING? Stephen C. Spencer1, Michael G. Sullivan1 and A. Lee Foote2. 1 Fish and Wildlife Division, Alberta Sustainable Resource Development, Spruce Grove Alberta and University of Alberta, Edmonton, Alberta. 2. University of Alberta, Edmonton, Alberta. (email: Stephen.Spencer@gov.ab.ca) A recent concern of managers and recreational anglers in Alberta is the lack of large walleyes (Sander vitreus) in fisheries with minimum-size regulations. Anglers are frustrated by the lack of harvestable fish and believe that the fisheries have become stunted. Alberta fishery managers face one of the most difficult challenges in all of North American, with very few waterbodies, numerous anglers and low natural productivity. In the mid-1990's, restrictive minimum length regulations were implemented to recover collapsed walleye fisheries. This strategy was partially successful on growth over-fished lakes, but has created fisheries with large numbers of small fish and few fish surpass the size limit. Analyses indicated that it was difficult to determine if the high densities of small walleyes was caused by (1) overharvest with size-selective mortality or (2) compensatory growth responses to high density. Therefore, an adaptive management study was employed to determine the cause of the apparent stunting. Four lakes with truncated walleye size distributions had management regulations manipulated to change angling effort, and thus, walleye densities. Anglers were quickly able to reduce walleye densities and further truncate the population size structure. Compensatory population responses to reduced density were overwhelmed by this increase in harvest. Conversely, the lakes with reduced angling effort had increased numbers and survival of larger walleyes. This study suggests that the dominant effect of minimum-size limits in low productivity walleye lakes with high angling effort is to truncate population size structure.	Rec. Fish.	11
REPLACEMENT OF TOP FISH PREDATORS BY CORMORANTS: IS FISHERY RESTORATION POSSIBLE? Davis*, C., A. McGregor, and M. G. Sullivan, Alberta Fish and Wildlife Division. (email: Chris.Davis@gov.ab.ca) Extensive and prolonged overfishing resulted in collapse of the dominant predatory fish species – walleye and northern pike in Lac La Biche - a large, eutrophic lake in northern Alberta. Along with the loss of these important recreational fish species, there has been a significant change in the fish community and, to a degree, replacement of the pre-existing fish predators with an avian piscivore – the double-crested cormorant. This ecosystem may now be stable, or at least resilient to reversal, in its present state. In addition, the long timeframe of ecosystem shift has lead to a change in perception by stakeholders. While they are unsatisfied with the current state, stakeholders are resistant to a return to the former state. In particular, the drastic changes now necessary to restore the ecosystem are viewed as extreme and unnecessary. The proposed approach involves complete closure of all fishing, aggressive walleye stocking, and dramatic reductions in cormorant nesting populations. A key plank in the program is an adaptive management plan including ongoing monitoring of changes in the fish community and behavioural responses of cormorants to control measures. This presentation outlines the plan for lake restoration, and solicits opinion from the audience about the efficacy of the approach.	Rec. Fish.	12
IS BIGGER BETTER FOR WALLEYE (SANDER VITREUS) RECRUITMENT: A MODELLING APPROACH Venturelli*, P. A., B. J. Shuter, T. A. Johnston, N. P. Lester, and C. A. Murphy. Department of Zoology, Univeristy of Toronto, Toronto, Ontario (email: paulv@zoo.utoronto.ca) Models of stock size and recruitment are often used to establish fishing regulations that will protect the long-term viability of a population. A major assumption of these models is that the survival of offspring is independent of parentage. This assumption might not hold for a number of species,	Rec. Fish.	13

however, including the walleye (Sander vitreus), one of Canada's most popular game fishes. We summarize results from collaborative research and the literature that suggest that the size and age of adult walleye affects the quality of eggs and sperm and, ultimately, the viability of offspring. We incorporated these relationships into a size-structured population model, and examined their affect on the dynamics of walleye populations under various scenarios of harvest. Our results demonstrate the degree to which the recruitment potential of a harvested population can be overestimated when parental effects are ignored, particularly when regulations are such that they encourage the harvest of large individuals. Fisheries managers should consider the size- or age-structure of a population when deciding policy, and explicitly assess the benefits of adopting regulations that promote escapement of large, old individuals.		
THE EFFECTS OF ISOLATION AND COLONIZATION HISTORY ON THE GENETIC STRUCTURE OF MARINE-RELICT POPULATIONS OF ATLANTIC COD IN THE CANADIAN ARCTIC Hardie*, D., Bower, M. and J. Hutchings. Department of Biology, Dalhousie University, Halifax, Nova Scotia B3H 4J1 (email: dhardie@dal.ca) Understanding the genetic effects of extend periods at unnaturally low population size is fundamental to the conservation of severely depleted species such as the Atlantic cod (Gadus morhua). We compared microsatellite genetic variability among cod populations isolated in Canadian Arctic lakes and bay resident and inshore cod from Eastern Canada. The Arctic populations had the lowest genetic diversity and were the most strongly genetically structured and distinct. In contrast, Eastern Canadian samples had high allelic diversity, and were not significantly genetically structured or distinct relative to each other, while bay-resident cod were intermediate to the Arctic and Eastern Canadian groups. Our results support the hypothesis that the Arctic populations were colonized between 8000 and 5000 years ago, and have experienced little or no gene flow since that time. We discuss reasons why, despite isolation under difficult conditions at the extreme of the species' range, the Arctic populations appear to have maintained relatively high heterozygosities and high relative genetic effective population sizes (Ne/Nc ratios). These include the absence of fishing pressure allowing the persistence of large, highly fecund individuals, as well as biotic (e.g. absence of planktivores) and abiotic (e.g. low environmental stochasticity) factors in the Arctic lakes that minimize individual variance in reproductive success.	Rec. Fish.	14
ECOLOGICAL DIVERGENCE OF NORMAL AND DWARF MORPHOTYPES OF WALLEYE (SANDER VITREUS) IN LAKE WINNIPEG Moles, M.D. 1*, T.A. Johnston 2, B.W. Robinson 1, W.C. Leggett 3, R.A. Cunjak4, W. Lysack5, M.D. Wiegand6, and C.C. Wilson7 1 Department of Integrative Biology, University of Guelph, Guelph, ON (* email: mmoles@uoguelph.ca) 2 Ontario Ministry of Natural Resources, Cooperative Freshwater Ecology Unit, Sudbury, ON 3 Department of Biology, Queen's University, Kingston, ON 4 Department of Biology, University of New Brunswick, Fredericton, NB 5 Fisheries Branch, Manitoba Conservation, Winnipeg, MB 6 Department of Biology, University of Winnipeg, Winnipeg, MB 7 Ontario Ministry of Natural Resources, Aquatic Research and Development Section, Peterborough, ON Ecological-based polymorphisms occur in many fish taxa found in north temperate lakes. Such populations appear structured due to phenotypic variation associated with different habitats and resources. The walleye (Sander vitreus) of Lake Winnipeg is the only walleye population, to our knowledge, where polymorphisms have been detected. In the south basin of the lake, a slower growing 'dwarf' morphotype coexists with 'normal' growth walleye. We sampled spawning aggregations of both morphotypes in Lake Winnipeg in spring 2004 in order to compare phenotypic and genetic differences between them. Both morphotypes were captured in the same spawning location and appear to spawn at roughly the same time. Distinct size-at-age differences between the two groups were confirmed, and ages for dwarf fish indicated that they have greater longevity than	Rec. Fish.	15

previously reported. Dwarf walleye exhibited lower fecundity and larger egg size (adjusted for maternal size) than the normal morphotype. Using individuals of similar size, geometric morphometric analysis demonstrated that the two morphs differ significantly in the size of the head, snout, eye, and mouth, and location of fins, in ways consistent with functional expectations that dwarf morphotypes inhabit a benthic niche. However, stable isotope analysis did not support this hypothesis as the C and N signatures of dwarf walleye did not differ significantly from either immature or mature normal walleye. Microsatellite and mitochondrial DNA techniques are currently being used to determine the genetic structure of the population and to test hypotheses of allopatric or sympatric origins, and the role of phenotypic plasticity in this system.		
EXPLOITATIVE COMPETITION IN AN UNEXPLOITED FISH COMMUNITY: ASSESSING THE IMPACTS OF HARVEST AND COMPETITOR REMOVAL Cameron J.A. MacKenzie*, Brett T. van Poorten and John R. Post. Division of Ecology, Department of Biological Sciences, University of Calgary, Calgary, Alberta, Canada. (cjmacken@sfu.ca) Competitive interactions influence population and community structure and are important factors to consider before manipulating a system through a change in policy. In this study, we (a) quantified the current potential for exploitation competition in an unexploited fish community of rainbow trout (Oncorhynchus mykiss) and lake chub (Couesius plumbeus) and (b) simulated two plausible manipulations to the community: complete removal of lake chub and introducing rainbow trout recreational angling. Rainbow trout and lake chub had a high (98%) diet overlap in our study lake and shared the same trophic position. Although lake chub were numerically dominant, the rainbow trout population consumed six times more food annually due to their much larger size. However, the highly competitive nature of lake chub in this system was demonstrated by similar diet and trophic positions and by the large growth and abundance potential realized by rainbow trout given lake chub removal. Interestingly, lake chub received more benefit to growth from the introduction of angling than the rainbow trout.	Rec. Fish.	16
THE IMMEDIATE AND SHORT-TERM IMPACTS OF CATCH-AND-RELEASE ANGLING ON MIGRATING PRE-SPAWNING CONDITION RAINBOW TROUT (ONCORHYNCHUS MYKISS) IN THE BOW RIVER, ALBERTA Rhodes*, T.R. and J. R. Post. Alberta Sustainable Resource Development, Fish and Wildlife Division, Fisheries Management Branch, Calgary, Alberta (email: Trevor.Rhodes@gov.ab.ca). Anglers on the lower Bow River in southern Alberta target concentrations of migrating rainbow trout (Onchorynchus mykiss) that are staging in the spring at the mouth of the major spawning tributary. The population size was estimated to be 37,187 mature individuals. Approximately 70% of the rainbow trout were found by radio-telemetry to migrate into the Highwood River drainage where they are vulnerable to the spring recreational fishery. Anglers catch rates were 0.76 and 2.44 rainbow trout per hour with total catches of 2187 and 9599 in 2001 and 2002, respectively. It was estimated that only 66 fish (0.18 % of the mature population) died in the 2002 fishery as a result of post-release hooking mortality. Immediate and short-term mortality from being caught, landed and released is negligible for spawning condition fish. The risk to the rainbow population from this fishery is minimal.	Rec. Fish.	17
ABUNDANCE, DISTRIBUTION AND IDENTIFICATION OF THE SHORTJAW CISCO (COREGONUS ZENITHICUS) IN THE PROPOSED LAKE SUPERIOR MARINE PROTECTED AREA Pratt* T.C. and N.E. Mandrak. Great Lakes Lab for Fisheries & Aquatic Sciences, Fisheries & Oceans Canada (prattt@dfo-mpo.gc.ca)	Rec. Fish.	18

The shortjaw cisco (Coregonus zenithicus) has been extirpated or seen dramatic declines in its abundance throughout its' native range. This has led to the shortjaw cisco being listed as Threatened under the Canadian Species at Risk Act. The difficulty in distinguishing this species from other deepwater ciscoes, in addition to overfishing and changes in fish community structure, has likely contributed to the low abundance of shortjaw cisco in Lake Superior. In this survey, we aimed to 1) determine the abundance of shortjaw cisco, and compare the current deepwater fish community, with historic surveys, 2) examine the depth distribution of Coregonus spp., and 3) determine which morphological characteristics best allow for identification of deepwater ciscoes, in a portion of Lake Superior near Rossport, that is located within the proposed boundaries of the Lake Superior National Marine Conservation Area. We documented the presence of shortjaw cisco at all our fishing sites, and shortjaw cisco made up, on average, 10 percent of the deepwater cisco assemblage. An average of 5.5 shortjaw cisco / net km were captured. These abundance levels were significantly reduced from surveys performed in the 1920's, but abundance levels were higher than any other area of Lake Superior. We were able to successfully differentiate shortjaw cisco from other coregonids based on an occluded lower jaw and the number of gillrakers.		
OPTIMUM AGE AND SIZE OF MATURITY WITH AN APPLICATION TO WALLEYE (Sander vitreus) Lester, Nigel P. and Brian J. Shuter. Aquatics Research, Ontario Ministry of Natural Resources, Peterborough, Ontario (Nigel.lester@mnr.gov.on.ca) In previous work we have shown that a biphasic von Bertalanffy growth model predicts associations among growth parameters, reproductive investment and mortality that are largely consistent with observed patterns in fish. Here, we use this model (and life history theory) to predict relationships between optimum age and size of maturity. Optimum age of maturity decreases as mortality rate increases; optimum size increases with mortality rate, rising rapidly towards a plateau. The elevation of this plateau depends on egg size and early life survival rate. A smaller size at maturity (for a given age of maturity) is predicted when egg size is small or early survival is high. Variation in size and age of maturity of walleye (Sander vitreus) populations in eastern Canada is interpreted through this model. Walleye living in stained or turbid lakes grow slower and mature at a smaller size than walleye living in clear lakes. The reduced size of maturity suggests that early survival is higher when water clarity is low. Implications are discussed for walleye fisheries in Ontario lakes where changes in water clarity have occurred in recent years.	Rec. Fish.	19
INFORMATION NEEDS FOR ASSESSING CRITICAL HABITAT OF FRESHWATER FISH Jordan Rosenfeld*, B.C. Ministry of Environment, 2202 Main Mall, Vancouver, B.C. V6T 1Z4 (Jordan.Rosenfeld@gov.bc.ca) Todd Hatfield, Solander Ecological Research Limited, 1324 Franklin Terrace, Victoria, B.C. V8S 1C7 The core assumptions of critical habitat designation are a positive relationship between habitat and population size, and that a minimum habitat area is required to meet a recovery target. Effects of habitat on population limitation scale from 1) effects on performance of individuals (growth, survival, fecundity) within a life-history stage, to 2) limitation of populations by habitats associated with specific life-history stages, and 3) larger-scale habitat structure required for metapopulation persistence. The minimum subset of habitats required to achieve a recovery target will depend on the extent, quality, and spatial configuration of habitats available to sequential life-history stages. Although populations may be limited by available habitat for a single life-history stage, altering habitat quality for subsequent stages will also affect individual survival and population size, providing multiple leverage points within a life-history for habitat management to achieve recovery targets. When habitat-explicit demographic data are lacking, consequences of uncertainty in critical habitat assessment need to be explicit, and research should focus on identifying habitats most likely to be limiting based on species biology.	Rec. Fish.	20

DOUBLE-CRESTED CORMORANT DIET ON BOREAL LAKES: IMPLICATIONS FOR FOOD WEB STRUCTURE AND FISHERIES MANAGEMENT Earle, S.N.*, and C. Paszkowski. Department of Biological Sciences. University of Alberta (email: suzanne.earle@ualberta.ca) In lake ecosytems, knowledge of the direct and indirect effects of apex predators and piscivory is essential to managing fisheries and maintaining water quality. Trophic interactions between waterbird, fish and invertebrate species can significantly influence lake ecosystem properties including productivity, decomposition rates, nutrient cycling, and resistance to perturbations. Understanding these interactions remains a challenge to predicting ecological dynamics and effectively managing these ecosystems. To determine if population increases of the Double-Crested Cormorant (Phalacrocorax auritus) are influencing ecosystem dynamics and trophic structure via top-down effects on boreal lakes, we used a combination of conventional diet, and stable isotope analyses on three different lake communities in north-central Alberta, Canada. Regurgitation samples collected from bird colonies during 2003 and 2004 nesting seasons show a dominance of small bodied (55 – 80 mm) fishes including yellow perch, sticklebacks and spottail shiner. Yellow perch was the most frequently captured species (70%) and comprised the largest percent biomass (67%) in diets. Diet composition is likely a reflection of prey availability within the lake since netting data have also yielded a high abundance of juvenile yellow perch in Lac La Biche, the main foraging site. Isotopic ratios of 15N and 13C are consistent with the prey items identified by conventional diet analysis. Double-Crested Cormorants occupy a similar trophic level to predatory fish including walleye and northern pike. New strategies for managing both fisheries and waterbirds may be essential to achieve a desired change in the current ecosystem state of many large boreal lakes.	Rec. Fish.	21
FORAGING EFFICACY AND REPLACEMENT OF TOP PREDATORS IN AQUATIC FOOD WEBS McGregor*, A., L. Foote, M. Sullivan, and C. Davis. Department of Renewable Resources, University of Alberta, Edmonton, Alberta. (e-mail: sialia@telus.net) Discussion of aquatic food webs has historically been centered on the structuring role of large, dominant fish species such as walleye and northern pike. The role of avian predators like cormorants, pelicans, and gulls that feed in aquatic systems is often overlooked, despite their potential influence on fish community dynamics. Recently, dramatic increases in fish-eating birds have raised concerns over their impact on game fish. Avian predators' alteration of either the abundance or behaviour of prey species within aquatic food webs has been identified as a driver in these systems. The concept of alternate stable states in ecological systems 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. Recent increases in cormorant populations in North America and Europe have been closely linked to changes in fish communities, specifically fewer large predators and increased forage fish (yellow perch in Alberta). These changes in predator-prey dynamics suggest an alternate state in cormorant-dominated systems; however, both the stability, and threshold variables controlling state shifts remain uncertain. Identifying the positive feedback mechanisms between apex predators and the aquatic environment which cause shifts between states is necessary for developing policy options suitable for the existence of either state.	Rec. Fish.	22
SPORTFISH SPATIAL DISTRIBUTIONS IN THE SOUTH SASKATCHEWAN RIVER BASIN AND THEIR RELATIONSHIP TO CHANGING THERMAL, CHEMICAL AND MORPHOLOGICAL RIVER FEATURES Robins*, G. L. and Post, J. R., Department of Biological Sciences, University of Calgary, Calgary, Alberta. (email:glrobins@ucalgary.ca) Climate change is anticipated to increase air temperatures and decrease precipitation in Southern Alberta which will likely cause biologically significant changes in river thermal habitat for sportfish species. The impact of changes to river habitat in southern Alberta on sportfish spatial	Rec. Fish.	23

distributions is dependent on the relative importance of temperature compared to other spatial variables in defining the ranges of these fish species. The utility of physical and spatial parameters in predicting the presence of fish species has not been determined in the major rivers of Southern Alberta. A spatial database of presence and absence data for 16 species of sportfish in the South Saskatchewan River Basin and water temperature, chemistry and river basin morphology was analyzed. The functional relationships between the probability of presence for several key sportfish species and abiotic parameters were determined using logistic regression. Preliminary analyses indicate that current day spatial distributions of economically important fish species are significantly influenced by mean July water temperature.		
CLIMATE IMPACTS PLANKTONIC PRODUCERS AND CONSUMERS IN BOREAL LAKES Graham, M.D. (1), Christensen, M.R. (1), Vinebrooke, R.D. (1), Findlay, D. (2), and Paterson, M. (2) (1) Freshwater Biodiversity Laboratory, Department of Biological Sciences, University of Alberta, Edmonton, Canada, T6G 2E9 (2) Department of Fisheries and Oceans, Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba, Canada, R3T 2N6 Climate warming impacts boreal lakes by increasing the variability of allochthonous inputs (e.g., nutrients, dissolved organic carbon (DOC)) and heating of surface waters. Under drier and warmer conditions, reduced allochthonous inputs result in these lakes becoming clearer, thereby increasing their sensitivity to summer heating events. Alternatively, wetter and colder conditions increase allochthonous inputs, causing lakes to become more coloured (high DOC), nutrient-rich, and thermally stable. Correlative evidence from a reference boreal lake (L239, Experimental Lakes Area, Ont.) suggests that interactions among temperature and allochthonous inputs expectedly determine the impacts of climate change on planktonic consumers and producers in boreal lakes. We corroborated these correlative findings with an in situ mesocosm experiment to test for the interactive effects of temperature and terrestrial runoff on planktonic consumers and producers. The factorial design consisted of three allochthonous input levels (ambient, amended, reduced) and three temperature levels (ambient, cooled, warmed), and was replicated three times for a total of 27 mesocosms. Warming amplified significantly the positive effect of reduced allochthonous inputs on total zooplankton biomass (i.e. a synergistic interaction). In contrast, allochthonous inputs significantly stimulated total phytoplankton biomass. Our findings demonstrate that interactions among climate-related factors have different effects on consumers and producers, thereby complicating predictions of the future impacts of climate change on food webs in boreal lakes.	Climate change	19
MISSING THE TARGET: IMPLEMENTATIONAT UNCERTAINTIES IN SOCKEYE SALMON FISHERIES IN BRITISH COLUMBIA AND ALASKA Holt, C.A.*, and R.M. Peterman, School of Resource and Environmental Management, Faculty of Applied Sciences, Simon Fraser University, Vancouver, British Columbia Uncertainties are widespread and pervasive in sockeye salmon (Oncorhynchus nerka) fisheries. Implementation uncertainty refers to the difference between annual target spawner abundance (escapement) and the realized abundance (or between target and realized exploitation rates). This topic has received little attention despite potential large impacts on management success. When managers ignore implementation error, escapements may be higher or lower than targeted, resulting in sub-optimal long-term harvests and/or conservation concerns. The objective of this study was to quantify the relation between target harvest rules (i.e., relation between forecasted recruitment of adult salmon and target escapement), and realized harvest functions (i.e., relation between realized recruitment and escapement) for 10 sockeye salmon stocks in British Columbia and Alaska (1962 – 2003). For most stocks, realized escapements were higher than targeted at low recruitment, and the opposite was true at high recruitment. We then evaluated the performance of various harvest rules in a Monte Carlo simulation model that accounted for implementation uncertainty. To simulate implementation uncertainty, we used the function describing the relation between the target harvest rule and the realized harvest function in combination with stochastic variation in realized harvest rates.	Climate change	20

REGULATION OF SALMON NURSERY LAKE PRODUCTION BY MARINE DERIVED NUTRIENTS AND CLIMATE DURING THE PAST 1000 YEARS. Leavitt, P.R. (1), Brock C.S. (1), Schindler D.E. (2), Johnson S.P. (2) and Quay P.D. (3) (1) Limnology Laboratory, University of Regina, Regina, Saskatchewan, Canada, S4S 0A2. Peter.Leavitt@uregina.ca (2) School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington, USA, 98195; (3) School of Oceanography, University of Washington, Seattle, Washington, USA, 98195. Coastal lakes can serve as nursery systems for anadromous semelparous salmon (e.g., Oncorhynchus nerka), species that transport marine-derived nutrients (MDN) into freshwaters. Despite speculation, little is known of the role of MDN in regulating primary or secondary production of nursery lakes. To address this issue, we estimated past MDN flux (using sedimentary δ15N) and algal production (using fossil pigments) for four O. nerka nursery lakes and two reference ecosystems that lacked anadromous fishes. During the past 200 years, production of algae (mainly diatoms) within nursery lakes with abundant salmon was significantly and positively correlated ($r = 0.54$-0.87, $p<0.001$) with sedimentary δ15N. In contrast, algal abundance was inversely correlated with sedimentary δ15N ($r = -0.41$ to -0.66) in reference lakes in which terrestrial nutrient inputs may be regulated by meteorology. In principle, therefore, the absolute sign of the δ15N-pigment correlation can be used to distinguish among lakes or periods of time in which production is regulated mainly by MDN flux (positive correlation) or climatic events (negative or no correlation). We tested this hypothesis during the past 1000 years at Nerka Lake, one of the principal sockeye nursery lakes of SW Alaska. Preliminary analyses of isotope and pigment covariance suggests that while MDN have regulated lake production since 1700, climatic controls may have been paramount during ca. 1350-1700. Further, comparison of salmon densities based on escapement and sedimentary estimates suggests that salmon production has been independent of algal production since at least 1800.	Climate change	21
HOW ENVIRONMENTAL VARIATION MAY DRIVE LIFE HISTORY PARAMETERS IN LAKE TROUT McDermid1*, J., B.J. Shuter1,2, and N.P. Lester2. 1University of Toronto, Toronto, ON, 2Ontario Ministry of Natural Resources, Peterborough, ON (email: jmcdermid@zoo.utoronto.ca) Lake trout exhibit substantial life history variation across their range. Populations at the northern and southern extremes of the distribution are markedly different, but considerable local variation also occurs. This observed life history variation makes it difficult to build models for predicting sustainable levels of fishing pressure and effective harvest regulations. Three hypotheses have been proposed to explain the observed life history variation: (1) the colder temperatures at higher latitudes are responsible for most of the variation across the range, (2) differences in the diets of lake trout populations are responsible for most of the variation within regions, and (3) life history characteristics vary between populations as a function of lake area and total dissolved solids. To address these hypotheses, multivariate statistical techniques (Procrustean Analysis and Canonical Correlation Analysis) were applied to a large number of lake trout lakes from Quebec to Yukon to summarize life history variation (age and length at maturity, maximum length and age, growth, and condition factor) and relate these patterns to climate, lake morphology, and water quality. The results showed a significant association between climatic conditions and lake trout life history characteristics ($p=0.0001$). Data on lake morphology and water quality was sparse across the range, thus we were only able to access these parameters for two regions: (a) British Columbia, and (b) Ontario and Quebec. The relationship between water quality and life history characteristics was not significant for either region, however lake morphology was significant for the Ontario and Quebec region ($p=0.02$) but not British Columbia ($p=0.3$). The information from this study could provide insight into the impacts of climate change on lake trout.	Climate change	22

CLIMATE CHANGE IMPACTS ON ARCTIC FRESHWATER ECOSYSTEMS AND FISHERIES – ACIA CHAPTER 8. Reist, J.D.*(1), F.J. Wrona (2), and T.D. Prowse (2) (1) Fisheries and Oceans Canada, Winnipeg, MB (reistj@dfo-mpo.gc.ca); (2) Water and Climate Impacts Research Centre, U of Victoria, Victoria, BC. The Freshwater Ecosystems and Fisheries chapter of the Arctic Climate Impact Assessment (ACIA, http://www.acia.uaf.edu/) assessed climate change impacts on these systems and their biota. Significant arctic-wide direct effects of climate change will occur on both terrestrial and freshwater habitats; these in turn will cascade as indirect effects upon processes within freshwater systems, their biota, and to processes and biota (including humans) dependent upon these systems. The effects and consequences will be variable within and among arctic areas, hence regional and sub-regional assessments will be required to more fully understand the future states of these ecosystems and their components. The following general types of effects will result: 1) Changes in runoff, water levels and river-ice regimes; 2) Changes in biogeochemical inputs from altered terrestrial landscapes; 3) Altered wetlands and ponds; 4) Effects from altered lake-ice cover; 5) Effects on higher level biotic components (e.g., fish and fisheries); and, 6) Synergisms of climate change with other impacts (e.g., contaminants, exploitation). Each of these in turn embody many specific impacts that will very likely alter these ecosystems, however, assessing particular effects especially at a local level was limited by key knowledge gaps. The most substantive general issue hampering understanding of climate change impacts was the absence of detailed and comprehensive data regarding the ecosystems. Thus, the development of an aquatic monitoring and research programme at sites representative of the range of aquatic systems throughout the Arctic is required to quantify the nature, regionality and progress of climate change and related impacts.	Climate change	23
Climate impact and adaptation responses of salmon and water managers on the Somass River to the 2002 fall drought in British Columbia Kim Hyatt1, Josie Cleland, and Margot Stockwell, Fisheries and Oceans Canada (hyattk@pac.dfo-mpo.gc.ca) Salmon populations on the southern end of their range are considered to be highly vulnerable to climate warming impacts. Southern British Columbia experienced a severe fall drought in 2002. On Vancouver Island's Somass River, limited water supplies and high temperatures created multiple threats to fish and fisheries associated with natural and cultured populations of salmon. Water supplies and withdrawals are regulated at several locations in the Somass system to meet the needs of fish, industry (hydro, pulp mill, aquaculture facilities) and urban populations. Review of impact and adaptation responses of fish, fisheries and water managers to the drought indicated the following. Fish experienced delayed migration, delayed spawning, shifts in habitat selection, and decreased survival. Managers responded through emergency retrieval of daily information on resource status and an order of magnitude increase in consultations with stakeholders. The 2002 drought confirmed the vulnerability of major assets in both natural and "built" environments on the Somass and other BC rivers to climate change. Future extremes may dictate negotiation of multiple-asset "tradeoffs" involving significant economic losses. Development of impact models and adaptation options including "standing order responses" to extreme climate events could reduce the magnitude of future water resource conflicts, fisheries management crises and costly litigation in Canada. However, the creation of integrated assessment models and overarching processes to increase our adaptive scope to climate change outcomes in fisheries will require much greater levels of interdisciplinary and inter-sectoral co-operation than current institutional arrangements produce.	Climate change	24
Low flows and increased temperatures are concerns for salmonid management of the Nicola River basin as the human demand for water increases and climate changes in south central British Columbia. Marvin L. Rosenau. Fish, Wildlife and Recreation, British Columbia Institute of Technology, 3700 Willingdon Avenue, Burnaby, BC V5G3H2 (marvin.rosenau@gov.bc.ca)	Climate change	25

Mark Angelo. Fish, Wildlife and Recreation, British Columbia Institute of Technology, 3700 Willingdon Avenue, Burnaby, BC V5G3H2 (mangelo@bcit.ca) Prior to the European settlement of the Nicola River watershed in the Thompson River drainage of British Columbia this basin was a salmonid-rich ecosystem. Historically, extensive withdrawal of water for agriculture and other human uses has affected the fisheries habitat capacity of this watershed but substantial aquatic-ecosystem values still remain. The Nicola basin is located in a climatically dry basin of the province and experiences very warm temperatures during most summer periods. Climate change may be further exacerbating the impacts to salmonids. For several decades now, fisheries professionals and interested stewardship groups have pointed to declining salmon runs as evidence that all was not well with the state of fish stocks and the management of flows in this watershed. In 1983 government agencies completed the Nicola Basin Strategic Plan, which contained provisions for the protection and recovery of salmon and steelhead through safeguards and proactive management of the area's water resources, in order to address these issues. Subsequent to the executive sign-off of this plan several decades ago, there was a slowing in the rate of further licensed allocations of water within the basin. Nevertheless, in spite of these efforts intense pressure still persists for the provincial government to allocate additional water for both development and agricultural purposes within the Nicola River basin. As a result, an updated water use plan is now being developed by the senior environmental agencies, in consultation with the stakeholders, with the objective of providing protection to the salmonid resources in the face of continued demand for water for development and agriculture in this watershed.		
THE OKANAGAN FISH-WATER MANAGEMENT (OKFWM) TOOL: BALANCING WATER OBJECTIVES IN REAL-TIME AND PROMOTING SOCKEYE SMOLT PRODUCTION GAINS Kim Hyatt, Pacific Biological Station, Science Branch, Fisheries and Oceans Canada, Hammond Bay Road, Nanaimo, BC V9T 6N7, hyattk@pac.dfo-mpo.gc.ca; Clint Alexander*, ESSA Technologies Ltd., 1479 Aspen Court, Kelowna BC, V1Y 3R3, 250.860.3824(w), 604.648.9900 (f), calexander@essa.com; Brian Symonds, 3547 Skaha Lake Road, Suite 201, Penticton BC, V2A 7K2, brian.symonds@gems9.gov.bc.ca; Andrew Wilson, Ministry of Water, Land and Air Protection, Penticton BC, Andrew.Wilson@gems4.gov.bc.ca; David Marmorek, dmarmorek@essa.com; Brian Guy, Summit Environmental, 17A-100 Kalamalka Lake Road, Vernon BC, V1T 7M3 bg@summit environmental.com; Howie Wright, Okanagan Nation Fisheries Commission, 3255 C Shannon Lake Road, Westbank BC, V4T 1V4, hwright@syilx.org; Brent Philips, bp@summit environmental.com; Harvey Andrusak, Redfish Consulting Ltd., 5244 Highway 3A, Nelson BC,V1L 6N6, Harvey_Andrusak@telus.net; Deana Machin, deanamachin@syilx.org; Chris Bull, Glenfir Resources, S16 C10 RR1, Naramata, BC, glenfir@vip.net. Water levels on Okanagan Lake are managed to provide a balance between fisheries, flooding, and other interests. Water levels must provide sufficient water to meet target flows for Okanagan Lake kokanee and downstream sockeye salmon populations, and minimize flooding of both lakeshore and downstream properties. Owing to a variety of factors, Okanagan River sockeye are the only significant remnant stock of more than a dozen anadromous salmon stocks that historically returned to Canada through the US portions of the Columbia River. The Okanagan Basin Technical Working Group (OBTWG) identified improvements to Okanagan River flow management practices as one means of achieving significant sockeye production gains. With this goal, the OBTWG oversaw the development of OKFWM, an Internet-accessible software application as the central tool for defining these improved water management practices. OKFWM enables water managers and fisheries scientists to combine best science subsystem models and integrate real time data to make daily/weekly decisions regarding Okanagan Lake Dam water releases. Using this tool, a comprehensive retrospective analysis was performed for the 1974 to 2003 period. Results showed routine use of OKFWM may yield an average annual increase in Okanagan sockeye smolt abundance by as much as 55% without significantly increasing socio-economic losses associated with other water use interests. This encouraging result owes to improved understanding of fundamental ecological processes controlling	Climate change	26

juvenile production, the application of real-time data to inform physical and biological parameters, and a heightened awareness of trade-offs – all features seamlessly captured within the OKFWM tool.		
"SQUEEZE PLAY": THE ROLE OF TEMPERATURE, OXYGEN, AND ANNUAL CLIMATE VARIATIONS IN CONTROLLING HABITAT UTILIZATION BY JUVENILE SOCKEYE SALMON (ONCORHYNCHUS NERKA) IN OSOYOOS LAKE, BRITISH COLUMBIA. D. Paul Rankin and Kim D. Hyatt. Canada Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B. C. Email: rankinp@pac.dfo-mpo-gc.ca Okanagan sockeye salmon spawn and then rear in Canadian portions of a small section of the Okanagan River and Osoyoos Lake respectively. Lakes and rivers of the British Columbia southern interior exhibit annual and seasonal changes in physical variables (temperature and oxygen) that are extreme enough to pose serious threats to the persistence of a cold water species such as sockeye salmon which are near the southern end of their geographic range. Multiyear results from acoustic and trawl surveys are used here to determine annual and seasonal variations in the distribution and abundance of juvenile sockeye salmon relative to "extreme" changes in temperature and oxygen conditions in Osoyoos Lake. Comparative observations of juvenile sockeye subjected to a narrower range of physical conditions in Great Central Lake B. C. serve as an "experimental control". Major findings from this study are: (i.) juvenile sockeye salmon in both lakes exhibit nearly identical behavioural responses to similar variations in temperature and oxygen conditions, (ii.) water column extremes of high temperature and low oxygen values in Osoyoos Lake result in much greater restrictions on seasonal and diel patterns of habitat use by Osoyoos than by Great Central Lake sockeye and (iii.) physical variable conditions are severe enough to directly account for a portion of cumulative spring to fall mortality observed for juvenile sockeye in Osoyoos but not in Great Central Lake.	Climate change	27
FRESHWATER ECOSYSTEMS OR WATER RESOURCES? FISHES OR FISHERIES? - CLIMATE CHANGE AND THE BATTLE BETWEEN CONSERVATION AND USE IN CANADA Minns*, C.K. Department of Zoology, University of Toronto/DFO Emeritus Burlington (email: ken@minns.ca) Climate change is already altering Canada's ecosystems. Future changes will produce profound impacts. Freshwater ecosystems will be negatively affected as thermal, hydrologic, and watershed regimes change. While basking in a national ethos based on vast pristine wildernesses, Canadians are busy dominating landscapes everywhere and thereby altering, disrupting and destroying freshwaters. Government efforts are doing nothing to reverse the negative trends. Apart from subsidizing the energy sector, climate change programs have centred on assessing vulnerability and scoping adaptation with humans and their activities as the main subjects. Despite broad support for taking an ecosystem approach recognizing humans as part of greater ecosystems, programs mainly deal in water resources and fisheries as commodities for use and allocation. Natural freshwater ecosystems and their fishes, and their vital ecological services, are largely ignored. Everywhere exploitive use trumps conservation. For freshwaters this means that increased use of water for hydroelectricity, irrigation, effluent disposal, drinking, etc., is considered despite an increased likelihood of drought and further impairment of aquatic ecological services and hence water quality. For freshwater fisheries this means continued overexploitation and further tinkering with introductions and stocking despite the extirpation risks for many valued species, the rampages of invasives, and further impairment of the ecological services provided by fishes and hence of ecosystem health. To galvanize prevention efforts and promote successful adaptation in the interim, government programs need to improve impact assessments, and to shift emphasis away from human use and security toward conservation of Canada's freshwater ecosystems and fishes.	Climate change	28

NITROGEN FIXATION BY CYANOBACTERIA: LANDSCAPE-SCALE PATTERNS AND IMPORTANCE TO THE INVERTEBRATE FOOD WEB *Patoine, A. and Leavitt, P.R. Department of Biology, University of Regina, Regina, SK, S4S 0A2 Email: alain.patoine@uregina.ca Nitrogen-fixing cyanobacteria are a regular feature of lakes in central North America; however, little is known of their importance in regulating the nitrogen cycle. We hypothesized that cyanobacteria constitute a significant source of nitrogen to primary consumers, and that the importance of atmospherically-derived nitrogen to the food web varies as a function of lake position in the landscape. We characterized phytoplankton composition and determined the nitrogen isotopic content (d15N) of algae (as particulate organic matter, POM), Daphnia spp., Leptodiaptomus siciloides, Diacyclops thomasi and Leptodora kindtii in six chained lakes of the Canadian Prairies over the period 1994-2004. Nitrogen isotopic composition of POM was inversely related to the relative abundance of nitrogen-fixing cyanobacteria ($r=-0.87$, $p<0.001$). In downstream lakes, d15N of zooplankton also showed an inverse relationship to cyanobacteria density, suggesting that zooplankton were feeding on those algae. In contrast, there was no evidence that zooplankton fed on nitrogen-fixers in upstream lakes. Based on the seasonal variation of d15N-POM, we estimated the fraction of nitrogen derived from the atmosphere in each lake and found it was linearly related to the longitudinal position of the lake or to its drainage area. Our results indicate that the relative importance of nitrogen fixation is favored in downstream lakes in part because of differential export rates of nitrogen and phosphorus from upstream to downstream lakes.	SCL General	1
DOES SEDIMENT RESUSPENSION CONTRIBUTE TO PHOSPHORUS LOADING IN LITTORAL AREAS OF LAKE OPEONGO, AN OLIGOTROPHIC CANADIAN SHIELD LAKE? *Cyr, H.(1), and G.K. Nürnberg(2) Email: helene@zoo.utoronto.ca (1) Dept. Zoology, Ramsay Wright Zoological Labs, University of Toronto, Toronto, ON M5S 3G5 (2) Freshwater Research, 3421 Hwy 117, Baysville, ON P0B 1A0 Phosphorus loading from sediments occurs most readily under anoxic conditions, but has been shown under oxic conditions. In this study, we test whether the resuspension of sediments in the (oxic) littoral areas of lakes could release phosphorus to the water column. We collected sediments from 17 littoral sites in Lake Opeongo, an oligotrophic Canadian Shield lake, and ran P-sorption experiments with freshly collected sediments and filtered lake water to determine the equilibrium P concentration, the maximum uptake capacity and the P-buffering capacity of the sediments. The maximum P-uptake capacity ranged from 20-115 mgP g-1 dry mass, and increased with sediment Fe content but was best related to sediment water content. Equilibrium P concentrations ranged from 0.2 to 5 mg L-1, suggesting that some sediments could release phosphorus to P-depleted waters during resuspension. The P-buffering capacity of these littoral sediments ranged from 0.25 to ~1 L g-1 dry mass (a value of 1 is perfect buffering capacity) depending on the concentration of resuspended sediments. These results suggest that sediment resuspension from surface or internal wave action could release P in the oxic littoral zone of lakes and help fuel littoral food webs.	SCL General	2
INTERACTIONS AMONG TIME, DEPTH, DISSOLVED ORGANIC MATTER AND INORGANIC NUTRIENTS ON ALGAL BIOMASS AND UVR ATTENUATION IN WATER FROM ENCLOSURES *Curtis, P.J (1), Radomske, E.R. (2), and Luider, C.D.(1) (1) Department of Earth and Environmental Sciences, UBC Okanagan, Kelowna, BC V1V 1V7 (2) Biology Department, Okangan College, 1000 K.L.O. Rd. Kelowna BC V1Y 4X8 (Email: Jeff.Curtis@ubc.ca) Experiments were conducted in enclosures to assess interactions among depth, dissolved organic matter, inorganic nutrients and time on the	SCL General	3

biomass of phytoplankton and the UV transparency of water. Experiments were conducted in closed bottom enclosures at the Experimental Lakes Area (northwestern Ontario). Depth was manipulated using different length of enclosures (0.5 and 3.0 m). DOM was manipulated by filling enclosures with waters from different sources (an inflow stream, a humic lake, a and two clearwater lakes). Nutrients were manipulated by addition of inorganic nitrogen and phosphorus to levels consistent with eutrophic conditions. Phytoplankton biomass, dissolved organic carbon and UV Absorbance were measured at weekly intervals for 10 weeks in two summers. Response of phytoplankton biomass was consistent with photoinhibition at low DOC concentration and shallowest depth, and with light limitation at highest DOC concentration and greatest depth. DOC concentration increased in enclosures ammended with nutrients. Loss rates for UVR attenuation from enclosures decreased with decreasing DOC concentration and depended directly on depth. Nutrient loading did not affect loss rates of UVR attenuation. Thus, climatic change resulting in decreases in DOM loading and decreases in depth interact positively to increase the exposure of aquatic organisms to UVR. Eutrophication-enhanced DOC concentration will not affect the exposure of aquatic organisms to UVR because the autochthonous DOM attenuates poorly in the environmental UVR range.		
IRON LIMITATION OF CYANOBACTERIA IN FRESHWATERS *Molot, L.A.(1), N. Kelton (2), S.A. Miller (2,3), D.L. Findlay (4), P.J. Dillon (5), G. Li (2) and S.B. Watson (6). (1) Faculty of Environmental Studies, York University, Toronto, ON, M3J 1P3 Email: lmolot@yorku.ca (2) Department of Geography, York University, Toronto, ON, M3J 1P3 (3) Present Address: Gartner-Lee Limited, 11B Taylor Rd, Bracebridge, ON, P1L 1S6 (4) Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, MB, R3T 2N6 (5) Environmental Resource Studies, Trent University, Peterborough, ON K9J 7B8 (6) National Water Research Institute, Environment Canada, Burlington, ON, L7R 4A6 Many hypotheses have been advanced to explain the large populations of colonial and filamentous cyanobacteria typical of eutrophic freshwaters. However, there is no clear understanding of the specific mechanisms that limit growth of large cyanobacteria in oligotrophic waters and eucaryotic algae in eutrophic waters. Small and large cyanobacteria have much higher P-transport affinities than many eucaryotic algae. While large cyanobacteria are typically rare in P-limited waters, small cyanobacteria often co-exist with eucaryotic algae. Our results and others suggest that small and large cyanobacteria have higher Fe requirements than eucaryotic algae. Preliminary results also show that dissociation rates of organically bound Fe are very low in the absence of ultraviolet and short-wave visible radiation which we hypothesize limits the supply rate of biologically available Fe, causing Fe-limitation of cyanobacteria in apparently P-limited oligotrophic waters. Thus, dual resource limitation may account for co-existence of small cyanobacteria and eucaryotic algae in oligotrophic waters. Large surface area/volume ratios likely favour small cyanobacteria over large cyanobacteria under low Fe conditions. In eutrophic waters, diffusion of Fe(II) from highly reduced sediments increases the supply of biologically available Fe along with other nutrients. Fe(II) concentrations were much higher in fertilized Lake 227 than in nearby oligotrophic Lake 239.	SCL General	4
THE ROLE OF SILICA DEPLETION IN CHANGING ALGAL QUALITY IN LAC LA BICHE, ALBERTA *Crowe, A.M.(1), Schindler, D.W.(1) CW405 Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9 Email: amcrowe@ualberta.ca In freshwater lakes, phosphorus inputs enhance the production and sedimentation of diatoms, resulting in potential silica limitation. As a result, siliceous species such as diatoms may be replaced by non-siliceous species such as Cyanobacteria. We hypothesized that the onset of Cyanobacterial blooms under eutrophic conditions could be delayed by preventing silica limitation. Nutrient amendment experiments were conducted in mesocosms in Lac la Biche, a large lake in northern Alberta, currently undergoing significant anthropogenic eutrophication. The experiments	SCL General	5

consisted of 3 nitrogen and phosphorus treatments (ambient, nitrogen limited, phosphorus limited) and 2 silica treatments (ambient, high). The initial community in the mesocosms was dominated by Cyanobacteria and diatoms. The silica concentration declined in ambient silica, phosphorus limited bags to below values where silica limitation was expected. Silica additions significantly lowered chlorophyll a concentrations and total phytoplankton biomass, and resulted in increased proportions of diatoms and decreased proportions of Cyanobacteria. We conclude that varying silica concentrations can significantly alter the structure and biomass of phytoplankton communities.		
METACOMMUNITY DYNAMICS THROUGH TIME: CLADOCERAN COLONIZATION OF NEW POOLS *Cottenie, K. (1), Louette, G. (2), and De Meester, L.(2) Email: cottenie@uoguelph.ca (1) Department of Integrative Biology, University of Guelph, Guelph, ON, N1G 2W1 (2) Laboratory of Aquatic Ecology, Katholieke Universiteit Leuven, Leuven, Belgium Metacommunity theory studies communities linked through dispersal of individuals, and integrates local environmental with spatial processes. However, the temporal aspect of this integration has so far largely been neglected. We monitored the cladoceran colonization and succession of 25 newly dug and isolated pools during three consecutive years. With variation decomposition techniques, we found that dispersal from water bodies within a three kilometer radius was already high enough to provide species to new pools within the first year. As the ponds matured, the pools received enough propagules of well-adapted species such that species sorting became an important determinant of local community composition. However, an significant signal of the regional species pool remained during the whole study period. The often used alternative method to detect local versus regional processes, analyzing the relationship between local interacting and regional species richness, failed to detect any of the above patterns. However, we presented an alternative construction method using the relationship between cumulative local species richness and regional species richness. This analysis revealed that dispersal continued to be an important limiting process, even after three years.	SCL General	6
RESURRECTED ZOOPLANKTON RESTING EGGS REVEAL RAPID ECOLOGICAL SHIFTS IN RESPONSE TO HISTORICAL LAKE ACIDIFICATION *Derry, A.M. and Arnott, S.E. Department of Biology, Queens University, Kingston, ON K7L 3N6 Adaptive changes in populations can occur rapidly in response to selection over ecological timescales, such as from habitat disturbance associated with anthropogenic activities. Tens of thousands of boreal shield lakes were damaged by acid rain during the mid-1900s, and although many lakes have recovered chemically, processes that control biological recovery, such as adaptive responses, are poorly understood. To test if zooplankton populations have undergone shifts in acid tolerance within circum-neutral lakes with a history of past acidification, a “resurrection” ecological approach was adopted by hatching recent and old (pre-1900s) resting eggs from sediment cores collected from George Lake, Killarney Provincial Park, ON. Thirty 40-cm cores were collected from a depositional zone (40-m depth) and were extruded at 1-cm intervals. Previous Pb210 dating employed for paleo-ecological re-construction of lake acidification history was employed to determine intervals of pre-industrialization (pre-1880; 8 to 13 cm), acidification (1950s to 1970s; 4 to 7 cm), and circum-neutral recovery (1990s; 1 to 3 cm). Calanoid copepod eggs from these time intervals were induced to hatch, and freshly-hatched Leptodiaptomus minutus nauplii were exposed to a gradient of pH treatments ranging from pH 4.2 to 8.0. Surviving nauplii were counted at the end of five days. Although George Lake has been circum-neutral (pH 6.5) for over a decade, the recent “recovered” sub-population from the 1990s had a similar broad acid tolerance as the “acidic” sub-population that inhabited the lake during the 1950s during peak lake acidification. In contrast, the pre-industrial sub-population had significantly lower acid tolerance at pH 4.7 than these more recent sub-populations, a pH at which the species is prevalent in other lakes. Although other studies have shown chemical and some community-level recovery in acid-recovering lakes, this work provides evidence for lasting ecological effects of lake acidification at the population level.	SCL General	7

VICARIANCE AND DISPERSAL EFFECTS ON PHYLOGEOGRAPHIC STRUCTURE AND SPECIATION IN A WIDESPREAD ESTUARINE INVERTEBRATE DAVID W. KELLY*, DANIEL D. HEATH & HUGH J. MACISAAC Great Lakes Institute for Environmental Research, University of Windsor, Ontario, Canada, N9B 3P4. (email: dwkelly@uwindsor.ca) Vicariance and dispersal strongly influence population genetic structure and allopatric speciation but their importance in the origin of aquatic biodiversity remains unresolved. In transitional estuarine environments, habitat discreteness and dispersal barriers could enhance divergence, providing insight to evolutionary mechanisms underlying marine and freshwater biodiversity. We examined this by assessing phylogeographic structure in the widespread amphipod Gammarus tigrinus across 13 northwest Atlantic estuaries from Quebec to Florida. Mitochondrial and nuclear phylogenies supported deep genetic structure consistent with Pliocene separation and cryptic 'northern' and 'southern' species. This break occurred across the Virginian/ Carolinian coastal biogeographic zone where physical gradients may restrict gene flow. Ten populations of the northern species occurred in four distinct clades with a history of Pleistocene separation. Glaciation effects on genetic structure of estuarine populations are largely unknown, but AMOVA showed a deep break between clades of formerly glaciated versus non-glaciated areas across Cape Cod, Massachusetts. A non-significant latitude vs. genetic diversity relationship supported Pleistocene vicariance and divergence of clades in different northern glacial refugia. AMOVA and private haplotypes in most populations also supported an allopatric distribution across estuaries. The occurrence of cryptic species and deeply divergent population structure suggests that dispersal limitation, habitat distribution and historical factors are important determinants of estuarine speciation and diversification. Although there are no comparable studies over the same geographic range, these findings have implications for the management of threatened and commercially important coastal species.	SCL General	8
DO AQUATIC PREDATORS NEED PATCHY PREY TO SURVIVE? Sprules, W.G. Department of Biology, University of Toronto at Mississauga, Mississauga, ON, L5L 1C6 Although considerable research has been done on the physical and biological processes leading to spatial patterning in aquatic ecosystems, few studies have addressed the effects of these patterns on the efficiency of material flow through food webs. Theoretical and modelling studies indicate that most predators can meet their energy requirements only if they can exploit local food concentrations that are higher than the regional mean concentration. Few empirical tests of this conjecture exist, and hence the question of how important prey patchiness is for predator survival in nature emerges. A review of the literature suggests that some predators (e.g. those with efficient energy storage and low activity costs) may be less dependent on patchy prey than others (e.g. those with reduced energy storage and high activity costs). I summarize these ideas for zooplankton and fish and attempt a synthesis of the concepts with a view to stimulating future research.	SCL General	9
SPATIAL MODELS FOR CHARACTERIZING THE COMPLEXITY OF VERTICAL PROFILES *Peres-Neto, P.R.(1) and Beatrix Beisner (2) (1) Department of Biology, University of Regina (2) Département des sciences biologiques, Université du Québec à Montréal (UQÀM) Limnologists commonly measure vertical profiles as a means to investigate the mechanisms underlying variation in biotic and abiotic variables and to establish the connections between environmental drivers of biotic dynamics. Although methodological advances have greatly improved our ability to collect data along depth gradients, we still lack flexible analytical tools for describing and comparing patterns among vertical profiles. Such a methodology would provide an advance in the field as it would allow us to (1) characterize the complexity of multivariate vertical profiles, (2) to better	SCL General	10

describe the components driving this complexity (i.e., spatial versus non-spatial components) as well as (3) control for spatial autocorrelation when describing the association between variables of interest in the water column. We address this problem by developing a framework to determine the spatial and non-spatial components shared by multiple vertical profiles taken in the same sampling location. We introduce a flexible spatial modeling approach for vertical profiles and provide global measures based on the spatial and non-spatial components for comparing vertical profiles. These measures can be used to assess differences between sampling locations within a system (e.g., sampling sites within a single lake) or between systems (e.g., lakes within a region). We present an application where we estimate the relationship between the complexity in vertical profiles regarding the biomass of key phytoplankton groups estimated via pigment composition using a beam fluorometer (BBE Fluoroprobe) and lake morphometry data.		
ARE DIATOMS GOOD INTEGRATORS OF WATER QUALITY? *Lavoie, I. (1), Campeau, S. (2), and Dillon, P. (1) (1) Environmental & Ressource Studies, Trent University, Peterborough, ON, K9J 7B8 (2) Geography department, Université du Québec à Trois-Rivières, Trois-Rivières, QC, G9A 5H7 Traditional physico-chemical measurements used in water quality monitoring do not provide a temporally integrated picture of ecosystem response to external stresses, nor do they provide information about the effects of these stresses on biological communities. We developed a diatom-based index that integrates the effects of multiple stresses on streams. Correspondence analysis (CA) was used to develop a ''chemistry-free'' index where the position of the sites along the gradient of maximum variance (first axis) is strictly determined by diatom community structure and, therefore, independent of measured environmental variables. The Estern Canadian Diatom Index (IDEC: Indice Diatomées de l'Est du Canada) also integrates temporal variations in water quality which provides a better evaluation of the ecological status of an ecosystem than water chemistry measurements made at a single point in time. The purpose of this study was to evaluate the response of the IDEC with respect to temporal water chemistry variability. Diatom communities, collected on a weekly basis from May to October, were used to calculate the index. Daily or weekly water chemistry data were available depending on the site. The variability in both water quality parameters and index values was compared in order to verify the use of bioindicators as integrators of water quality.	SCL General	11
THE USE OF PERIPHYTON AS A MONITORING TOOL TO ASSESS CHANGES RELATEDTO DIAMOND MINING ACTIVITIES IN A SUB-ARCTIC LAKE *Gerein, K.M. (1), Schryer, R.P. (1), Turner, M.A. (2), and Johnstone, R.M. (3) kgerein@golder.com (1) Golder Associates Ltd., 200-145 1st Avenue North, Saskatoon, Saskatchewan, S7K 1W6 (2) Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, Manitoba, R3T 2N6 (3) De Beers Canada Inc., 300,-5102 50th Avenue, Yellowknife, Northwest Territories, X1A 3S8 De Beers Canada Inc. owns and operates the Snap Lake Project in the Northwest Territories. Snap Lake is unique for the region in that it is classified as an oligo-mesotrophic lake. It has been projected that the diamond mining activities will lead to a gradual increase in concentrations of total dissolved solids and nutrients over the estimated 22 years that the mine is expected to be in operation. This has raised concerns with the Mackenzie Valley Environmental Impact Review Board regarding changes in periphyton productivity and biomass, which may affect fish habitat within Snap Lake. In 2004, the periphyton community within Snap Lake was assessed to gain information on baseline conditions (i.e., composition and biomass) and to determine if periphyton could be used as an effective monitoring tool. While there is work being conducted to assess if periphyton can be as used as an indicator of lake health (e.g., USEPA 2003, Turner et al. 1995), it is less commonly used as a monitoring tool than in streams and rivers. Much of the lake monitoring has focused on large scale changes, such as acidification and global warming as opposed to the possibly more subtle	SCL General	12

changes that might occur in the periphyton community in response to increased nutrients. In addition, there has been only limited monitoring conducted in sub-arctic lakes. The information gathered during the 2004 monitoring program was used to determine if periphyton could be a viable long-term monitoring tool for the Snap Lake Project.		
ARE WE DOING A GOOD JOB AT MEASURING THE NET DEPOSITION OF MERCURY TO ECOSYSTEMS? *St.Louis, V.L., Graydon, J.A., and Kirk, J.L. Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9 Precipitation monitoring networks have been installed across N.A. to quantify the wet deposition of elements and contaminants, including mercury (Hg). Although gaseous elemental Hg(0) makes up a large proportion of the atmospheric pool of Hg, it is primarily inorganic Hg(II) that is deposited to ecosystems in wet deposition events. However, the almost immediate photoreduction of deposited Hg(II) to gaseous Hg(0) in surface waters and snowpacks, and on canopy foliage, can significantly reduce the Hg(II) available in aquatic and terrestrial pools for subsequent methylation to methylmercury (MMHg), the toxic form of Hg that bioaccumulates through food webs. Furthermore, dry deposition of Hg to watersheds (which may include litterfall inputs) can be much larger than the amount of Hg that is deposited in precipitation. We will show that monitoring event-based wet loadings of Hg(II) in open areas is only one component of estimating net deposition of Hg to watersheds.	SCL General	13
LINKING TROPHIC DYNAMICS AND HABITAT-COUPLING TO MERCURY BIOACCUMULATION IN FISH: A BI-DIMENSIONAL APPROACH TO FOOD WEB STRUCTURE. *Roux, M-J (1), Anderson, M.R. (2), Planas D. (3), and Veinott, G. (2) Email: rouxmj@dfo-mpo.gc.ca (1) Memorial University of Newfoundland, St-John's, Canada. (2) Department of Fisheries and Oceans, St-John's, Canada. (3) Université du Québec à Montréal, Montréal,Canada. Mercury exposure through fish consumption is a health risk for subsistence fishers of the boreal forest. Mercury pollution management is in this context complicated by spatial variations in fish mercury concentrations within regions subject to comparable mercury loadings. Trophic status, trophic transfers, and food chain length modulate mercury movement through aquatic environments and thus influence mercury levels in fish. Evidence for the active transfer of methylmercury via periphytic communities suggest a distinction in the regulation of mercury levels between littoral/benthic and pelagic-based food webs. We propose a bi-dimensional approach to food web structure for mercury bioaccumulation, or the integration of both vertical (trophic) and horizontal (carbon-source) dimensions in the structural conceptualisation of food webs. Using stable isotope ratios of carbon and nitrogen as carbon source/flux tracers and trophic indicators, we applied this concept to four Labrador lakes used by local Innu fishers. Our results confirm a dual influence of inter-habitat omnivory and trophic status on the extent of mercury accumulation in fish, and establish this influence as site, specie and/or life-stage specific, depending on fish ontogeny, lake morphometry, habitat productivity and community interactions. As a lake-specific feature related to fish biology and community ecology, bi-dimensional food web structure improves our ability to predict mercury concentrations in fish, and may account for differences in the extent of mercury bioaccumulation among lakes of the boreal forest.	SCL General	14
WHY DO CHAOBORUS LIVING IN ACIDIC LAKES CONTAIN SO LITTLE CADMIUM? Orvoine, J., Hare, L.*, and Tessier, A. INRS-ETE (Institut national de la recherche scientifique – Eau, terre et environnement), 490 de la Couronne, Québec, QC, G1K 9A9 (landis@ete.inrs.ca)	SCL General	15

Emissions from some Canadian metal smelters have caused lakes that are downwind to become highly acidic and contaminated with trace metals such as cadmium, copper and zinc. We used a biomonitor, the phantom midge Chaoborus, to estimate bioavailable metal concentrations in such lakes. We found that although this insect is not useful for monitoring Cu and Zn (it regulates the concentrations of these metals), it can be used to monitor Cd in the water of circum-neutral lakes. However, in highly acidic lakes Chaoborus contain little Cd in spite of the high concentrations of this and other metals in such lakes. We explained this phenomenon by hypothesizing that H ions compete with Cd ions at biological uptake sites, thereby reducing Cd bioaccumulation in highly acidic lakes. We tested this hypothesis experimentally and determined that Cd2+-H+ competition does not take place directly on Chaoborus, in part because this insect does not take up Cd from lakewater (zooplankton are the source of its Cd). In contrast, Cd concentrations in its prey (copepods) were influenced by ambient pH because they take up the majority of their Cd from lakewater. It is also likely that Cd2+-H+ competition occurs at the base of the food chain (algae), because the measured effect of competition on prey was not sufficient to explain the low Cd concentrations measured in Chaoborus from highly acidic lakes. Overall, our results suggest that understanding metal transfer along food chains is a prerequisite to explaining metal concentrations at upper trophic levels.		
A COMPARISON OF METHODS AND A FIRST ESTIMATION OF CO2 EMISSION FROM AQUATIC SYSTEMS WITHIN THE EASTMAIN-1 RESERVOIR LANDSCAPE PRIOR TO FLOODING. 1Prairie, Y.T., P.A. del Giorgio1, C. Roehm1 and A. Tremblay2. 1Département des Sciences biologiques/GRIL, UQÀM, Box 8888, station Centre-Ville, Montréal, Canada. 2Hydro-Québec Production,Direction Barrages et Environnement, Unité Environnement, 75 Boul. René-Lévesque, 10 ième étage, Montréal, Québec, Canada. In the Fall of 2005, Hydro-Quebec began filling a new 600 km2 hydro-electric reservoir in northern Quebec (Eastmain-1). We sampled about 40 lakes as well as several streams/rivers from that landscape to establish baseline CO2 emissions prior to flooding. All lakes were net sources of CO2 to the atmosphere at all sampling periods. We found that small lakes contributed disproportionately to the aquatic emissions. Given the Pareto-type lake size distribution in this region, we calculated an average weighted areal CO2 emission rates for undisturbed aquatic systems of about 30 mmol m-2 d-1, a value comparable to emissions from the surface of many reservoirs. To this value has to be added net emissions from the Eastmain river mainstem as well as from small streams heavily enriched in CO2.	SCL General	16
SUMMERTIME NET AUTOTROPHY IN LAKES OF THE MACKENZIE DELTA, NORTHWEST TERRITORIES *Tank, S.E. (1) and Lesack, L.F.W. (2) Email: suzanne_tank@sfu.ca (1) Department of Biology, Simon Fraser University, Burnaby, BC (2) Departments of Biology and Geography, Simon Fraser University, Burnaby, BC The Mackenzie Delta is a lake-rich region of approximately 45,000 lakes. During the annual spring flood, more than one third of the peak flow of the Mackenzie River, which drains 20 percent of the Canadian landscape, is deposited in Delta lakes. After floodwaters subside, many Delta lakes are effectively cut off from external inputs of dissolved organic carbon (DOC) and nutrients because of low regional precipitation, small watersheds directly surrounding lakes, and the presence of permafrost that limits groundwater flow. In this study, we hypothesized that lakes in the Mackenzie Delta transition towards net autotrophy as the time since cutoff from the river increases, and the input of terrestrially-derived DOC therefore decreases. Forty-two Delta lakes were surveyed 3 times during the summer of 2005, and 6 of these lakes were followed more closely (3 visits weekly) throughout the summer. By midway through the open water season, surface water measurements of the partial pressure of CO2 suggest that approximately 85 percent of the surveyed lakes were CO2 sinks. Early results suggest that lakes that showed a neutral CO2 balance tended to have retained their connection to the river system, while those that were net emmittors of CO2 appear to have undergone substantial thermokarst	SCL General	17

activity. The moderate levels of DOC (previous years' concentrations circa 7 to 16 mg/L), and low to moderate levels of water column productivity (previous years' chlorophyll a circa 1 to 6 µg/L) in these lakes suggests that most should have a CO2 balance that is neutral to supersaturated. However, these shallow lakes show higher than expected productivity because of extensive macrophyte growth.		
THE INFLUENCE OF REGINAL VALUABLES ON THE LONG-TERM PATTERNS IN DISSOLVED ORGANIC CARBON FROM LAKE DISTRICT ACCOSS ONTARIO *Hudson, Jeff and Jan Zhang. Department of Biology, University of Saskatchewan, Saskatoon, SK, S7N 5E2 Email: jan.zhang@usask.ca Lake specific factors (e.g., wetland area and lake morphometry) are known to affect dissolved organic carbon concentrations (DOC). However, the effects of regional factors on DOC, such as climate, are poorly understood. Only recently, has the influence of climate on long term DOC patterns been illustrated. For example, the analysis of 9 lakes in the Dorset Environmental Science Centre database (Ontario) has revealed significant correlations between the pattern in long-term ice-free DOC with radiation, temperature and precipitation. We take this analysis one step further and examine the influence of regional factors (i.e., temperature, precipitation, radiation, the southern oscillation index, and others) on the concentration of ice-free DOC in 35 lakes from four regions across Ontario: Dorset (data from 1978 to 1998), Turkey Lakes area (1982-2002), Sudbury area (1980-2000) and the Experimental Lakes Area (1981 to 2002). Regression models that describe the relationship between the ice-free DOC pattern and regional factors will be developed for each region. Models will then be compared and the similarities and differences will be discussed.	SCL General	18
THE EFFECTS OF DOC COMPOSITION AND INCIDENT SOLAR IRRADIANCE ON PHOTOBLEACHING RATES IN LAKES OF THE MACKENZIE DELTA, WESTERN CANADIAN ARCTIC. Gareis*, J.A.L.1, Lesack, L.F.W.2, and M.L. Bothwell3. 1 Department of Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6 (email: jolieg@sfu.ca). 2 Departments of Geography and Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6. 3 National Water Research Institute, Pacific Biological Station, Nanaimo, BC V9T 6N7. Arctic ecosystems are expected to respond to climate change more rapidly than any other region of earth. The concurrent stressors of increased solar ultraviolet (UV) irradiance, permafrost melting, and a northward treeline shift are of particular interest in the Arctic due to their potential combined effects on high-latitude aquatic ecosystems. Lakes of the Mackenzie Delta lie along a flooding frequency gradient that strongly controls the dissolved organic carbon (DOC) composition and water clarity of individual lakes. Three experiments were conducted in Inuvik, NT during the summers of 2004 and 2005 to assess the photobleaching capacity of lake water with differing DOC compositions (primarily allochthonous/coloured CDOC versus primarily autochthonous/non-coloured NCDOC) and its dependence on incident solar irradiance. Selectively screening out some or all incident UV irradiance showed that UVA causes the majority of in situ photobleaching despite the greater photobleaching capacity of UVB per photon. Photobleaching rates were strongly related to the amount of CDOC in the lake water, with higher proportions of CDOC giving higher rates. Sequentially reducing incident irradiance in predominantly CDOC versus predominantly NCDOC lake water showed that removing a fixed percentage of all irradiance (regardless of wavelength) led to corresponding declines in photobleaching rates. These results indicate that future increases in photobleaching substrate caused by melting permafrost and increased vegetation cover may not be offset by increased photobleaching since ozone thinning will lead to an increase in UVB irradiance only. This may significantly alter the aquatic environment of the Mackenzie Delta by increasing the sunscreening capacity of the lakes.	SCL General	19

CLIMATE VARIABILITY AND CLIMATE CHANGE: PREDICTING THE EXTINCTION OF WOOD FROGS IN THE NORTHERN PRAIRIE ECOZONE. Donald, D.B., Aitken, W., Syrgiannis, J. Environment Canada, 2365 Albert Street, Regina, SK, S4P 4K1 Current models suggest that climate change will result in less precipitation in the northern Great Plains. This could have significant impacts to wetlands and their fauna. To assess landscape scale population recruitment for wood frogs, we monitored late stage tadpole abundance in 26 wetlands dispersed through 304,000 km2 during a wet – dry – wet cycle in the northern prairies of Saskatchewan (1997 to 2005). These wetlands were optimal breeding habitat for wood frogs, and they usually had late stage tadpoles during wet years (1997 and 2005). However, tadpoles were absent and therefore recruitment zero during the severe droughts of 2001 and 2002, and they were often absent from some of the wetlands in other low precipitation years. Wetlands that were either dry or had unsuitable water quality did not have tadpoles. The percentage of wetlands (optimal tadpole habitat) that produced wood frog recruitment (Y) = winter snow as water equivalent in mm (275.8 log10X) – 442.6 with r = 0.95, N = 9, and p < 0.001. This model, and the historic precipitation record (1890 t0 2005), indicated that wood frog recruitment occurred in ≥ 50% of wetlands about half the time, in 65 of 116 years. However, the 7 year period from 1998 to 2004 was the most severe on record for wood frog recruitment with the percentage of wetlands producing tadpoles ranging from 0% to 52%. After this dry period, some suitable wetland habitats did not have tadpoles. Wood frogs might become extinct in the northern plains when winter precipitation is always less than 63 mm and often less than 45 mm for 9 consecutive years (linear model) or for 16 consecutive years (curvilinear model).	SCL General	20
ASSESSING THE EFFECT OF FISH DENSITY ON THE CONSUMPTION AND ACTIVITY RATE OF ARCTIC CHAR FROM A NORWEGIAN LAKE Guénard*, G. and D. Boisclair. Département de sciences biologiques, Université de Montréal, Montréal, Québec (email: guillaume.guenard@umontreal.ca) Bioenergetics models have been used to predict fish growth, mortality, their impacts of prey community, nutrient recycling, etc. These models rely on balancing the amount of energy acquired from food (consumption) into compartments representing losses (fecal and urinary), metabolism (digestion, maintenance, and activity), and growth. A wide range of models has been proposed to either predict or measure each of these compartments. Density-dependant growth is commonly cited as an important factor controlling population size. Conceptual works as well as field and experimental studies have evidenced that density-dependant growth is driven by underlying phenomenon like the depletion of food (exploitation competition) or agnostic behaviour (interference competition). In bioenergetics perspective, both of these mechanisms have potential impact on consumption and activity rates. Knowledge about to what extend fish density affects their bioenergetics (consumption and activity rate) is an important issue when managing fish populations from bioenergetics models. In our study, we quantify the effect of fish density on consumption and activity rate estimated on the same individuals. We used an experimental approach in which arctic chars (Salvelinus alpinus) are reared at three controlled densities. Consumption rate of each fish is estimated using isotopic caesium analysis. Activity rate are estimated at the temporal scale one month and individual level from mass-balanced bioenergetics equation. Moreover, activity rate have also been estimated at short time scale (1 hour) and at the population level using stereo-cameras and image analysis. This dataset allowed us to draw relevant conclusions about the impact of density on fish bioenergetics.	CCFFR general	1
USE OF NATURAL AND ARTIFICIALLY CREATED HYPOXIC REGIONS BY PREDATORS AND PREY: POTENTIAL REFUGES AND IMPLICATIONS FOR COMMUNITY STRUCTURE Hedges*, K.J. and M.V. Abrahams. Department of Zoology, University of Manitoba, Winnipeg, Manitoba (email: umhedges@cc.umanitoba.ca)	CCFFR general	2

Variable environments can maintain community complexity by altering dominance in predatory and competitive interactions. Prey should adapt to exploit environmental conditions which provide antipredator benefits since predation creates a strong selective pressure. A field experiment was conducted to determine whether hypoxia is used as a predator refuge, specifically testing for forage fish accumulation in and predator avoidance of hypoxic areas. The experiment included the effects of both seasonal changes in dissolved oxygen (DO) and localized persistent hypoxic regions. Five artificial bays (10X10m) were created in Blind Channel, Delta Marsh, Manitoba, by extending fine mesh netting perpendicular from shore. Bags of decaying vegetation were submerged to create localized hypoxic pockets in manipulated bays while controls were created using bags filled with monofilament nylon. The relative abundance of forage species among bays was monitored using minnow traps and habitat quality from the prey's perspective was measured using Giving-Up Densities. Predatory fish were tagged with Passive Integrated Transponders to provide remote individual identification by two antennae placed at the mouth and rear of each bay. Predators (northern pike, freshwater drum, black bullheads and brown bullheads) were collected and tagged throughout the summers of 2004 and 2005; artificial bays were created in May 2005 and predator and prey use were monitored from June through August 2005. Forage fish were most abundant in low DO bays. Northern pike and drum were detected less frequently and remained for shorter durations in hypoxic bays. Bullheads were detected in all bays with considerable variation in visit duration.		
OTOLIYH STRONTIUM ANALYSIS OF RESIDENT AND ANADROMOUS LIFE HISTORY FORMS OF ARCTIC CHARR (Savelinus alpinus) WITHIN ARCTIC LAKE SYSTEMS OF SOUTHERN BAFFIN ISLAND, NUNAVUT CANADA Tracey N. Loewen*1,2, Ross F. Tallman1, and Darren Gillis2. 1Department of Fisheries and Oceans Canada, Winnipeg MB and 2Department of Zoology, University of Manitoba, Winnipeg, MB. (loewent@dfo-mpo.gc.ca) Even though Arctic charr (Salvelinus alpinus) are known to exist as multiple resident forms, migrants or both within one lake system, the co-existence of multiple life history forms existing within the same lake system is not well documented in the scientific literature for North American Arctic regions. The objective of my research was to identify resident and anadromous life history strategies of Arctic charr that co-exist within the same arctic lake systems seasonally. Three lakes in the Southern Baffin Island region, Nunavut, Canada: Iqalugaarjuit Lake, Shark Fjord, Qasigiat, Ptarmigan Fjord and Qinngu, Blandford Bay were the focus of my study. Otolith microchemistry, specifically strontium concentration was examined via scanning electron microprobe analysis to verify the existence of resident and anadromous life history forms. Strontium concentrations within resident form otoliths were higher than expected but did not vary significantly indicating a resident type life history. Anadromous form otoliths had low strontium concentrations until individuals smolted. Post-smolting, strontium concentrations significantly increased and fluctuated seasonally as individuals migrated out to sea to feed and returned to freshwater for over-wintering. Due to short river systems (< 1 km) and strong tidal influence, there maybe a tidal influx into lake systems during spring tides. Early maturing charr may utilise river and/or estuary habitat since they already have a high salinity tolerance from saltwater influx into freshwater habitat.	CCFFR general	3
GROWING-DEGREE DAY PREDICTS FISH GROWTH Neuheimer, A.B.*, and C.T. Taggart. Department of Oceanography, Dalhousie University, Halifax, Nova Scotia (email: anna.neuheimer@phys.ocean.dal.ca) Temperature variation and the associated growth estimates in fish, typically derived from size-at-age data, are integral to explaining and predicting variation in stock/population health, distribution, maturation, catch forecasting, and the consequences of climate change. Size-at-age is the integral of growth rate over time and it is well known that temperature is a major determinant of growth rate in fish. Thus, the time integral of the temperature acting on growth should reflect size-at-age. However, most fish-growth models are solely age-dependent and ignore other time-dependent variables	CCFFR general	4

(e.g. temperature). Moreover, models that do incorporate temperature typically use an instantaneous measure of temperature or some kind of time-based mean. The growing-degree-day (GDD; ºC d) estimate, a time-based integral of potential heat transfer, is universally recognized as the relevant physiological time-scale for ectotherms; particularly plants and insects. Surprisingly, this has not been generally recognized for fish. In this paper we show that among 42 unique datasets representing 10 fish species fish length-at-day (LaD; mm) is a strong and linear function of the GDD that explains between 92 and 99% of the variation. In all cases the non-linear evolution of the LaD series parallels the corresponding non-linear evolution of the GDD series; consistent with what we proposed above. The resulting growth model, the first of its kind for fish that we know of, offers better predictive skill for growth estimates in fish relative to the extant methods that include the von Bertalanffy growth function and its several variants. This simple model allows the incorporation of temperature, a key environmental variable, in a physiologically-relevant and meaningful manner that has important implications to climate change investigations, fisheries studies and coupled biological/physical modeling.		
WESTERN SILVERY MINNOW DISTRIBUTION, ABUNDANCE, AND HABITAT USE IN THE MILK RIVER, ALBERTA. Watkinson, D.A.* and W.F. Franzin. Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, MB (watkinsond@dfo-mpo.gc.ca) The Milk River in southern Alberta is one of a few rivers in Canada at the extreme northern edge of the Missouri River watershed. Since 1915, it has been supplemented during the spring and summer months by water from the St. Mary River via a siphon with a capacity of 850 cfs. The western silvery minnow occurs in Canada only in the Milk River and is listed under the Species At Risk Act (SARA) as “Threatened”. In July, 2005 we conducted a 120 km survey of the Milk River to better understand the distribution, abundance, and habitat preference of western silvery minnow in Canada. We collected western silvery minnow at 34 of 157 sample locations. Western silvery minnow was the second most abundant fish in the Milk River comprising 24% of the total catch and was distributed throughout the entire survey area. Western silvery minnow selected for habitats that were shallow with silt bottoms and less than 0.1 m/sec water velocity. This survey found that this species at risk is much more common in Canada than previously believed.	CCFFR general	5
SELECTION ON PHENOTYPIC AND GENETIC VARIATION FOR BODY SIZE IN BROOK TROUT (SALVELINUS FONTINALIS) IN FRESHWATER RIVER, NEWFOUNDLAND Morrissey*, M.M., Hutchings, J.A., and Ferguson, M.M. Department of Integrative Biology, University of Guelph, Guelph, Ontario. (email: mmorriss@uoguelph.ca) Natural selection on phenotypic variation can only effect evolutionary change if fitness differences occur among individuals with different genotypes. Recent theoretical and empirical work has shown that even in the case of phenotypic selection on a heritable trait, the pattern of selection at phenotypic and genetic levels are not necessarily concordant. This study is designed to test the general hypothesis that selection on body size is different at phenotypic and genetic levels in a population of stunted brook trout in which strong positive phenotypic selection on body size has previously been documented. We are using molecular markers to obtain pedigree information from which quantitative genetic methods can be applied to predict individual breeding values, or the mean expected phenotype of individuals due to additive genetic effects. Predicted breeding values can be used in selection analyses as a measure of genetic variation for quantitative traits. We have tested for body-size reproductive success relationships at both phenotypic and genetic levels. We have also tested for viability selection on alevin body size at both levels. This study will ultimately include such analyses of viability selection throughout the entire life of one cohort in the study system.	CCFFR general	24

GENE EXPRESSION PATTERNS IN AN ANADROMOUS STEELHEAD (ONCORHYNCHUS MYKISS) AND A DERIVED FRESHWATER RESIDENT POPULATION. Aykanat*1 T., Thrower2 F., Heath1 D.D. 1Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Ontario. 2National Marine Fisheries Service, Alaska Fisheries Science Center, Auke Bay Laboratory Juneau, Alaska. (e-mail: aykanat@uwindsor.ca) Natural populations harbor considerable phenotypic variation that has underlying genetic components. Although the genetic component is usually defined in terms of additive genetic variance, the specific mechanism driving that variation is poorly characterized. Gene expression, or transcription, patterns within a population may represent an important source of additive genetic variation, and it may respond to evolutionary forces, such as drift or selection. In this experiment, we used anadromous steelhead (A) and landlocked resident rainbow trout (R) which originally derived from the anadromous stock 70 years ago as parental stock. Pure type crosses (i.e., AxA and RxR) as well as their crosses (AxR and RxA) were reared in common environments for 2 generations. We saltwater challenged 15 2-year-old juveniles from each cross type, and sampled gill tissue for RNA at t=0, t=2 and t=24 hours. Using real-time quantitative PCR, we are measuring the expression of NaK ATPase subunit 1αa (which is known to be downregulated during saltwater stress) before and after the saltwater challenge. We tested for evidence of evolved gene transcriptional difference between the anadromous and freshwater populations. Our observed gene expression differences provide evidence for the role of transcription evolution under selection.	CCFFR general	25
GENETIC ANALYSIS OF IMMUNOLOGICAL DIFFERENCES IN TRIPLOID VERSUS DIPLOID CHINOOK SALMON Ching* , B., Heath, D. and A. Hubberstey. Department of Biological Sciences, University of Windsor, Windsor, Ontario (email: ching1@uwindsor.ca) The increasing numbers of fish farms have led to growing concerns for the potential impacts of the industry on wild stocks. Since different forces of selection are acting on fish in captivity, domesticated fish at fish farms are genetically quite different than those in the wild, hence, escaping farmed fish pose a genetic contamination risk. Triploidization, the incorporation of an extra set of chromosomes, has been proposed as a possible way of ensuring genetic containment, since triploid salmon are sterile. The extra set of chromosomes produces several observable changes in chinook salmon such as lack of sexual maturation in females, larger cell sizes, and lower aggression, and possible lower disease resistance. The major objective of this study is to investigate the gene expression effects of the third set of chromosomes on immunological function in Chinook salmon. Using degenerate RT-PCR, eight immune function genes (TNF α (tumour necrosis factor), IL-1 β(interleukin 1), IL-1 receptor(interleukin 1 receptor), IL-8 (interleukin 8), IL-8 receptor (interleukin 8 receptor), RAG-1 (recombination activating gene 1), pentraxin, and IgM (immunoglobulin M)) have been isolated and sequenced. An immunological challenge with live Vibrio anguillarum was conducted on diploid and triploid juvenile offspring, ranging from approximately five to thirteen grams, from matings between a single female salmon and three male salmon. Both sham and vaccinated fish were sampled at time zero and at various time points over a ten day period. Using quantitative real-time PCR and primer/probe combination designed from our cDNA sequences we are testing for effects of triploidization on the expression of selected immune function genes. Preliminary data have shown a strong up-regulation of IL-8 and IL-8 receptor) in both the diploid and triploid offspring.	CCFFR general	26
POPULATION GENETIC STRUCTURE IN CORAL REEF FISH: SPATIAL AND TEMPORAL GENETIC PATTERNS OF THE BICOLOR DAMSELFISH (STEGASTES PARTITUS) Hepburn*, R.1, Dixon, B.2 & Heath D.D.1 1Great Lakes Institute for Environmental Research and Department of Biological Sciences,University of Windsor,401 Sunset Avenue, Windsor,	CCFFR general	27

Ontario. 2Department of Biology, University of Waterloo, 200 University Avenue West, Waterloo, Ontario. Dispersal in marine systems is of great importance within the context of ecology, evolution and conservation. Yet, in coral reef fish with pelagic larvae, little is known about their levels of connectivity, as it is very difficult to directly track these organisms through their deep-water dispersive stage. The dispersal of juvenile bicolor damselfish (Stegastes partitus), sampled from 16 sites on the Meso-American Barrier Reef System (MBRS), was inferred from allele frequency data based on six microsatellite DNA markers at three spatial scales: small (<20 km), medium (20 to 40 km), and large (100 to 300 km). Juvenile bicolor damselfish within the MBRS were found to possess genetic homogeneity at large geographic scales, with cryptic genetic structure detected at small and medium scales, most likely due to micro-geographic effects. The stability of the genetic structure in 12 of these sites was examined over annual and seasonal scales using the same suite of genetic markers. The genetic structure of these populations was found to be variable over both time-scales examined. From these results, it can be inferred that dispersal patterns of the bicolor damselfish are more stochastic than directed, and that temporally unstable genetic patchiness is present in newly recruited bicolor damselfish over the MBRS, possibly due to high reproductive variance. These findings are of importance for future research, as well as conservation and management strategies addressing connectivity in coral reef fish.		
GENETIC DRIFT, MIGRATION AND TEMPORAL INSTABILITY OF CHINOOK SALMON (ONCORHYNCHUS TSAWYTSCHA) POPULATIONS Tutku Aykanat1, Ryan P. Walter1*, J. Mark Shrimpton2 and Daniel D. Heath1 (Email: walterj@uwindsor.ca) 1Great Lakes Institute of Environmental Research, University of Windsor, 401 Sunset Ave, Windsor, ON, Canada N9B 3P4 2University of Northern British Columbia, 3333 University Way, Prince George, BC. CANADA V2N 4Z9 Changes in allele frequencies within a population through time demonstrate that genetic composition within a population is temporally unstable. Measuring allele frequencies at 11 microsatellite loci, we evaluated the temporal stability of five populations of Chinook salmon from the Upper Fraser River, British Columbia, Canada. Significant temporal variation in the allele frequencies were found between populations. Assignment tests revealed moderate levels of population assignment with variation in migration levels between populations. statistics showed populations with consistent migration have reduced drift effects over time while populations showing lower or inconsistent migration with adjacent populations appear to be more readily impacted by genetic drift. These results highlight the complex interaction of genetic drift and migration and the need for temporal analyses to allow a greater understanding of genetic structure in natural populations.	CCFFR general	28
POTENTIAL INTERACTIVE IMPACTS OF FALLING CALCIUM AND TP LEVELS AND RISING SUMMER TEMPERATURES ON DAPHNIA PULEX: A LABORATORY STUDY OF MULTIPLE STRESSORS *Ashforth, D. (1) and Yan, N. D. (1, 2) (1) Department of Biology, York University, Toronto, ON, M3J 1P3 (2) Dorset Environmental Science Centre, Ontario Ministry of the Environment, Dorset, ON, P0A 1E0 Calcium (Ca) levels are declining in lakes across the Canadian Shield. Daphniids have a high Ca requirement and acquire much of the Ca from lake water. While an inadequate supply of Ca could reduce the growth or likelihood of survival of daphniids, little is currently known about the potential effects of Ca decline on daphniids, especially at the population level. We sought to determine population-level responses of the soft-water species Daphnia pulex to Ca decline, both on its own and in the presence of two other current stressors: temperature increase and phosphorus decline. D. pulex were reared individually in growth chambers across a Ca gradient (0.1 to 10 mg Ca l-1) at four temperatures (20oC, 24oC, 28oC, and 32oC) and two food levels (High: 1.33 * 105 cells·ml-1 and Low: 1.33 * 104 cells·ml-1) in a fully factorial design. The intrinsic rate of natural increase (r) was greatly reduced between 1 and 1.5 mg Ca l-1, and could not be determined at 0.1 mg Ca l-1 as the individuals reared at this level of Ca did not	Poster	

reproduce. The decline in r was attributed to delays in brood production and reductions in brood size and number. We also detected interactions between temperature increase, phosphorus decline, and Ca decline, which enhanced the effects on various population metrics. We conclude that Ca levels below 1.5 mg Ca l-1 are detrimental to populations of D. pulex, and this threshold Ca concentration rises at high temperatures and low phosphorus levels.		
INVESTIGATING THE SOURCES OF HIGH FECAL COLIFORM CONTAMINATION OF MARINE SHELLFISH GROWING WATERS Beach*, K. and E. Pinkerton. School of Resource and Environmental Management. Simon Fraser University, Vancouver (email: kbeach1@sfu.ca) Large-scale closures have threatened to devastate the shellfish industry in some remote communities on the west coast of Vancouver Island. The impact of these closures, spawned by recent findings of high fecal coliform levels, have been intensified by the uncertainty on the part of the communities and government as to the source of the high counts. The science behind the sampling protocol is both complex and unclear for harvesters, yet because of federal budget constraints, they may be the link to facilitate intensive investigation of the problem. Collaborative research is currently being undertaken to connect First Nations traditional ecological knowledge with Environment Canada water quality monitoring protocol, as prescribed under the Canadian Shellfish Sanitation Program. The research will help to promote cooperation between First Nations and various government agencies by building the capacity to hypothesize, analyze, and mitigate sources of pollution of shellfish growing areas. I will work with community representatives and government agencies to ensure comprehensive research that will help to address the concerns about the mammalian source of the fecal coliform, the potential contribution of extensive clear-cutting, and the contribution of organic matter to the counts. The collaborative process of design and investigation will help harvesters and communities to understand the protocols and to provide serious suggestions to decision makers in the future. This paper will explore the validity of various hypotheses developed by the communities and the government to explain the high counts, and explain methodologies that are currently being used to investigate the water quality concerns.	Poster	
CULVERTS AS INSTREAM BARRIERS TO FISH MOVEMENT AT THE LOCAL AND RIVERSCAPE LEVELS IN SMALL COLDWATER STREAMS IN NORTHWESTERN, ONTARIO Berglund*, E. and R. Mackereth. Department of Biology and Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources, Lakehead University, Thunder Bay, Ontario. (eberglun@lakeheadu.ca) Stream crossings may alter fish habitat and fragment lotic environments, which could lead to changes in fish assemblage structure and population dynamics at the local and riverscape level. There is currently limited information on habitat fragmentation and the cumulative effects at the riverscape level caused by stream crossings along the northwestern shore of Lake Superior. The objectives of this study are to: (1) quantify the relative influence that culverts have on fish community structure along streams above and below culverts using a suite of local-scale environmental variables; (2) determine whether the focused disturbance at culverts is similar to that of confluence sites; (3) create a predictive model for stream fish assemblages, that considers watershed network geomorphology and ecology using confluence-link as a measure of stream network position, as well as the relative fragmentation of a watershed. Our study area comprises 7 major watersheds along Lake Superior from Thunder Bay to Nipigon, Ontario. Habitat and single-pass electrofishing surveys were carried out once at 43 culvert and 7 confluence sites and twice at 10 of the 43 culvert sites on small coldwater streams during the summer of 2004 and 2005. Preliminary results indicate that there is a significantly greater number of species below culverts compared to above (n= 40, p= 0.001) and that the mean weight (n=9, p= 0.012) and length (n=8, p= 0.019) of brook trout (Salvelinus fontinalis) was greater above culverts compared to below. Further analysis will focus on the composition of fish species assemblage and community functional trait characteristics.	Poster	

PLANKTONIC NUTRIENT KINETICS, AND FOOD WEB STRUCTURE IN THE PELAGIC ECOSYSTEMS OF SEMI-SALINE JACKFISH AND MURRAY LAKES *Bogard, M.(1), Hudson, J. Department of Biology, University of Saskatchewan, Saskatoon, SK, S7N 5E2 (mjb838@mail.usask.ca) Jackfish Lake (Zmax ~4.5m, area ~62km2) and Murray Lake (Zmax ~7.4m, area ~14km2) are located approximately 42 km north of North Battleford, SK. Both Lakes have been experiencing a prolonged drought, driving them to a weakly saline condition. For example, water levels in Jackfish have dropped ~85cm in past decades, and salinity has risen (1170 – 3510 mg L-1 TDS). Both are eutrophic systems, and although TP concentrations have increased, algal biomass has not shown an increasing pattern. In fact, chlorophyll a concentrations in Jackfish and Murray are much lower than expected. We investigated the effects of these physical-chemical changes on the pelagic food web structure and kinetics in both lakes. We compared P-kinetics and food web structure to freshwater lakes across Canada. Whole water P-kinetics (turnover time of dissolved phosphate, regeneration and turnover of particulate P) were typical of freshwater lakes. However in some instances, the kinetics and structure of sub components of the food web of Jackfish and Murray Lakes were different from those of freshwater lakes.	Poster	
Modelling mercury biomagnification in riverine food webs: The South Saskatchewan River basin. Brinkmann*, L. and J.B. Rasmussen Department of Biological Sciences, The University of Lethbridge, Lethbridge, Alberta (email: lars.brinkmann@uleth.ca) Biotic transport of contaminants in rivers has received little study. Contaminant models have so far been developed for and applied to lacustrine systems and assume spatial averaging of contaminant concentrations. This assumption works well in lakes however, the linear hierarchy of food webs in rivers, exposure gradients, and the possibility of migration between ecoregions require spatial parameters to be included. This can be of special interest in systems where annual migrations of fish occur, and more so, where precise data about the migration of fish do not exist. These fish may accumulate mercury in lower reaches of the river and transport it into food webs upstream. We want to further develop our understanding of contaminants as tracers in the study of fish migration. The mercury gradient is established by measuring mercury concentrations in invertebrates (caddisfly larvae) and small forage fish (longnose dace, sucker species) from samples taken from the headwaters of the Oldman river down to the mouth near Medicine Hat. These organisms do not migrate and therefore reflect local exposure conditions very well. We are applying a mercury mass balance model designed for lakes to this river system and identify data discrepancies resulting from spatial dynamics of food webs. We are augmenting the existing algorithms with parameters that account for spatial variation and migratory influences of local food webs in the river.	Poster	
EFFECTIVENESS OF PROTECTED AREAS IN ONTARIO IN CONSERVING FISH SPECIES BIODIVERSITY Buckley, J.* and Wilson, C. Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario (email jbuckley@trentu.ca) Ontario has the greatest diversity of freshwater fishes and inland aquatic habitats in Canada. Despite this, Ontario has no assessment framework for conserving aquatic biodiversity, and protection is generally focused on identified "at risk" or exploited species rather than communities or regional biota. A proactive approach is needed to determine the species diversity within protected areas and its representation of the provincial fauna. To meet these goals, fish species biodiversity inside and outside of protected areas throughout Ontario were compared at local and regional (secondary watershed) scales. The comparative effectiveness of different types of protected area in protecting native species richness is being assessed using GIS data layers and species occurrence records. Regional comparisons of species diversity are focusing on changes in beta diversity to determine if the current protected area system provides regional representation and adequate coverage for aquatic biodiversity. Preliminary results indicate that the park network does poorly on a provincial scale, with the greatest species richness in the south (42° to 46° latitude) and the greatest total area	Poster	

protected above the 48th parallel. Protected areas are regionally representative, however, with very little change in diversity inside and outside of park borders. Despite this, the current protected areas network does not safeguard an adequate proportion of the provincial fish fauna. Future park planning for conservation purposes will need to consider species occurrence at provincial as well as local scales; studies such as this have significant potential to provide direction to help ensure the sustainable future of aquatic species and habitats in Ontario and elsewhere.		
ABSENCE OF GROWTH TACTICS IN AGE 2 YELLOW PERCH FROM LAKES HURON AND ERIE Collins*, N.C., E. Cairns, and K. Habib. Biology Department, University of Toronto at Mississauga, Mississauga, ON (email: ncollins@utm.utoronto.ca) Compensatory or catch-up growth tactics in fish that have been food-deprived have been documented in numerous lab studies, and a number of environmental conditions that should select for growth compensation have been worked out. However, there have been few attempts to evaluate whether these tactics are expressed under field conditions, where food scarcity and predation risk are likely more severe than those used in the lab. Indeed, field conditions might produce another kind of growth ”tactic,” in which alternative behavioral or physiological traits produce persistently fast- and slow-growing individuals. All of these possibilities could be evaluated under field conditions by comparing growth of members of a single cohort that are initially different in size. Accordingly, we compared growth from age 2 to 4 of relatively large and relatively small members of single cohorts of yellow perch, using scale back-calculations to estimate size at age 2. We also compared Lake Huron and Lake Erie populations because their contrasting overall growth rates might differently constrain the expression of any growth tactics. We found it tricky to avoid statistical and mathematical artifacts that biased outcomes, but our most defendable results for both absolute and relative growth rates showed little or no evidence of size-dependence in either population. For the Lake Erie population we compared male and female responses to initial size and found equally negligible effects on growth rates for both sexes. We emphasize that our results cover the age range for sexual maturation in these populations should probably not be extrapolated to younger juveniles.	Poster	
SURFACE WATER QUALITY AND LIMNOLOGICAL CONDITIONS OF SYLVAN LAKE Cooley, H.M (1), Irving, E.C.* (1), Mitchell P. (2), Kroeker K. (1), Brecia D. (3), and Eccles R. (3), McClymont G. (4) (1) North/South Consultants Inc. Suite 500, 805 - 8th Ave. S.W. Calgary, Alberta, T2P 1H7 (eirving@nscons.ca) (2) Patricia Mitchell Environmental Consulting, 3013 Lloyd Rd. RR1, Canyon, British Columbia, V0B 1C1 (3) AXYS Environmental Consulting Ltd., Suite 300, 805 - 8th Ave SW, Calgary, Alberta, T2P 1H7 (4) Westwater Environmental Ltd., Suite 410, 808 - 4th Avenue SW, Calgary, Alberta, T2P 3E8. Sylvan Lake is a popular recreation destination in Alberta, and its location halfway between the cities of Calgary and Edmonton has resulted in increasing development pressure. A need was identified to evaluate current surface water quality conditions and trends in the lake that may affect the ecological integrity and recreational potential of the lake, both in the short and medium term. The emphasis of this study was the evaluation of nutrients and related variables, in order to assist in the development of management plans for Sylvan Lake. Available water quality and limnological data for Sylvan Lake and its tributaries, were summarized and analysed for evidence of temporal changes and spatial differences (where applicable). The nutrient status of Sylvan Lake was then assessed based on this information. In addition, as a component of this study, Sylvan Lake was sampled in September 2004 to evaluate water and sediment quality and phytoplankton species composition. The 2004 study was intended to provide information on the spatial variability of water quality in the lake; evaluate conditions in nearshore areas; update and digitize lake bathymetry; and evaluate sediment quality in deep and nearshore areas of the lake. Furthermore, the water quality of inflowing tributary streams was examined to assist in the determination of nutrients sources and loads to Sylvan Lake. Uncertainties and data gaps in the current data set were identified and recommendations made regarding future monitoring needs.	Poster	

DIATOMS AS PALEOENVIRONMENTAL INDICATORS OF CLIMATE CHANGE ON BATHURST ISLAND, CANADIAN HIGH ARCTIC *Crawley, C. (1), Douglas, M.S.V. (1), and Smol, J.P. (2) Email: catherine_crawl@hotmail.com (1) Department of Geology, University of Toronto, ON, M5S 3B1 (2) Paleoecological Environmental Assessment and Research Laboratory, Queen's University, Kingston, ON, K7L 3N6 High Arctic ecosystems are especially sensitive to climatic changes, and so the sediments preserved in the numerous lakes and ponds in this region represent important archives of past climatic and other environmental conditions. Our earlier paleolimnological work using diatom microfossils preserved in sediments from shallow ponds in the Canadian High Arctic identified a warming trend dating back as early as ca. 1850 AD. The typical shifts in diatom assemblage consisted of a pre-19th century Fragilaria-dominated flora that persisted for several millennia. Many lake and pond ecosystems shifted to markedly different assemblages over the last 100-150 years, with shifts to taxa characteristic of decreased ice conditions. A subsequent circum-polar analysis of paleolimnological changes across four Arctic countries recorded similar responses of biological indicators to climate warming (Smol et al. 2005; PNAS). Different regions of the Arctic, however, record different ecological trajectories. Bathurst Island represents a relatively lush High Arctic island, which has not yet been studied using diatom-based paleolimnological approaches. In July 2005, we obtained a sediment core from a pond at Polar Bear Pass, Bathurst Island (75° 42`N / 97° 21`W). Our preliminary data indicate that diatoms assemblages have changed in this profile, also consistent with warming. These data suggest that diatoms have recorded recent climatic warming in this relatively lush region of the east-central High Arctic.	Poster	
MEASURING THE RELATIVE IMPORTANCE OF DISTANCE AND HABITAT CHARACTERISTICS ON BETA-DIVERSITY OF DRAGONFLIES AND DAMSELFLIES (INSECTA: ODONATA) Colin Curry1*, Donald Baird1,2, and Allen Curry1 1Canadian Rivers Institute, Department of Biology, 2National Water Research Institute (Environment Canada), University of New Brunswick, Fredericton, NB, Canada E3B 6E1 *colin.curry@unb.ca Beta-diversity is the turnover in species composition between localities in a landscape. It has been identified as a useful metric for aquatic biomonitoring at large spatial scales (i.e. watersheds). However, because reference conditions are difficult to establish at this scale, they must be modeled. A first step is to determine the amount of data necessary for accurate field measurement of beta- diversity at the spatial scale of interest. Here we present preliminary data from two sub-watersheds in southern New Brunswick, Canada. During May – July 2005, physical, chemical, and biological variables were quantified for 20 sites in each sub-watershed according to a nationally accepted sampling protocol, developed as a component of Environment Canada's CABIN program. River sites were sampled for aquatic macroinvertebrates, with a particular focus on larval dragonflies and damselflies. Within each site, three nested microhabitats were sampled: fast-flowing riffles, slow-flowing pools and backwater areas. A multivariate clustering technique was used to group sites in each watershed based on field-measured variables. This grouping will allow sites to be compared based on both geographical proximity and habitat similarity. Once species data are fully available, they will be used to develop rarefaction curves that indicate the extent to which the regional fauna has been sampled. Species data will also be analyzed to determine if community similarity is greater between proximate sites or sites with similar habitat characteristics. Results will generate hypotheses regarding the spatial and physicochemical factors driving species composition. This information will aid in the modeling and field quantification of beta-diversity.	Poster	
SIMULATED BLASTING EXPOSURE ON SURVIVAL OF RAINBOW TROUT EGGS Faulkner*, S.G., and W.M. Tonn. Department of Biological Sciences, University of Alberta, Edmonton, Alberta. M. Welz. Department of Physics, University of Alberta, Edmonton, Alberta. (email: sgf@ualberta.ca)	Poster	

Blasting in or near water has the potential to negatively affect fish. In Canada, maximum allowable limits exist for blasting induced over-pressure and peak particle velocity (PPV), to protect fish and their incubating eggs, respectively. Previous studies have focussed on fish mortality induced by over-pressure, with no studies relating PPVs from blasting to mortality of incubating eggs. The allowable PPV limit of 13 mm/s was thus developed using minimal information. To address this information gap we developed a laboratory blast simulation method that can measure egg mortality at different PPV exposures. We subjected rainbow trout eggs, at five sensitive developmental stages (46, 54, 62, 75 and 95 degree-days), to PPVs of up to 250 mm/s. Eggs were also exposed to a previously described drop-height method, where the final velocity attained by the eggs is used to estimate PPV exposure. With this latter method, we tested both an out-of-water treatment and in-water treatment. Using the blast simulation, we found no increase in egg mortality despite exposures of 250 mm/s repeated 7 times. Using the drop-height method, eggs out of water are more sensitive to a given exposure level than eggs in water. Results indicate that PPVs greater than 1000 mm/s may be needed to cause mortality and that the current PPV guideline provides ample protection for spawning beds and could in fact, be increased substantially, at least for rainbow trout. Because of limitations of our blast simulation procedure, however, the level of PPV exposure that increases mortality of eggs remains unknown.		
METAL MINING EFFLUENT CHARACTERIZATION AND WATER QUALITY MONITORING DATA IN PRAIRIE AND NORTHERN REGION Holzapfel. A., Gray, M., *Ferone, J.M., Siwik, P. Environment Canada, Prairie and Northern Region, Edmonton, AB, T6B 2X3 Email: jenny.ferone@ec.gc.ca Under the Metal Mining Effluent Regulations (MMER), metal mines discharging into the aquatic environment are required to conduct effluent characterization on each final discharge point. In addition, mines are required to monitor water quality in a reference and exposure area around each final discharge point. The first sets of annual data required under the MMER were collected in 2003 and 2004. This poster presents a summary of the data submitted by 21 regional mines located in Manitoba, Saskatchewan, the Northwest Territories, and Nunavut. The 3 types of mines (Gold, Uranium and base metal) generally have distinct effluent characterization based on metal concentrations. The environmental impact of mine effluents will likely be influenced by site specific conditions, such as the size and type of receiving environment, timing and duration of discharge, as well as regional history.	Poster	
ASSESSMENT OF THE SUMMER SPORT FISHERY FOR WALLEYE (SANDER VITREUS) AND NORTHERN PIKE (ESOX LUCIUS) AT LESSER SLAVE LAKE, ALBERTA, 2004. Fortier*, G.. Alberta Conservation Association, Peace River, Alberta (greg.fortier@gov.ab.ca) and Tchir, J.P. Alberta Sustainable Resource Development, Grande Prairie, Alberta Environment (john.tchir@gov.ab.ca) Lesser Slave Lake sustains the largest recreational walleye fishery in the province of Alberta. An angler survey was conducted from 20 May through 28 August 2005 to assess the summer recreational fishery for walleye (Sander vitreus), northern pike (Esox lucius), and yellow perch (Perca flavescens). Fisheries managers of Alberta Sustainable Resource Development use this information in the evaluation and development of angling regulations. A multiple access, reduced effort angler survey was employed with two crews surveying four access points. Each access was surveyed over the entire angling day for five consecutive days, averaging 37 days surveyed at each access. Two access points were surveyed in each sub-basin of Lesser Slave Lake. Data collected at each access point included anglers in each party, fish harvested, sub-legal and legal fish released, time of completed trip, time spent fishing, predominant depth of fishing, hook type, bait, fishing method, use of electronics, and angler residence. Aerial boat counts were conducted on random dates to determine the ratio of use for each access site. This ratio was then applied to fishery metrics (e.g., number of anglers, angler effort, catch and harvest) for each site using bootstrapping to estimate these metrics for the entire lake. Results were compared to 1999 survey results to determine changes in the summer recreational fishery. This survey will also serve as a baseline to gauge	Poster	

changes in the fishery as a result of regulation changes to occur in 2006. A follow-up survey (post regulation change) is planned to occur within three years and comparisons will be made to gauge effects and ensure management objectives are being met.		
ECOLOGY OF THE REDBREAST SUNFISH LEPOMIS AURITUS IN TWO NEW BRUNSWICK LAKES: A SPECIES OF CONCERN (COSEWIC) Gautreau, M. and R. Allen Curry. Canadian Rivers Institute, Department of Biology, University of New Brunswick, Fredericton, NB. E3B 6E1. (Email:mgautrea@unb.ca) The redbreast sunfish, Lepomis auritus, is distinguished from other centrachidae by its long and narrow opercular flap lacking a coloured border. The northern limit of the redbreast sunfish extends into Canada only in southern New Brunswick where it is found in both rivers and lakes. The Committee on the Status of Endangered Wildlife in Canada listed this species as a "species of concern" in 1989. The purpose of this study is to investigate the reproductive habits and population sizes of the redbreast sunfish in Oromocto and Yoho Lakes. Spawning occurred in late June to early July when water temperatures was around 20 – 24 oC. Snorkeling surveys were conducted in early July to observe nests which were identified by the guarding male. The nests were measured for width, depth, distances from other nest and structures and habitat characteristics recorded. Yoho Lake nests (n=43) averaged 51.37 cm in width, were in 35.3 cm of water, and had an excavated depth of 8.37 cm. Oromocto Lake nests (n=20) had diameters of 50.35 cm, in 50.95 cm of water and excavated depth of 6.55 cm. Mark-recapture sampling was conducted in September 2005 using fyke nets and windemere traps. In Yoho, 105 fish were marked over three sampling days with eight recaptures. Using the Schnabel formula this generated a population of 810 individuals. A total of 138 fish were examined in Yoho Lake with an average fork length of 11.98 cm and weighing 42.38 g. Fish aging and stomach analysis is ongoing.	Poster	
TESTING THE USE OF BENTHIC MACROINVERTEBRATES AS AN INDICATOR OF RECOVERY FOR ACID AND METAL DAMAGED AQUATIC ECOSYSTEMS IN SUDBURY, ONTARIO Genrich*, E. and J.M. Gunn. Department of Biology, Laurentian University, Sudbury, Ontario (Email: ex_genrich@laurentian.ca) Benthic macroinvertebrates have been widely used in recent years to assess the water quality of streams and lakes. Typically, a reference condition approach that compares impacted or damaged sites to non-impacted ones similar in zoogeography is used. In Ontario, the Ministry of the Environment (MOE) has been instrumental in implementing the use of benthic macroinvertebrates in rapid assessment procedures that are designed to be simple and inexpensive to conduct. However, the applicability of these bioassessment methods has not been adequately tested in predicting the recovery of historically damaged ecosystems. Sudbury, Ontario is an ideal location to test the effectiveness of the MOE rapid bioassessment methods in correctly identifying damaged and recovering lake ecosystems. Using the reference condition approach as a guide, I will compare the benthic macroinvertebrate communities in 30 Sudbury area lakes to 30 non-impacted lakes near Dorset, Ontario. Benthic samples were collected at five sites in each lake. These sites were chosen to characterize the composition of the littoral zone habitat in the lake (<1 meter). 100 organisms were randomly picked from each of the five samples. I will identify these selected organisms to family level and they will be kept as a reference collection to be verified by an experienced taxonomist. Multivariate statistical methods (PCA, discriminant function analysis, multiple regression) and sensitivity analysis will be used to compare the benthic macroinvertebrate communities in the impacted (Sudbury) lakes to the reference condition, non-impacted (Dorset) lakes. Analysis is underway and results will be reported at CCFFR in January.	Poster	
ECOLOGICAL PROCESSES CONTROLLING METHYLMERCURY PRODUCTION IN PRAIRIE WETLANDS *Hall, B.D. Department of Biology, University of Regina, Regina, SK, S4S 0A2 Email: Britt.Hall@uregina.ca	Poster	

The microbial methylation of inorganic mercury (HgII) is the most important transformation in the environmental Hg cycle because the product, a neurotoxic, methylated form of Hg (methylmercury; MeHg), is easily bioaccumulated by humans and wildlife. MeHg production is thought to be mainly mediated by microbes and the amount of Hg methylation in an aquatic environment depends on environmental factors that control microbial population growth or metabolic function. Factors that promote Hg methylation are particularly important in wetland sediments and prairie wetlands across the Great Plains of North America offer ideal conditions for high rates of Hg methylation. Prairie wetlands are critical wildlife habitats, providing cover and nesting sites for hundreds of game and non-game wildlife species and containing the some of the most important waterfowl breeding habitat remaining in North America. Elevated rates of MeHg production could result in significant health and environmental risks to prairie wildlife. As well, if waterfowl have high MeHg concentrations, hunters and their families consuming prairie wildlife could be exposed to MeHg levels that exceed Hg consumption guidelines. There is no current information on MeHg in prairie wetlands and this topic raises two important questions: 1. What are the concentrations of MeHg in water, sediment, and biota in different types of prairie wetlands?; and 2. What are the chemical and physical mechanisms that control MeHg production in prairie wetlands? To characterize the production and bioaccumulation of MeHg in prairie wetlands, we propose a new ecosystem-level study designed to investigate environmental factors regulating MeHg production in prairie wetlands. This research will provide novel insights on the pathways and regulatory mechanisms involved in biological production, and the subsequent uptake, of MeHg into prairie food webs. Examining environmental factors regulating MeHg production in prairie wetlands is vital to addressing fundamental gaps in understanding of environmental controls on Hg methylation and will provide information necessary to protect wildlife populations inhabiting these vulnerable habitats.		
THE ROLE OF INVASIVE BYTHOTREPHES SP. IN INLAND LAKE FOOD WEBS AND MERCURY TROPHIC TRANSFER TO FISH *Hatton, E.C.(1), Campbell, L.M.(2), Arnott, S.E.(1) Email: hattone@biology.queensu.ca (1) Department of Biology, Queen's University, Kingston, ON, K7L 3N6 (2) School of Environmental Studies, Queen's University, Kingston, ON, K7L 3N6 Bythotrephes, an exotic, predatory cladoceran, has spread rapidly through the Great Lakes region. Invaded lakes can have reduced plankton species richness and biomass and altered native zooplankton community structure. Recent evidence suggests that Bythotrephes may also affect the diet and trophic position of Mysis relicta, a common predatory macroinvertebrate and an important prey species for forage fish. Bythotrephes competes with Mysis for zooplankton prey, while also being consumed by Mysis. It is hypothesized that the interaction between these two species may result in: 1) changes in the energy transfer to forage fish, having bottom-up affects on contaminant concentrations; or 2) forage fish shifting to a benthic, rather than pelagic food source thereby changing the source of contaminants (i.e., benthic vs. pelagic). In lakes without Mysis, the introduction of Bythotrephes may lengthen the food chain, resulting in increased contaminant concentrations at higher trophic levels. Using a combination of mercury (Hg) and stable isotope (i.e., δ13C, δ15N) analysis we can assess changes associated with Bythotrephes invasions in food web structure and bioaccumulation of Hg. In the summer of 2006, a comparative survey of 24 lakes with known water chemistry and plankton communities in the Muskoka, Ontario area will be conducted. Changes in the energy pathways in pelagic food webs in response to Bythotrephes invasion will have important implications for food web structure, Hg bioaccumulation and ultimately Hg concentrations in fish consumed by humans and other fish predators.	Poster	
COMMUNITY RESPONSES TO THE INTRODUCTION OF CABOMBA CAROLINIANA *Hogsden, K.L, Sager, E.P.S., and Hutchinson, T.C. Email: khogsden@gmail.com Environmental and Resource Studies Program, Trent University, Peterborough, Ontario, K9J 7B8 Introduced species can completely transform the diversity and function of aquatic ecosystems. Dense monocultures or extensive canopies formed by non-native macrophyte species can influence biotic communities, often through changes in physiochemical characteristics (e.g., decreased light and	Poster	

nutrients). For example, the abundance and composition of biotic communities may be negatively affected by reduced dissolved oxygen in dense non-native macrophyte beds or positively affected due to increased food availability or the creation of refuge from predators. Following a recent introduction into one lake in central Ontario, Cabomba caroliniana now forms tall, dense stands in shallow waters (1-3m), covering extensive areas in Kasshabog Lake. However, little is known about the broader ecological implications of its introduction and establishment. Using a survey approach, we compared the macrophyte, benthic invertebrate, and epiphytic algae communities found in Cabomba beds to those in native macrophyte beds. Physiochemical differences between Cabomba and native beds were also examined. Our preliminary findings suggest that, over time, the establishment of Cabomba may adversely affect native macrophyte communities while creating superior habitats for some benthic invertebrates. Further, reduced epiphytic algae production in Cabomba beds, owing to decreased light availability, may have important implications for lake productivity in this oligotrophic lake.		
LONGNOSE DACE EFFECTIVELY IDENTIFY EVIRONMENTAL STRESS IN THE OLDMAN RIVER, ALBERTA (P) Jeffries*, K. M., Jackson, L. J., Nelson, E. R. and H. R. Habibi. Department of Biological Sciences, University of Calgary, Alberta. (email: kmjeffri@ucalgary.ca) Longnose dace, Rhinichthys cataractae, are a common fish in the Oldman River, Alberta. We sampled longnose dace at multiple sites along the Oldman River, and correlated changes in individual and population metrics to land-use. Abundance and size of longnose dace increased downstream of the city of Lethbridge, likely in response to nutrient inputs from municipal wastewater. The sex-ratios at multiple sites were heavily skewed towards females when compared to longnose dace sex-ratios in the Bow and Red Deer Rivers, two major rivers immediately north. Skewed sex-ratios may be a population level response to endocrine disruption and potentially suggests exposure to estrogenic chemicals during sexual differentiation. Longnose dace exposure to estrogenic compounds was determined using semi-quantitative reverse transcriptase polymerase chain reaction (RT-PCR) to determine mRNA levels. Adult males and females displayed increased mRNA levels for the gene that codes for vitellogenin, a female-specific precursor for egg yolk protein. The results will be discussed in the context of physiological responses of male and female longnose dace to estrogenic chemical contaminants in the Oldman River.	Poster	
AN INTEGRATED APPROACH TO RESTORING STREAM CONNECTIVITY IN TWO WATERSHEDS IN NORTHWESTERN ALBERTA Johns*, T. and J. Tchir. Alberta Conservation Association, Bag 900-26, 9621-96 Avenue, Peace River, Alberta T8S 1T4 Canada. (Email: tyler.johns@gov.ab.ca) Stream crossings often result in barriers to fish movement. Structures such as culverts and bridges, allow for both road crossings and connectivity of waterways, with minimal aquatic impacts when properly installed, monitored and maintained. Improperly sized and installed culverts have been shown to constrict stream channels, leading to increased water velocities, scouring, sedimentation and eventually hanging outlets. To better manage watersheds within their Forest Management Agreement Area (FMA), Canadian Forest Products Limited (CANFOR) Grande Prairie has been working with the Alberta Conservation Association (ACA) to enhance knowledge of fish distribution and assess stream crossings for their potential to fragment stream habitat. We conducted stream fish inventories upstream and downstream of crossing structures and at streams that were not previously inventoried. These data along with archived fish inventory data were used to model the occurrence of bull trout (Salvelinus confluentus), Arctic grayling (Thymallus arcticus) and other fish based on geomorphic attributes within their FMA area. Models provided insight into the expected occurrence of fish throughout the FMA area. Inferences made from modeling and in-stream sampling provided a basis to identify potentially sensitive areas and plan remediation efforts at road crossings to minimize habitat disturbance. CANFOR's proactive approach, and collaborative efforts with the ACA to resolving culvert-crossing issues provides a good model for culvert management and stream fish conservation.	Poster	

Landscape and land management influences on farm pond water quality on the Portage Plains of south-central Manitoba. Scott Kolochuk and Gordon Goldsborough. Department of Botany, University of Manitoba, Winnipeg, MB, Canada R3T 2N2 ph. (204) 474-8469, kolochuk@yahoo.com It has long been speculated that livestock add nutrients and pathogens to water which potentially degrade its quality. However, remarkably little quantitative research has been done to evaluate this conclusion. In 2003, our preliminary study of water quality in 35 farm ponds in southern-central Manitoba showed that cattle do have a negative impact on water quality and this impact intensified when cattle had direct access to pond water. Ponds with a greater intensity of cattle access had higher concentrations of ammonia, total nitrogen, total phosphorus, algal chlorophyll, E. coli, fecal coliforms, and turbidity, and lower surrounding vegetative cover, compared to ponds with less intense cattle access. Ponds with a greater intensity of cattle access tended to have lower nitrate, sulphate, and chloride concentrations, and lower pH and conductivity, than ponds with little to no cattle use. More generally, agricultural use of fertilizers and pesticides, land clearing, and other practices may threaten water quality too. During the summer of 2005, we have selected 60 farm ponds across a wider range of land use practices, soil types, and topography within a 8,300 km2 area. We are characterizing pond water quality at three to four week intervals. In addition to chemical analysis of water, we are deploying nitrogen- or phosphorus-diffusing substrata at selected sites as a bioassay of nutrient availability for periphytic algae. Using existing GIS data, ground reconnaissance, and questionnaires, we are investigating correlations between a range of landscape and land use variables, and water quality.	Poster	
AQUACULTURE PROVIDES A NOVEL ENERGY SOURCE FOR THE NATIVE FRESHWATER FOOD WEB Kullman, M.†, K. Kidd†*, C. Podemski‡ †Canadian Rivers Institute, Department of Biology, University of New Brunswick-Saint John, Saint John, New Brunswick; ‡Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, Manitoba (email: kiddk@unbsj.ca) A study was initiated in 2002 at the Experimental Lakes Area in northwestern Ontario to examine the effects of freshwater aquaculture on lake ecosystems. Each summer in 2003 through 2005, the experimental aquaculture operation cultured 10,000 rainbow trout (Oncorhynchus mykiss) following current industry practices. The industrial fish feed used in this experiment was comprised primarily of marine herring or menhaden, and had isotopic signatures that were distinct from energy sources within this freshwater ecosystem. The objective of this study was to determine whether the feces and excess feed became an important source of energy and nutrients to this food web. Stable carbon (δ13C) and nitrogen (δ15N) isotope ratios of native biota were compared before and after the introduction of aquaculture operation. After one season of cage culture, there were no changes in the stable isotope signatures of littoral invertebrates, zooplankton, or Mysidae when compared to background and reference lake data. After two years of cage culture, we observed shifts in the δ15N of zooplankton, Mysidae, profundal Chironomidae, Tanypodinae, Caenidae, Ephemerellidae, and Heptageniidae towards the signature of the feed, likely due to the widespread incorporation of dissolved nitrogenous wastes (ammonia and urea) into the primary producers. In contrast, a shift in δ13C was only observed in the profundal Chironomidae collected near the cage site. Waste feed and feces only accumulated beneath the cage and appeared to have provided a localized source of carbon for the chironomids. These results indicated that aquaculture wastes were being incorporated into the native food web, and that the extent of the impacts depended upon the type of waste being generated.	Poster	

ANADROMY VS. RESIDENCY: A COMPARISON OF DIVERGENT LIFE HISTORY STRATEGIES OF ARCTIC CHARR (Salvelinus alpinus) SEASONALLY CO-EXISTING IN LAKE-SYSTEMS OF SOUTHERN BAFFIN ISLAND, NUNAVUT, CANADA Tracey N. Loewen*1,2, Ross F. Tallman1, Darren Gillis2. 1Department of Fisheries and Oceans Canada, Winnipeg MB and 2Department of Zoology, University of Manitoba, Winnipeg, MB. (loewent@dfo-mpo.gc.ca) Alternative life history strategies of resident and anadromous Arctic charr (Salvelinus alpinus) that live in co-existence within the same lake system of Canadian Arctic waters is not well understood. The three lakes in the South Baffin Island region: Iqalugaarjuit Lake, Shark Fjord, Qasigiat, Ptarmigan Fjord and Qinngu, Blandford Bay were used as study sites to characterise the two alternative life history strategies. Fish were captured via multi-mesh (38 mm-102 mm stretched mesh) and 140 mm gillnets and dead sampled for basic biological information required for examining life history traits within the stock. Ageing structures (otoliths) were sectioned for analysis and fecundity measured by whole egg counts on females in spawning condition. Size-at-age data indicate that resident charr grow at a slower rate than anadromous charr within all of the three lake systems. Resident charr within each lake system were dominated by the male sex but fecund and resting females were occasionally observed. Female resident charr in spawning condition were significantly less fecund and had comparable egg size when compared to anadromous females.	Poster	
STABLE CARBON AND NITROGEN ISOTOPE ANALYSIS OF ENERGY FLOW AND FOOD WEB STRUCTURE WITHIN WILD RICE AND NATIVE MACROPHYTE BAYS IN WEST-CENTRAL MANITOBA Lowdon*, M., K. Kidd1, and D. Bodaly. Department of Zoology, University of Manitoba, Winnipeg, Manitoba. (email:lowdonm@dfo-mpo.gc.ca) 1 Canadian Rivers Institute, Biology Department, University of New Brunswick, Saint John, New Brunswick Introductions of wild rice (Zizania palustris) to lakes in west-central Manitoba have led to concerns about the effects this plant may have on the native biota, including potential changes in energy flow and food web structure. To examine this, we analysed carbon (d13C) and nitrogen (d15N) stable isotope ratios of primary producers through tertiary consumers to characterize trophic interrelationships and to assess whether food webs differ in bays with wild rice or bays with natural vegetation within three lakes. These oligotrophic lakes ranged in surface area from 150 to 2400 hectares, all contained bays with well-established and abundant wild rice and bays with native macrophytes and little or no wild rice, and had similar fish species. Fish muscle and whole invertebrates were collected from sites within each bay in both June and August of 2003. Biplots of all of the d13C and d15N data showed that pathways of energy flow and food web structure were similar between wild rice and native macrophyte bays for each lake. After adjusting the d15N values of top predators for slight differences in basal signatures, we found that the food web was slightly longer in wild rice bays when compared to native macrophyte bays in two of the three systems examined (difference in TL were 0.64, 0.06, and 0.93). Wild rice (mean d13C = -27.60 ‰) may have provided an additional energy source for some invertebrates (-36.74 to -21.62 ‰) and fish (-28.14 to -18.03 ‰) as their carbon isotope signatures overlapped. In general, few differences in the energy flow and food web structure were observed between bays with introduced wild rice and bays with native macrophytes.	Poster	
GIS TOOLS FOR LOCATING UNMAPPED STREAMS McCormick*, D. and R. Mackereth. Centre for Northern Forest Ecosystem Research, OMNR, Thunder Bay, ON. (email: darren.mccormick@mnr.gov.on.ca) Small streams, which can be ephemeral and/or discontinuous, are often difficult to map. The effectiveness of natural resource management planning can be limited by incomplete mapping, making the fish habitat available in unmapped small streams vulnerable to land use impacts. We developed	Poster	

GIS tools for predicting unmapped stream location by delineating the pathways of runoff as defined by the topography in a 25m digital elevation model (DEM) for the Mackenzie River Watershed (369 sq km), located north of Thunder Bay, ON. Predicted stream locations were surveyed with a high precision GPS to validate the presence/absence of small streams and to map runoff expression (i.e. channelized surface flow or subsurface flow) along each of 59 pathways. Among these, 37 were channelized along sections of their lengths and 22 had no channels. Channel width, where present, ranged between 5 and 270 cm (median = 81 cm). Preliminary analyses using upstream contributing area alone to define channel initiation suggest that 68 to 258 km (12 to 47%) of stream length is not mapped on Ontario's GIS base maps for the Mackenzie River Watershed. Our field survey dataset will be used with derivatives of the DEM (e.g. slope, roughness, curvature, topographic indices, etc.) and other GIS data (e.g. ecosite classes, surficial geology, etc.) to develop and validate models for predicting the hydrologic characteristics of entire sub-catchments and specific channel sections. These models will improve our understanding of boreal forest hydrologic processes and lower the risk of adverse effects from land management.		
THE IMPORTANCE OF AUTOCHTHONOUS AND ALLOCHTHONOUS CARBON. WHAT'S DRIVING THE FOOD WEB? McWilliam Hughes, S. & Cunjak, R. Canadian Rivers Institute, Biology Dept. University of New Brunswick, Fredericton, NB (email: c0zn6@unb.ca) The productivity of a food web is driven by the energy produced at its base by the primary producers. Aquatic food webs use energy from two types of primary producers: autochthonous (aquatically-derived) and allochthonous (terrestrially-derived) carbon sources. Stable isotope analysis (SIA), along with mixing models, can be used to differentiate between relative contributions of the different carbon sources that sustain aquatic communities. Stable carbon ratios are effective food source tracers because little alteration (0-1‰) occurs as the element is transferred through the food chain. The objective of this study was to determine and quantify the relative contribution of autochthonous versus allochthonous carbon sources to aquatic food webs throughout a river continuum. The Upper Salmon River, which runs through Fundy National Park NB and empties into the Bay of Fundy, was sampled from headwaters to river mouth (above head of tide) with eight study sites reflecting the stream orders present. Samples included algae, leaf litter, aquatic invertebrates, and different species and age classes of fishes. Based on SIA, no obvious autochthonous food source was sampled. Aquatic bryophytes, however, seemed to be demonstrating a similar isotopic signature as the autochthonous food source consumed by 'scraper-type' invertebrates and was therefore, used as an autochthonous food source representative in the mixing model calculations. Mixing model results demonstrated that the allochthonous carbon pathway contributed to >80% of the diet of predatory invertebrates and fish throughout the Upper Salmon river system.	Poster	
THE EFFECTS OF SELENIUM ON THE PHYSIOLOGIAL STRESS RESPONSE IN RAINBOW TROUT AND BROOK TROUT FROM A COAL MINING AREA Miller*, L.L., J.B. Rasmussen(a), V. Palace(b), and A. Hontela(a). *Department of Biological Sciences, University of Lethbridge, Lethbridge, Alberta (email: lana.miller@uleth.ca); (a) University of Lethbridge, Lethbridge, Alberta; (b) Department of Fisheries and Oceans, Winnipeg, Manitoba. Selenium (Se), an essential element that can also be toxic when available in excess, is found at high concentrations in runoff from some coal mines. Exposures (estimated by Se muscle concentrations) that cause teratogenesis in rainbow trout (Oncorhynchus mykiss) do not have similar effects in brook trout (Salvelinus fontinalis). The physiological stress response enables fish to maintain homeostasis during exposure to stressors and, if compromised, survival, quality of gametes, and reproductive recruitment may be adversely affected. The objective of the present study is the compare the physiological stress response in the two salmonids sampled from streams situated in a coal mining area and from reference areas. Parameters measured include: muscle Se, plasma cortisol, plasma glucose, gill Na+/K+ ATPase, and the ability of the head kidney to secrete cortisol. Se, at levels sufficient to induce teratogenesis, did not activate the physiological stress response of rainbow trout (no significant difference in	Poster	

measured parameters); although, Se may have compromised the rainbow trout's ability to secrete cortisol. Brook trout analyses are in progress. The effects of Se on brook trout's physiological stress response will also be discussed.		
SPATIAL MODELING OF A RIVERINE FOOD WEB ON A TEMPERATURE GRADIENT: THE EFFECT OF FRAGMENTATION ON COMMUNITY INTERACTIONS Montina T. and Rasmussen J.B., Department of Biology, University of Lethbridge, Lethbridge Alberta, T1K3M4 (email:tony.montina@uleth.ca) We have developed a matrix-based spatial Matlab model of a food web situated on a thermal gradient, which addresses the different temperature adaptations of fish and seasonal shifts in population distribution. The elements of the matrix for each species represent the transition probabilities among different sections of the river. These transition elements are calculated for each time step based on the relative growth potential in each river section, which is determined by a system of differential equations that describe the food web dynamics. The parameters of these differential equations are temperature dependant functions governed by a Gaussian function that declines at temperatures above and below the temperature optimum for the species. Thus the trophic interactions among species are strongly influenced by the seasonal temperature cycle for each section, whose amplitude and mean will decline from downstream to upstream sections. As a result, the distributions of each species will shift upstream during summer and downstream during fall and winter, and the distributional boundaries between species will be dependant on both the temperature preference range (fundamental niche) and the species interactions (realized niche). This model can be used to simulate the effect of obstructions which prevent upstream movement of fishes, such as a weir. In the case of a weir upstream fish can shift their distributions upward during summer, but fish from downstream often aggregate below the obstruction, minimizing interactions with upstream fish.	Poster	
HYDROLOGIC VARIABILITY AND EXTREMES IN NW ONTARIO: PALEOLIMNOLOGICAL INVESTIGATIONS FROM LAKE 239 (EXPERIMENTAL LAKES AREA) *Moos, M.T.(1) and Cumming, B.F. Department of Biology, Queen's University, Kingston, ON, K7L 3N6 (moosm@biology.queensu.ca) Two 13-m sediment cores were taken from Lake 239 at the Experimental Lakes Area (NW Ontario). Diatom assemblages were enumerated and identified to the species level in order to understand diatom community changes throughout the Holocene. The diatom inferred history was conducted at a resolution of every 8.0 cm, with higher resolution from 7700 – 9400 cal years B.P. planned as part of a larger project on Great Lakes climate change in Ontario. Secular variation (paleomagnetics) is currently being carried out on the two overlapping cores to obtain calendar dates, and Carbon 14 dating of pollen samples will be assessed. Three large sand lenses were noted in core 2 occurring in meters 10 and 11, this may be evidence of drier conditions during the time period represented by these sections. The direct importance of this research includes: 1) the extension of paleoclimate data into the early Holocene for the Experimental Lakes Area; 2) a better understanding of century-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.	Poster	
PREDICTING FUTURE DISTRIBUTION OF SMALLMOUTH BASS (MICROPTERUS DOLOMIEU) IN LAKE TAHOE, CAILFONIA Ngai*, K.L. and B.J. Shuter, Dept of Zoology, University of Toronto, Toronto, Ontario (email: christine.ngai@utoronto.ca) Smallmouth bass (Micropterus dolomieu) is an exotic species introduced to Lake Tahoe, California and may be a key species affecting the re-colonization of cutthroat trout (Oncorhynchus clarki henshawi) in that lake. The major objective of this project is to identify potential thermally suitable	Poster	

bass habitats at a regional level within Lake Tahoe. I will use predicted future water temperatures generated by empirical surface water temperature models and fish bioenergetics models to forecast how shifts in climate may affect the distribution of smallmouth bass within the lake. Outcomes of this research should facilitate the design of removal plans for smallmouth bass in Lake Tahoe. Using water temperature data collected from Lake Tahoe in 2001 and 2003, we identified three distinct thermal regions (offshore, marinas, and Emerald Bay) within the lake. Daily air and water temperatures from these regions were then used to develop region-specific models for predicting daily surface water temperature. A modified version of the Matuszek and Shuter (1996) predictive model is used to construct our models. These region-specific models should permit one to backcast and forecast daily surface water temperatures for different regions within the lake. We tested the predictive powers of the offshore model using independently collected daily air and surface water temperature data from the period of 1996-2000. Preliminary results from the tests show that our models provide reasonably accurate predictions. These results will be summarized and implications for the future spread of smallmouth bass in Lake Tahoe will be discussed.		
SUMMER DISPERSAL OF WALLEYE IN CALLING LAKE, 2002. Patterson, B. Alberta Conservation Association, Edmonton District Office, Alberta, Canada. Email: bill.patterson@gov.ab.ca During the summer of 2002, the Alberta Conservation Association conducted a biotelemetry survey to examine the movements and home ranges of walleye in Calling Lake, Alberta. Radio transmitters were implanted into a total of 12 walleye. All radio-tagged walleye survived implantation and were alive at the end of the study period. Between 14 June and 28 August, these 12 walleye were located on 173 different occasions. The proportion of walleye located in ≤3m-depth strata was significantly different from random in respect to depth (Chi square <0.001, P<0.001, n=173), indicating that fish selected shallow water. Analyses of movement data showed that walleye did not preferentially occupy a particular area of the lake. Rather, walleye are dispersed throughout the entire lake, and movement did not appear to vary with walleye size (P>0.05, r2=0.01, n=12). I identified home ranges of walleye in Calling Lake by delineating areas of use through the application of a minimum convex polygon (MCP) approach (following Minns 1995). Using this method, I quantified home ranges for all 12 walleye (mean 4,282 ha, 95% CI 1936 ha, range 464-9,185 ha, n=12). Most walleye occupied extensive home ranges. Walleye that had larger home ranges (Linear regression, r2=0.46, P<0.05, n=12) tended to have a higher rate of travel (km/day). When these data are dissolved into a single home range for all 12 study individuals, walleye used 89% (12,355 ha) of the total area of Calling Lake.	Poster	
Effects Based Assessment of Golden Shiners (Notemigonus crysoleucas) Collected From a Lake Ontario Tributary Surrounded by Pesticide Usage Lisa E. Peters1, John Struger2, and Vince P. Palace1 1 Department of Fisheries and Oceans, Winnipeg MB Canada R3T 2N6, 2 Environment Canada, Burlington ON, Canada The Department of Fisheries and Oceans' Center for Environmental Research On Pesticides (CERP) has identified model field systems to examine the potential effects of pesticides on native fish populations. An effects-based approach has been employed that includes analysis of population structure and basic physiological and reproductive parameters as well as selected biochemical indicators. One of these is an in vitro technique to assess capacity of the gonads to produce sex steroids (modified from McMaster et al. 1995). The potential for altered population structure, reproductive success and steroidogenic capacity was examined in golden shiners (Notemigonus crysoleucas), a small bodied forage fish species, captured from four locations on Twenty Mile Creek, a Lake Ontario tributary surrounded by moderate to heavy pesticide usage. Several pesticide residues have been routinely detected in surface waters of this system. Population structure differed at downstream sites, with results suggesting that recruitment was compromised. These indications included fewer numbers of fish, an absence of young of the year and compromised capacity for production of estradiol and testosterone in adult fish. Pesticide concentrations in water for the current study year are not yet available. Heavy flow events appeared to have some influence on pesticide residues in 2004 during peak application periods. Because 2005 was characterized by lower	Poster	

overall flow and fewer high flow events, data for the current year could provide information regarding the influence of water flow during peak application windows and their potential influence on pesticide residues and fish populations. Supporting field and laboratory work is ongoing.		
INVERTEBRATE COMMUNITY STRUCTURE IN RIVERS: STRUCTURAL DETERMINANTS IN THE SSRB *Powell, H. (1), Jackson, L.J. (1), and Culp, J.C. (2) Email: hmpowell@ucalgary.ca (1) Department of Biology, University of Calgary, Calgary, AB, T2N 1N4 (2) Canadian Rivers Institute, University of New Brunswick, Fredericton, NB E3B 6E1 A major issue in ecology concerns the relationship between ecosystem structure (e.g. community organization) and ecosystem function (e.g. material transport, energy fluxes). Once structure is identified, the functional relationships between material transport, energy flux and biotic communities can be elucidated. Attributes of the abiotic environment act as filtering mechanisms, which constrain organisms able to inhabit an area. These constraints are well understood in terrestrial ecology but less so in aquatic systems. Two major theoretical approaches are the 1) terrestrial landscape approach (TLA), which links aquatic community structure with components of the terrestrial environment (slope, soil characteristics, precipitation, and terrestrial vegetation), and 2) longitudinal gradient approach (LGA), which views rivers as longitudinally linked systems where upstream processes are linked to downstream areas. Here, river sections are considered gradients or continua, not discrete units. The LGA also conceptually links a rivers and the surrounding environment in four dimensions: longitudinal, lateral, hyporheic, and temporal. My Ph.D. research will combine the two major theoretical approaches and empirically determine the major abiotic drivers structuring riverine communities. Using benthic macroinvertebrates, I will organize rivers into areas of distinct community structure or ecotones. If the abundance and distribution of aquatic biota reflects their response to environmental drivers, we should be able to define riverine ecotones in relation to terrestrial ecotones. River ecotones are somewhat analogous to alternate stable states. In rivers, each ecotone could be considered an alternate state, and the transition zones between ecotones are spatial analogs of the temporal transitions between alternate stable states.	Poster	
MOVEMENT OF BROOK TROUT IN THE CYPRESS RIVER, LAKE SUPERIOR Pratt, T.C., Fisheries and Oceans Canada, Sault Ste. Marie, Ontario, Chase, M., Ontario Ministry of Natural Resources, Thunder Bay, Ontario, O'Connor, L.* Fisheries and Oceans Canada, Sault Ste. Marie, Ontario (oconnorl@dfo-mpo.gc.ca) Brook trout (Salvelinus fontinalis) stocks in the Lake Superior basin were systematically degraded over the past century by habitat loss, over-fishing and exotic species. Coaster brook trout, a migratory lake-dwelling ecotype, were diminished to the point where only a few viable populations now remain. Recent evidence suggests that anadromy in brook trout populations on the Atlantic coast may be influenced by differences in individual growth potential, so in 2004-05 we PIT (passive integrated transponder) tagged brook trout in the Cypress River, a historical coaster brook trout stream, to investigate whether growth patterns influenced lake movements. In-stream antennae were located near the stream mouth and in the Little Cypress River, approximately 1.7 km away. In total we tagged 380 brook trout (mean fork length 171 mm, mean weight 90 g). 57 and 8 brook trout were recorded in the Cypress and Little Cypress rivers, respectively; two of the brook trout were only recorded in the Little Cypress River. There was no difference in size between fish moving into or out of Lake Superior and those fish that did not move. The vast majority of recorded movement occurred at night and dawn. Fish were moving both into and out of the Cypress River, as 29 fish were recorded moving upstream and 23 were recorded moving into the lake.	Poster	

BIODIVERSITY OF ARCTIC CHARS – KEY INTEGRATORS AND MONITORS OF ECOSYSTEM CHANGE. Reist, J.D. *(1), M. Power (2), and B. Dempson (3) 1. Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, R3T 2N6, reistj@dfo-mpo.gc.ca; 2. Dept. of Biology, University of Waterloo, Waterloo, ON, N2L 3G1; 3. Fisheries and Oceans Canada, St. John's, NL, A1C 5X1. Arctic systems are experiencing great change from anthropogenic stressors such as climate change. Monitoring and assessing change in arctic aquatic ecosystems, researching possible causes, and projecting future possible states will be critical to our abilities to prepare and implement appropriate resource mitigation and/or adaptation strategies. Arctic char (Salvelinus alpinus complex), a group of closely related fish species, is a key renewable resource for northern peoples. Chars are long-lived and exhibit great biodiversity both within and among locations (e.g., ecological forms, life history types, etc.). Identifiable forms may act as distinct ecological 'species' in arctic systems, thereby contributing to ecosystem stability and resilience. Chars may also occupy and migrate between available habitats during their life history, thereby acting as key components and linkages among arctic freshwater (lakes and rivers), estuarine, and near-shore ecosystems. Longevity implies chars are also pivotal integrators of both short-term (e.g., exploitation, contaminants) and long-term (e.g., climate variability and change) anthropogenic impacts on these ecosystems. These attributes make chars ideal for monitoring and understanding the effects of arctic variability and change both locally and regionally throughout the Arctic. The development and implementation of Arctic-wide research and monitoring programmes are, therefore, essential to understanding and documenting impacts on this key resource and the ecosystems it occupies, and to their conservation. Without such understanding it will be impossible to project the future status of either the species or these aquatic ecosystems, or to prepare adaptation, conservation or development strategies compatible with the challenges of change in the Arctic.	Poster	
THE ECOLOGICAL CONSEQUENCES OF HYBRIDIZATION BETWEEN WESTSLOPE CUTTHROAT TROUT AND INTRODUCED RAINBOW TROUT IN SOUTHWESTERN ALBERTA. Robinson, M.D*. and J.B. Rasmussen. Biological Sciences Department, University of Lethbridge, Lethbridge, Alberta (email:mikerobinson@hotmail.com) 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 clarki 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. This study will assess any metabolic differences between O. clarki lewisi, O. mykiss and hybrids to determine their relative competitive abilities. We hypothesize that the hybrids will have a higher metabolic rate that will reduce their competitive abilities in first and second order streams allowing for coexistence to occur. We will analyze stomach samples to determine if the presence of hybrids will force a diet shift in O. clarki lewisi leading to resource partitioning and increasing the chance of coexistence. We will also assess the degree to which morphology can be used to distinguish between these pure strains and their resultant hybrids.	Poster	
THE SIGNIFICANCE 0F FISH NUTRIENT RELEASE (N AND P) TO MOUSE AND RANGER LAKES FROM 1993 TO 1995 Sereda, Jeff M. (1), Hudson, Jeff J. (1), Taylor, William D. (2), Demers, Eric (3). Email: saskman2@hotmail.com (1) University of Saskatchewan, Saskatoon SK, S7N 5E2 (2) University of Waterloo, Waterloo ON, N2L 3G1 (3) Malaspina University-College, Nanaimo BC, V9R 5S5	Poster	

The importance of fish for supplying limiting nutrients to pelagic environments has been under debate for decades. Many studies claim that fish make significant contributions to the pelagic environment of lakes; however, these studies rarely put their observations into the context of total nutrient regeneration by entire planktonic food webs. We directly measured the egestion and excretion of P and the excretion of NH4 by fish in Mouse and Ranger Lakes (Ontario) during the summers of 1993 to 1995. The analysis included the most abundant fish in both lakes: golden shiners (Notomegonus crysoleucas), pumpkinseed (Lepomis gibbosus), yellow perch (Perca flavescens), largemouth bass (Micropterus salmoides), and white sucker (Catastomus commersonii). We also directly measured total planktonic P regeneration. The average rate of fish release of P over three years was 1.533 ng P l- h-1 in Ranger and 1.636 ng P l-1 h-1 in Mouse. The average rate of fish release of NH4 over three years was 6.024 ng NH4 l-1 h-1in Ranger and 12.390 ng NH4 l-1 h-1 in Mouse. The rate of total planktonic P regeneration, based on the three year average TP of each lake, was 29.286 ng P l-1 h-1 for Ranger and 31.433 ng P l-1 h-1 for Mouse. The fish contribution represented ~ 5% of total planktonic P regeneration in both Ranger and Mouse Lakes.		
CONTINUED RECOVERY FROM ACIDIFICATION IN KILLARNEY PARK, ONTARIO: 1971-2005. Shead, J. A. and S. E. Arnott. Department of Biology, Queen's University, Kingston, ON, K7L 3N6 Tens of thousands of boreal shield lakes were damaged by acid rain from mining smelter emissions during the early half of the twentieth century. With the combination of legislated control programs and modernization initiatives by industry in the 1960s, the mid-1990s, and the present, Sudbury smelter emissions (SO2) were reduced by over 90%. As a result, many lakes in the Sudbury region are starting to show evidence of chemical and biological recovery from historical acidification. In the summer of 2005, 48 lakes in Killarney Park (located approximately 80 km from Sudbury) and surrounding area were sampled for crustacean zooplankton composition, phytoplankton biomass, and water chemistry. We compared the current chemical and biological conditions of our study lakes with previous data from peak acidification (1970s) and post-acidification periods (1990 and 2000). Data from past surveys revealed limited recovery of zooplankton communities despite improvements in water chemistry. Our survey assesses the amount of chemical and biological recovery that has occurred during the past five years, as well as the temporal trends in crustacean zooplankton species richness and composition from 1971-2005. Our data indicate that pH is continuing to increase. 73% of the lakes experienced an increase in pH of at least .5 over the past five years, whereas, 25% stayed the same (less than +/- .5 pH change), and 2% decreased (> .5 pH decrease). Preliminary results also indicate that the zooplankton communities are continuing to recover as well.	Poster	
THE AFFECTS OF METEOROLOGY AND LIMNOLOGY ON FISHER EFFORT AND CATCH RATES OF TWO COMMERCIALLY VALUABLE FISH SPECIES IN LAKE WINNIPEG, CANADA Speers, J. and D. Gillis*. Department of Zoology, University of Manitoba, Winnipeg, Manitoba (email:dgillis@cc.umanitoba.ca) The prevalence and extent of the environmental influence on both the decision to fish and the distribution of the fish themselves were examined using the commercial fishery of Lake Winnipeg's south basin for the years of 1996 through to 2004. The spatial variation of these influences was examined by comparing several regions within the south basin. The fisher effort and catch rates of sauger (Sander canadensis), and walleye (S. vitreus) were established through commercial catch records. Limnological conditions were restricted to examination of the discharge rate of the large, sediment-laden Red River, while meteorological conditions examined consisted of barometric pressure, cloud opacity, dry bulb temperature, atmospheric visibility, and wave height. Fishing effort was found to increase with increasing river discharge rates and decreases in temperature and wave height. Walleye catch rate (expressed as catch per unit effort or 'CPUE') was found to increase with decreasing temperature, while sauger CPUE was found to increase with decreasing river flow rates. The first result is consistent with the literature; walleye are known to prefer colder waters than sauger, although why sauger CPUE declines with increasing river discharge rate (a turbid water source) is unknown. The effort-environment relationship is	Poster	

interpreted as fishers increasing fishing effort when fishing is good; thus environmental conditions which increased walleye CPUE (the main target species) resulted in an increase in effort. The relationship between effort and wave height is attributed to the increased difficulty in handling fishing gear when large waves are present.		
QUANTIFYING THE HEALTH OF GRASSLAND STREAMS IN ALBERTA USING INDEX OF BIOTIC INTEGRITY AND MULTIVARIATE METHODS Stevens, C.*, G. Scrimgeour, W. Tonn, C. Paszkowski, M. Sullivan, and S. Millar *Alberta Co-operative Conservation Research Unit, University of Alberta, Edmonton AB (stevens.cam@gmail.com) Grassland stream ecosystems are widely impacted by agricultural activities that can alter the abundance of fish and structure of stream communities. Variable hydrological conditions, however, coupled with inherently low species richness and assemblages dominated by tolerant species, makes assessments of stream health difficult. We develop an index of biological integrity (IBI) and use a multivariate reference-condition approach to assess the ecological condition of fish communities and streams in east-central Alberta. Data on fish communities were combined with stream and watershed-scale environmental variables to quantify the ecological condition of 69 stream reaches that reflected a broad range of agricultural disturbance levels and types. Preliminary analyses indicate that stream fish communities were numerically dominated by brook stickleback (Culaea inconstans) (46% of all individuals captured) and fathead minnow (Pimephales promelas) (49%), whereas lake chub (Couesius plumbeus) and white sucker (Catostomus commersonii) were detected at many sites but were seldom numerically dominant. Based on length-frequency data, fish populations at individual sites typically comprised multiple year classes. Black spot disease was particularly prevalent on the fathead minnow in one watershed (Threehills Creek) but was relatively uncommon in other locations. The development, evaluation and application of an IBI, and how it compares and contrasts to assessments using a reference condition approach, are ongoing but will consist of a suite of standard and novel metrics correlated with grazing intensities and agricultural disturbance after correction for watershed area.	Poster	
COOLING LAKES WHILE THE WORLD WARMS: EFFECTS OF WIND SPEED AND WATER CLARITY REDUCTIONS ON THE THERMAL STRUCTURE OF A RECOVERING SUDBURY LAKE *Tanentzap, A.J.(1), Yan, N.D. (1,2), Keller, W (Bill) (3), Girard, R (2) Email: tanentz@yorku.ca (1) Department of Biology, York University, Toronto, ON, M3J 1P3 (2) Dorset Environmental Science Centre, Ontario Ministry of the Environment, Dorset, ON, P0A 1E0 (3) Laurentian University Co-op Freshwater Ecology Unit, Ontario Ministry of the Environment, Sudbury, Ontario Via their effects on dissolved organic carbon (DOC) concentrations, and surface wind speeds, deforestation, climate change, and acid rain may have profound effects on the thermal structure of lakes. To investigate the joint influence of rising DOC and falling wind speeds on lake thermal regimes, the one-dimensional Dynamic Reservoir Simulation Model (DYRESM) was employed on a long-term (1973-2000) data set from Clearwater Lake, near Sudbury, Ontario. Both a 30% reduction in wind speed and 6-fold increase in DOC levels contributed to a 4 m rise in the thermocline depth and 10 °C fall in bottom water temperature at the time of maximum heat content. Changes in air temperature were less important. Ongoing mixing was as important as the initial, spring heat budget in determining summer thermal structure. While the majority of wind speed reductions precede 1985, most changes in DOC have occurred since that time. Hence, the principal determinants of lake thermal structure switched over time reflecting these realities. A colder, thicker hypolimnion will increase the availability of cold-water habitat, as long as hypolimnetic oxygen concentrations remain stable. Although future climate warming may reduce cold-water habitat, management strategies that reduce surface wind speeds may mitigate habitat losses.	Poster	

EFFECTS OF MUNICIPAL WASTEWATER EFFLUENTS ON RESIDENT FISH POPULATIONS Tetreault*1,2 G., K. Oakes2, M. McMaster1, and M. Serovs2 1. Environment Canada, National Water Research Institute, Burlington, ON 2. University of Waterloo & Canadian Water Network, Waterloo, ON. (Gerald.tetreault@ec.gc.ca) An emerging issue in Canada involves the effects of Municipal Wastewater Effluents (MWWE) in the aquatic receiving environment. MWWE is a mixture of household waste, ammonia, inorganic chloramines, textile mill effluents, and nonylphenol and pharmaceuticals all of which have been detected in environmental samples. We are interested in determining whether MWWE effects normal reproductive development in fish and if so, does impaired reproductive health influence fish populations, and alter the fish community? We assessed sentinel fish responses in terms growth (condition), reproduction (in vitro sex steroids, and gonadosomatic indices) and survival, upstream and downstream of the Kitchener and Brantford sewage treatment plants where existing NWRI studies are monitoring pharmaceutical levels. Studies downstream of the Kitchener plant revealed Etheostoma nigrum to have lower liver somatic index than fish collected at the reference site. However, the capacity of follicular tissue from these fish to produce sex steroids was more responsive to chemical stimulation. Luxilus cornutus exposed to Kitchener effluent also had an increased capacity to produce testosterone and 17b-estradiol. Similar to the Kitchener study, collections downstream of the Brantford MWWE resulted in a trend for follicular tissue to have greater capacity to produces steroids. Pimephales notatus from the same site had smaller livers when compared to reference fish collections, and demonstrated alterations in sex steroid production. Although this is preliminary data, the project is currently in Year II. We will be noting fish abundance, diversity, size distribution and type of fish to evaluate the impact of MWWE on fish assemblages.	Poster	
DETECTING CHANGE IN THE NEARSHORE SMALL FISH COMMUNITY IN LAKE HURON Tran*, J.L. and N.C. Collins. Department of Biology, University of Toronto at Mississauga, Mississauga, Ontario. (email: jennifer.tran@utoronto.ca) The Nearshore Small Fish Survey in Lake Huron began in 2003 by the Ontario Ministry of Natural Resources (Upper Great Lakes Management Unit, Owen Sound) and the Canada-Ontario Agreement to examine the current state of the nearshore small fish community and to identify important future changes. The survey used minnow traps, fyke nets, beach seines, and Nordic nets (modified gill nets) at a total of 17 different sites. Over the last 3 years, a total of 21 families and 77 species of fish were captured and identified. Repeated sampling and sampling across 3 seasons in some sites allow some evaluations of reliability of the measurements. Our first major goal is to determine whether adjustments to the combination of fishing gears or the amount of effort per site would make the assessments of presence-absence and diversity more cost-effective. Our second major goal is to calculate species-specific baseline estimates of probability of capture and occupancy rate (percent of sites occupied), and to set criteria for what should be considered important future changes. We will use a Bayesian approach to identifying changes in occupancy rates based on successive years of future surveys, and estimate the power of an annual survey to detect changes in this fish community.	Poster	
WALLEYE STOCKING IN CRAWLING VALLEY RESERVOIR: CHALLENGES FOR MANAGING OUR SUCCESS Wallman, C, T. Rhodes, and T. Ripley. Alberta Sustainable Resource Development, Fish and Wildlife Division, Fisheries Management Branch, Calgary/Brooks Area, #100, 3115 - 12th St. N.E. Calgary, AB. T2E 7J2. Email: Travis.Ripley@gov.ab.ca Crawling Valley Reservoir in Southern Alberta is considered a walleye stocking “success” story. A regionally significant recreational catch-and-release walleye fishery has developed as a result of three years of fingerling stockings (1990-1992). Relatively high angler catch rates are now resulting in demands for harvest. We developed a comprehensive field program, completed in 2004, to assess the status of the walleye population and to	Poster	

determine current angler pressure. A tagging, test angling, and fall index netting program indicated a population density of nearly ten (catchable sized) walleye per hectare. An angler creel survey estimated angler pressure to be 26,000 angler hours resulting in an estimated catch of 22,413 walleye or a catch-per-unit-effort of 0.87 walleye per hour. Post-release mortality was estimated to be five percent or 1110 walleye (0.4 kg/year) and illegal harvest was estimated at 0.14 kg/ha/yr. The total annual walleye mortality of 0.54 kg/ha is 0.16 kg/ha/yr less than the equilibrium allowable catch of 0.70 kg/ha/yr (approximately 440 walleye). The future challenge is to identify angling regulation options that are socially acceptable yet ensure controlled harvests in order to ensure the sustainability of this valuable walleye fishery.		
LANDSCAPE INFLUENCES ON FLOW REGIME CHARACTERISTICS IN ONTARIO Yunker*, G. and N. Jones. River and Stream Ecology Unit, Ontario Ministry of Natural Resources-Trent University, 1600 West Bank Drive, Peterborough ON, Canada K9J 7B8 geoff.yunker@mnr.gov.on.ca Flow regime is of central importance in sustaining the ecological integrity of flowing water systems and can be considered a “master variable” that limits the distribution and abundance of riverine species. The five components of the flow regime, magnitude, frequency, duration, timing, and rate of change, are linked to many critical physicochemical characteristics of rivers, such as water temperature, channel geomorphology, and habitat diversity. Alteration of flow thus has cascading effects on the ecological integrity of rivers. We generated flow metrics, components of the flow regime, using the Indicators of Hydrologic Alteration (IHA) software on flow data provided by the Water Survey of Canada for regulated streams in Ontario. A subset of these metrics will be used to group ecologically similar flow regimes using principal components and cluster analyses. Phase two of this project will focus on building models to predict various aspects of the flow regime largely on the basis of landscape-scale factors. These predictive models will then be used to predict flow characteristics in ungauged watersheds in Ontario. Classifying flow regimes in Ontario will help us understand the fundamental nature of our rivers, aid in understanding changes to flows in settled landscapes and how to restore rivers. This understanding in Ontario is sorely needed as we venture in to licensing hydro-power facilities, developing a framework for state of the resource reporting and will be a valuable tool for fisheries management in lotic systems.	Poster	