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PRINTED ABSTRACTS WILL NOT BE AVAILABLE AT THE CONFERENCE

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Adams, B. K. and J. A. Hutchings. Department of Biology, Dalhousie University, Halifax, Nova Scotia (email: bkadams@dal.ca).

EVIDENCE FOR GENETICALLY DISTINCT ANADROMOUS AND NON-ANADROMOUS ATLANTIC SALMON (*SALMO SALAR*) IN WILD AND INTRODUCED POPULATIONS

Non-anadromous populations of Atlantic salmon (*Salmo salar*) are common throughout the island of Newfoundland, and are often sympatric with anadromous populations. Although the non-anadromous individuals tend to be significantly more abundant than the anadromous salmon, very little data exists on the relationship between the two life history forms. The goal of this study was to define the relationship between these life history forms via a genetic comparison of sympatric individuals. Eight microsatellite markers were used to compare salmon within three watersheds on the island of Newfoundland. 1) Indian Bay, a wild population of sympatric anadromous and non-anadromous individuals, 2) Northwest River, a wild population where the alternate life history forms are sympatric today, but were separated by an impassable barrier historically, and 3) Rocky River, previously inhabited by non-anadromous individuals only, anadromous salmon were introduced to this river in the mid eighties. The results from the wild population suggest that the anadromous and non-anadromous salmon are genetically distinct sympatric populations, rather than life history variants within a single panmictic population. The data also suggests that the removal of the impassable barrier in Northwest River and the introduction of anadromous salmon to Rocky River, have not produced significant gene flow among the anadromous and non-anadromous salmon. We hope the genetic data will provide a basis for a life history and behavioral study that may suggest which factors work to reduce geneflow between these sympatric life history forms.

[SAT, 11:30-11:50]

Addison, P.¹ and C. Wilson². ¹Biology Department, Trent University, Peterborough, Ontario; ²Ministry of Natural Resources and Trent University, Peterborough, Ontario. (email: paddison@trentu.ca)

DETERMINING APPROPRIATE SCALES OF MANAGEMENT FOR BROOK TROUT IN ALGONQUIN PARK, ONTARIO.

Determining appropriate spatial scales for fisheries management is a common challenge for oceanic and freshwater fisheries. For inland fisheries, however, management or harvest regulations are often selected and implemented as general regional guidelines or on a lake-by-lake basis. Wild lentic brook trout (*Salvelinus fontinalis*) populations in the Galipo River watershed of Algonquin Park, Ontario, were used as a model system to determine the extent of population structure among lakes and to identify appropriate scale(s) for managing inland brook trout fisheries. Although tagging data show at least some limited movement of individuals among the different lake habitats within the watershed, three lakes (Harry, Rence and Welcome) are managed as trophy fisheries and two upstream lakes (Florence and Frank) are governed by the general park regulations for brook trout harvest. Brook trout were nonlethally sampled by angling and finclipped to obtain tissue for genetic resolution of structure within this system of lakes, using sample sizes of 30-50 fish per lake. In conjunction with tagging data, multilocus genotypes for individual fish will be measured using six microsatellite loci and used to characterize movement and gene flow among lakes. The resulting spatial structure will be compared with current management strategies to determine their suitability.

[POSTER]

Deborah Austin, W.D. Bowen, J.I. McMillan and C.A. Beck. Department of Biology, Dalhousie University, Halifax, NS (email: daustin@dal.ca).

USING QUANTITATIVE ANALYSES OF MOVEMENT TO CHARACTERIZE INDIVIDUAL MOVEMENT BEHAVIOUR IN A LARGE MARINE PREDATOR, THE GREY SEAL, *HALICHOERUS GRYPUS*

Foraging entails movement. To date, analyses of marine mammal movement patterns have been largely descriptive, despite increased use of quantitative indices and modeling techniques to study animal movement in other taxa. Correlated random walk (CRW) models reveal how behaviours can mediate individual movement, such that deviations may reveal search tactics or other behaviour. Grey seals, have been implicated in failure of cod stocks to recover in the Northwest Atlantic, but current predation models assume predation to be constant in time and space (Mohn and Bowen 1996). Using ARGOS calculated locations for 52 grey seals fitted with satellite-linked recorders (on Sable Island), we modeled movement as a CRW for individual animals. Mean move length, turning angle, and net squared displacements (Rn^2 : the rate of change in area over time) at successive moves over 3 to 9 months were calculated. Grey seals displayed three types of movement: Migratory - animals exhibiting directed long distance return travel (move length 50.96, SE 2.28 km) that are significantly underpredicted by the CRW (23% of animals; $P < 0.05$); Central place foragers - seals using Sable Island (move length 24.26, SE 1.43 km) that are

overpredicted by the model (29% of animals; $P < 0.05$); and Correlated random walkers - those (48% of animals) in which movement is predicted by the CRW model. Regions of constant Rn^2 , in a plot of Rn^2 over time, indicate residence within prey patches from days to weeks. Delineation of these areas may be important in assessing areas of the Northwest Atlantic used for foraging, and their relation in regards to the distribution of commercially important fish stocks. Kernel home ranges were estimated for all seals and compared. Correlated random walkers had significantly larger kernel home ranges, 235,843 km² (95%) and 42,897 km² (50%; Mann-Whitney, $P < 0.001$ both sizes), compared to central place foragers, 32,882 km² and 3,560 km², respectively. Results demonstrate a great deal of individual variation in movement and distribution of grey seals, suggesting that assumptions of current predation models may need re-evaluation. Hence, quantitative movement models can be used to refine predictions of predation impact.

[SAT, 16:00-16:20]

Bailey, S.A., I. C. Duggan, C.D.A. van Overdijk and H.J. MacIsaac. Great Lakes Institute, University of Windsor, Windsor, Ontario. (email: bandoni@uwindsor.ca)

TRANSOCEANIC INVASION TIME BOMBS? VIABILITY OF RESTING EGGS COLLECTED FROM RESIDUAL SEDIMENTS IN NOBOB VESSELS

Ballast water is taken up by ships that are not fully laden with cargo to increase stability. If ballast from foreign waters is discharged, nonindigenous species (NIS) can be introduced to the Great Lakes. This phenomenon has been well studied, resulting in ballast exchange regulations to reduce the threat of invaders. However, invasions still occur in the Great Lakes. Likely this is due to the fact that the regulations apply to a small percentage of ships, as 75 – 95 % enter the Great Lakes with no ballast on board (NOBOB). NOBOB ships are currently unregulated, as they are considered to have "empty" tanks. However, ships cannot completely empty their ballast tanks due to structural limitations, and always carry residual amounts of ballast. When a ship ballasts, it can stir up sediments that are also taken up in ballast water. These sediments build up in sheltered areas of the tanks acting as a refuge for aquatic organisms and their associated dormant stages. Ships that deballast while in transit can deposit NIS or their resting eggs into the Great Lakes. To determine the possibility that NOBOB sediments act as a vector for NIS we investigated the density and viability of invertebrate resting eggs within residual sediments of >30 transoceanic vessels inbound to the Great Lakes. Resting egg viability was determined under various day-length and salinity treatments. Here, we report preliminary findings from hatching experiments, providing the first evidence that residual sediments can indeed carry viable invertebrate resting eggs. While additional work is needed to quantify risk, results from this study indicate that NOBOB vessels that load and subsequently discharge ballast water while operating on the Great Lakes are a potential source for new NIS.

[FRI, 14:20-14:40]

Baulch, H. M.¹, M. A. Turner¹, D. L. Findlay¹, R. Vinebrooke², W. F. Donahue³ and L. L. Hendzel¹ ¹Experimental Lakes Area, Fisheries and Oceans, 501 University Cresc., Winnipeg, Manitoba, Canada, R3T 2N6 ²Freshwater Biodiversity Laboratory, Department of Biology, University of Regina, Regina, Saskatchewan, S4S 0A2 ³Department of Biology, University of Alberta, Edmonton, Alberta, T6G 2E9 E-mail: BaulchH@dfo-mpo.gc.ca

IS CHLOROPHYLL A MISUSED AS A MEASURE OF BIOMASS IN BENTHIC ALGAL STUDIES?

Chlorophyll a is often used to assess benthic algal biomass. Using both lake and mesocosm studies, we explored the merits of using chlorophyll a as a biomass indicator for epilithon (benthic algal association on rock surfaces). Although in some cases chlorophyll a accrual within lakes was positively correlated with carbon accrual, chlorophyll a was often a poor predictor of algal biovolume. In perturbed systems affected by acidification or increased temperature, we found that chlorophyll a accrual and direct measurements of algal biovolume were decoupled. As a result, reliance solely on chlorophyll a as a biomass indicator could have led to spurious conclusions about community responses to these stressors. Given that the relationship between chlorophyll a and biomass may be affected by light, nutrient status, temperature, species composition and other factors that vary within natural environments, caution should be used when using chlorophyll a as a biomass indicator. We recommend that future studies in which chlorophyll a is employed as an indicator of algal biomass include a calibration step that assesses the correlation between these measures under the study conditions.

[POSTER]

Bettles, C.M., M. F. Docker, B. Dufour, D.D Heath Great Lakes Institute for the Environment and Department of Biological Sciences, University of Windsor, Windsor, Ontario (email: bettles@uwindsor.ca)

EXTINCTION BY INTROGRESSION? A GENETIC INVESTIGATION OF HYBRIDIZATION BETWEEN CUTTHROAT AND RAINBOW TROUT

Introgressive hybridization among certain *Oncorhynchus* ssp represents a major concern for population viability. Coastal cutthroat trout *O. clarki* and coastal rainbow/steelhead trout *O. mykiss* exist sympatrically along North America's west coast; however, studies suggest that these populations are also experiencing introgressive hybridization. To determine the extent of introgressive hybridization between coastal cutthroat and rainbow trout, fin clip samples were collected from thirty streams located on Vancouver Island, BC. DNA was extracted from a subset of individuals from each location and screened to determine the level of introgression using 8 PCR-based diagnostic co-dominant markers and one mitochondrial DNA-based

(Mt-DNA) species marker. A minimum of 30 individuals from the populations with high levels of introgression were then chosen, and genotyped using the same markers. Levels of introgression among different size-classes (and hence presumably age-classes) will be compared; if differences are found, they likely reflect differential mortality of the introgressed individuals relative to pure cutthroat or rainbow trout. The nature of the presumed selection will be investigated by examining patterns of first generation (F1) versus backcross genotype individuals. The F1 and backcross genotype data will also be used to determine the likelihood of historic versus present and ongoing hybridization events among the introgressed populations. The documentation of levels of introgression is important for fisheries management and conservation; however, it is also critical to understand the mechanisms behind introgression resulting from loss of reproductive isolation among distinct fish species and the associated loss of fitness in the progeny.

[FRI, 14:00-14:20]

Binks, J., Aquatic Ecology Lab, University of Toronto, Toronto, Ontario (email:jbinks@utm.utoronto.ca) Arnott, S.E., Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Ontario (email: arnotts@biology.queensu.ca) Sprules, W.G., Aquatic Ecology Lab, University of Toronto, Toronto, Ontario (email: gsprules@cyclops.erin.utoronto.ca)

THE INFLUENCE OF BIOTIC AND ABIOTIC FACTORS ON ZOOPLANKTON COMMUNITY RECOVERY FROM ACIDIFICATION

Lakes in Sudbury, Ontario provide a unique opportunity to examine factors that shape community structure once a past stressor is removed. Extensive reductions in sulfur emissions by local smelters over the past several decades have resulted in water quality improvements. Studies by local scientists, however, have indicated that biological recovery has lagged this chemical recovery. For biotic recovery to occur, species must first arrive at the recovering lake and then must survive and reproduce. Survival and reproduction may be influenced by biotic interactions with established species and abiotic conditions. We conducted a six-week mesocosm experiment in Swan Lake, a small historically acidified lake within the city of Sudbury. It offers a unique opportunity for study because it has been continuously monitored for the past two decades and its biological recovery has lagged chemical recovery. Despite increases in pH, the zooplankton community has remained dominated by a single species and has shown little sign of recovery. A 2x2 factorial design was used to determine the influence of pH (5.5 and 6.5) and the local community (with and without local zooplankton) on colonizing species. Some species (ie. *Daphnia* sp., $p < 0.000$) had higher abundances in the augmented pH treatment, but were not influenced by local community interactions. Recovery of these species is probably limited by the chemical recovery of the lake. Other species (ie. *Skistodiaptomus oregonensis*, $p < 0.000$) were influenced by the resident community but not by pH. The presence of Swan Lake zooplankton decreased the abundances of these colonizing species. Both *Mesocyclops edax* and *Chydorus sphaericus* were unaffected by the treatments. This raises the interesting question; why are these species not found in Swan Lake? These results suggest that although chemical recovery has started to occur in Swan Lake, further recovery is necessary for some species to survive and reproduce. Also, interactions with the local community may play a role in the colonization and success of new species.

[SAT, 10:30-10:50]

Biro, P.A., Post, J.R., and Parkinson, E.A. Department of Biological Sciences, University of Calgary (email: pbiro@ucalgary.ca) and B.C. Ministry of Fisheries

FROM INDIVIDUALS TO POPULATIONS: RISK-TAKING BY PREY FISH MEDIATES MORTALITY IN WHOLE-SYSTEM EXPERIMENTS.

Discovering key mechanisms to include in population models is critical for general predictions of fish population growth and survival. Recent research suggests that the behavior of individuals under risk of predation could be a key link between individual behavior and population dynamics. Yet, existing theory remains largely untested at large spatial and temporal scales. We manipulated food available to age-0 rainbow trout while at risk of cannibalism, in a replicated factorial whole-lake experiment, to test whether the trade-off between growth and mortality rates is mediated by foraging activity for young fish under predation risk. We found this trade-off exists for young fish at the whole-system scale and that food-dependent behavioral variation has large mortality consequences. Age-0 trout spent less time moving, fewer individuals swam continuously, and those swimming continuously swam at slower speeds in high food lakes than in low food lakes. Age-0 trout also used deep, risky habitats less when food was abundant. This lower activity, combined with avoidance of risky habitats, resulted in 68% higher survival in high food lakes. We observed no differences in growth between populations in low or high food lakes during the period when differences in risk-taking were observed. Thus, mortality in these populations was linked to risk-taking behavior per se, and not lowered growth rates as is often cited as the dominant mechanism for mortality (i.e. growth rate dependent mortality). If general, the activity- and habitat-mediated tradeoff between growth and mortality rates may be a key mechanism linking individual behavior to population-level processes in size-structured populations.

[FRI, 16:00-16:20]

Blanchfield, P.J., A.J. Majewski, V. Palace and K. Kidd, Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba (BlanchfieldP@dfp-mpo.gc.ca)

THE EFFECT OF A SYNTHETIC ESTROGEN ON THE REPRODUCTIVE SUCCESS OF MALE FATHEAD MINNOWS: A WHOLE-LAKE ADDITION EXPERIMENT

Many surface waters contain sufficient concentrations of natural and synthetic estrogens to cause reproductive abnormalities in fish. 17 β -ethynylestradiol (EE2) is the most common estrogenic compound used in oral contraceptives and is an extremely potent synthetic estrogen, capable of producing physiological effects in fish at very low concentrations. We conducted a whole-lake addition study at the Experimental Lakes Area to examine the effect of environmentally relevant concentrations of EE2 on fish populations. Among fishes, courtship behavior and nesting defense are strong predictors of reproductive success. Exposure to EE2 can alter the breeding behaviour of male fathead minnows (*Pimephales promelas*), lowering their reproductive success. For species with complex courtship behaviours, such as fathead minnows, males must successfully complete a series of behaviours to entice females to deposit eggs, and then they must guard these eggs for a period of time to ensure survival to the free-swimming stage. If the exposure to EE2 decreases a male's ability to fully perform these tasks, or a female's ability to interpret cues necessary for reproduction, then reproductive success will be adversely affected. Thus, EE2-induced behavioural changes may present a mechanism influencing fish recruitment. We documented the reproductive behaviour of fathead minnows in L260 and other ELA lakes prior to and during EE2 additions. Similarly, we used mark-and-recapture techniques to evaluate the population sizes of fathead minnows during this same time period. Here we present data linking behavioural and population-level responses of fish to a synthetic estrogen.

[POSTER]

Blanchfield, P.J. and L.S. Flavelle, Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba (BlanchfieldP@dfo-mpo.gc.ca)

DEFINING A THERMAL NICHE FOR LAKE TROUT IN BOREAL LAKES

Small boreal lakes are thought to be some of the most sensitive aquatic ecosystems to climate change. Correspondingly, the cold-water fish communities of these lakes are likely to be the most revealing in terms of understanding the sensitivity and adaptability of fish species to a changing climate. Lake trout (*Salvelinus namaycush*) are a widespread, coldwater species with a relatively narrow preferred thermal niche (~8-12°C), although recent research suggests that this species may be more tolerant to warmer temperatures than previously thought. We examined lake trout thermal habitat via continuous monitoring of water temperature and fish tagged with depth-sensing acoustic tags in lakes at the Experimental Lakes Area (ELA), located in the boreal forest of north-western Ontario. Diel and seasonal patterns in the pelagic distribution of lake trout among lakes are used to clearly define a thermal "niche". We incorporate estimates of lake trout thermal habitat into predictive models, based on observed climate-related changes in hypolimnetic volume from long-term ELA data sets, to provide an understanding of the vulnerability of this fish species to forecasted climate changes.

[SUN, 9:10-9:30]

Stephanie A. Boudreau¹ and Norman D. Yan ^{1,2} stephboudreau@hotmail.com, nyan@yorku.ca ¹ Department of Biology, York University, Toronto, Ontario, ²Dorset Environmental Science Centre, Ontario Ministry of the Environment, Dorset, Ontario.

THE IMPACT OF BYTHOTREPHES LONGIMANUS ON THE CRUSTACEAN ZOOPLANKTON COMMUNITIES OF ONTARIO INLAND LAKES.

The invading predatory Cladoceran, *Bythotrephes longimanus*, is currently spreading rapidly among Canadian Shield lakes in Ontario, and it has been implicated in major changes in the crustacean zooplankton in one Shield lake, Harp Lake in central Ontario. Unfortunately information on other Shield lakes is not currently available. To determine if the results in Harp Lake may be generally applicable, we compared the zooplankton of 17 invaded and 13 uninvaded, or reference lakes in Ontario. Total zooplankton density was not different between the two groups of lakes ($p=0.8$); however, biomass was 42% lower in invaded lakes ($p=0.01$). In the reference lakes, the mean animal weight was larger ($p=0.04$) and species richness was 30% higher. Total Cladoceran density, biomass and richness were significantly lower in invaded lakes. Mean densities and biomasses of all individual species did not differ between the two groups in MANOVAs; however, cladoceran and cyclopoid densities were. Independent samples t-tests showed that 3 cladoceran species, *Daphnia catawba* ($p=0.010$), *Daphnia dubia* ($p=0.008$), and *Bosmina freyi* ($p=0.025$), and one cyclopoid, *Mesocyclops edax*, ($p<0.001$) were less abundant in invaded lakes. *Diaphanosoma birgei* and *Bosmina tubicen* approached significance ($p=0.06$), both again having reduced abundance in invaded lakes. These results indicate that the Harp Lake study is not unique. Zooplankton communities of Shield lakes with *Bythotrephes* do differ from uninvaded lakes.

[FRI, 15:40-16:00]

Bowman M.F.¹, P.A. Chambers², and D.W. Schindler¹. ¹Department of Biological Sciences, University of Alberta, Edmonton, Alberta, T6G 2E9, National Hydrology Research Institute, Environment Canada, Burlington, Ontario, S7N 3H5 (email: m Bowman@ualberta.ca)

ECOLOGICAL STOICHIOMETRY OF PERIPHYTON AND GRAZERS IN OLIGOTROPHIC ROCKY MOUNTAIN RIVERS OF CANADA

Previous research in lakes has clearly shown that the growth of herbivores is frequently more limited by the relative quantity of mineral elements in food than by food quantity. We measured the mineral content of periphyton and grazers, upstream and downstream of nutrient inputs to three oligotrophic rivers to compare 1) lentic and lotic mineral composition of producers and consumers in various nutrient environments, and 2) propose an alternate explanation to increased food quantity for increases in

size or numbers of primary consumers downstream of nutrient inputs. We found that the relative amounts of carbon (C), nitrogen (N) and phosphorus (P) in periphyton and heptageniid mayfly tissue was generally within the range reported for lentic producers and consumers. As predicted, the C:P and C:N ratio in periphyton tissue decreased downstream of nutrient inputs. The number of grazers was more highly correlated to the mineral content of periphyton than to the abundance of periphyton. These results suggest that the ecological stoichiometry of benthic organisms should be considered when studying stream processes such as nutrient cycling or energy transfer between trophic levels.
[SUN, 11:10-11:30]

Brasfield, S., B. Galloway, M. Gray, L. Peters, A. Curry, K. Munkittrick University of New Brunswick and Canadian Rivers Institute (email: sandra.brasfield@unb.ca)

IDENTIFICATION OF AN UPSTREAM SOURCE OF CONTAMINATION ON THE SAINT JOHN RIVER NEAR CLAIR, NEW BRUNSWICK

In 1999, an extensive survey of fish performance was conducted to examine areas of concern in the upper Saint John River. Fish collected from reference sites upstream of Edmundston suggested a potential source of contamination. Subsequent collections in 2000 suggested the source was near a poultry processing plant located 40 km upstream, and this was confirmed in 2001 by sampling sites adjacent to the discharge pipe from the facility. That poultry processing plant burned down during the winter of 2001-02, putting 250 people out of work. The plant is currently being rebuilt and appears to be close to reopening by the end of 2002. This has presented a unique after-before-after situation, and fish were collected upstream and downstream of the plant in August of 2002, before operation recommences. The slimy sculpin (*Cottus cognatus*) was chosen to assess the potential aquatic impacts of these inputs. This small, relatively sedentary fish species exhibits many desired characteristics for use as an indicator species. They show high site fidelity, and respond to localized discharges, and were a useful sentinel species at sites in the upper basin where water levels are shallow, and in tributaries. Slimy sculpin were collected (20 males, 20 females) at an upstream reference site, immediately downstream of the effluent, and further downstream following inputs from sewage and at Clair. In both 2000 and 2001, sculpin at all sites downstream of the poultry processing effluent showed larger livers. Further, following shutdown in early 2002 the fish have recovered, and there is no difference in condition factor, liversomatic index (LSI) or gonadosomatic index (GSI) in either male or female sculpin collected in August 2002. This may confirm that the source of contamination could be the poultry processing plant effluent and not upstream agricultural inputs.
[SAT, 11:30-11:50]

Breau C., L. K. Weir and J. W. A. Grant. Department of Biology, Concordia University, Montréal, Québec (e-mail: breaucindy@hotmail.com)

INDIVIDUAL VARIABILITY IN ACTIVITY PATTERNS OF JUVENILE ATLANTIC SALMON IN CATAMARAN BROOK, NEW BRUNSWICK.

Previous work on the activity of salmonid fishes has been based on the counts of untagged fish in the wild or on laboratory studies. To quantify individual variation in activity, we tagged (fluorescent elastomer paint) and followed 35 age-0+ and 9 age-1+ salmon over a period of 50 days during the summer. We used snorkeling to quantify activity and foraging rate at 9 different times of day, 8 times over the season for a total of 56-67 observations per tagged fish. The fish were extremely sedentary, on average they moved 0.50m and 0.36m over the season for age-0+ and age-1+ fish, respectively. The most important variable predicting the activity of juvenile salmon was time of day. In general, age-0+ salmon were active during the day and inactive at night, whereas age-1+ salmon showed the opposite pattern. However, there was incredible individual variability: some age-0+ fish increased their activity with time of day while others showed a decrease or a dome-shaped relationship. A multiple logistic regression indicated that the daytime activity of some individuals was also related to time of day, day of year, water temperature and light intensity. However, daytime activity for both age-classes was influenced primarily by water temperature. Nighttime activity varied with time of day and season for age-0+ fish whereas no variable was associated with age-1+ fish night activity.
[SAT, 10:50-11:10]

Brind'Amour, A. and Boisclair, D. Département de sciences biologiques, Université de Montréal, Montréal (Québec). (email : anik.brindamour@umontreal.ca).

MULTISCALE SPATIAL DISTRIBUTION OF LITTORAL FISH ASSEMBLAGES IN RELATION TO ENVIRONMENTAL FACTORS

Many studies have been done to develop relationships between descriptors of fish assemblages and environmental characteristics. However, the identification of the proper spatial scale(s) at which the existence of such relationships should be tested remains a difficult problem. Fundamental contributions and efforts deployed towards the development of spatially-explicit, individual-based, and numerical habitat models illustrate the recognition that fish may not be affected only by local environmental conditions, or by the quantity of habitats possessing specific key characteristics, but also by the spatial arrangement of habitats relative to fish behaviour. Our study aimed the assessment of the spatial patterns of littoral fish assemblages displayed at different scales. Data were obtained from visual surveys conducted along the complete perimeter of the littoral zone of a lake. A new form of multiscale analysis, the Principle Coordinates of Neighbour Matrices (PCNM), was

used to determine the spatial patterns of fish assemblages. Our results showed the existence of spatial patterns of fish assemblages at three different scales; fine-scale (50m), meso-scale (500 m), and coarse-scale (1000 m) km. Our work illustrates that PCNM may be used to identify the spatial scales that may allow to better understand and/or predict fish community assemblages.

[SAT,10:30-10:50]

Leduc, A., M. Noseworthy and G. Brown.

THE EFFECTS OF REDUCED PH ON THE DETECTION OF CONSPECIFIC AND HETEROSPECIFIC CHEMICAL ALARM SIGNALS BY JUVENILE PUMPKINSEED SUNFISH.

While much is known regarding the effects of heavily acidified water bodies on the growth, survival and recruitment of fishes, surprisingly little is known regarding the potential effects of weakly acidic conditions. We have previously demonstrated that the ability of fathead minnows (*Pimephales promelas*, Cyprinidae, Ostariophysi) to detect and respond to conspecific alarm pheromones is significantly impaired under weakly acidic (pH 6.0) conditions. In a series of laboratory experiments, we test the effects of weakly acidic conditions on the ability of a non-ostariophysan species to detect and respond to conspecific and heterospecific alarm pheromones. Juvenile pumpkinseed sunfish (*Lepomis gibbosus*) were held for 4 days under normal (pH 7.5) and weakly acidic (pH 6.0) conditions and exposed to conspecific skin extract, the skin extract of an allopatric congener (green sunfish, *Lepomis cyanellus*) or hypoxanthine-3-N-oxide (the putative Ostariophysan alarm pheromone). Conspecific and congeneric skin extracts elicited a strong antipredator response under normal pH conditions and a significantly weaker, but detectable response under acidic conditions. H3NO elicited a significant response under normal conditions, but was not significantly different from a distilled water control under acidic conditions. We found no significant effect of pH on the rate of foraging, suggesting that the loss of response to chemical alarm signals is not due a change in overall activity levels. These data suggest that the ability of juvenile pumpkinseed sunfish to detect and avoid potential predators is impaired under weakly acidic conditions.

[POSTER]

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THE EFFECT YELLOW PERCH ON THE TROPHIC POSITION AND RESOURCE USE OF BROOK TROUT: A POSSIBLE DEPENDSATORY INTERACTION

We determined the trophic position and resource use of brook trout in a set of Algonquin Park lakes that varied in fish community composition from cyprinids only, to cyprinids and white sucker, to cyprinids, white sucker and yellow perch. Brook trout showed distinct changes in trophic position and resource use with changes in fish community composition. The presence of yellow perch resulted in a higher trophic position of brook trout, an increased use of profundal prey and a high degree of piscivory on yellow perch. Mean trophic position of brook trout <25cm fork length was 3.3 in all community types. The trophic position of brook trout >25cm fork length remained constant at 3.3 in cyprinid only communities, increased to 3.6 when white sucker was present and to 4.0 when both yellow perch and white sucker were present in the lake. Gut content analysis indicated a significantly higher occurrence of piscivory in lakes containing yellow perch with perch being the preferred prey. Carbon isotopic signatures of brook trout tissue indicated brook trout utilize pelagic resources in cyprinid only communities, a mixture of pelagic and benthic resources in white sucker communities and a mixture of benthic and profundal resources in communities containing yellow perch. Gut content analysis indicated a reduced occurrence of chaoborus, trichoptera, odonata, and ephemeroptera in brook trout guts when yellow perch were present in the lake. Brook trout dramatically alter their resource use and trophic position in response to the presence of competitors such as white sucker and yellow perch in the fish community. This alteration in food web position will have implications for growth, population stability and the effect of fishing pressure on brook trout populations. We suggest the interaction between brook trout and yellow perch is dependsatory in nature and intend to test this hypothesis in future studies.

[FRI, 16:20-16:40]

Browne, R. M and M. K. Litvak. Centre for Coastal Studies and Aquaculture, Department of Biology, University of New Brunswick Saint John, Saint John, NB. (email: michael.browne@unb.ca).

SPERMATOOZA SWIMMING CHARACTERISTICS AND FERTILIZATION SUCCESS FOR SHORTNOSE STURGEON (*ACIPENSER BREVIROSTRUM*) AND ATLANTIC STURGEON (*A. OXYRHYNCHUS*) FROM THE SAINT JOHN RIVER, NEW BRUNSWICK: CAN ONE MALE DO THE JOB OF MANY?

Over a period of three spawning seasons (1999-2001) we observed the motility and swimming characteristics of shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*A. oxyrhynchus*) spermatozoa from the Saint John River, New Brunswick. The Saint John River is the only river in Canada to host the shortnose sturgeon, and has one of the few remaining spawning populations of Atlantic sturgeon. Spermatozoa collected from both species were activated and their movement, including mean average and mean maximum speed, path linearity and motility, was recorded over a five minute time period. Mean average (SNS 212 mm.s⁻¹ vs. ATL 137 mm.s⁻¹) and mean maximum speeds (SNS 372 mm.s⁻¹ vs. ATL 268 mm.s⁻¹) differed significantly between species, as did motility. Mean path linearity did not differ significantly between species or times. We also determined fertilization success rates for differing dilutions and activation time of the spermatozoa, and for the

exposure time of the eggs. A sperm activation time of five minutes and egg exposure time of ten minutes were used as maximums, and fertilization decreased significantly at the maximum activation / exposure times. Freshwater fish species, in general have a limited time period for reproduction, both because of sperm activation and osmotic swelling of the egg after exposure to water. However, sturgeon sperm have greater longevity and their eggs remain fertile significantly longer than most other freshwater spawners. Our results suggest that the possibility of promiscuous mating is high in both species.
[SAT, 15:40-16:00]

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PREDICTION OF DAILY FOOD CONSUMPTION USING MECHANISTIC MODEL: TESTS AND CORRECTION FACTORS.

Food consumption being the only energy input for fish, therefore it constitutes a key component of any mass balanced equation. This situation stimulates the development of prediction tools to obtain reasonable estimation of food consumption, when measurements are not possible or not necessary. One of the prediction tools available is the mechanistic models which have the merit to be function of variables that change in space and time, opening the possibility to estimate food consumption in changing environment, such as in rivers. These models exploit mechanism of food consumption such as the fish size, the reactive distance to a prey, prey density and size, to assess the effect of variations of environmental conditions on fish foraging success, and hence, consumption rates. Validation of bioenergetic mechanistic model has been done a few times with varying degrees of success regarding the selection of the habitat, at the microhabitat scale. However validation is required to confirm the models accuracies in predicting the daily food intake, and if the models can support transferability from microhabitat scale to a larger scale as homogeneous river zone, compatible with habitat models used to predict impact of flow regime on fish habitat. Some parameters in the models, such as the probability of capture that is given a value of one, may be an avenue that can be explored to adapt the model to different situations. The objectives of our study were 1) to compare the daily consumption rate values estimated using field surveys of fish stomach contents to predictions made by three existing mechanistic models, in an homogeneous river zones and 2) to suggest a correction factor to modify the probability of capture.

PRÉDICTION DE LA CONSOMMATION JOURNALIÈRE DE NOURRITURE PAR DES MODÈLES MÉCANIQUES : TESTS ET CORRECTIFS.

La consommation de nourriture étant la seule source d'énergie pour les poissons, il va de soi qu'elle constitue un élément clé de tout budget énergétique. Cette situation encourage le développement de modèles prédictifs afin d'obtenir une estimation raisonnable lorsque les mesures ne sont pas possibles ou non nécessaires. Les modèles mécaniques sont de ces outils. Ces derniers ont le mérite d'utiliser des variables changeant dans l'espace et le temps, ce qui ouvre la possibilité de prédire la consommation de nourriture dans des environnements instables tels que les rivières. Ces modèles utilisent la mécanique de la consommation de nourriture telles que la taille des poissons, la distance de réaction à une proie, la densité des proies, la taille des proies, afin d'évaluer l'effet des conditions environnementales sur la capture de proies et par le fait même de la consommation de nourriture. La validation des modèles mécaniques a été effectuée à quelques reprises en ce qui a trait à la prédiction du choix d'un microhabitat. Par contre, un exercice de validation est nécessaire pour confirmer la prédiction de la consommation journalière ainsi que pour évaluer la possibilité d'utiliser ces modèles à une échelle spatiale plus grande, compatible avec les modèles de qualité d'habitat utilisés pour prédire l'impact de débit sur l'habitat du poisson. La probabilité de capture est un paramètre des modèles mécaniques qui est fixé à un, cela pourrait être une avenue à explorer pour ajuster les modèles mécaniques à différentes situations. Les objectifs de cette étude étaient 1) de comparer la consommation journalière calculée à partir de contenus stomacaux à celle prédite par trois modèles mécaniques dans des zones homogènes de rivière, et 2) de proposer un facteur de correction pour modifier la probabilité de capture.

[SAT, 17:00-17:20]

Carr¹, G.M., A. Morin¹ and P.A. Chambers². 1Department of Biology, University of Ottawa, Ottawa, ON; 2National Water Research Institute, 867 Lakeshore Blvd., PO Box 5050, Burlington, Ontario L7R 4A6 (e-mail: gcarr@science.uottawa.ca)

BIOMASS, PRODUCTION AND INSTREAM WATER QUALITY

Bacteria and algae in stream periphyton were sampled over two summers to quantify the relationship between autotrophic and heterotrophic biomass and production and instream water quality. Chlorophyll a and bacterial abundance increased with inorganic nutrient concentrations, although the strength of the relationships was weak. Bacterial abundance did not explain a significant component of the variance in chlorophyll variability. Heterotrophic production was relatively constant across water quality, but differences were observed in autotrophic production, when light regimes at the sampling stations were taken into consideration. Rates of carbon turnover in the autotrophic and heterotrophic will be compared and their relative contribution to invertebrate production estimated.

[SUN, 10:30-10:50]

John M. Casselman and Jason Dietrich Ontario Ministry of Natural Resources Aquatic Research and Development Section Glenora Fisheries Station R.R. 4, Picton, Ontario K0H 1E0

THE EFFECTS OF LONG-TERM CHANGES IN CLIMATE AND WATER LEVEL ON RECRUITMENT AND ABUNDANCE OF NORTHERN PIKE (*ESOX LUCIUS*) IN LAKE ONTARIO AND THE UPPER ST. LAWRENCE RIVER

Northern pike is a spring spawner that uses flooded shallow wetlands for reproduction and nursery habitat. Climate and water regimes directly affect these wetlands. We examined pike catch and year-class strength in relation to assembled long-term environmental data (seven decades) associated with water regime (precipitation, discharge, and water level) and water temperature for eastern Lake Ontario and the upper St. Lawrence River. Annual temperatures increased significantly over the past seven decades, most dramatically in recent years (Lake Ontario, mean 10.9°C, from 10.5 to 11.3°C—0.82°C, a shift in dynamics occurred in 1977; St. Lawrence River, mean 9.2°C, from 9.0 to 9.5°C—0.51°C, a shift in dynamics occurred in 1985). Relative abundance of pike in eastern Lake Ontario over this seven-decade period was positively correlated with temperature (explained variance 7.8%) and, unexpectedly, negatively correlated with water elevation (explained variance 9.6%). CUSUM shifts in water levels occurred in 1943, 1956, and 1972, with levels much more stable from 1972 to 2001. Since the beginning of the 1970s, year-class strength has been curvilinearly correlated with midsummer temperatures and negatively correlated with late-summer levels; the latter implicates water stabilization but requires a longer-term analysis, including the 1950s and 1960s, when water level was much more variable.

[FRI, 14:40-15:00]

Casselman, S. and R. Montgomerie. Department of Biology, Queen's University, Kingston, Ontario (email: cassel@biology.queensu.ca)

MALE CONDITION AND SPERM CHARACTERISTICS OF WALLEYE (*STIZOSTEDION VITREUM*) FROM FIVE LAKES ACROSS CENTRAL CANADA

Male reproductive success in many species of fish is largely determined by the number of eggs fertilized. Fertilization success has been shown to be limited by ejaculate quality. Males that are able to produce high quality ejaculates are likely to fertilize more eggs. Despite the importance of ejaculate quality, little is known about the factors which influence sperm quality in externally fertilizing fish. Sperm traits have been found to vary significantly among males in several species of fish, suggesting that aspects of male quality might influence ejaculate quality. In this study, we examine sperm characteristics (morphology, concentration, motility and initial ATP level) and body condition (Fulton condition factor, percent dry muscle mass and residuals from mass-length regression) of male walleye (*Stizostedion vitreum*) collected from five different populations across central Canada. All sperm traits measured were found to differ significantly among populations. Sperm swimming speed immediately after activation was found to be positively correlated with male condition. Within certain populations males in better condition produced more concentrated ejaculates with greater sperm motility. Males in better condition may be able to allocate more energy into reproduction, producing higher quality ejaculates which may result in increased reproductive success. These results suggest that if a population of fish experiences a decrease in condition through climate change or exploitation, male reproduction may be negatively affected through reduced ejaculate quality.

[FRI, 14:40-15:00]

Zakhodnova, T.¹, and A. Cattaneo². 1Russian Academy of Science, St. Petersburg, Russia. 2Département de sciences biologiques, Université de Montréal, Montréal, Québec (antonia.cattaneo@umontreal.ca)

THE RESPONSE OF ALGAE ATTACHED TO MOSSES AND GRAVEL TO CHANGES IN STREAM WATER LEVEL

Global warming scenarios generally forecast increased variability in stream and river flow. To study the response of benthic algae to water level variations, we sampled a Quebec stream four times during the summer along a vertical gradient spanning from substrata continually submerged to those increasingly exposed to drying. We examined algae growing on mosses (*Fontinalis*) and on gravel to test if substratum type might affect algal response. There was a significant vertical gradient in the biomass of algae growing on moss with higher values observed on deeper substrata. Such pattern was evident on gravel only after a protracted period of reduced flow in August. Algal taxonomical composition changed depending on water depth and substrata. Diatoms were generally dominant on deep, constantly submerged substrata. Chlorophytes became prevalent on mosses periodically exposed to drying, whereas Cyanobacteria became abundant on exposed gravel. Substratum height below or above the water surface was an important variable to explain spatial variations in algal biomass and taxonomic composition in this stream with permanent but seasonally variable flow. Depending on substratum type, moss vs. gravel, attached communities exhibited different seasonal trends and responded differently to hydrological variations. Algae on mosses could reach higher biomass than those on gravel but appeared more sensitive to occasional droughts. Our study underlines the need to consider substratum type when assessing the response of attached algae to perturbations. 1 Gartner Lee Ltd. 9B Taylor Rd. Bracebridge, ON, P1L 1T8. 2 Muskoka Lakes Association. P.O. Box, Port Carling, ON, & Dept. of Environmental Engineering, Dalhousie Univ. 3 Gartner Lee Ltd. 9B Taylor Rd. Bracebridge, ON, P1L 1T8. 4 Muskoka Lakes Association. P.O. Box, Port Carling, ON, & Dept. of Environmental Engineering, Dalhousie Univ. 5 Lake & Bays Association. P.O. Box, Baysville, ON.

[SAT, 11:30-11:50]

Cena, C., D.D. Heath, ccena13@hotmail.com

HATCHERY IMPACTS ON GENETIC VARIATION IN WALLEYE (STIZOSTEDION VITREUM).

Walleye (*Stizostedion vitreum*) is an important recreational and commercial fish species in Ontario. Since 1904, Ontario supportive breeding programs have released hatchery reared juveniles to stabilize or increase populations that have been diminished due to environmental and/or anthropogenic events. Despite the intentions of supportive breeding programs, controversy remains over the effect that releases of hatchery reared juveniles may have on the target fish populations. The purpose of this study is to analyze the genetic effect that released hatchery walleye have on walleye populations occupying small upland lakes in Ontario. A number of small south central Ontario upland lakes (N=10-20) were selected based on documented efforts to maintain quality walleye fisheries through supportive breeding. A hatchery effect index (HEI) that estimates the magnitude of hatchery efforts among lakes was calculated by dividing the average number of fish released by the total lake surface area. Using existing walleye tissue samples (N*50) collected from each of the selected lakes, 5 – 10 walleye microsatellites markers will be applied to the extracted DNA in order to determine genetic diversity. Hatchery supplementation is expected to reduce within population genetic variation and erode genetic divergence among populations. Our analysis of microsatellite marker variation will determine hatchery release influence on the genetic variation and divergence, as well as establishing the genetic relationships among of small upland lake walleye populations.

[FRI, 16:20-16:40]

P.A. Chambers and M. Guy Environment Canada, National Water Research Institute, 867 Lakeshore Blvd., PO Box 5050, Burlington, Ontario L7R 4A6 (email: patricia.chambers@ec.gc.ca)

THE IMPACTS OF SEWAGE DISCHARGE ON CANADIAN WATERS

Domestic sewage is a major threat to receiving waters throughout the world. In Canada, 69% of the population was served by municipal wastewater treatment in 1996. Of the remaining population, 4% were served by sewage systems that discharged raw sewage and 27% were located in villages or rural settings served by septic disposal systems or lagoons. Despite a relatively high level of sewage treatment, discharges from wastewater treatment plants, septic disposal systems and sewers have caused adverse impacts to lakes, rivers and coastal waters in Canada. The most publicly recognized impacts are shellfish harvesting restrictions and beach closures resulting from microbial contamination. Eutrophication, reduction in dissolved oxygen concentrations, habitat degradation and, occasionally, toxicity also occur and these have altered the abundance and diversity of aquatic organisms in certain aquatic ecosystems. New issues are emerging (e.g., endocrine disrupting compounds; pharmaceutical and personal care products) and conventional treatment methods may have little effect on these compounds. An integrated approach to wastewater management is needed that addresses loadings from treatment plants, sewers and other wastewater sources in order to attain further improvements in water quality.

[SAT, 14:20-14:40]

Cheek, K. and S. B. Watson. Department of Biological Sciences, University of Calgary, AB (kcheek@alumni.ucalgary.ca)

THE IMPACT OF LOW-MODERATE ANTHROPOGENIC DISTURBANCE ON ALPINE ALGAL COMMUNITIES

Increasing human activity is having a profound impact on alpine ecosystems, which have poor resiliency and are particularly susceptible to disturbance. Algal communities in many alpine surface waters show low productivity and species diversity, attributed to the short growing season, low temperatures and nutrients, and exposure to high UV irradiance. Despite these harsh conditions, alpine surface waters can respond to eutrophication by increases in algal biomass and noxious taxa, indicating that nutrients play a dominant regulatory role. For many of these systems, however, the impacts of eutrophication cannot be fully assessed because the natural range in algal species composition and biomass is unknown. Lake O'Hara is a small lake in Yoho National Park, BC., and an ideal site to investigate the impact of moderate-low anthropogenic activity on alpine systems. Most of the inflow to the lake is from three drainage basins with a series of small, interconnected streams and lakes, two of which are glacier-fed. This has long been a popular recreational area, but public access has been restricted and early studies of the lakes indicate very low productivity. More recently, Lake O'Hara has shown increased algal growth in some nearshore areas, but it is not known if this stems from any of the several potential sources of disturbance, a residential lodge, a campground, and public day-use. It also is not known to what extent these outbreaks deviate from the natural variance in algal communities within this watershed. This paper will present the results of the first year of an intensive study in the O'Hara basin, the goals of which have been to characterize the algal communities and water quality and thereby gauge the impact that low-moderate human activity has on these alpine systems. Preliminary data indicate that there may be significant point source loading in one area of Lake O'Hara, resulting in significantly higher nearshore phosphorus levels and a shift in the periphyton community from diatoms to chlorococcales.

[POSTER]

Chen, H. (1), Prepas, E.E. (2) and Fedorak, P. M. (1) (1) Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9 E-mail: huirong@ualberta.ca (2) Faculty of Forestry, Lakehead University, Thunder Bay, ON, P7B 5E1

EFFECTS OF LOW DISSOLVED INORGANIC CARBON CONCENTRATIONS ON CYANOBACTERIAL GROWTH AND TOXIN PRODUCTION

The occurrence of cyanobacterial blooms and the numerous toxins they produce have caused a serious health problem in lakes and reservoirs worldwide. Many environmental factors have been related to cyanobacterial growth and toxin production. Until recently, regulatory mechanisms for toxin production have been unknown. Our study focuses on the effects of low dissolved inorganic carbon (DIC) concentrations and associated high pH on biomass and toxin (mainly microcystin LR) production in *Microcystis aeruginosa*. Past research suggests that cyanobacteria utilize the carbon-concentration mechanism (CCM) when competing with other phytoplankton for DIC when it is at low concentration. Further, some researchers have proposed that cyanobacterial toxins played a role in the CCM. However, there are few experiments focusing on characterizing toxin production during periods of DIC stress. We monitor growth characteristics and toxin content in cultures of *M. aeruginosa* grown in controlled laboratory conditions in media with different initial pH levels. Data generated in this research will help to elucidate links between laboratory studies and environmental factors that trigger or enhance cyanobacterial toxin production in natural settings.

[SAT, 10:50-11:10]

Cheng, C. and I. Novales Flamarique. Department of Biology, Simon Fraser University, Burnaby, British Columbia (email: clc@sfu.ca)

RETINAL CONE TOPOGRAPHY IN CYPRINID FISHES FOLLOWING EXPOSURE TO RETINOIC ACID OR THYROID HORMONE

Retinoic acid and thyroid hormone are ligand molecules that regulate gene expression by binding to nuclear receptors. Previous research has shown that both compounds affect the development of the retina in zebrafish and mammalian embryos. In addition, it has been suggested that external exposure to either of these compounds will induce the disappearance of the ultraviolet cone receptor in rainbow trout, though this claim has now been challenged. To assess whether retinoic acid or thyroid hormone (the precursor T4) could induce changes in retinal cone topography in cyprinid fishes, we exposed juvenile goldfish and adult zebrafish to each compound, individually. No statistically-discernable changes in retinal cone distributions were found for either species as a function of treatment compared with the controls. Both controls and treated zebrafish showed highest cone densities in the ventro-temporal sector of the retina and lowest in the naso-dorsal sector. The ratio of double cones to single cones was on average 1 everywhere throughout the retina, i.e. ultraviolet cones did not disappear nor were regenerated. The goldfish juvenile retina lacked ultraviolet cones throughout most of the retina with the average double to single cone ratio approaching 2. Instances of a lower ratio (in the range 1.68-1.87) were found along the dorsal retina of both control and treated animals. As in the zebrafish, the highest cone densities in goldfish were found in the ventro-temporal retina, both for treated animals and controls. We conclude that retinoic acid and thyroid hormone do not alter the cone topography of the post-embryonic retina in cyprinid fishes.

[SAT, 13:20-13:40]

Cooke, S.J., J.F. Schreer, P.J. Weatherhead, D.H. Wahl, and D.P. Philipp Queen's University Biology Station and the Center for Aquatic Ecology, Illinois Natural History Survey (email: scooke@uiuc.edu).

THE PHYSIOLOGICAL ECOLOGY OF PARENTAL CARE IN CENTRARCHID FISHES

Using coupled field and laboratory assessments, we studied the energetics and cardiovascular performance of six species of paternal care providing centrarchid fishes that occur syntopically in Lake Opinicon, Ontario. The duration of parental care, activity patterns and energetic costs varied widely among species. Overall, the duration of care increased with increasing parental size. When energetics were adjusted for the species-specific differences in the duration of parental care, the cost of parental care increased with the size of the fish. Fish with extended parental care exhibited stage-specific patterns of activity and energy expenditure consistent with parental investment theory, whereas fish with short duration parental care tended to maintain high levels of activity throughout the entire parental care duration. Resting cardiovascular values were consistently higher for nesting fish when adjusted for variation in temperature. When exposed to exhaustive exercise, nesting fish took longer to exhaust but recovered more rapidly than non-nesting individuals. The maximal cardiac variables were usually slightly higher in nesting fish than non-nesting fish such that cardiac scope was maintained during the parental care period. Several cardiovascular variables were correlated with parental care metrics. Collectively, these data suggest that parental care providing fish possess adaptations that enhance their ability to provide protracted care at high intensities and reveal the important link between physiological performance and fitness. These data also reveal the extreme energetic consequences of parental care.

[SAT, 14:20-14:40]

Cooke, S.J., J. Steinmetz, J. Degner, E.C. Grant and D.P. Philipp. Queen's University Biology Station and Illinois Natural History Survey (email: scooke@uiuc.edu)

INTERACTION OF FISH SIZE AND AVIAN PREDATOR SPECIES ON THE NON-LETHAL COSTS OF PREDATION IN LARGEMOUTH BASS.

Non-lethal costs of predation are rarely considered in ecological research. Recently, researchers have identified that non-lethal costs may arise not only from lost energy intake, but also potentially from increased energetic expenditure. During periods of heightened stress following unsuccessful predation attempts, organisms may remain in altered physiological state with elevated

metabolism for some time. Few studies have quantified these non-lethal energetic costs of predation. We monitored the cardiac response (cardiac output (CO), heart rate (HR) and stroke volume(SV)) of largemouth bass *Micropterus salmoides* ranging in size from 200-450 mm to simulated avian predation attempts by great blue heron *Ardea herodias* and osprey *Pandion haliaetus*. Cardiac output and its components are strongly correlated with metabolic rate and enable robust estimates of energetic costs in real-time. Fear bradycardia during a 30 second predation attempt varied depending upon the size of the fish and the type of predator. The magnitude of the bradycardia decreased with increasing size of the fish, however, the disturbances were consistently more extreme in response to osprey than to blue heron models. The maximal cardiac disturbance of fish following simulated predation attempts by osprey were consistent among size classes of bass. The magnitude of the disturbance following heron predation attempts, however, was reduced as the size of fish increased. Size specific trends were even more extreme for the time required for cardiac recovery. Largemouth bass of all sizes exposed to osprey predation attempts required ~40 min for CO and HR, and ~30 min for SV to return to predisturbance levels. Although small bass exposed to heron predation attempts required recovery times similar to fish exposed to the osprey, as the size of largemouth bass exposed to the heron model increased above ~300 mm, the recovery time decreased significantly. We conclude that the size-specific response of largemouth bass to different predators is reflective of their ability to assess the risk posed by different predators. Fish of all sizes tested (200-450 mm) could be easily captured by osprey, whereas, herons would be gape limited to fish less than ~300 mm. The magnitude of metabolic disturbance and the required recovery period for stress associated with avian predation attempts is similar to that observed during exposure to a variety of other stressors. We conclude that the non-lethal costs of predation can be substantial and should be considered in future bioenergetics models.

[POSTER]

Cooper, A. and S. Arnott. Department of Biology, Queen's University, Ontario (coopera@biology.queensu.ca)

THE INFLUENCE OF MACRO-INVERTEBRATE PREDATORS ON THE RECOVERY OF ZOOPLANKTON COMMUNITIES IN SWAN LAKE, SUDBURY, ON

Swan Lake, like many lakes in the Sudbury area, has been affected by atmospheric acid deposition in the past. In recent years, there have been signs of chemical recovery in these lakes, however, biological recovery has been variable. In many lakes fish have been extirpated due to high acidity. This alteration of the aquatic food-web allows macro-invertebrate predators to flourish, but delays the recovery process of the zooplankton community. I conducted both a field mesocosm experiment in Swan Lake and several laboratory feeding experiments to determine the effects of macro-invertebrate predators on zooplankton communities. The invertebrate predator, *Graphoderus liberus* (Say) (Coloepoptera) was used in a field enclosure experiment to determine its effect on resident Swan Lake zooplankton and potential zooplankton colonists from a nearby lake, Kelly Lake. Two treatments (*G. liberus* and a control) were established with four replicates each. Enclosures were monitored for five weeks and changes in abundance, diversity, and richness in zooplankton communities were recorded. The results show that *G. liberus* significantly lowered the overall abundance of zooplankton and of four dominant zooplankton taxa. Richness and diversity of zooplankton were significantly lower in the *G.liberus* predator treatment than in the control treatment. Many of the Kelly Lake colonists declined at the end of the experiment, possibly because of a pH stress. Short-term (48-hour) laboratory feeding experiments were also conducted to investigate feeding preferences of *G.liberus*. Three trials including instars I, II, and III of the *G.liberus* predator were run and in each of these trials, the treatments consisted of predator (*G. liberus*) and control. Three zooplankton prey assemblages were used: 100% Swan Lake, 100% Kelly Lake, and an equal amount of zooplankton from the two lakes. Each treatment had five replicates. Preliminary results suggest that *G. liberus* larvae selected for larger zooplankton prey which exist in the recovered zooplankton community of Kelly Lake. These results show that invertebrate predators have an important impact on recovery of zooplankton community structures and they may be controlling the recovery of damaged lakes.

[SAT, 10:50-11:10]

James W. Rajotte and Patrice Couture Department of Biology, Laurentian University, Sudbury, Ontario (e-mail:

pcouture@laurentian.ca)

METABOLIC CAPACITIES AS POTENTIAL BIOMARKERS OF METAL CONTAMINATION IN PERCID POPULATIONS

Tissue metabolic capacities have long been used as physiological tools in zoological studies. Several metabolic capacities are altered by exposure to certain xenobiotics such as metals (ex. copper, cadmium). For this reason, metabolic capacities have the potential to be used as biomarkers in field populations of animals exposed to potential toxic substances. To assess their use as potential biomarkers, metabolic capacities of liver and white muscle were determined in wild populations of yellow perch (*Perca flavescens*) inhabiting lakes with varying degrees of metal contamination near the Greater City of Sudbury, Ontario. In separate studies over a five-year period, tissue metabolic capacities from several metabolic pathways were examined (aerobic, anaerobic, lipid metabolism, anabolism) as were rate-limiting enzyme activities for each of the major metabolic fuel sources (protein, carbohydrate, lipid). Due to their crucial involvement in cellular energy production, enzyme activities of the mitochondrial electron transport chain were also assessed. Our data provide a weight of evidence suggesting that chronic metal exposure inhibits aerobic capacities in wild yellow perch. Aerobic capacities were consistently impaired in the white muscle of metal-contaminated fish, as indicated by the activities of several enzyme indicators. The extent of aerobic impairment appeared

more important in older fish from metal-polluted lakes. On the contrary, muscle anaerobic or anabolic capacities did not show a consistent pattern of impairment with metal exposure. Liver metabolic capacities did not appear affected by metal contamination either. Given the consistency of these studies, indicators of muscle aerobic capacities are potentially useful bioindicators of metal stress in wild fish.

[SAT, 13:40-14:00]

Crago, C. and R. Carignan. Département de sciences biologiques, Université de Montréal, Montréal, Québec (email :ccrago2@hotmail.com)

PHOSPHORUS TRANSPORT IN A POPULATED LAURENTIAN WATERSHED (LAC CONNELLY, QUÉBEC)

Numerous Laurentian lakes appear to be experiencing water quality degradation, possibly due to increased nutrient loading. In order to understand the factors and processes (both natural and anthropogenic) controlling nutrient generation and transport within forested watersheds, we monitored total and dissolved phosphorus transport at twenty stations distributed along the drainage network of a typical 30 km² watershed located in the Basses Laurentides, near Montreal. High phosphorus concentrations (100 µg/l) were found in streams draining sub-watersheds containing areas recently flooded by beavers, where phosphorus exportation can reach 200 mgP m⁻² y⁻¹. However, phosphorus exportation by the entire watershed remained surprisingly low (5-6 mgP m⁻² y⁻¹), given the presence of a 1000 cottages and homes in the watershed.

[SAT, 14:00-14:20]

James A. Crossman, Alisha Giberson, Ryan Hardy, Ronald M. Browne, Matthew K. Litvak. Department of Biology, University of New Brunswick Saint John, Saint John, PO Box 5050, NB, E2L 4L5 (email: h76e9@unb.ca)

ESTIMATING POPULATION SIZE AND WILD GROWTH RATES OF THE SHORTNOSE STURGEON (ACIPENSER BREVIROSTRUM) IN THE SAINT JOHN RIVER, NB.

Shortnose sturgeon (*Acipenser brevirostrum*) is currently listed by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC) as a species of special concern. In Canada, its distribution is limited to the Saint John and Kennebecasis rivers in New Brunswick. In the United States most populations are endangered. Despite this, little information is available on shortnose sturgeon population ecology or basic biology which could be used to generate management plans for conservation efforts. Our lab is currently engaged in a mark recapture study to estimate Canada's only population of this species. We use short-set gill nets to capture juvenile and adult shortnose sturgeon. Fish are tagged with both Carlin Dangler and an anchor tags. Over the past five years, we have tagged fish throughout the lower Saint John and Kennebecasis rivers from the end of April until late fall. To date we have tagged 891 shortnose sturgeon, 38 of which have been recaptured. Our current population estimates now indicate that there are 9,682 (upper and lower 95% limits are 6,712 and 14,525 respectively) shortnose sturgeon in the Saint John River. This is the first population estimate since 1976.

[POSTER]

R. Allen Curry, New Brunswick Cooperative Fish and Wildlife Research Unit, Canadian Rivers Institute, Biology Department, University of New Brunswick, Fredericton. E3B 6E1 (racurry@unb.ca)

DISTRIBUTION OF FRESHWATER FISHES IN ATLANTIC CANADA

The distribution of freshwater fishes is presented for the region stretching from the Gaspé to Newfoundland. Of the 49 species found in freshwaters, the greatest diversity of obligate freshwater species occurred in NB (34) and the fewest in Newfoundland (2) and PEI (8). The greatest diversity of species was located in the Saint John River (23) and Western Bay of Fundy (22) watersheds. There are eight exotic species in the documented records of the region. All freshwater fishes would have been extirpated from the region 18,000 ybp at the maximum extent of the glacier expansion. The mainland areas and presumably the first freshwaters were open to re-introductions by 13,000 ybp. Newfoundland was beginning to become ice-free at the same time. It would appear that most freshwater fishes re-invaded from a Mississippian Refugium.

[SAT, 15:40-16:00]

Dawson, A. and S. Arnott. Department of Biology, Queen's University, Kingston, Ontario. (email:dawsona@biology.queensu.ca)

THE EFFECTS OF INTRA-ANNUAL PH FLUCTUATIONS ON RECOVERING ZOOPLANKTON COMMUNITIES IN SWAN LAKE, SUDBURY, ONTARIO

Very little is known about the role that environmental variability plays in the recovery of damaged ecosystems, however, the importance of interactions between the environment and recovering systems is becoming increasingly recognized. Swan Lake, a small lake that was historically acidified by mining-related sulphur dioxide emissions, is beginning to show chemical recovery in response to reduced emissions. However, despite improvements in water quality, there has been little recovery of the biota. For example, acid-sensitive zooplankton such as *Daphnia*, have not re-colonized Swan Lake. One possible explanation for this is the large degree of variability in pH levels that occurs within a single year. These environmental fluctuations may play a significant role in the recovery of species that have already been subjected to long term stresses. To test whether or not short term pH fluctuations influence the ability of a zooplankton community to recover from acidification, pH levels were experimentally manipulated within large epilimnetic enclosures (~2800L). A two-factor experimental design

was established to test the effects of low magnitude (pH fluctuation from 6.5 to 5.8) versus high magnitude (pH fluctuation from 6.5 to 5.0) pulses and low frequency (9 day) versus high frequency (3 day) pH pulses. A control treatment where the pH was fixed at 6.5 was also used. Results show differences in community structure between the most extreme treatment (pH lowered to 5.0 for 9 days), and the control and the least extreme treatment (pH lowered to 5.8 for 3 days). These results show that intra-annual pH fluctuations have an effect on the ability of a zooplankton community to become re-established in recovering lakes. Understanding the processes and factors that influence biotic recovery from environmental stresses will have important implications for determining recovery trajectories of damaged ecosystems.

[SAT, 11:10-11:30]

DeBruyn, A.M.H. and F.A.P.C. Gobas. School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC (email: adebruy@sfu.ca)

LINKING THE FATE OF AQUACULTURE-ASSOCIATED CHEMICALS TO ORGANIC MATTER CYCLING IN AQUATIC SYSTEMS

Organic chemicals that have low solubility in water become associated with living and dead organic matter (OM) in aquatic environments. Current models and assessment methods view this OM as an inert matrix within which chemicals achieve an equilibrium distribution according to their thermodynamic properties. It is well known, however, that OM in aquatic systems is a dynamic entity that cycles on time scales much shorter than those required for many chemical distribution processes to approach equilibrium. Here, we use a dynamic model of simultaneous chemical partitioning and OM degradation to show how the fate of organic chemicals associated with salmon aquaculture (e.g., chemotherapeutants, feed contaminants) is strongly linked to OM cycling in the receiving environment. The model predicts that low-level OM enrichment of the sediment will promote remineralization, inflating chemical concentrations and increasing the risk of contamination to detritivores. High rates of OM sedimentation will promote sediment burial, keep chemical concentrations in the sediment low, and reduce contamination risk to detritivores. However, high sedimentation rates will simultaneously increase the production of detritivores, and thus increase the flux of contaminants into the benthic food web.

[SAT, 16:40-17:00]

T. Delongchamp, J. Gunn, N. Belzile, Y. Chen and J. Tong Laurentian University, Ramsey Lake Road, Sudbury, ON, P3E 2C6 (Email:tm_delongchamp@nickel.laurentian.ca)

ANTAGONISTIC EFFECT OF SELENIUM ON MERCURY ACCUMULATION BY INVERTEBRATES AND FISH IN SUDBURY AREA LAKES

Sudbury, Ontario, and its surrounding area, offers a unique opportunity to study the relationship between mercury and selenium in freshwater ecosystems because of the gradient in lake water Se concentrations at increasing distances from the smelters. To understand how Se affects Hg accumulation in the food chain of lakes in this area, samples were collected of zooplankton, mayflies (*Stenonema* sp.), and amphipods (*Hyallela azteca*) from 10 lakes located at various distances (5-100km) from the Sudbury metal smelters. These organisms were chosen to represent lower levels of the aquatic food chain and test the antagonistic effect of Se on Hg, previously observed in perch and walleye tissues. Total concentrations of dissolved Hg and Se in the study lakes were also determined from late fall water samples. Preliminary results showed an inverse relationship between Se concentrations of lake water and Hg concentrations in zooplankton ($r^2=0.5238$), mayflies ($r^2=0.6087$), and amphipods ($r^2=0.7667$). The presence of Se in these lakes could therefore be an important factor affecting Hg assimilation in aquatic food chains.

[POSTER]

Demers, M., J. Blais, and F.R. Pick. Department of Biology, University of Ottawa, Ottawa, Ontario. (e-mail: mdemers@science.uottawa.ca)

ACCUMULATION OF PERSISTENT ORGANIC POLLUTANTS IN LAKES FROM THE CANADIAN ROCKY MOUNTAINS

Human and wildlife health risks associated with persistent organic pollutants (POPs) have been well documented around the Great Lakes, but there is a widespread assumption that lakes removed from point sources, such as arctic and alpine lakes, are pristine. Ongoing research has shown that the high elevations of the Canadian Rockies are susceptible to this cold-condensation effect which acts to enhance semi-volatile organochlorine compounds in colder, high elevation regions. Concentrations of POPs in sediment and fish from lakes ranging in altitudes from 900 to 2700 m in mountain parks were examined in relation to biological, physical and chemical variables. We hypothesized that the concentrations of persistent organic pollutants be elevated and will correlate with altitude because alpine lakes experience lower temperatures, higher precipitation, lower phytoplankton abundance, and lower dissolved organic carbon than montane and prairie lakes. All of these factors may enhance bioaccumulation of POPs, either by suppressing evaporation, enhancing atmospheric deposition, or increasing bioavailability.

[POSTER]

Depew, D.¹, R.E.H. Smith¹, S.J. Guilford¹, and M.N. Charlton². ¹Department of Biology, University of Waterloo, Waterloo, Ontario. ²Canadian Centre for Inland Waters, Burlington, Ontario. (email: ddepew@scimail.uwaterloo.ca)

PRIMARY PRODUCTION IN DREISSENID INFESTED LAKE ERIE (EAST BASIN)

Phytoplankton production, chlorophyll concentrations, and underwater extinction coefficients (K_d) were determined at 19 stations in 2001, and at 20 stations in 2002, in the Eastern basin of Lake Erie in order to characterize primary production patterns in this dreissenid- colonized system. Mussels have had well-documented impacts on plankton biomass in shallow and/or nearshore (<20 m depth) parts of the Great Lakes but their effects on primary production rates have been less studied. Both ¹⁴C uptake and O₂ production methods were used to estimate rates of primary production. Compared to rates observed at offshore stations, volumetric phytoplankton production rates were reduced in nearshore areas shallower than 5m, where mussel impacts should be greatest. The smaller production rates were caused by lower planktonic biomass (chlorophyll a) and diminished values for light-saturated rates of photosynthesis (P_{bmax}) and light utilization efficiency (*). Extinction coefficients were higher and extremely variable in the nearshore. The average light climate in the relatively shallow nearshore water column was still more favourable than in the deeper offshore but could not fully offset the lower biomass and photosynthetic performance of the nearshore phytoplankton. Areal planktonic primary production rates were lower in the shallow nearshore than in the offshore. Benthic primary production is likely to assume an important role in the dreissenid- colonized nearshore, with major implications for the dynamics of the food web.

[FRI, 16:00-16:20]

Derry, A.M.(1), K. Sherman(2), T. Howell (1), and D. Boyd (1). ¹Water Monitoring Section, Environmental Monitoring and Reporting Branch, Ministry of Environment (e-mail: duncan.boyd@ene.gov.on.ca) ²Severn Sound Environmental Association, Midland

WATER QUALITY MONITORING IN SELECTED EMBAYMENTS OF SOUTHEASTERN GEORGIAN BAY

In order to establish groundworks for balancing future development with preservation of water quality, it is necessary to characterize the variability in water conditions found within the Georgian Bay archipelago. The southeastern coast of Georgian Bay consists of a network of constricted embayments with limited water exchange for extended periods of time. The embayments are subject to intensive use by cottagers and boaters during the summer months. Nutrient leaching from cottage septic systems and grey water discharge from boats are both sources that can contribute to lake eutrophication. Further, fecal contamination of water is associated with waterborne pathogens. The objectives were to characterize the range of water chemistry conditions that occur along a river system gradient and to compare the relative effect of cottagers, boaters, and marinas on water quality in isolated embayments in southeastern Georgian Bay. Sampling of water chemistry was conducted along the Go Home River system from July to September. Water chemistry variables and bacterial densities were measured on a weekly basis from June to September within embayments with different anthropogenic uses (reference, boat anchorage, cottages, and marina) in Honey Harbour. Preliminary results indicate water chemistry along the Go Home river gradient system is highly variable. Of the four Honey Harbour embayments with different uses, the highest bacteria concentrations were observed in the boat anchorage bay in mid summer. Recommendations from this study will be provided for the Great Lakes Heritage planning process.

[SAT, 14:20-14:40]

Ngan K. Diep¹ and Ralph E.H. Smith¹ ¹University of Waterloo

"THE ROLE OF ULTRA-VIOLET RADIATION (UVR) ON THE QUALITY AND QUANTITY OF DISSOLVED ORGANIC MATTER FROM THE EASTERN BASIN OF LAKE ERIE"

The role of ultraviolet radiation on the bioavailability of dissolved organic matter (DOM) was investigated in samples from oligo-mesotrophic Lake Erie. Filtered (0.2µm nucleopore) water samples were subjected to either ultraviolet radiation or to dark conditions. Exposure to ultraviolet radiation resulted in a decrease in the spectral slope of the absorbance spectra for all samples and a concurrent decrease in fluorescence. Spectrofluorometric spectra indicated a pronounced difference between the exposed and non-exposed samples. To determine the bioavailability of DOM, the samples were inoculated with natural bacterial communities and measurements were made for absorbance, fluorescence, fluorescence-excitation emission spectra, bacterial counts, and biological oxygen demand (BOD) after varying incubation periods. Differences between exposed and non-exposed samples were generally small. However, the bacteria appeared to influence the optical properties of the samples as they grew during the incubations. Additional experiments were designed to determine whether the bacteria and their biomolecules (e.g.DNA) were responsible for the optical effects, or whether the bacteria changed the quality and quantity of DOM, perhaps by taking up smaller molecular weight DOM.

[SAT, 17:00-17:20]

Docker, M.F., M. Nurse, C.R. Busch, and D.D. Heath. Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Ontario (email: docker@uwindsor.ca)

IMPROVING NATURAL DISEASE RESISTANCE IN FARMED CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSCHA*, USING MARKER-ASSISTED SELECTION

In aquaculture, disease outbreaks are quite common and can substantially reduce profitability. Vaccines have been developed for some fish diseases and antibiotics may be used to cure others, but vaccination and antibiotics are not effective against all diseases and they can be difficult and expensive to administer. Furthermore, there are concerns that bacteria will develop resistance to these antibiotics and that residues will be present in the fish when they reach the consumer. An effective long-term solution then is to improve the natural disease resistance of farmed fish through selection, using fish that survive exposure to specific disease agents as broodstock. An alternative approach is to develop indirect selection criteria where, instead of subjecting individuals to experimental infections, characters related to disease resistance are used for evaluating potential spawners. The goal of the present study was to develop DNA markers that detect variation at immune-function related loci in chinook salmon and to evaluate their usefulness as indirect criteria for broodstock selection. Using PCR-RFLP assays that detect genetic variation in immunoglobulin heavy chain (IgH, which is involved in antibody-dependent immunity), transferrin (which can provide resistance to bacterial infection by limiting the availability of iron in blood serum and other body fluids), and a class II major histocompatibility complex (MHC) gene (which encodes cell-surface proteins that recognize and bind foreign antigens together with the T-cell receptor), we determined the parental genotypes in 94 families of farmed chinook salmon. Survival and other aspects of disease resistance (e.g., mortality during a natural vibriosis outbreak, incidence of bacterial kidney disease, and lysozyme levels) were evaluated in these families and were related to parental genotype. We found that parental IgH and MHC-B1 genotypes were correlated with performance of the offspring and have potential for use in selecting broodstock with improved disease resistance.

[FRI, 13:20-13:40]

Chad A. Doherty (1), R. A. Curry (1) and K. R. Munkittrick (2) (email: v3tq@unb.ca) (1) Canadian Rivers Institute New Brunswick Cooperative Fish and Wildlife Research Unit Department of Biology, University of New Brunswick – Fredericton 2. Canadian Rivers Institute Department of Biology, University of New Brunswick – Saint John

SEASONAL WHITE SUCKER MOVEMENTS IN THE SAINT JOHN RIVER, NEW BRUNSWICK, CANADA

White sucker are widely distributed in Canada, and are commonly used for environmental monitoring. We studied the movements of white sucker (*Catostomus commersoni*) using radio telemetry on the Saint John River. The Saint John River is one of the largest rivers in Eastern Canada, with the middle reach being subject to hydroelectric operations, industrial and municipal effluent discharges. Goals of the study included describing white sucker spatial and temporal movements in areas of human development within a large river. Winter site fidelity of radio tagged suckers was close to the respective release points (1-2 km) at two sites (Hartland & Woodstock, NB). At the remaining site located closer to a main stem hydroelectric facility (Florenceville) fish initially exhibited greater downstream movement (10-14 km) after which movement throughout the winter was limited. Increased movement corresponded with spring spawning migrations (late April – mid May). Both upstream and downstream migrations were observed with three spawning tributaries being identified. Males tended to enter the tributaries prior to females. In addition, a common secondary-spawning tributary was visited by two male suckers originally from different primary tributaries. One tagged sucker died within in a tributary after spawning. After the spawning migration, >70% of the fish moved back towards either their over-wintering area or original release points within approximately 3-4 weeks. Two remaining individuals selected new areas where they typically showed little movement.

[SAT, 16:20-16:40]

DOKA, S. E., and C.K. Minns. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Rd., P.O. Box 5050, Burlington, Ontario, L7R 4A6. (email: dokas@dfo-mpo.gc.ca)

A SPATIALLY-EXPLICIT, HABITAT-BASED MODELLING APPROACH FOR YELLOW PERCH POPULATIONS.

Fish are affected by physical and biological factors that limit space and resources. Physical habitat is inherently variable at different scales, therefore fish habitat use and availability through time and space is important to model. The limited supply of essential habitat can create a threshold that constrains population dynamics, range and abundance. Linking population parameters and rates with habitat supply estimates for specific life stages can help identify potential limits to productivity and thus define 'essential' habitat; which may differ for consecutive life stages. A pilot study of habitat characterisation, suitability analysis, and a spatially-explicit, yellow perch, habitat-based population model has been completed for Long Point Bay, Lake Erie. It is hypothesised that nearshore, vegetated and thermally suitable habitat is critical to the early life stages of yellow perch. The results show how habitat can affect spawning, egg development and young-of-the-year growth and survival in a spatially heterogeneous environment, in particular how a variable thermal regime in a large embayment can affect the timing and spatial dynamics of a metapopulation. Also, the demonstration of how limiting habitat characteristics, which determine the success of yellow perch, can be used to guide conservation efforts. The framework for the model is flexible and can be applied to other fish species to test habitat-based species interactions.

[SAT, 15:40-16:00]

Drinkwater, K.F. Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, N.S., Canada B2Y 4A2, drinkwaterk@mar.dfo-mpo.gc.ca

THE ROLE OF CLIMATE VARIABILITY IN THE DECLINE OF NORTHERN COD

Abstract - In 1992 the northern cod (*Gadus morhua*) stock off southern Labrador and northeastern Newfoundland (NAFO Subareas 2J3KL) declined to such low levels that the Canadian government imposed a fishing moratorium. A decade later, with the moratorium still largely in place, there is little evidence of a recovery. While fishing is believed to be the major factor in the collapse, evidence is provided that severe climate conditions, in particular cold temperatures, also played an important role in the decline of the cod. They contributed to slower growth rates and reduced size-at-age. Approximately 30-50% of the decline in the biomass of the northern cod during the 1980s to the early 1990s was due solely to changes in weight. The presence of large numbers of smaller size fish led to illegal dumping by fisherman, thereby adding to the fishing mortality. Colder temperatures also led to increased mortality of cod eggs and likely lower recruitment. An environmentally-induced southward displacement of the cod may also have resulted in lower recruitment.

[SUN, 9:50-10:10]

Enache Mihaela and Brian F. Cumming, Dept. of Biology Queen's University Kingston ON email: enachem@biology.queensu.ca

CLIMATE AND FOREST FIRE RELATIONSHIPS INFERRED FROM LAKE SEDIMENTS ALONG A NORTH-SOUTH TRANSECT ON INTERIOR PLATEAU, B.C., CANADA

Predictions of the impact of increasing amounts of greenhouse gases have important implications to the incidence of large and extensive wildfires. British Columbia currently experiences forest fires, which have cost more than \$800 million over the last ten years (Ministry of forests, B.C.). If warmer and drier conditions are predicted in this region, an important question is how will fire intensity and frequency change? A possible key to answer this question is to decipher the relationship between climate and fire regime through time since the last deglaciation. The history of past fires, as well as corresponding climatic conditions, covers only the last century. Consequently, it is not possible to develop a comprehensive understanding of climate/ fire dynamics. Our research project is based on the biogeochemical information preserved in lake sediments to assess changes in forest fire regimes in the framework of changes in climatic conditions over the past 10 000 years. Three long cores were collected from lakes along a north-south transect, in three distinct biogeoclimatic zones (Sub-boreal Spruce, Interior Douglas Fir, and Engelman Spruce/Interior Douglas Fir). Analysis of diatom assemblages along with variation in charcoal distribution are used to establish how climatic conditions determined changes in fire regimes over the last ten millennia and consequently to explore the possibility to build plausible scenarios for the future.

[POSTER]

Enache Mihaela and Brian F. Cumming, Dept. of Biology Queen's University Kingston ON email: enachem@biology.queensu.ca

CHANGES IN CLIMATE AND FOREST FIRES OVER THE PAST TWO HUNDRED YEARS ALONG A NORTH-SOUTH TRANSECT IN BRITISH COLUMBIA

Over the past century key climatic elements, such as precipitation and air temperature recorded important changes in the western part of Canada. Warmer and drier conditions are forecasted for British Columbia under increasing greenhouse gas concentrations, but the highly heterogeneous landscape of this province make generalizations of future climatic conditions difficult. Because fire is one of the most important disturbance factors in forested landscapes from BC, climate change will have important implications on fire regime. Under warmer and drier conditions, one would potentially expect an increase in fire intensity and frequency. This study investigated, using paleolimnological techniques, the important changes in climate and fire regimes over the past two centuries. Climate characteristics and fire events were inferred from lake sediments collected from three different biogeoclimatic zones (Sub-boreal Spruce, Interior Douglas Fir, and Engelman Spruce/Interior Douglas Fir) along a north-south transect on Interior Plateau, BC. A strong correlation between instrumental data and diatom assemblages in these lakes suggests that they have responded to changes in climate over the last two centuries. Changes in charcoal concentrations in the sediment cores from image analysis techniques indicate that fire regimes showed distinctive regional patterns in each of the study regions. These results support the necessity of long-term investigations of climate-fire dynamics to establish reliable patterns climate-fire relationships to which regional models of climate-forest fire dynamics can be compared.

[SAT, 9:10-9:30]

Enders, E.C.¹, D. Boisclair¹, and A.G. Roy². 1Département de sciences biologiques, 2Département de géographie, Université de Montréal, Québec, Canada. (email : Eva.Enders@umontreal.ca)

COST OF SWIMMING IN TURBULENT FLOW OF WILD, FARMED, AND DOMESTICATED JUVENILE ATLANTIC SALMON

Domestication has been shown to have an effect on the morphology and physiology of Atlantic salmon. We compared the swimming costs in turbulent flow of juvenile Atlantic salmon using wild fish from the Sainte-Marguerite River, Quebec, Canada, farmed fish which were progenies from wild genitors of the Sainte-Marguerite River and domesticated fish which were progenies from genitors used in the Norwegian aquaculture for several generations. We assessed the swimming costs of juvenile Atlantic salmon using two mean flow velocities of 18 and 23 cm·s⁻¹ and two standard deviations of flow velocity of 5

and 8 cm·s⁻¹. The respirometry experiments were conducted with fish in a weight range of 5 to 15 g wet at a water temperature of 15°C. Our results confirm that (1) the swimming costs are affected by different levels of turbulence such that, for a given mean flow velocity, fish spend more energy as turbulence increases, (2) domesticated fish differ in their morphology and their activity metabolism from wild and farmed fish, and (3) suggest that models developed for farmed juvenile Atlantic salmon can be applied to estimate the energetic costs of wild fish in their turbulent environment.

[SAT, 11:30-11:50]

Evans, D.O. OMNR/Trent University, 1600 West Bank Drive, P.O. Box 4840, Peterborough, Ontario Canada K9J 8N8 (email:david.evans@mnr.gov.on.ca)

A NEW DISSOLVED OXYGEN CRITERION FOR THE PROTECTION OF LAKE TROUT HABITAT: LINKING PHYSIOLOGICAL REQUIREMENTS TO RECRUITMENT AND PRODUCTIVE CAPACITY

The objectives of this study were to examine the effects of hypoxia on lake trout and to propose a new dissolved oxygen criterion for the protection of lake trout in Ontario lakes. The study examined the effects of hypoxia on metabolic scope-for-activity, growth and natural recruitment of wild populations. Scope-for-activity is defined as the difference between standard (resting, post-absorptive) metabolic rate and the maximum sustained metabolic rate. Hypoxia limits the transport of dissolved oxygen across the gill membrane and the amount of cellular metabolic activity, which in turn inhibits vital activities of the whole organism, including feeding and growth, avoidance of predators, migration, spawning and all other types of volitional activity. Standard and active metabolic rates of yearling lake trout were determined in laboratory trials by Gibson and Fry (1954). They also determined the limiting effect of hypoxia on the active metabolic rate. At temperatures from 4-16 C, ¼, ½, and ¾ scope-for activity of the yearling lake trout corresponded to dissolved oxygen concentrations of about 4.5, 6.0, and 7.0 ±0.2 mg L⁻¹, respectively. Most daily life-support activities of post-larval salmonids can be achieved within the bounds of ¾ scope-for-activity, with the exception of spawning migration in sockeye salmon, *Oncorhynchus nerka*, which required almost 80% of the sustained aerobic capacity. The threshold for growth impairment in several species of salmonids, including lake trout, occurs at about 7 mg L⁻¹ dissolved oxygen. Juvenile lake trout inhabit and are confined to the hypolimnia of thermally stratified lakes during summer. Independent surveys of lake trout populations in four geographic areas of Ontario revealed that natural recruitment of wild lake trout populations was good to excellent when the mean volume-weighted hypolimnetic dissolved oxygen concentration (MVWHDO) averaged about 7 mg/L during late summer. Recruitment was average to poor when MVWHDO was <6mg/L. An environment that provides for ¾ scope-for-activity of juvenile lake trout, i.e. 7 mg/L dissolved oxygen, should provide adequate long-term habitat protection and prevent the loss of lake trout productivity. A minimum MVWHDO concentration of 7 mg L⁻¹ is recommended for protection of lake trout during late-summer (August 15-September 15) in Ontario lakes.

[FRI, 15:20-15:40]

Filion, J.-M. Ecole secondaire catholique Algonquin, 555 rue Algonquin, North Bay, Ontario (email: jmlois@yahoo.com); J. D. Young, A. Croft and N.D.Yan, Biology Department, York University, Toronto, ON.; and O. Saadeldin, J.C. Headwaters, Inc. Oakville Ontario.

THE AUTONOMOUSLY MONITORED "BYTHO-NET": A NEW, LARGE-VOLUME, HIGH EFFICIENCY PLANKTON NET FITTED WITH A MICRO-PROCESSOR- BASED DEPTH / EFFICIENCY MONITOR DESIGNED FOR THE COLLECTION OF LARGE RARE INVERTEBRATES IN DEFINED DEPTH STRATA

Large pelagic macroinvertebrate predators (eg. Leptodora, Mysis, Chaoborus, and Bythotrephes), are generally less abundant and less evenly distributed in the water column than other smaller zooplankton. This creates sampling problems if an investigator needs accurate information on the density and demographics of these predators in predetermined depth strata. Currently, we have no readily available sampling gear which can satisfy this need. We describe a micro-processor-equipped plankton net, which can be towed both horizontally and vertically, and which logs sampling depth and net filtration performance during hauls. The onboard software is switched between three modes (data download, vertical sampling, horizontal sampling) by illuminating a phototransistor. In the data download mode, information on all haul depths, and net performance are transferred either to a laptop or IPAQ computer. We have now used the net successfully for two years to assess the vertical distribution of several large invertebrates, especially, Bythotrephes and Leptodora in a large mesotrophic lake (Lake Nipissing), and in a small oligotrophic lake, Harp Lake in Muskoka. With this new gear, we can now track vertical distributions and abundances of macroinvertebrates when populations are very small (<0.01 animals/m³), and we can collect large numbers of animals required for detailed demographic research. We will bring the gear to the poster session for display.

[POSTER]

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FEEDING AND PREY SELECTIVITY OF YOUNG-OF-THE-YEAR RAINBOW SMELT (*OSMERUS MORDAX*) IN LAKE SAINT-JEAN.

Landlocked Atlantic salmon (*Salmo salar*) in lake Saint-Jean presents important inter-annual fluctuations in growth and abundance. The recent decline in landlocked Atlantic salmon stocks is related with a decrease of its main prey, the rainbow smelt. Knowledge of factors that could determine recruitment of rainbow smelt are lacking, especially events occurring during their first growing season. Our objectives were to describe the diet of young-of-the-year (YOY) rainbow smelt in lake Saint-Jean, to determine if they select their prey and to measure the influence of prey density on their feeding success. Young smelts and zooplankton were collected from May to September 1998 and 1999 at 25 sampling stations in lake Saint-Jean. Identification and count of zooplankton was done in the digestive tract and in the lake. Results showed that the diet of YOY smelt is mainly composed of cladocera *Bosmina longirostris*, nauplii of copepods and copepods *Diaptomus minutus* and *Cyclops scutifer*. Selection of larger prey increased with the growth of young smelts. The relationship between feeding success of smelt larvae and the density of their preferred prey (nauplii and *C. scutifer*) showed that the number of prey is sufficient to assure their survivorship. Our results suggest that feeding of YOY is probably not a major factor determining recruitment of rainbow smelt in lake Saint-Jean.

ALIMENTATION ET SÉLECTION DES PROIES PAR LES JEUNES ÉPERLANS ARC-EN-CIEL (*OSMERUS MORDAX*) DU LAC SAINT-JEAN.

La ouananiche (*Salmo salar*) du lac Saint-Jean connaît des fluctuations inter-annuelles d'abondance et de croissance très importantes. La plus récente baisse des stocks de ouananiches est associée à une diminution de l'abondance de sa principale proie, l'éperlan arc-en-ciel. Les connaissances sur les facteurs pouvant influencer le recrutement de l'éperlan sont insuffisantes, particulièrement les événements survenant lors de leur première saison de croissance. Les objectifs de ce projet étaient de décrire le régime alimentaire des jeunes éperlans arc-en-ciel du lac Saint-Jean, de déterminer s'ils sélectionnent leurs proies et de mesurer l'influence de la densité de proies sur leur succès d'alimentation. Nous avons échantillonné 25 stations au lac Saint-Jean de mai à septembre 1998 et 1999 afin de capturer des jeunes éperlans et leurs proies zooplanctoniques. L'identification et le dénombrement des organismes zooplanctoniques ont été effectués dans les tractus digestifs des éperlans et dans le lac. Nos résultats montraient que les jeunes éperlans se nourrissent principalement du cladocère *Bosmina longirostris*, des nauplii de copépodes et des copépodes *Diaptomus minutus* et *Cyclops scutifer*. La sélection des proies de plus grande taille s'accroît au fur et à mesure que les jeunes éperlans grandissent. La relation entre le succès d'alimentation des larves d'éperlans et la densité de proies préférées (nauplii et *C. scutifer*) montrait qu'il y avait suffisamment de nourriture dans le milieu pour permettre leur survie. Nos résultats suggèrent que l'alimentation des jeunes éperlans ne semble pas être le principal facteur influençant le recrutement de ce poisson fourrage au lac Saint-Jean.

[POSTER]

Ferguson, L. D. Ontario Ministry of Natural Resources, Kirkland Lake District, Kirkland Lake, Ontario (email: larry.ferguson@mnr.gov.on.ca)

EFFECTS OF WATER QUALITY AND CLIMATE CHANGE ON LIFE HISTORY VARIATION OF WALLEYE (*STIZOSTEDION VITREUM*) IN NORTHEASTERN ONTARIO

Fall Walleye Index Netting (FWIN) assessment was used to collect 3305 walleye from 71 Northeastern Ontario lakes (surface areas from 47.7 to 90971.7ha). From this data, walleye (*Stizostedion vitreum*) life history characteristics were examined for sources of variation. Life history variables in the study included pre-maturation growth rate (h), age and length at 50% maturation (A50%, L50%), fecundity, asymptotic length (L_{∞}) and mortality (Z). Possible contributors to walleye life history variation from previous research including latitude, climate (water temperature), lake physical features, water transparency (Secchi depth), nutrient regime and biotic factors were examined as well. Water samples were collected from each of the study lakes and examined for potential relationships with the walleye data. Water chemistry variables examined included pH (ranging from 6.29 to 8.30), DOC (ranging from 3.10 to 22.20 mg·L⁻¹), Total Phosphorous (ranging from 0.004 to 0.114 mg·L⁻¹), Conductivity (from 29 to 410 uS·cm⁻¹) and others. Results from principal component and regression analyses found nutrient factors including pH, DOC, and total Phosphorous, to be negatively correlated with life history parameters h, A50%, and L50%. Water clarity and climate variables were positively correlated with growth suggesting walleye growth increases and maturity is reached earlier in nutrient-poor, clear water bodies of southern latitudes. Results of this study may provide a tool for fisheries research and management allowing comparison and prediction of walleye population status in Northeastern Ontario lakes as well as allowing for prediction of alteration in population dynamics due to climate change or water quality impairment.

[FRI, 13:20 - 13:40]

Blanchfield, P.J., T.F. Hodge, and L.S. Flavelle, Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba (FlavelleL@dfo-mpo.gc.ca)

DOES MANUAL TRACKING INFLUENCE FISH ACTIVITY AND DISTRIBUTION?

The use of radio and acoustic telemetry is a widely accepted tool to determine patterns of animal distribution. The monitoring of fish locations by boat, often called tracking, is a common approach to estimate daily and seasonal patterns of activity. However, it has never been clearly demonstrated whether the act of tracking itself influences fish distribution and activity, for example, through boat avoidance. We tested this hypothesis by manually tracking acoustically-tagged fish whose spatial and pelagic distribution were being continually monitored by a passive radio-linked acoustic fish positioning system. Individual

fish were manually tracked for one hour, and their spatial and pelagic distribution and rates of movement were compared with passive data collected one hour prior to and after tracking. We chose a shallow-water species, white sucker (*Catostomus commersoni*), and a deep-water species, lake trout (*Salvelinus namaycush*), to examine the influence of boat proximity on changes in fish behaviour. In addition, we compared the response of fish to manual tracking versus general boat traffic on the lake. Our results have important implications for fish ecology studies employing manual tracking.

[POSTER]

William G. Franzin Department of Fisheries and Oceans, Central and Arctic Region, Freshwater Institute, University Crescent, Winnipeg, MB, R3T 2N6 (franzinw@dfo-mpo.gc.ca) Kenneth W. Stewart Senior Scholar, Zoology Department, University of Manitoba, Winnipeg, MB, R3T 2N2 (kwstewart3@shaw.ca) Joseph S. Nelson Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9 (joe.nelson@ualberta.ca)

CHANGES IN THE FISH FAUNAS OF THE WATERSHEDS OF THE PRAIRIES AND SOUTHWESTERN HUDSON BAY: 1973 TO THE PRESENT.

The Canadian Prairies occupy a unique place in the drainage basins of the continent, with waters draining to the Arctic, the Gulf of Mexico and to Hudson Bay. Similarly, this same area was greatly influenced by the Pleistocene glaciation, and subsequent peri-glacial lakes have had significant effects on the distribution of fish species. Evidence has shown that the origins of fish species and morphs that we see in this part of the country include at least five glacial refugia; the Bering, Columbian, Missourian, Mississippian and Great Lakes. In Freshwater Fishes of Canada, Scott and Crossman lumped a lot of coastal drainages in western and southern Hudson Bay with the Churchill-Nelson drainage, the very drainage at the hub of the center of the continent. However, coastal marine inundation of the Hudson Bay coastal areas after the draining of Lake Agassiz could have prevented much freshwater fish dispersal. We prefer to treat the Churchill-Nelson-Winnipeg watershed as a unit, dealing with its obvious linkages to the Peace-Athabasca, Great Lakes and Missouri-Mississippi drainages determined from the post-Pleistocene geological record. The several independent coastal drainages around the margins of Hudson Bay are dealt with separately since we know so little about their faunas relative to the others. That aside, species numbers in Alberta, Saskatchewan and Manitoba have increased from 51 to 59, 60 to 66 and 79 to 91 respectively. Increases in the numbers of species in these provinces during the time since FFC was published in 1973 largely are due to increased collecting effort, detection of species not properly identified, natural invasions and human introductions. However, there are many point location records in our databases that require verification by re-examination of museum specimens.

[SAT, 14:20-14:40]

Dylan J. Fraser and Louis Bernatchez, Département de biologie, Université Laval, Sainte-Foy, Quebec (email: fraserdylan@hotmail.com)

MIXED-STOCK ANALYSIS IN A SPATIOTEMPORAL CONTEXT: DISTRIBUTIONS OF BROOK CHARR (*SALVELINUS FONTINALIS*) POPULATIONS IN MISTASSINI LAKE, QUEBEC, USING MICROSATELLITE DNA

Contemporary fisheries management is increasingly adopting molecular tools for addressing such large-scale issues as stock structure and the maintenance of integral genetic diversity in natural populations. In particular, individual multi-locus genotype population assignments provide powerful tools to not only estimate harvest contributions of individual stocks in mixed stock fisheries, but also to explore spatial distributions of fish populations and the potential for cryptic population structure to occur at the intraspecific level. The latter may be especially significant because the sampling of all possible source populations in mixed-stock analyses is often difficult in many species. Here, we combine these diverse elements in an assessment of summer spatial distributions of brook charr populations in Mistassini Lake, Quebec, using microsatellite DNA markers. A heterogeneous and temporally stable distribution of populations was noted over a two year sampling period, providing important information on the migratory behaviour of differing populations. Moreover, the spatial distribution of individuals 'rejected' in the lake from source populations was also non-random and temporally stable, revealing significant structuring which was not detectable under traditional assignment methods. We discuss these findings in relation to maintaining intraspecific diversity for management and conservation purposes.

[FRI, 14:40-15:00]

Anas Ghadouani, Bernadette Pinel-Alloul GRIL - Département de sciences biologiques, Université de Montréal, C.P. 6128, succ. Centre-ville, Montréal, Québec, H3C 3J7, Canada (aghadoua@sciborg.uwaterloo.ca) and Ellie E. Prepas Faculty of Forestry and Forest Environment, Lakehead University, Thunder Bay, Ontario, P7B 5E1, Canada and Department of Biological Sciences, University of Alberta, Edmonton, Alberta, T6G 2E9, Canada *Present address: Department of Biology, University of Waterloo, 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada.

RELATIONSHIPS BETWEEN ZOOPLANKTON AND CYANOBACTERIA ALONG INCREASING CYANOBACTERIAL BIOMASS GRADIENT IN BOREAL ALBERTA LAKES

Changes in phytoplankton and zooplankton communities were studied in 16 lake-years during a large-scale experimental before-after study as part of the TROLS project. After forest harvesting, phytoplankton biomass and especially cyanobacterial biomass increased in some of the experimental lakes, up to an order of magnitude. Although the response of phytoplankton

was not proportional to intensity of forest harvesting, this study provided a unique opportunity for studying the effects of an increasing gradient in cyanobacterial biomass on zooplankton communities. Cladoceran size structure and biomass were negatively correlated with lake trophy, as was cladoceran to copepod ratio, suggesting that large cladocerans were inhibited by the increase in cyanobacterial biomass. Thus the ratio of zooplankton to phytoplankton tended to decline with trophy while biomass of inedible cyanobacterial species and concentration of hepatotoxic microcystin-LR increased. As no correlation was found between the loss of large cladocerans and the toxin concentration, our results point more towards feeding inhibition, by filamentous and colonial cyanobacteria, as a possible cause for the decline in large cladoceran biomass. These results will be discussed, compared to smaller scale studies and potential explanations proposed.

[SUN, 9:10-9:30]

Ghadouani, Anas and Ralph E. H. Smith Department of Biology, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, N2L 3G1, Canada. (aghadoua@sciorg.uwaterloo.ca).

ARE DREISSENIDS RESPONSIBLE FOR THE RECENT INCREASE OF POTENTIALLY TOXIC CYANOBACTERIAL SPECIES IN LAKE ERIE ?

In recent years, there has been a growing concern about Lake Erie trophic status as phytoplankton biomass seems to have increased during the last couple of years. There have also been more reports on the occurrence of potentially toxic cyanobacterial species such as *Microcystis aeruginosa*. It has been stipulated that the observed changes in phytoplankton communities may have been caused by the dreissenid mussel invasions of Lake Erie. Small-scale studies have shown that zebra and/or quagga mussels can increase nutrient availability and hence increase phytoplankton growth and possibly promote a selective growth of toxic cyanobacterial species. In the summer of 2002, we have used a new in situ fluorometric method (Fluoroprobe) to estimate phytoplankton biomass and composition during several cruises on Lake Erie. Although highly variable, phytoplankton biomass was generally high across the entire lake but was especially high in the Central and the Western basin. This is consistent with recent reports stating that Lake Erie may be becoming as productive as it was in the early 1980s. High biomass of potentially toxic cyanobacterial species, mainly *Microcystis aeruginosa* and *Anabaena* spp., were found at several locations in the Western and Central basins and may be indicative of the recent eutrophication problems in Lake Erie. Results from the 2002 summer cruises will be discussed and potential explanations proposed.

[FRI, 16:20-16:40]

Giberson, A.V. and M.K. Litvak Centre for Coastal Studies and Aquaculture, Department of Biology, University of New Brunswick Saint John, Saint John, NB (email: alishagiberson@hotmail.com)

FOOD AVAILABILITY: DOES IT AFFECT INTRA- AND INTERSPECIFIC COMPETITION AMONG JUVENILE SHORTNOSE STURGEON (*ACIPENSER BREVIROSTRUM*) AND ATLANTIC STURGEON (*A. OXYRHYNCHUS*)?

Shortnose (*A. brevirostrum*) and Atlantic sturgeon (*A. oxyrinchus*) are morphologically similar species and are often sympatric. They are thought to share common nursery grounds as young juveniles. Consequently, a potential for food resource competition between juveniles of these species exists. Differences in aggression and hence competitive ability have been well documented in sympatric populations of fish species as well as within a fish species. However, the relative importance of intra- and interspecific competition on growth varies from species to species. We tested for differences in weight gain (g), growth rate (%/d) and CV of weight (%) of juvenile sturgeon reared in single species or mixed groups being fed a ration of either 1 or 3 % bw/d. Four fish were placed in one of eighteen floating cages. The cages contained four shortnose sturgeon, four Atlantic sturgeon or two of each species. Each tank was assigned a ration of 1 or 3 % bw/d. Atlantic sturgeon raised in single species and mixed groups exhibited similar weight gain and SGR. However, shortnose sturgeon reared with Atlantics showed very little or negative weight gain and growth. All tanks experienced increases in CV of weight over the course of the experiment. Indicating that intraspecific competition may also affect juvenile sturgeon growth. This study provides further evidence on the importance of interspecific competition among sympatric species. It also addresses the possibility that social systems and dominance hierarchies exist within each of these sturgeon species.

[SAT, 13:40-14:00]

Gibson¹, S.F., D.A. Jackson¹ and C.K. Minns^{1,2} ¹Department of Zoology, University of Toronto, Toronto, ON, Canada ²Department of Fisheries and Oceans Canada, Burlington, ON, Canada (email: sgibson@zoo.utoronto.ca)

ASSESSING THE ROLE OF BIOGEOGRAPHY, INSTREAM HABITAT AND WATERSHED FEATURES IN STRUCTURING SOUTHERN ONTARIO STREAM FISH COMMUNITIES

The southern Ontario landscape is a patchwork of anthropogenic landuse practices, yet despite the highly altered landscape this region contains the most diverse freshwater fish fauna in Canada. In order to protect and manage these unique fish communities, we need to understand how biogeography, instream habitat and watershed-level features influence the distribution and community composition of fishes in this region. A standardized protocol was used to quantify instream habitat (e.g., microhabitat, cover, substrate, etc.) and fish community composition at 240 sites across southern Ontario. In addition to instream habitat, we looked at several watershed-based variables (e.g., landuse, surficial geology, climate, etc.) and biogeographic variables (i.e., drainage). We used a combination of Canonical Correspondence Analysis (CCA) and partial CCA to partition the variance in the fish community data with respect to the spatially nested variables. This approach allowed

us to quantify how much variation is explained by each of the predictor variables, thus providing an objective method of determining which features are most influential in structuring fish communities in this region. The results will then be used to develop assemblage-based predictive models for this region and forecast the biological outcomes of proposed landuse changes and habitat alteration.

[SAT, 9:10-9:30]

Girard, P.¹, Boisclair, D.¹ and Leclerc, M.² (email: philippe.girard@umontreal.ca) 1Département des Sciences Biologiques Université de Montréal, Montréal, QC. 2INRS-Eau, Québec, QC.

THE EFFECT OF CLOUD COVER ON THE DEVELOPMENT OF HABITAT QUALITY INDICES FOR JUVENILES OF ATLANTIC SALMON (*SALMO SALAR*).

We assessed the relative importance of cloud cover and water temperature on the number of parrs of Atlantic salmon actively foraging during the summer. We tested the validity of the predictions made by a habitat probabilistic index (HPI) developed using a description of the physical conditions (depth, current velocity, substrate size) used and avoided by parrs during days of different cloudiness. Thirteen surveys were designed to estimate the number, the distribution, and the conditions used and avoided by parrs actively foraging within a 300 m reach of a river. During these surveys, the number of parrs actively foraging ranged from 12 to 118, cloud cover ranged from 5% to 100%, and water temperature ranged from 16.5oC to 21.7oC. The number of parrs actively foraging was negatively related to cloud cover ($r^2=0.44$ to 0.88) but was independent of water temperature. HPI models developed under low (<33%) and intermediate cloud cover (34-67%) explained 82 to 98% of the local variations of fish density. HPI model developed under high cloud cover (67-100%) was unable to predict fish distribution observed during cloudy days. Our results suggest that HPI models developed when cloudiness is >67% may have a limited predictive power.

[SAT, 10:30-10:50]

Mark D. Graham¹, Michael A. Turner², and Rolf D. Vinebrooke³ 1Department of Biology, University of Regina, Regina, Saskatchewan, S4S 0A2 (mark.graham@uregina.ca), 2 Freshwater Institute, 501 University Ave. Winnipeg, Manitoba R3T 2N6, 3Freshwater Biodiversity Laboratory, Department of Biology, University of Regina, Regina, Saskatchewan, S4S 0A2

COMMUNITIES IN BOREAL LAKES

Conifer pollen rain events are visually dramatic along the shorelines of boreal lakes during early summer, and may represent major allochthonous inputs of carbon and phosphorus to these P-limited ecosystems. We conducted a lake survey and mesocosm experiment at the Experimental Lakes Area (ELA) in northwestern Ontario to test the hypothesis that pollen inputs increase algal biomass and shift species composition towards nitrogen-fixing cyanobacteria in the littoral zone of boreal lakes. To measure pollen accumulation rates (PAR) we deployed and monitored a series of floating litterfall collectors along transects that span a headwater reference lake (Lake 373). Survey results showed that Lake 373 (27ha) received an estimated 250 kilograms of pollen during the spring, representing a potentially significant annual input of 3.0 µgP/L to the lake. These data were used to conduct a pollen amendment experiment using 1000-L mesocosms within three reference lakes (Lake 373, 442, and 239), which served as a blocking effect. The pollen treatment consisted of three levels (ambient, 3X, 10X) with repeated measures. High pollen amendments both enhanced phytoplankton and periphyton biomass, and altered species composition by stimulating filamentous green algae. Our findings suggest that conifer pollen rain events significantly subsidize nutrient levels and algal blooms during the pre-stratification mixing period in boreal lakes.

[SUN, 9:30-9:50]

Gray, M.A.¹, R.A. Curry¹, and K.R. Munkittrick² 1 Department of Biology and New Brunswick Cooperative Fish and Wildlife Research Unit (NBCFWRU), University of New Brunswick, Fredericton, NB, E3B 6E1 2 Department of Biology, University of New Brunswick, Saint John, New Brunswick, Canada E2L 4L5 (Email: r55me@unb.ca)

INVESTIGATION OF THE IMPACTS OF AGRICULTURAL STRESSORS ON SCULPIN POPULATIONS

Welch et al. (1977) reported the biological and physical factors in 33 New Brunswick streams influenced by clear-cut logging and intensive agriculture. They found reductions in the number of trout, sculpin, and benthos associated with increased sedimentation in farmed watersheds. During the summer of 2001, we repeated the study with 20 streams in forested (FOR) or agricultural (AGR) watersheds. On average, the streams in agricultural watersheds were warmer than streams in forested watersheds (median = 16.0°C and 13.3°C, respectively). The increased temperature was correlated with increased sizes and decreased densities of young-of-the-year (YOY) sculpin. Sediment deposition was greatest at the agricultural sites with increased fine sediments deposited at agricultural sites and an increase in larger, coarse sands at two sites with active forest operations. Sites that were common to both the 1974 and 2001 studies (n=11) were ranked by relative abundance of fish to facilitate comparisons. There were no changes in the rankings of sculpin abundance in streams in forested watersheds. Five agricultural sites from 1974 that reported no sculpin now had at least one adult sculpin, though none of had YOY sculpin present. There are indications of slight improvements over the past 27 years, however, the absence of YOY fish in agricultural regions is a major concern. Although this survey did not detect a strong direct effect of sediment on the fish population, sediment is known to be associated with smothering, habitat damage, transport of chemicals off the fields and reductions in

food availability. Further, detailed studies are needed to define the roles that sediment, chemicals, temperature and nutrients play on agricultural impacts on fish.

[SAT, 16:20-16:40]

Gray, M.A.¹, R.R. Doucett², R.A. Cunjak¹, and K.R. Munkittrick³ ¹ Department of Biology, University of New Brunswick, Fredericton, New Brunswick, Canada E3B 6E12 ² Department of Biological Sciences, Northern Arizona University, Flagstaff, Arizona, USA 86011-56403 ³ Department of Biology, University of New Brunswick, Saint John, New Brunswick, Canada E2L 4L5 (Email: r55me@unb.ca)

THE USE OF STABLE ISOTOPE ANALYSIS TO DEFINE SITE FIDELITY IN SLIMY SCULPIN (*COTTUS COGNATUS*)

To investigate the impacts of agricultural activity on fish populations, we assessed the suitability of the slimy sculpin (*Cottus cognatus*) as a sentinel species. For a species to be a sensitive sentinel species to assess environmental impacts there are certain characteristics that are desirable in order to attribute responses to local conditions. The priority issues are abundance, residency and suitability for measuring responses. Stable isotope analysis was used as a tool to investigate site fidelity and mobility to establish residency and exposure for the sculpin. Tagging studies that we conducted with the slimy sculpin have shown limited movements with some fish recaptured within a few meters over a four-month period. We predicted that sculpin collected from sites adjacent to agricultural activity would show higher $\delta^{15}\text{N}$ values than those collected from sites in forested areas due to isotopic enrichment by fertilizers. Muscle tissue samples from sculpin collected along the river gradient from forested to agricultural land-use areas did not show a significant increase in $\delta^{15}\text{N}$ values. We did, however, find an incremental enrichment of approximately 3‰ in $\delta^{13}\text{C}$ values in a downstream direction, irrespective of surrounding land-use. This step-wise increase in $\delta^{13}\text{C}$ resembled the relationship predicted by the river continuum concept. In addition, isotopic signatures of sculpin at each site have low variability, which maybe a reflection of a site-specific isotope signature, and related to the sculpin's limited mobility. A comparison of both nitrogen and carbon isotope signatures was successful at demonstrating a lack of movement between adjacent sites in the river system. The results support the use of the slimy sculpin as a sentinel species for investigating site-specific environmental impacts.

[SAT, 15:20-15:40]

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INVESTIGATING THE FATE AND TRANSPORT OF PERSISTENT ORGANIC POLLUTANTS INTRODUCED BY SOCKEYE SALMON INTO THEIR FRESHWATER NURSERY LAKES: A FOOD-WEB ANALYSIS

Over the past decade, contaminant studies have clearly demonstrated the importance of atmospheric pathways in the delivery of volatile persistent organic pollutants (POPs) to areas where some of these chemicals have never been used. The alarming concentrations of POPs documented in Arctic food webs, highlights the role of atmospheric transport, as well as the power of biomagnification. Another potentially important pathway for contaminants that has received little attention to date, is biotransport. This is where migratory biological organisms accumulate contaminants in one location and release them in another. An initial study by Ewald et al. (1998) suggested that anadromous Pacific salmon may be significant vectors in the delivery of POPs to freshwater ecosystems. Because Pacific salmon have lipid-rich tissues that bioaccumulate POPs and have a lifecycle where the adults return from the North Pacific to their natal nursery lake to spawn and die, there is potential for the contaminant burdens from these fish to be transferred to the aquatic environment and biomagnified in the food web. To explore the importance of sockeye salmon relative to other sources of contaminant loading, we have collected sockeye salmon tissue samples from a suite of nursery lakes in B.C. and Alaska that represent a large gradient of salmon returns (between 0 and 43,000 of spawners/km²). These samples, along with tissue samples from resident fish populations, zooplankton and periphyton are being analysed for POPs and isotopes to help identify contaminant transfer within nursery lake food webs.

[POSTER]

Guy, M., and Chambers, P.A. National Water Research Institute, CCIW, 867 Lakeshore Rd., P.O. Box 5050, Burlington, ON, L7R 4A6. (Email: martha.guy@ec.gc.ca)

EMPIRICAL EVIDENCE OF THE IMPORTANCE OF POLLEN RAIN TO ALGAL DEVELOPMENT OF NUTRIENT GUIDELINES FOR NORTHERN ALBERTA RIVERS

Addition of nutrients in the form of nitrogen (N) and phosphorus (P) to streams and rivers can result in eutrophication characterised by nuisance development of macrophytes, increased oxygen consumption, and/or changes in macroinvertebrate community structure and abundance. Development of nutrient guidelines (i.e., maximum admissible concentrations) for rivers must be based on predictive models relating structural or functional changes in ecosystems to nutrient concentrations and must be calibrated to the background, or reference, conditions of a particular ecoregion. We analysed 15 years of water quality and periphyton chlorophyll a data from Alberta Environment's long- and medium-term monitoring stations for the Athabasca and Wapiti-Smoky Rivers in northwestern Alberta to establish an approach for setting scientifically-defensible nutrient guidelines for rivers. N and P concentrations representative of reference conditions were established for the montane/subalpine, boreal foothills, and boreal mixed wood ecoregions in these watersheds. For each ecoregion, models were developed relating nutrient

concentrations (TP, TDP, TN, NO₃+NO₂, TKN and TNH₃) to periphyton chlorophyll a (chl_a) concentrations. Benthic algal biomass was found to be significantly higher in reaches exposed to effluent from municipal wastewater treatment facilities and pulp mills than for reference reaches of the Athabasca and Wapiti-Smoky Rivers. Based on knowledge of reference conditions and ecosystem changes associated with elevated benthic chl_a concentrations, we proposed nutrient guidelines suitable for the ecoregions in these watersheds.

[SUN, 11:30-11:50]

Croteau, M.-N., L. Hare and A. Tessier. INRS-ETE, Université du Québec, Sainte-Foy, Québec (email:landis@inrs-ete.uquebec.ca).

INCREASES IN FOOD WEB CADMIUM FOLLOWING REDUCTIONS IN ATMOSPHERIC INPUTS TO SOME LAKES

Awareness of the negative environmental impacts of atmospheric emissions from metal smelters has spurred costly increases in stack heights and changes in operations that have led to declines in the quantities of acid and metals reaching nearby lakes. Such declines have led to the partial recovery of animal communities in many impacted lakes. Recovery has likely been due to simultaneous increases in lakewater pH and declines in toxic metals, although metal bioaccumulation data is lacking. To fill this void, we measured the toxic metal cadmium (Cd) in water and animals (*Chaoborus punctipennis*) over a 13-year interval in lakes located near two Canadian metal smelters (Rouyn-Noranda and Sudbury). Although Cd in lakewater consistently declined over time, Cd in animals increased in some lakes. This apparent contradiction was explained when we considered the simultaneous reductions that have occurred in lakewater acidity; under these conditions, animal Cd can increase if there are insufficient hydrogen ions to out-compete Cd ions at biological uptake sites. We conclude that the risk of metal exposure and toxicity has increased in the intermediate term for members of the food webs of some lakes recovering from smelter emissions.

[SAT, 15:20-15:40]

Hayes, T.M.E. and R.E.H. Smith. Department of Biology, University of Waterloo, Waterloo, Ontario (email: tmehayes@sciborg.uwaterloo.ca)

BACTERIA AND ALGAE IN STREAM PERIPHYTON: RELATIONSHIP BETWEEN NAPHTHENIC ACIDS AND MAJOR IONS: MULTIPLE STRESSORS ON PHYTOPLANKTON COMMUNITIES IN NORTHERN ALBERTA'S OIL SANDS REGION

Cross gradient microcosm experiments with indigenous phytoplankton communities were conducted in a randomized block design to determine the independent and interactive effects of naphthenic acids (NA) and salinity on plankton communities. In all treatments phytoplankton communities demonstrated positive growth as chlorophyll a concentrations. Higher NA (>25 ppm) and/or salinity (>3 ppt) concentrations were associated with extended lag phases and lower maximum chlorophyll a concentrations. Despite evidence in previous studies that NA exert toxic effects at comparable concentrations, and community structure effects at more moderate (10-20 ppm) concentrations, phytoplankton were eventually able to grow to high abundance even at the highest test concentrations used here. Members of the Cyanophyta dominated the high salinity treatments whereas Chlorophyta species dominated in the high NA treatments. These general patterns of algal community composition resemble patterns observable among ponds and lakes with varying NA and salinity levels.

[SAT, 16:00-16:20]

Heard, K.S., M. Hanson-Lee, S.B. Heard and R.A. Curry. Department of Biology, University of New Brunswick, Fredericton, New Brunswick (email: kheard@unb.ca)

DO KICKNETS AND ROCKBAGS TELL THE SAME STORY ABOUT STREAM BENTHIC INVERTEBRATES?

Comparisons of kicknets and rockbags were made in the Magaguadavic River and its tributaries in New Brunswick, Canada (n = 9 sites). Rockbags were placed in the stream for 4 weeks to be colonized by invertebrates. On the same day that rockbags were collected, kicknets were taken were taken in the same riffle as each corresponding rockbag (n = 3 for both methods). Overall, kicknets collected similar abundances within the main channel, however, within the tributaries kicknets collected statistically more insects (both rare and common) and greater richness (at family and generic levels) than rockbags. Rockbags collected significantly more net-spinners while kicknets collected significantly more burrowers and clingers. The rockbags themselves seemed to be creating an alternate habitat for net-spinners and collector-filterers. We conclude that rockbags have limitations for complete, invertebrate community analyses, particularly in smaller watercourses.

[POSTER]

Henderson, B.A., G.M. Morgan, and A. Vaillancourt. University of Toronto at Mississauga, Ontario (email: bahender@credit.utm.utoronto.ca)

OPTIMAL FORAGING AND GROWTH EFFICIENCIES OF WALLEYE

Male and female walleye (*Stizostedion vitreum vitreum*) have higher growth efficiencies in lakes with lake herring (*Coregonus artedii*) than those without lake herring. Lake herring were the predominant prey in herring-lakes and yellow perch (*Perca flavescens*) were the main prey in non-herring lakes. Walleye from herring-lakes matured at a smaller size than walleye in lakes without herring. Growth efficiency was estimated from annual increments in somatic mercury and the mercury content of yellow perch and lake herring. Walleye were sampled in September and October from 38 lakes in Ontario in 1998 and 1999,

using multimesh monofilament gillnets. Yellow perch and lake herring were sampled from inland lakes (1995-1999). Lake herring grow larger than yellow perch and therefore could provide optimum prey sizes over a wide range of walleye sizes. Optimal foraging theory predicts that walleye feeding on a optimal prey sizes should grow more efficiently, if the ratio of feeding benefit (energy) to cost (search and seizure) is a function of the ratio of predator and prey size.

[FRI, 14:40-15:00]

Jocelyne Heneberry¹, Bill Keller¹ and John Gunn² ¹Ministry of the Environment and Energy, Cooperative Freshwater Ecology Unit ²Ministry of Natural Resources, Cooperative Freshwater Ecology Unit (*email: jheneberry@nickel.laurentian.ca)

MULTIPLE STRESSOR EFFECTS: A NEW DIRECTION FOR RESEARCH IN NORTHEASTERN ONTARIO

Historically much of the research on lakes in the Sudbury area of Northeastern Ontario has focussed on assessing damage due to acidification brought on by the large mining and smelting operations in the area and long-range atmospheric transport of sulphur. This led to an estimated 7000 lakes that were damaged in a 70,000km² area. Reductions of Sudbury sulfur emissions by 90% since the peak emissions period in 1960s, led to a shift in research focus to recovery from acidification. In recent years however, it has become apparent that there are a variety of factors complicating lake recovery. Long term datasets from the Cooperative Freshwater Ecology Unit have shown the importance of multiple stressor effects on lakes, particularly the combination of acidification, climate and UV-B irradiance. Drought events may lead to pulses of acids and metals, causing re-acidification events which can have dramatic biological, chemical and physical effects on lakes. For example, drought can have a dramatic effect on the clarity of lakes through reacidification and also directly, through reduced input of DOC from watersheds. This can greatly affect the penetration of UV-B and the thermal structure of lakes. Superimposed on these and many other changes is a trend towards declining calcium levels in many of our lakes. Calcium is known to ameliorate the biological effects of high levels of metals, acidity and UV-B exposure. This downward trend may affect future biological recovery of these lakes.

[SAT, 14:00-14:20]

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IMPROVING SAMPLING PROTOCOL FOR NEARSHORE LAKEFISH COMMUNITIES

Monitoring programs need to establish accurate descriptions of nearshore lakefish communities using a minimum expenditure of effort, yet there is a paucity of information on what factors have the largest influence on catch estimates. Using catch data from small lakes in south-central Ontario, we calculate catch-per-unit-effort (CPUE) by species and examine the relative effects of gear, habitat and season on the accuracy of CPUE estimates and the rank abundance of each species in the community. We use resampling techniques to compare the effect of different combinations of gear, habitat and season on species richness values. We provide recommendations regarding the choice of sampling gear or habitat types that provide optimal data for monitoring lake fish communities.

[SAT, 8:50-9:10]

Holt, C. and R. Peterman, Fisheries Research Group, School of Resource and Environmental Management, Simon Fraser University, Vancouver, BC

FORECASTING AGE-SPECIFIC PACIFIC SALMON RECRUITMENT IN A CHANGING ENVIRONMENT

Sibling-age-class relationships (SACR) are widely used in Pacific salmon management to forecast age-specific recruitment. This relationship is based on unique life-history characteristics of Pacific salmon. First, they return to freshwater between ages 3-7 years before they spawn and die. Second, the relationship between the number of adult recruits in one age class returning in a given year and adults recruits in the next age class in the subsequent year (i.e. the same brood class) allows managers to forecast age-specific recruits from previous years' recruits (e.g. $\log_e(\text{recruits of age 1.3}) = a + b \log_e(\text{recruits of age 1.2})$), where a and b are parameters, and 1.3 recruits are 5-year-olds that spend 3 winters in the ocean, and 1.2 recruits are 4-year-olds that spend 2 winters in the ocean). The principal assumption of this model is that the relative proportion of age-specific recruits is stationary (i.e. the parameters are constant). However, this assumption may be invalid because of changing environmental and ecological conditions in the North Pacific Ocean resulting in temporal variability in ocean productivity, salmon survival and growth. Using a Kalman filter model, we estimated considerable increases over time in the a parameter (Y-intercept) of sibling-age-class relationships for 24 sockeye salmon stocks in British Columbia and Alaska (e.g. fish mature later). This model allowed for annual updating of the a parameter by attributing the annual variation in abundance of 1.3 recruits to both underlying process changes (e.g. changes in the a parameter) and random noise. The spatial scale of covariation in a parameters among different stocks can help identify the spatial scale of processes driving changes in a parameters. Large positive covariation in the time series of a parameters among stocks and among regions suggests that changes are driven by ocean basin-scale processes. Increases in sockeye abundance in the North Pacific Ocean and changes in environmental conditions (Pacific Decadal Oscillation index and sea surface temperature in the Gulf of Alaska) occur at similarly large spatial scales and are correlated with changes in a parameters. Both density-dependent ecological interactions and changing environmental conditions may therefore explain non-stationarity of SACR parameters.

[FRI, 16:40-17:00]

Holtham, A.J. (P.E.A.R.L., Dept. of Biology, Queen's University, Ont., email: holthama@biology.queensu.ca), Pellatt, M. (Parks Canada, Vancouver, BC), Smol, J.P. (P.E.A.R.L., Dept. of Biology, Queen's University, Ont.)

CHANGES IN SOCKEYE SALMON NURSERY LAKES ON THE WEST COAST OF VANCOUVER ISLAND OVER THE LAST ~250 YEARS – PALEOLIMNOLOGY AS A TOOL FOR ASSESSING HISTORIC SALMON POPULATIONS AND WATERSHED DISTURBANCES.

Sockeye salmon nursery lakes in British Columbia are under pressure from a number of potential stressors, including climatic change, habitat degradation, forest harvesting, fishing, and natural disturbances such as storms and earthquakes. Due to the important cultural and economic value of Pacific salmon along the Coast, there is now considerable interest in assessing the status of these stocks, and determining which factors may influence their survival. Disturbances in the lakes and watersheds that serve as sockeye spawning grounds can be critical factors in reduced survival rates. Paleolimnology, the study of biological, chemical and physical indicators in lacustrine sediment cores to reconstruct past environmental conditions, can be used to understand the long-term impacts of these disturbances. This study was a multiproxy investigation, in which paleolimnological indicators including diatoms, pollen, 15N, 13C and geochemical data were used to reconstruct the influences of these various stressors on 3 lakes from within Pacific Rim National Park on the West Coast of Vancouver Island. Changes in sedimentation rate, C:N ratios and biological indicators suggest that at several times in the past, these watersheds have experienced significant disturbances, due to a possible combination of logging activities on nearby slopes, hurricanes and large earthquakes. Changes in the frequency of seawater inundation into one low elevation coastal lake were also recorded in the diatom record. This study has practical applications including developing appropriate management plans within the park in terms of logging, forestry, lake fertilisation and fishing levels, as well as furthering our understanding of paleolimnology as a tool for reconstructing historic sockeye salmon populations in this region.

[SAT, 14:40-15:00]

Hudson, J. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan (email: jeff.hudson@usask.ca)

TURNOVER OF PLANKTON COMMUNITIES CONFORMS TO Q₁₀ OF 2

Many pelagic environments are warming in response to climate change. This warming can be expected to increase P/B and rates of nutrient cycling. However, the pattern and the magnitude of this increase are poorly understood. With a large set of diverse lake types (i.e., alpine, montane, prairie and boreal), I examined the relationship between temperature and planktonic phosphorus turnover. Total phosphorus concentrations ranged from 0.06 to 4.5 µM. Pelagic temperatures ranged from 9 to 24 oC. Turnover rates of particulate (planktonic) phosphorus ranged from 5 to 49% per day. These rates were significantly correlated with temperature; a ten-degree increase in temperature (from 10 to 20oC) resulted in a doubling of the turnover rate of particulate phosphorus. Therefore, it appears that plankton turnover rates conform to a Q₁₀ of about 2 and increases in water temperature will result in significant increases in the flux of nutrients through pelagic food webs.

[SAT, 16:20-16:40]

HUNTER, K.L.¹, FOX, M.G.², ABLE, K.W.³, ¹ Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario. ² Environmental and Resource Studies Program and Department of Biology, Trent University. ³ Institute of Marine and Coastal Sciences, Marine Field Station, Rutgers University, Tuckerton, New Jersey. (Email: kahunter@trentu.ca)

HABITAT INFLUENCES ON POPULATION DYNAMICS, MOVEMENT AND LIFE HISTORY OF THE MUMMICHOG, FUNDULUS HETEROCLITUS, IN SOUTHERN NEW JERSEY SALT MARSHES.

Decreased reproduction and growth have been observed when fish are subject to physiological stress, and under different environmental constraints, the allocation of energy may also vary according to habitat suitability. Our study focused on reproductive allocation and growth of mummichog (*Fundulus heteroclitus*) inhabiting subtidal creeks and marsh pools in salt marshes. Results from 2001 revealed that fish in marsh pools contributed less energy to reproduction over the season and ceased reproduction one period prior to fishes in creeks. Growth analysis showed that pool fish stopped growing in early July, which corresponded with the cessation of reproduction. Results also show that variability of both reproductive allocation and growth patterns were significant in pool habitats, but creeks show significant homogeneity. In 2002, variability in GSI was again high in pools, but unlike in 2001, GSI was higher in pools than in creeks. In 2001 and 2002, we monitored temperature, salinity and DO to determine whether these influenced variation and reproductive allocation and growth patterns in pool habitats. In 2002, we investigated population dynamics, movement and mortality rates of pool populations. Six populations were studied using mark recapture methods throughout the spring and summer, where two pools were enclosed to prevent movement. Preliminary results indicate that pool population density declined drastically over the season. This pattern may be explained by emigration during high marsh flooding events, or by high mortality rates caused by the harsh pool environment. We hypothesize that reduced population density has affected reproductive allocation in pools because of increased energy availability.

[SUN, 9:50-10:10]

Jeffrey A. Hutchings. Department of Biology, Dalhousie University, Halifax, Nova Scotia (email: Jeff.Hutchings@Dal.Ca)

SURVIVAL CONSEQUENCES OF SEX-BIASED PATTERNS IN SEASONAL GROWTH

Based on a five-year, mark-recapture study of unexploited brook trout (*Salvelinus fontinalis*), I tested the null hypotheses that (i) survival is independent of growth, and that (ii) seasonal growth does not differ between sexes. Both hypotheses were rejected. Survival through a given year was positively associated with growth throughout the previous year, independent of body size and age. Fitness costs associated with slow growth differ between sexes and appear to be exacerbated during periods of energetic stress. In summer, immediately prior to spawning, male growth was almost twice that of females. In contrast, annual growth did not differ between sexes, suggesting that females grow faster during winter and early spring. The bias in seasonal growth can be explained by sexual differences in the proportional allocation of energy to gonadal and somatic tissue. [FRI, 15:20-15:40]

Neil Hutchinson, Gartner Lee Ltd. 9B Taylor Rd., Bracebridge, ON Canada P1L 1T8. nhutchinson@gartnerlee.com

LIMNOLOGY, PLUMBING AND PLANNING : NUTRIENT-BASED LIMITS TO SHORELINE DEVELOPMENT IN PRECAMBRIAN SHIELD WATERSHEDS.

The concept of using water quality models as a planning tool for recreational lakes has been in active practice in Ontario and parts of the USA for approximately 25 years. Linking a steady state mass balance model of phosphorus to a water quality objective allows planners to set capacities for phosphorus loads, and hence shoreline development such as cottages, resorts or permanent homes. This paper reviews the development and calibration of a water quality model which links 15 subwatersheds and 512 lakes to set capacities for 161 individual lakes in the Muskoka region of Ontario. The median agreement between modelled estimates and measurements of phosphorus concentration was 7.4% and model error was positive, a result of over-conservative assumptions regarding the mobility of septic phosphorus. Accounting for the geochemistry and retention of septic phosphorus by soils was required to produce acceptable estimates in the water quality model. The importance of reviewing assumptions and export coefficients and of validating model predictions with good monitoring data are emphasized. The availability of a scientifically-based water quality model has over-emphasized water quality as a planning tool and has generated unrealistic expectations of a single capacity determinant among the public. Alternative planning determinants must be developed and implemented. These could include enhanced setbacks, shoreline naturalization and septic inspection programs and acknowledge the importance of social determinants such as noise, crowding, powerboats and the wilderness aesthetic, thus diversifying planning approaches from their existing focus on plumbing and septic systems. [SAT, 13:20-13:40]

Hyatt, Kim D. Canada Department of Fisheries and Oceans, Pacific Biological Station, Hammond Bay Road, Nanaimo, B. C. V9R 5K6. 250-756-7217, hyattk@pac.dfo-mpo.gc.ca

CLIMATE IMPACTS ON LIFE HISTORY EVENTS OF TWO SOUTHERN BRITISH COLUMBIA SOCKEYE SALMON (*ONCORHYNCHUS NERKA*) POPULATIONS AND OPTIONS FOR ADAPTIVE MANAGEMENT IN THE FACE OF FUTURE CLIMATE CHANGE.

Populations of sockeye salmon on the southern end of their range in the eastern Pacific are considered to be especially vulnerable to effects of future climate warming. In this paper two of these stocks are examined for historic interactions among climate change, life history events and management responses to changes in fish abundance. Both model analyses and empirical observations suggest that periods of climate warming are accompanied by (i.) increases in the frequency and magnitude of adult migration delays and mortality events, (ii.) delays in the timing of peak spawn and egg hatch, (iii.) moderate to pronounced seasonal reductions in lake rearing habitat, (iv.) annual reductions in marine survival and (v.) large decreases in stock productivity. Sustainable fisheries for Barkley Sound sockeye salmon on the west coast of Vancouver Island have been maintained over approximately 100 years in spite of high variability in total returns of adult salmon. By contrast, fisheries for Okanagan sockeye salmon returning to Canada through the Columbia River system have all but disappeared given a multidecadal trend for stock declines. Results reported here provide a preview of potential future climate impacts on production variations of southern salmon stocks and the scope for adaptive responses by salmon, fisheries resource stakeholders and the institutions that form an important interface between them. [SUN, 8:30-8:50]

Imre, I., J.W.A. Grant, and E.R. Keeley1. Department of Biology, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, Quebec, H3G 1M8, Canada (email: i_imre@alcor.concordia.ca) 1 – Department of Biological Sciences, Idaho State University, Pocatello, ID 83209, U.S.A.

THE EFFECT OF FOOD ABUNDANCE ON TERRITORY SIZE AND ABUNDANCE OF JUVENILE STEELHEAD TROUT (*ONCORHYNCHUS MYKISS*)

Models of optimal feeding-territory size usually predict a decrease in territory size with increasing food abundance. However, most optimal territory size models may not be applicable to salmonids, because they defend contiguous territories. The only model proposed for the contiguous situation predicts that 1) territory size will only decrease when food abundance is high enough to induce a reduction in territory size below the compressed optimum and 2) territory size does not change at low food abundance levels. In order to test this model, we raised equal densities of juvenile steelhead trout in outdoor stream channels at several natural and one higher than natural food abundance level for 25 days. In our confined populations density dependence operated through a decrease in growth and increase in mortality. Increasing levels of competition for food resulted in

increasing mortality, higher willingness to emigrate, higher variance in body mass, lower growth, lower population density, lower biomass and lower percent habitat saturation. In agreement with previous studies, the territories defended by the trout decreased with increasing local population density and increased over time as fish grew in length. Territory size did not change with food abundance. This study is particularly important because it establishes a quantitative relationship between natural food abundance and population abundance.

[SAT, 8:50-9:10]

T. Janoscik, N. Lester, and N. Collins. Ontario Ministry of Natural Resources, Peterborough, ON, and The University of Toronto at Mississauga, Mississauga, ON. (email: tamara.janoscik@utoronto.ca)

CALIBRATING AN INDEX FISHING METHOD: HOW MANY LAKE TROUT (*SALVELINUS NAMAYCUSH*) ARE IN THE LAKE?

Spring Littoral Index Netting (SLIN) has been implemented as a standard method for assessing the status of lake trout populations in Ontario lakes. SLIN uses the catch-per-unit-effort (CUE) of randomly placed gillnets as an index of lake trout abundance. To be a valid method for obtaining an index of abundance, SLIN CUE should change relative to the actual abundance of lake trout. The relationship between index netting CUE and lake trout density was analyzed for 13 lakes. We developed a predictive model relating lake trout density to CUE and lake surface area, validating SLIN as a method for obtaining an index of abundance.

[SAT, 9:10-9:30]

Johnson, T.B. and B.A. Henderson, Aquatic Research and Development Section, Ontario Ministry of Natural Resources, R.R. #2, 320 Milo Road, Wheatley, Ontario, N0P 2P0

ECOLOGICAL CHANGE IN LAKE ERIE: PATTERNS IN STABLE ISOTOPE SIGNATURES OF RAINBOW SMELT *OSMERUS MORDAX*, YELLOW PERCH *PERCA FLAVESCENS* AND WALLEYE *STIZOSTEDION VITREUM*, 1978-2000.

Stable isotope analysis is a well established tool for describing aquatic food webs: ¹⁵N is an indicator of trophic position while ¹³C provides information about the base of the foodweb. We used fish scales archived from commercial and index sampling to evaluate the patterns of ecological change experienced by rainbow smelt, yellow perch, and walleye collected in Lake Erie between 1987 and 2000. Walleye, the top predator, remained 1 trophic level (3-5 o/oo) above smelt and yellow perch for the entire time series. Walleye and yellow perch had similar carbon signatures indicative of a benthic / littoral food base, while smelt were more closely tied to pelagic resources. Over time, the nitrogen signature for all 3 species declined suggesting a shortening of the foodweb. The carbon signature for all 3 species declined until the late-1980s (smelt, perch) or mid-1990s (walleye) before recovering to various extents. These temporal changes will be discussed with reference to known ecological events (phosphorous abatement, invasion by exotic species, changing habitat), as well as changes in fish diet, distribution and growth.

[FRI, 16:00-16:20]

Fiona D. Johnston and John R. Post, Department of Biological Sciences, University of Calgary, Alberta (email: fdjohnst@ucalgary.ca)

DEMOGRAPHICS OF AN OVER-EXPLOITED BULL TROUT POPULATION

Like many sport fish populations in Canada, bull trout populations have declined in abundance and distribution. Due to their slow growth, late maturity and opportunistic nature bull trout are extremely susceptible to overfishing. Increased access of anglers to more remote mountain streams and lakes has also contributed to their decline. In Lower Kananaskis Lake, Alberta, the bull trout population had declined to 60 spawning adults by the fall of 1992. In 1991 half of the adult population was harvested and 75% of the fish harvested were immature. In an attempt to restore this population, angling regulations in the reservoir were changed in 1992 to catch-and-release and a bait ban was implemented. The spawning population has been monitored since 1992 to determine it's recovery. The adult population appears to have recovered, reaching a carrying capacity at approximately 1600 individuals. However, recruitment into the adult stage has remained relatively constant at 400 new recruits per year. This begs the question, which stage of the life-cycle is limiting this population? Bull trout in this system have a complex life history. They rear in the creek for 3 years before entering the reservoir. At this stage Mysiss sp. and forage fish in the reservoir become available as food sources. The juveniles spend a further 4 years in the reservoir before they spawn for the first time. From the annual monitoring of juvenile abundance in an index section of the spawning creek, it appears that this is the life stage that is limiting this population's growth. Juvenile densities in the creek have remained relatively constant or declined while the adult population has increased. This indicates that it takes very few adults to maintain a viable population in this system, and that the population may have been growth-overfished but not recruitment-overfished at the time the regulations were altered. The recovery of this population demonstrates that with proper management over-exploited populations can recover. However, it is important to understand the influence each life stage has on the overall population dynamics when attempting to manage a fishery.

[SAT, 8:30-8:50]

Johnston, T.A., Department of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington, ON (email: JohnstonT@dfo-mpo.gc.ca), M.D. Wiegand, Department of Biology, University of Winnipeg, Winnipeg, MB, S.B. Brown, Environment Canada, National Water Research Institute, Burlington, ON, L.M. Miller and A.R. Kapuscinski, Department of Fisheries and Wildlife, University of Minnesota, St. Paul, MN, and W.C. Leggett, Department of Biology, Queen's University, Kingston, ON

AMONG-FEMALE VARIATION IN WALLEYE EGG QUALITY: A REVIEW

The mature portion of iteroparous fish stocks is often composed of a wide variety of ages and sizes of adult fish. It has long been recognized that the reproductive value of adult females varies substantially with the larger and older females producing more eggs. However, it is becoming increasingly clear that the quality of these eggs may also vary with the age, size, or condition of individual spawners. Thus, the demographics of the adult stock may be as important as the biomass of spawners in determining recruitment. We review recent research on patterns of among-female variation in egg quality in walleye to determine which spawners produce high quality eggs and offspring. Incubation experiments have found that egg survival to hatch is positively related to maternal age in some cases but not others. Variation in egg survival among females may be linked to egg size or composition but the mechanisms involved remain unclear. Burdens of bioaccumulative contaminants in walleye eggs increase with maternal age and size but these do not appear to influence egg survival. Research to date has also examined among-female variation in egg dry mass, thiamine content, thyroid hormone content, protein and lipid content and fatty acid profiles. Some of these characteristics vary with respect to maternal age and size (e.g., essential fatty acid content) whereas others do not. Current research is examining post-hatch survival in relation to egg and maternal traits.

[FRI, 14:00 – 14:20]

Jones, M.L. Department of Fisheries and Wildlife, Michigan State University. East Lansing, Michigan. (jonesm30@msu.edu)

GREAT LAKES – GREAT SUCCESSSES – GREAT CHALLENGES

Remarkably, despite widespread evidence for unsustainable management of marine fish stocks, North America's Great Lakes have enjoyed more than thirty years of largely successful fishery management. Valuable recreational fisheries have been maintained for both native and introduced salmonines, admittedly with a heavy dependence on hatchery contributions in all of the lakes except Superior. The primary commercial fisheries in the region – percids in Lake Erie and whitefish in the upper Great Lakes – have also enjoyed sustained periods of good harvests. Partly this is due to inter-jurisdictional cooperation fostered by institutional arrangements in the region that stem from the formation of the Great Lakes Fishery Commission in 1955. As well, fishery management in the Great Lakes, and the science that has supported it, has placed greater emphasis on ecosystemic issues (water quality, food web effects) than has been the case elsewhere. These differences may have resulted from the unique history and ecology of the Great Lakes, but I contend that it is worth exploring the extent to which the positive experiences with fishery management in this region have broader relevance to the protection and restoration of Canada's aquatic resources. Unfortunately, all is not well in the Great Lakes today. Continuing invasions of exotic species and climate-change mediated improvements to aquatic habitats for existing exotic species suggest a very uncertain future for Great Lakes food webs and the fisheries that depend on them. Ironically, it was an exotic species invasion - the sea lamprey – that initially motivated many positive changes to Great Lakes fisheries. Exotic species continue to pose the greatest threat to the lakes, and it remains to be seen whether management institutions will once again transform a threat into an opportunity.

[FRI, 11:20-12:00]

Jones, N.E., Tonn, W.M., Scrimgeour, G. and Katopodis, C

ENHANCING THE PRODUCTIVE CAPACITY OF A 3.4-KM DIVERSION CHANNEL IN THE CANADIAN ARCTIC.

We examined the effectiveness of four types of habitat enhancement structures, vortex weirs, ramps, groins, and veins, at increasing the productive capacity of a newly created 3.4-km diversion channel in the Barrenlands region of Northwest Territories, Canada. Using a before-after-control-impact (BACI) approach, we quantified changes in fish growth and abundance in the diversion channel as a whole and in the immediate area of each structure, with particular emphasis on young-of-the-year arctic grayling (*Thymallus arcticus*). All structures had significantly higher densities of young-of-the-year grayling than did non-enhanced sections of stream. Estimated growth rates of young-of-the-year grayling, however were greater for only 1 of 2 rocky ramps and 2 of 6 vortex weirs. Furthermore, the creation of fish habitat did not increase the overall density, biomass, or growth rates of young-of-the-year grayling in the channel relative to reference streams and pre-enhancement conditions. We suggest that enhancement structures simply redistributed fish within the channel but did not increase overall production because of a fundamental lack of allochthonous and autochthonous energy in the stream, which was more limiting to growth than apparent structural deficiencies. Support for this hypothesis came from the strong effects that seasonal weather conditions and distance from lake-outlet had on the growth of grayling in the channel.

[POSTER]

Juillet, I., Carignan, R., Bélanger, M. Département de Sciences biologiques, Université de Montréal, Montréal, Canada. (isabelle.juillet@umontreal.ca)

INFLUENCE DES COUPES FORESTIÈRES SUR LA CONTAMINATION DU POISSON EN MERCURE

Des travaux récents suggèrent une relation possible entre la contamination du poisson en mercure et la coupe forestière en forêt boréale (Garcia et al. 2000). Afin de vérifier expérimentalement l'effet présumé de la coupe sur la contamination en mercure, nous avons mesuré, entre 2000 et 2002, les teneurs en mercure chez le grand brochet (*Esox lucius*), le doré (*Stizostedion vitreum*) et la perchaude (*Perca flavescens*) avant et après coupe dans une dizaine de lacs de la forêt boréale québécoise. Une dizaine d'autres lacs n'ayant pas subi de coupe ont servi de témoins. Nous tenterons d'abord d'expliquer l'importante variation naturelle interlacs des concentrations en mercure, entre les poissons de même espèce, en examinant la position trophique ($\delta^{15}\text{N}$) des espèces ainsi que certaines propriétés des bassins versants telles le ratio de drainage, l'indice de saturation hydrique des sols, l'importance et le type des milieux humides, la pente moyenne et la présence de castors. Les données acquises après coupe nous permettront d'isoler les effets de la coupe dans chacun des lacs et de comparer ces effets aux facteurs responsables de la variabilité naturelle.

EFFECTS OF FOREST HARVESTING ON MERCURY CONTAMINATION IN FISH

Recent work, indicates that clear-cutting increases mercury levels in fish (Garcia et al. 2000). In order to verify experimentally the effects of harvesting on mercury contamination, we have measured, between 2000 and 2002, mercury levels in northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*) and yellow perch (*Perca flavescens*) before and after harvesting in ten boreal lakes. Ten additional pristine lakes were used as controls. The important natural inter-lake variability observed before logging, and in control lakes, will be related to trophic position ($\delta^{15}\text{N}$), lake/watershed properties such as the drainage ratio, the importance and type of wetlands, watershed slope, soil saturation index and beaver activity. Mercury levels measured before and after logging will allow us to isolate the effects of logging and to compare them to natural variability.

[FRI, 15:40-16:00]

Kelton, N. and L.A. Molot. Department of Geography, York University, Toronto, Ontario (email: nkelton@yorku.ca)

FORMATION OF COLLOIDAL AND PARTICULATE ORGANIC CARBON IN BOREAL STREAMS AND LAKES

The boreal lakes of Ontario store a large amount of carbon in their sediments, second only to peatlands in magnitude. This carbon is brought into these oligotrophic lakes primarily in the dissolved organic (DOC) form by streams, however, the mechanisms by which the sediments accumulate this carbon in the form of particulate organic carbon (POC) are not understood. It is important that we comprehend these processes in order to accurately estimate and balance current carbon budgets and to indicate how disturbance could affect this storage. We speculate that ultraviolet radiation initiates this retention by forming low molecular weight organic compounds since DOC remains biologically and chemically recalcitrant unless exposed to solar radiation. We hypothesize that irradiation of boreal stream and lake waters results in increasing amounts of organic colloids (COC) and POC even while the overall TOC concentration declines and furthermore, that COC and POC formation is complexly linked to Fe oxides.

[POSTER]

La Rose, J.¹, N. Collins¹, N. Lester², B.A. Henderson² and G. Morgan³. ¹Department of Zoology, University of Toronto at Mississauga; ²Aquatic Research and Development Section, Ontario Ministry of Natural Resources; ³Cooperative Freshwater Ecology Unit, Laurentian University. (email: jlrose@utm.utoronto.ca)

DO CHARACTERISTICS OF THE PREY COMMUNITY AFFECT THE BIOENERGETICS, GROWTH OR LIFE HISTORY OF WALLEYE, (*STIZOSTEDION VITREUM*)?

Management of Ontario's walleye (*Stizostedion vitreum*) fisheries requires an understanding of how lake environments affect walleye life history traits (e.g. growth and reproduction). Recent studies have explained variation in walleye life history using abiotic variables (e.g. climate, nutrients). This presentation will review progress in a study to determine how the growth, energy budgets and life histories of walleye populations are influenced by variation in prey size spectrum and fish community composition. The study has two elements. First, growth efficiencies of walleye sampled in 2001 and 2002 from seven northeastern Ontario lakes with differing fish communities are being estimated using a mercury mass balance approach. Second, we are looking for systematic variations in walleye life history as a function of prey community structure in a database of over 200 Ontario lakes sampled in the past decade. The intensive seven-lake energetics study should provide insight into the mechanisms leading to any patterns discovered in the 200-lake survey.

[FRI, 15:40-16:00]

Isabelle Lavoie, Peter Dillon, Stéphane Campeau, Jenny Winter and Keith Somers

DIATOM INDICES FOR MONITORING WATER QUALITY IN STREAMS IN QUÉBEC AND ONTARIO

Bioindicators provide a temporally integrated measure of water quality as experienced by aquatic biota, and therefore offer a useful addition to water quality monitoring strategies. In many European countries, water quality monitoring is achieved using biological indices based on benthic diatoms. These diatom indices have been shown to reflect changes in community structure as a result of disturbance in the ecosystem. Although preliminary studies in Canada have shown the potential for this method, there are no indices currently used in water quality monitoring programmes in Canada. The general goal of this project is to adapt and apply the existing European indices to diatom communities in streams in Québec and Ontario. As a first step, it is essential to test the European indices to verify if the species-specific ecological preferences in Europe and Canada are similar.

Streams in Québec (~130) and Ontario (~60) were selected to include a range of land uses in the watersheds (farming, urban activities and golf courses). Headwater sites upstream of impacted areas are sampled as a reference. Benthic diatoms were sampled on rocks (epilithon) in the late spring and late summer 2002 and will be sampled again in the late spring and late summer 2003. Canonical correspondence analyses (CCA) will be used to test the potential of diatom community as an indicator of water quality, i.e. to evaluate the total variance in species distribution explained by environmental variables. The European indices will then be applied on diatom communities sampled in Canada using the software "OMNIDIA". CCA will be conducted using the diatom indices calculated for each site in order to analyse the relationship between European diatom indices (calculated from Canadian diatom communities) and environmental variables. A Canadian diatom index could eventually be a useful tool for resource managers and consultants to use when diagnosing the factors responsible for observed water quality problems. Furthermore, a diatom index adapted for Canadian streams would be an excellent tool to add to present programmes responsible for monitoring ecosystem health.

[POSTER]

Lawrie, M.K. and R.W. Mackereth. Department of Biology and Centre for Northern Forest Ecosystem Research (OMNR), Lakehead University, Thunder Bay, ON (email:michelle.lawrie@mnr.gov.on.ca)

SPATIAL AND TEMPORAL PATTERNS OF SMALL STREAM HABITAT USE BY BROOK TROUT, SALVELINUS FONTINALIS, IN NORTHWESTERN ONTARIO.

Stream dwelling brook trout populations are widely distributed throughout the drainage systems that they occupy in Northwestern Ontario, including small tributary streams where they are often the only fish species present. Previous survey results suggest small streams containing brook trout are associated with larger streams or lakes for which the small streams serve as nursery habitat or refugia. The objectives of our study are to determine the fish species composition, brook trout size distribution and habitat characteristics of these small streams. We also evaluated the temporal and spatial patterns of small stream habitat use by brook trout. Fish communities were sampled using electrofishing in four small tributary streams (1 sq km catchment area) and the larger streams (>10 sq km catchment area) into which they flow. Brook trout were marked with PIT tags and fin clips. Two-way weirs were installed at the mouths of the small streams to monitor movement into and out of these streams. Larger streams had slightly higher mean fish species richness (4.29) than small streams (3.75), however, brook trout were the dominant species in the small streams. Brook trout length ranged from 24-241 mm in large streams and 15-199 mm in small streams where smaller fish were relatively more abundant. Small streams were consistently colder and had more cover than the larger streams. Movement of brook trout through the weirs was most frequent during the spring and fall. Movement was less frequent during the summer and was associated with rainfall and stream flow increases. Our data suggests that small brook trout seem to use the small tributary streams during the summer possibly due to favourable temperature, habitat, competition or predation conditions. Surveys and monitoring will continue through the fall spawning season to determine where spawning is occurring and if brook trout leave these streams for the winter.

[POSTER]

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STRANGER IN A STRANGE LAND: THE IMPORTANCE OF LIMNOLOGY IN ARID REGIONS

In this paper I argue that the importance of freshwater to Society varies inversely with its availability. Thus, the need for the participation of aquatic scientists in public forums is greatest when the supply of high quality water is least, relative to human demands. In the semi-arid Canadian prairies, more water is lost by evaporation than arrives by precipitation, and many lakes are either hyper-eutrophic, too saline to be potable, impacted by land use practices, or receive wastes from urban centres. Under these circumstances, limnologists can conduct studies that are firmly grounded in rigorous science, but which address issues essential to sustainable environmental quality and Society. Three examples are used to illustrate this message. First, mass balance studies, paleolimnology and stable isotopic analyses were used in the Qu'Appelle Valley to illustrate the relative importance of urbanization, agriculture and climate change as controls of water quality in prairie lakes and to provide Provincial managers with a hierarchy of management strategies. Second, a whole-lake experiment was conducted in downtown City of Regina to both investigate alternative means of macrophyte management and to forecast the impacts of future climate change on shallow lakes. Finally, paleoecological reconstructions of past climates were used to provide accurate assessments of the risks of future droughts in western Canada, while evaluating the impacts of climatic variability on basic ecosystem structure and function. In all cases, project success required end users (e.g., managers, corporations, governments) to participate as scientific partners throughout the research. This participation was essential also for engaging widespread media attention that ultimately brought the main scientific or environmental issues to the larger public.

[FRI,13:20-13:40]

Leduc, A. and G. Brown, Department of Biology, Concordia University, Canada (email: mirabiles@hotmail.com)

EFFECTS OF REDUCED PH ON CHEMICAL ALARM SIGNALS IN SALMONID FISHES: LABORATORY AND FIELD RESULTS.

A variety of fishes possess damage released chemical alarm signals, which play a critical role in the detection and avoidance of potential predation threats. Recently, we have demonstrated that the ability of fathead minnows (*Pimephales promelas*) and finescale dace (*Phoxinus neogaeus*) to detect and respond to conspecific alarm signals is significantly reduced under weakly acidic conditions (pH 6.0). Rainbow trout (*Oncorhynchus mykiss*) and Brook trout (*Salvelinus fontinalis*) are commercially and recreationally important species that possess an analogous alarm signaling system. It is unknown, however if the trout alarm signaling system is likewise affected by relatively weak changes in pH. We conducted laboratory and field trials to examine the potential effects of acute exposure to weakly acidic (pH 6.0) conditions on the detections and response of conspecific alarm signals by juvenile trout. Our results demonstrate that while juvenile trout exhibit significant increases in antipredator behaviour under normal pH conditions (pH 7.0-7.2), they do not respond to the presence of conspecific chemical alarm signals (i.e. response is not different from controls) under weakly acidic conditions. These data suggest significant, sublethal effect of acid precipitation on natural waterways.

[SAT 14:00-14:20]

Lee, V. A. and T. B. Johnson. Lake Erie Fisheries Station, Ontario Ministry of Natural Resources, Wheatley, Ontario (email: yicki.lee@mnr.gov.on.ca)

DEVELOPMENT OF A BIOENERGETICS MODEL FOR THE ROUND GOBY (*NEOGOBIUS MELANOSTOMUS*) IN WESTERN LAKE ERIE

The round goby (*Neogobius melanostomus*) is an invasive fish that was introduced into the Great Lakes in the 1990's through ballast water transfer. Due to their dietary preference for zebra mussels, gobies serve as vectors for energy transfer between the benthic and pelagic zones of Lake Erie. To quantify the flow of energy and eventually contaminants from the benthos to pelagic fishes, a bioenergetics model was developed. Weight and temperature dependent coefficients for metabolism and consumption were derived. Oxygen consumption increased 3-4-fold for fish between 2 and 40 g, and 3-fold as temperature increased from 5°C to 30°C. Consumption results also conform to the expected allometric and temperature-dependant relationship. The derived parameters have been used to construct a bioenergetics model (Fish Bioenergetics 3.0), which has undergone a sensitivity analysis. We then applied the model using field data from western Lake Erie to estimate energy and contaminant transfer mediated through the round goby population.

[SAT, 11:10-11:30]

Lepak, J. L. and C. E. Kraft. Department of Natural Resources, Cornell University, Ithaca, NY. (email: jml78@cornell.edu)

STABLE ISOTOPE MEASUREMENTS AS INDICATORS OF DIET SHIFTS IN A LAKE TROUT (*SALVELINUS NAMAYCUSH*) POPULATION IN AN OLIGOTROPHIC ADIRONDACK LAKE.

Measurements of carbon and nitrogen stable isotope ratios in organisms have helped to identify and quantify energy sources and the relative trophic position of fishes in lake food webs. Shifting carbon sources and food web structure of an Adirondack lake trout (*Salvelinus namaycush*) population was assessed using measurements of the naturally occurring stable isotope ratios $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$. Smallmouth bass (*Micropterus dolomieu*) abundance has declined precipitously in Little Moose Lake, a 271 hectare oligotrophic lake in the Adirondack mountains (New York, U.S.A.) due to a removal effort initiated in May 2000. Prior to the bass removal, lake trout in Little Moose Lake relied heavily on zooplankton as a food source. Following the bass removal, lake trout were expected to take advantage of increased numbers of native prey fishes resulting from diminished smallmouth bass predation. The $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ ratios from lake trout tissue samples, as well as lake trout diet and condition, were examined prior to and following removal of smallmouth bass to identify the impact of smallmouth bass upon trophic position and ultimate carbon sources of lake trout. As predicted, higher ^{13}C measurements indicate that lake trout are assimilating more carbon from the littoral zone. Lake trout exhibited elevated ^{15}N measurements and increasing numbers of prey-fish in their diets. Based on this study, in aquatic ecosystems with introduced predators, there is potential for restoration of native fish communities.

[SAT, 10:50-11:10]

Nigel Lester and Brian Shuter, Aquatic Research and Development Section, Ontario Ministry of Natural Resources, 300 Water St., Peterborough, Ontario K9J 6X4

LIFE HISTORY BASED ESTIMATION OF MAXIMUM EXPLOITATION RATES FOR WALLEYE FISHERIES

We used a simple energy allocation model to describe the lifetime growth pattern of a fish, to predict an optimal reproductive schedule, and to estimate the maximum mortality rate that can be sustained by a fish population. The growth model assumes 1) surplus energy is proportional to $W^{2/3}$ where W is somatic weight, and 2) annual reproductive effort equals RW where R is a reproductive index that is proportional to egg production. This model implies that pre-maturation growth rate is constant (h) and post-maturation growth is described by a Von Bertalanffy process in which the growth rate parameter (k) equals $R/3$, asymptotic length equals $3h/R$, and t_0 is a function of R and age at maturity (T_m). Net reproductive rate is maximized when annual reproductive effort equals annual mortality ($R = 1 - e^{-Z}$) and $T_m = 2/R - 2$. Reproductive schedules of walleye and other fish species are generally consistent with these predictions. Given this support of our model, we used it to generate an equation that predicts maximum sustainable mortality rate of an exploited population. Predicted maximum mortality rate is a function of M (natural mortality rate), the initial age/size of harvesting, and potential compensation in early survival and pre-

maturation growth rate. We demonstrate the application of this theory by calculating maximum sustainable exploitation rates for walleye fisheries in the province of Ontario.

[FRI, 15:20-15:40]

Brian Leung¹, David M. Lodge¹, David Finnoff², Jason F. Shogren³, Mark A. Lewis⁴, Gary Lamberti¹ 1Department of Biological Sciences, University of Notre Dame, Notre Dame, IN, 46556, USA. 2 Department of Economics, University of Central Florida, Orlando, FL 32816-1400, USA 3 Department of Economics and Finance, University of Wyoming, Laramie, WY 82071-3985, USA 4 Department of Mathematical Sciences, University of Alberta, Edmonton, AB, T6G 2G1, Canada (e-mail: bleung@nd.edu)

AN OUNCE OF PREVENTION OR A POUND OF CURE: BIOECONOMIC RISK ANALYSIS OF INVASIVE SPECIES

The 2001 US National Invasive Species Management Plan highlighted the urgent need for more rigorous and comprehensive risk analysis frameworks for nonindigenous species, so that prevention and control strategies can be targeted appropriately. The central public policy consideration is how much of society's resources should be expended in response to nonindigenous species, and how, for example, should it be allocated between prevention and control. Ideally, we would like to be able to assess alternative strategies, incorporate the interactions between ecology and economics, incorporate future expectations given that management strategies, if they are effective, should influence the environment, and acknowledge that the invasion process is highly stochastic and should be viewed probabilistically. We use stochastic dynamic programming as the mathematical basis for bioeconomic risk analysis. We apply the model to zebra mussel invasions, and show that society should spend up to \$324,000 USD/yr to prevent invasions of zebra mussels into each lake with a power plant. In sharp contrast, US Fish & Wildlife Services spent \$825,000 in FY2001 to manage all aquatic invaders for all lakes. Thus, greater investment in prevention appears warranted.

[FRI, 13:20-13:40]

Linkewich, A. and E.E. Prepas. Faculty of Forestry and the Forest Environment, Lakehead University, Thunder Bay, Ontario (email: adlinkew@lakeheadu.ca)

A REVIEW OF RIPARIAN MANAGEMENT GUIDELINES IN CANADA

The management of riparian areas is an issue of growing concern, because riparian forests are among the most productive forests in Canada and their importance in buffering waterbodies from watershed disturbance is recognized. Each province has a somewhat unique approach to managing riparian areas through differing guidelines and policies, however, the primary object remains consistent: to limit inputs from the watershed that could have a negative impact on water quality. Each province uses different methods to determine the physical limits of riparian buffers and the type of harvesting and other incursions permitted within them. This is due in part to topographic, vegetative, and climatic differences among the provinces. The Federal Department of Fisheries and Oceans represents a central regulatory agency, because it monitors the regulations set by the provinces and administers federal legislation regarding inland fisheries. Although riparian areas are considered instrumental in maintaining suitable fish and wildlife habitat and water quality, it is unclear if buffers fulfill these biological roles.

[FRI, 15:20-15:40]

Litvak, M. K., J. Crossman, A. Giberson, R. Hardy and R. M. Browne. Department of Biology, and Centre for Coastal Studies and Aquaculture, University of New Brunswick, Saint John, NB.(email:litvak@unbsj.ca)

DETERMINATION OF SHORTNOSE STURGEON, ACIPENSER BREVIROSTRUM, SPAWNING DATE AND LOCATION IN THE SAINT JOHN RIVER, NB.

Shortnose sturgeon is listed as endangered in the United States and a species of special concern by COSEWIC in Canada. The only population in Canada occurs in the Saint John River, NB. We know little of the ecology and requirements of this species. Prior to our lab's program, the only intensive study conducted on this population was in the early 1970's by Mike Dadswell. There have been very few wild collections of larvae of any of the 27 known species of sturgeon and shortnose sturgeon is no exception. Spawning locations are difficult to find. We tracked adult sturgeon (1998-2002) which had been tagged with sonic transmitters to try to find their spawning site in the Saint John River. Ichthyoplankton nets (60 cm paired bongo nets) were towed by boat to capture larvae at a potential spawning site found through sonic-tracking. In the past three years we have been able to capture 13 shortnose sturgeon larvae suggesting we are at or close to the site. All larvae captured contained yolk, indicating that they had recently hatched. We used previous work from our lab on the effect of temperature on growth of larval shortnose sturgeon to back-predict date of hatch and spawn. Based on these estimates during our sampling shortnose sturgeon in the Saint John River spawned earlier than previously reported.

[FRI, 16:00-16:20]

M. Logan⁴, Hutchinson, N.J.³, S.A. Miller¹, M. Casey & D. Cummings⁵. 1Gartner Lee Ltd. 9-B Taylor Rd., Bracebridge Ont. P1L 1T8. nhutchinson@gartnerlee.com, 2Muskoka Lakes Association. 121 Medora St., Port Carling Ont. P0B 1J0, 3Lake of Bays Association. RR #1 Baysville, Ontario. P0B 1A0

COMMUNITY MONITORING PROGRAMS FOR NEARSHORE PHOSPHORUS AND BACTERIA IN LARGE RECREATIONAL LAKES ON THE PRECAMBRIAN SHIELD.

Lake management and monitoring activities in Ontario have been focussed on whole lake responses to shoreline development. Reduced government commitments to research and monitoring activities in the late 1990s, coupled with increased concerns of water quality by lake residents, stimulated an innovative research program focussed on nearshore water quality. Professional limnologists provided advice to the Muskoka Lakes Association and the Lake of Bays Association to develop a water quality program and train volunteers in proper sampling, quality control and bacterial enumeration techniques. Volunteers collected biweekly water samples from the 1.5m water depth for analyses of total phosphorus and enumeration of coliform bacteria using a commercially available "Coli Plates". Results were compared against distilled water blanks, field duplicates and commercial bacteriological laboratories. Professional limnologists guided data analyses and reporting by the lake associations. The program was very popular among lake residents. Results showed that near shore water quality is important to guide land and stewardship activities, that natural factors such as wetlands had a greater influence on water quality than human activities and that supervised volunteers can collect useful research data.

[FRI, 13:40-14:00]

MacIsaac, Hugh J. Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON N9b 3P4 (email: hughm at uwindsor.ca)

RETROSPECTIVE ANALYSES OF NONINDIGENOUS SPECIES IN CANADA'S AQUATIC ECOSYSTEMS: A CENTURY OF DISASTER?

Canada has an extensive record of species introductions to its aquatic ecosystems, a by-product of both intentional (e.g. fish and invertebrate stocking programmes) and unintentional (e.g. ballast water release, hull fouling, stock contaminants etc.) releases. Species introductions have resulted in profound and virtually permanent changes in community composition even when planned introductions have subsequently failed (e.g. mountain lakes). Unintentional introductions of nonindigenous species also have had dramatic ecosystem-wide consequences in the Great Lakes, inland lakes, and coastal marine ecosystems. Some of these invasions have occurred with strong, adverse economic consequences, although the extent of financial damage has yet to be quantified systematically. Once established in staging ecosystems like the Great Lakes, nonindigenous species may be transferred in secondary invasions to inland lakes at rates that depend on the nature and strength of dispersal vectors. Analysis of these vectors is helping to illuminate factors that affect invasion success, as well development of protocols that may reduce human-mediated dispersal of nonindigenous species. Canada must act quickly and decisively to protect its aquatic resources from further species introductions, which are stealthfully but decisively eroding native biodiversity of our ecosystems.

[FRI, 10:40-11:20]

Malgorzata A. Marszalek (ma_marsz@alcor.concordia.ca) and Edward J. Maly (malyed@vax2.concordia.ca) Concordia University, 1455 de Maisonneuve Blvd. West, H3G-1M8, Quebec

PROXIMATE FACTORS INFLUENCING THE SPATIAL DISTRIBUTION OF A HIGH ALTITUDE COPEPOD: HESPERODIAPTOMUS SHOSHONE.

Spatial distribution shapes almost every aspect of the ecology of populations. Even though the importance of spatial distribution to the ecology of zooplankton is established, little is known about the factors that generate and maintain these aggregations (Megard et al. 1997). The role that environmental variables, specifically light intensity, and pond substrate coloration play on the formation and maintenance of aggregations was investigated in the freshwater calanoid *Hesperodiaptomus shoshone*. The spatial distribution *H. shoshone* was determined using traditional methods (i.e. the Morisita's index of dispersion) and spatial methods - trend analyses and autocorrelations- with the aim of clarifying distribution dynamics during a 24hr point interval sampling period. Copepods were found to be aggregated through the day and night with the highest aggregation levels at midday. Spatial patterns were not consistent either between the two ponds studied or between sampling times of the day. Partial regression analyses were used to identify the relative contribution of environmental and spatial factors structuring *H. shoshone* spatial distributions. Although the results were not consistent between the two ponds, light intensity and proximity to logs were two proximate factors influencing the observed copepod heterogeneity. Furthermore results showed that background colours of pond substrate were found to influence the aggregation behaviour of copepods in the water column.

[SAT, 8:50-9:10]

Edward J. Maly (malyed@vax2.concordia.ca) and Tamara Kelly Biology Dept., Concordia University, 1455 de Maisonneuve Blvd. W., Montreal, Quebec, H3G 1M8

BODY SIZE, CLUTCH SIZE, AND EGG SIZE RELATIONSHIPS AMONG FRESHWATER CALANOID COPEPODS.

Correlations among body sizes, clutches, and egg sizes within and among centropagid copepods found in Australia were determined. There is a strong negative relationship between egg size and clutch size in most species. In general, there is a positive relationship between body size and clutch size. There is no relationship between body size and egg size. Egg size

tends to be uniform across species within a genus with few exceptions. Trade-offs, nutrition, and type of habitat occupied may explain the patterns observed.

[SAT, 11:30-11:50]

Nicholas E. Mandrak. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, ON, L7R 4A6. (mandrakn@dfo-mpo.gc.ca)

FRESHWATER FISH SPECIES AT RISK IN CANADA: CURRENT STATUS, PROTECTION AND CAUSES OF DECLINE.

Currently, 45 freshwater fish species, 3 subspecies and 20 populations are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). All COSEWIC species will be listed in phases under the federal Species at Risk Act. The Species at Risk Act will require the development of recovery strategies and plans for Extirpated, Endangered and Threatened species, and management plans for Special Concern species. The richness of fish species at risk (SAR) ranges from 0 to 16 species in Canada's 975 tertiary watersheds. The greatest fish SAR richness occurs in southwestern Ontario where many fishes are at their northern range limit, and where human impact on the environment has been severe. This has led to debate as to whether or not the rarity of fish SAR is a function of natural population dynamics (HA1), or a result of human impact (HA2). These alternate hypotheses were tested by determining if rarity could be predicted by the distribution (HA1), or ecology (HA2) of the species. The ecological characteristics examined included life history and habitat preferences. Univariate and multivariate statistics were used to determine if northern range limits and ecological characteristics differ significantly between fish SAR and fish species not at risk.

[FRI, 13:20-13:40]

Nicholas E. Mandrak Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington, ON L7R 4A6. (mandrakn@dfo-mpo.gc.ca)

CHANGES IN THE FISH FAUNA OF THE CANADIAN GREAT LAKES BASIN: 1973-PRESENT.

The Great Lakes basin has the highest fish diversity of all of the major drainage basins in Canada as a result of its southern location and close proximity to the southern Pleistocene refugia. In 1973, *Freshwater Fishes of Canada* reported that the Canadian portion of the basin contained 121 native and nine introduced species. The number of established species has risen to 129 native species and 19 introduced species. An additional 10 introduced species (e.g. bighead carp) have been captured in the basin, but are not known to have established reproducing populations. This increase is largely the result of newly discovered (e.g. ghost shiner) or identified (e.g. striped shiner) native species, or accidental introductions (e.g. round goby). The most recent addition to the Great Lakes (and Canadian) fish fauna, the smallmouth buffalo, has likely expanded its range naturally in response to warmer annual temperature. Thirty-one species in the basin have been assigned a conservation status by COSEWIC. Many of these species (e.g. ciscoes) exhibited declines prior to 1973, while others (e.g. lake chubsucker) have declined since then. At least one species, the silver chub, has shown recovery from near extirpation. The major human impacts on the native fish fauna have shifted from overexploitation and eutrophication to introduced species (fish and others) and habitat degradation. These impacts are likely to continue, and may be exacerbated by climate warming.

[SAT, 15:20-15:40]

Marshall, T.R. and K.B. Armstrong. Ontario Ministry of Natural Resources, 25th Sideroad, Thunder Bay, Ontario P7C 4T9 (email: terry.marshall@mnr.gov.on.ca)

EFFECT OF THERMAL HISTORY AND FISH COMMUNITY ON WALLEYE GROWTH

Early growth of walleye is strongly temperature dependent. For a number of Ontario lakes, we examined the relationship between walleye size at the end of their third growing season (Age 2+) and the thermal history that they experienced, expressed as cumulative growing degree days >5°C (CGDD). Different growth trajectories are evident. The slope of these trajectories is similar, suggesting a linear growth response of immature walleye to increasing CGDD across their range in Ontario. Fish community composition may explain differences in the intercept of the growth curves, with accelerated growth evident in lakes where rainbow smelt are present.

[FRI, 13:40-14:00]

Marty, J.; Planas, D. Département des Sciences Biologiques, Université du Québec à Montréal, P.O. Box 8888, station centre ville Montreal (QC), H3C 3P8. (Email: marty.jerome@courrier.uqam.ca)

THE IMPACT OF ALLOCHTHONOUS CARBON ON ZOOPLANKTON COMMUNITY IN LARGE RESERVOIRS REVEALED BY STABLE ISOTOPES ANALYSES.

The importance of allochthonous material in lake foodwebs is still controversial within the heterotrophy-autotrophy debate. The large reservoirs from northern-Quebec give us an opportunity to study the impact of large inputs of organic matter originating from recent flooding and/or constant water instability due to changes in water level. Gas exchange measurement at the water surface of those reservoirs reveals a net production of CO₂ suggesting the importance of microbial organisms in the mineralization of organic matter. Thus, in such system, most of the carbon assimilated at higher levels in the food web may derive from flooded particulate matter. To verify this hypothesis, we compared the isotopic signatures of zooplankton carbon

in 2 large reservoirs (Manicouagan: 27 years and SM3: 3 years) from Northern Quebec. Six sites on each reservoirs were sampled twice during summer 2002, as well as 6 lakes situated in the same area. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ were measured in POM and in zooplankton for the different taxonomic groups (Calanoids, Cyclopoids) or different genus (ex: *Daphnia* sp., *Holopedium* sp., *Leptodora* sp.), assuming that organisms will exhibit a distinct signature according to their diet. Differences in isotopes signature will be discussed according to the season (spring/summer), longitudinal variation within reservoirs and site status (reservoir/lake).

[SAT, 9:50-10:10]

McCairns, R.J.S. and J.A. Hutchings. Department of Biology, Dalhousie University, Halifax, Nova Scotia (email: mccairns@dal.ca)

VARIATION IN BROOK TROUT (*SALVELINUS FONTINALIS*) LIFE HISTORIES: AN ADAPTIVE RESPONSE TO ENVIRONMENTAL DIFFERENCES ALONG AN ALTITUDINAL GRADIENT.

The study of life histories can be viewed as a search for patterns in the relationships between traits directly connected to reproduction, patterns that may be influenced by both extrinsic and intrinsic factors. Given that variation in these traits is likely to have a profound influence on reproductive success, it is reasonable to believe that life history traits must be under intense selective pressures. Perhaps then the ultimate goal in the study of life history evolution is to quantify the adaptive significance of such variation. A large body of theoretical work exists on the subject, but to date relatively little empirical evidence exists describing the adaptive significance of life history trait variation in fish populations. We are exploring trait variation within and between a number of brook trout populations in two distinct micro-climatic zones: a highland (pseudo-alpine/arctic) environment, and a more moderate lowland climate, in Gros Morne National Park, Newfoundland. Our approach to the problem of identifying trait variation as an adaptive response to the environment, and preliminary results will be presented.

[POSTER]

Whitelaw, JM, R Bradford, and AA McPherson. Department of Fisheries and Oceans, Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, NS B2Y 4A2. (email: mcpersona@mar.dfo-mpo.gc.ca)

DEPARTMENT OF FISHERIES AND OCEANS RECOVERY EFFORTS FOR THE ENDANGERED ATLANTIC WHITEFISH (*COREGONUS HUNTSMANI*)

The Atlantic whitefish (*Coregonus huntsmani*) is an endemic Canadian species known historically in only two watersheds in southwestern Nova Scotia. A pronounced decline in recent decades resulted in an "endangered" designation by the Committee on the Status of Endangered Wildlife in Canada in 1984. Wild adults are being held at the Department of Fisheries and Oceans' Mersey Biodiversity Facility, and through captive breeding, two F1 generations have been successfully reared in captivity. Contained populations enable the retention of genetic material and provide specimens necessary for research into life stage history and habitat preferences. As acidification of the aquatic habitat within the watersheds is suspected as a contributing factor to the decline of the species, preliminary short-term pH tolerance experiments have been conducted on juveniles and affirm survival is related to pH. Expansion of pH tolerance experiments to include all life history stages and longer-term exposures are planned. Salinity and water temperature tolerances and preferences will also be assessed. Genetic analyses consisting of three main components are underway. 1) The initial focus is on confirming phylogenetic lineage/distinct species status of the Atlantic whitefish using molecular techniques. 2) Microsatellite markers are being developed to assess kinship among captive adults for the purpose of balancing family representation within the captive breeding program. 3) To assess genetic adaptation, investigations of the presence and the amount of genetic potential for acid tolerance will be conducted during pH tolerance experimentation. Findings from hatchery, genetic work and field monitoring will be incorporated with other study results to enable development of protocols to achieve appropriate genetic makeup and survival of re-introduced populations when and where appropriate.

[POSTER]

Méthot, G (1)., Pinel-Alloul, B.(1) and R. J. Steedman (2). 1.GRIL - Département de sciences biologiques, Université de Montréal, Montréal, Québec.(email: ginette.methot@umontreal.ca; bernadette.pinel-alloul@umontreal.ca) 2.Ontario Ministry of Natural Resources, Centre for Northern Forest Ecosystem Research, Thunder Bay, Ontario. P7B 5E1. (email: rob.steedman@mnr.gov.on.ca)

IMPACT OF EXPERIMENTAL CATCHMENT HARVESTING ON BIOMASS AND SIZE STRUCTURE OF ZOOPLANKTON IN NORTHWESTERN ONTARIO LAKES:

Zooplankton biomass was monitored for 11 years (from 1991 to 2001) in six small Precambrian Shield lakes in northwestern Ontario. Three of these lakes (L26, L39, L42) had 33-71% of their catchment area clear-cut in 1996. Two other lakes were not logged, but received water from the clear-cut lakes: L20 downstream of L26, and L38 downstream of L39. One lake (L80) was used to monitor background regional temporal variability. Zooplankton were collected with a plankton net of 80 μm mesh size. Zooplankton samples were sieved through a sequential array of nets of decreasing mesh size and divided in three size fractions: 53-200 μm (rotifers, nauplii), 202-500 μm (large rotifers, small cladocerans and copepod copepodids) and > 500 μm (large cladocerans and adult copepods). The biomass of each of the three size fractions was estimated as ash-free-dry-weight per cubic meter, and summed to calculate total zooplankton biomass. Randomized Intervention Analysis (RIA) and Principal

Component Analysis (PCA) were used to test the impact of experimental harvesting using L80 as the regional reference and the clear-cut lakes (L26, L39 and L42) and the receiving lakes (L20 and L38) as perturbed systems. Preliminary results showed that in all of the logged lakes, there was a significant decrease in the abundance of the smallest biomass fraction (53-202mm). Other biomass fractions showed different responses in different lakes. Only one of two lakes located downstream of the clear-cut lakes showed a change in zooplankton biomass.

[FRI, 16:00-16:20]

Minns, C.K., C. Chu, and N.E. Mandrak. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Bayfield Institute, PO Box 5050, 867 Lakeshore Road, Burlington, Ontario (email: minnsk@dfo-mpo.gc.ca)

COMPARATIVE REGIONAL ASSESSMENT OF FACTORS IMPACTING FRESHWATER FISH RESOURCES IN CANADA

This study presents a broad analysis of freshwater fish species richness in relation to their habitat and the multiple stresses impacting those habitats across Canada. The study was conducted at the tertiary watershed level to allow integration of fish distribution, landscape and climate variables, and human activity metrics. Species presence-absence data were used to calculate richness and rarity indices by watershed. Richness is higher in the southern parts of Canada while rarity is concentrated in a "ring of rarity" around the periphery of the country. Productive capacity and stress indices were developed for each watershed using readily available mapped information. Principal components analyses were used to identify which variables should be used to develop each index. Productive capacity was estimated by combining four environmental variables, growing degree days above 5°C, elevation range (m) within the watershed, mean annual sunshine hours, and mean annual vapour pressure (kilopascals). Growing degree-days (above 5°C) was the most important predictor of species presence or absence. A human stress index was calculated using data from the 1996 census of Canada and contained two elements, industry and population. The number of crop farms, forestry, waste management and petroleum refining facilities represented the industrial component of the stress index. Road density (km/1000 km²), dwelling density and discharge sites (air) per 1000 km² described the population stresses in each watershed. Dwelling density and road density, measures of urban development, were dominant stresses throughout Canada. Crop farming and forestry stresses were important in British Columbia and Alberta. Conservation priority rankings were developed for the watersheds using an integrative index of biodiversity, productive capacity and cumulative stress levels. Southern Ontario and British Columbia watersheds were ranked high since they support both the greatest biodiversity and the most stress. Watersheds in Canada's interior were ranked low since they do not possess diverse fish assemblages and are relatively stress free when compared to the southern regions of the country. This study demonstrates how regional analyses can guide fish habitat and watershed management.

[SAT, 8:30-8:50]

L.A. Molot (Faculty of Environmental Studies, York University), S.A. Miller (Department of Geography, York University) and P.J. Dillon (Environmental & Resource Studies, Trent University). email: lmolot@yorku.ca.

RESPONSE OF THE PHYTOPLANKTON ANABAENA FLOS-AQUAE AND PSEUDOKIRCHNERIELLA SUBCAPITATA TO EXPOSURE TO UVB AND EXTRA-CELLULAR OXIDANTS

Surface blooms of algae are exposed to relatively high levels of UVB and reactive extra-cellular photo-oxidants such as the hydroxyl radical (OH[•]). Experiments were conducted to test the effects of exposure to UVB and extra-cellular photo-oxidants on a green alga and a colonial cyanobacterium in single-species batch culture under continuous cool-white illumination. The cyanobacterium, *A. flos-aquae*, survived and grew under UVB exposures of up to 14 hours per day whereas the chlorophyte, *P. subcapitata*, was unable to grow and declined under daily exposures of as little as 3 hours of UVB unless ascorbate was added daily. *P. subcapitata* was also unaffected by extracellular hydroxyl radicals produced in the absence of UV. Hence, we conclude that intracellular absorption of UV photons is required to initiate UV-mediated damage. These responses are consistent with the hypothesis that cyanobacteria must be able to tolerate relatively high exposures of UVB to dominate eutrophic waters and that high levels of UVB exclude intolerant algae. If UVB excludes intolerant phytoplankton from eutrophic waters, then it follows that a refuge with sufficient photosynthetically active radiation but negligible UVB must be present in oligotrophic and mesotrophic waters to permit growth of UVB-intolerant species. Evidence corroborating the refuge hypothesis is presented from a range of Canadian lakes.

[SAT, 9:50-10:10]

Morinville, G.R. and J.B. Rasmussen. Department of Biology, McGill University, Montreal, Quebec (email: Genevieve.Morinville@mail.mcgill.ca)

BIOENERGETIC TRADEOFF: EFFICIENTLY EXPLOITING LOCAL HABITATS OR LARGE-SCALE ENVIRONMENTAL HETEROGENEITY

Many salmonids, including brook trout, contain both anadromous (migrant) and non-anadromous (resident) forms within a population (partial migration), with the return migrants being larger than the residents. Although partial migration is commonly observed, the mechanisms governing the adoption of migration or residency are poorly understood. We used field estimates of fish growth coupled to in situ estimates of food consumption rates to demonstrate that a trade-off exists between the ability to efficiently exploit local environments (resident approach) and the capacity to capitalize from large-scale environmental

heterogeneity (migrant approach). We demonstrate that in the year prior to migration, migrant brook trout have higher consumption rates than resident brook trout. However, migrants have lower growth efficiencies (ratio of growth to consumption) than resident brook trout indicating that migrants have higher metabolic costs. In parallel, stable carbon isotopes (d13C) were used to establish the link between past habitat use and metabolic costs. Fish muscle d13C revealed that migrants use faster currents than residents during freshwater residence providing additional support to our bioenergetic results. Our findings thus agree with the notion that a link exists between metabolic costs (efficiency) and the adopted life-history strategy. [FRI, 15:40-16:00]

Morris, C. and J. Simms. Department of Fisheries and Oceans, Northwest Atlantic Fisheries Centre, St. John's, Newfoundland. (MorrisC@dfo-mpo.gc.ca)

THE ROLE OF SCIENCE IN ESTABLISHING A MARINE PROTECTED AREA (MPA) IN GILBERT BAY, LABRADOR

Canada's Oceans Act calls on the Department of Fisheries and Oceans to lead and facilitate the development of Marine Protected Areas (MPA) in Canada. Gilbert Bay, Labrador, is currently an Area of Interest having potential to become a MPA in the near future. Working together, scientists at Memorial University and DFO researchers provided scientific information to develop the MPA initiative. Research identified a genetically distinct resident population of Atlantic cod in Gilbert Bay. Sonic tracking and external tagging studies defined the population's range, which is about 60km². Biological characteristics such as year round residency, growth rates, and spawning period appear locally adapted to the Gilbert Bay environment. Within the proposed MPA, scientific research identified important spawning, nursery, and foraging areas, leading to the definition of zones for management purposes. Zones and MPA boundaries are established on basic ecosystem components, and are specifically identified by 3D multi-beam maps of the sea floor. Scientific research in Gilbert Bay has demonstrated the need for protection, based on Oceans Act policy, and the technical feasibility of monitoring and managing the resident population. [FRI, 15:40-16:00]

Mossop, B.¹ and M.J. Bradford² ¹School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, CANADA, V5A 1S6. (email:mossop@sfu.ca) ²Fisheries and Oceans Canada and Cooperative Resource Management Institute, School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, CANADA, V5A 1S6

RELATIONSHIP BETWEEN LARGE WOODY DEBRIS AND JUVENILE CHINOOK SALMON (ONCORHYNCHUS TSHAWYTSCHA) HABITAT IN SMALL BOREAL FOREST STREAMS OF THE UPPER YUKON RIVER

The importance of large woody debris (LWD) in forested stream ecosystems is well documented, however, little is known about LWD in northern boreal forest streams. We investigated the abundance, characteristics and function of LWD in small tributary streams of the upper Yukon River. Such streams provide important non-natal rearing habitat for juvenile chinook salmon (*Oncorhynchus tshawytscha*) prior to their downstream migration to the Bering Sea. Crews measured LWD, surveyed fish habitat and sampled fish densities in fifteen 100-200m reaches among thirteen study streams. Median LWD abundance was 22 pieces per 100m, which is within the range reported in other studies. Median LWD diameter was 14 cm, length was 4.0 m and volume was 0.27m³ per 100m². These values are similar to those for studies outside the Pacific coastal region but are smaller than values for Pacific coastal studies. LWD formed 28% of the pools, which also was within the range for other studies. We focused on the function of LWD in forming pools since pools are the preferred habitat for these chinook. LWD jams formed 63% of the LWD-formed pools while individual pieces formed the remainder. Individual pool-forming pieces were generally >11 cm in diameter and ring counts on fallen riparian trees indicated that these pieces were >30 years old. Compared to Pacific coastal studies, pool-forming pieces were slightly smaller yet much older. Reach-scale chinook densities were correlated with LWD abundance. We conclude that despite the unique climate and forest type of these northern boreal forest streams, the function of LWD in pool formation and hence its importance as habitat for juvenile salmon is consistent with research from other regions. [FRI, 14:20-14:40]

Muir, D.C.G. National Water Research Institute, Environment Canada, Burlington ON L7R4A6 (email: Derek.muir@ec.gc.ca)

USING REMOTE LAKES TO UNDERSTAND SPATIAL TRENDS AND BIOACCUMULATION OF CHEMICAL POLLUTANTS

It has been recognized for at least 20 years that remote lakes in Canada's boreal forest, alpine and arctic regions receive inputs of chemical contaminants such as persistent organic pollutants (POPs) and anthropogenic mercury (Hg), primarily from atmospheric inputs. This contamination is an important environmental and subsistence food consumption issue in Canada especially in the case of Hg. Sixty-five percent of the lake trout lakes in Ontario (excluding the Great Lakes) contain trout with Hg concentrations greater than the Canadian limit for commercial sale (0.5 ug/g) as do significant numbers in northern Quebec, Labrador and NWT. The lake-to-lake variation in concentrations of Hg and POPs in fish and food webs is very large and, at present, we cannot predict *a priori* the concentrations in important subsistence fish species. However, much progress has been made in the past 10 years in understanding this variation, much of it by Canadian limnologists. This presentation will

review the current state of knowledge of the physical, chemical, and biological factors influencing the lake-to-lake variation in bioaccumulation of contaminants. The biological characteristics include food chain length and species composition, growth rates, and lipid content. The physical characteristics include the trophic status and size of the lake. Properties of the chemicals and their characteristic “travel distances” also must be considered given that most of the contaminants originate from urban areas of southern Canada and the northern US. Building on this knowledge my colleagues and I have recently developed a dataset on the levels of POPs and Hg in food webs of 25 lake trout lakes combined with information on water chemistry and phytoplankton composition. Concentrations of major POPs were found to increase significantly with trophic level, as indicated by nitrogen stable isotope ratios ($\delta^{15}\text{N}$) in the organisms. Food web biomagnification factors for most POPs and Hg varied within a relatively narrow range of about 2-fold among 14 well characterized lakes and were influenced by water chemistry and phytoplankton composition. Thanks to the availability of remote lakes with a range of physical and biological characteristics we are closer to a general understanding of the lake-to-lake variation in bioaccumulation of contaminants.
[FRI, 9:05-9:45]

Gertrud K. Nürnberg & Bruce D. LaZerte, Freshwater Research, 3421 Hwy 117, Baysville, Ontario, P0B 1A0
(gkn@fwr.on.ca)

A BLOOM OF PLANKTOTHRIX RUBESCENS IN LAKE WILCOX, ONTARIO, PROBABLY INDUCED BY A LAKE RESTORATION TECHNIQUE

Lake Wilcox is a small (56 ha) kettle lake on the Oakridge's Moraine north of Toronto. It is a mesotrophic lake with long-term epilimnetic summer total phosphorus (TP) average concentrations in the high twenties ($\mu\text{g/L}$) and chlorophyll average of about 8 $\mu\text{g/L}$. As it strongly stratifies in the summer, anoxia quickly develops within the entire hypolimnion (average summer oxycline is at about 6 m) accompanied by a TP increase of up to 600 $\mu\text{g/L}$. A “Lake Lung” system was installed in the fall of 1997 to oxygenate the hypolimnion during summers and aerate and mix the water column in the fall and winter. Hypolimnetic oxygenation or aeration worked continuously during the summer of 1998 until mid-November and was then replaced by entire water column aeration and mixing. This treatment coincided with the proliferation of a toxic strain of the purple cyanobacteria, *Planktothrix rubescens*. Monitoring results show that the algae increased from values at the detection limit in June, to 100,000 mm^3/L in Oct. 1998 and 40 million mm^3/L in May 1999, producing bright red water seeping through the ice. Lake Wilcox is a typical lake for the occurrence of *P. rubescens* (i.e. small and stratified, mesotrophic with a possibly increasing trend in TP), and small numbers of *P. rubescens* have been detected especially in the fall, since monitoring started in 1995. Prolonged artificial mixing in the fall and winter of 1998 distributed the filaments throughout the water column, and to the surface in fall to spring when light was low enough for the algae to survive. There, the algae were supported by simultaneous entrainment and mixing of nutrients from the enriched bottom water. Such booms of *P. rubescens* and similar bluegreens in the context of whole-lake aeration and mixing techniques have been reported before in at least three lakes: two kettle lakes and a reservoir. Aeration and mixing does not appear to prevent the occurrence of winter blooms. Instead, the technique of hypolimnetic withdrawal (by damming the outlet and withdrawing water from the bottom in the summer) has been shown to decrease the potential for *P. rubescens* blooms in some lakes.

[SAT, 10:30-10:50]

O'Connor L. M.¹, J. R. M. Kelso¹, and F. W. H. Beamish². ¹Fisheries and Oceans Canada, Sault Ste. Marie, Ontario (email: oconnorl@dfo-mpo.gc.ca). ²University of Guelph, Guelph, Ontario.

DO ALL FEMALE SEA LAMPREYS SPAWN?

We introduced 1088 adult sea lampreys (560 male, 528 female), into two streams over two years to examine the relative proportion that remained at the time of spawning. We recovered and necropsied 56 female carcasses from the streams during the study period to classify the spawning condition and estimate the number of eggs remaining in each female. Based on spawning condition, females were classified as one of three groups: those that had not spawned (ovary intact), partially spawned (eggs loose in body cavity), and fully spawned (<1000 eggs remaining in body cavity). Fulton's somatic condition factor (K) was found to be significantly different (ANOVA, $p < 0.05$) between the three groups. Female sea lampreys that had spawned had a significantly higher condition factor (Tukey's post hoc test, $p < 0.05$, mean = 0.249) than either those that had partially spawned (mean = 0.209) and those that had not (mean = 0.192). We also retained a sample of 33 female sea lampreys to determine fecundity and condition factor for female lampreys at the time of the initial release. Using these females, we developed a linear model that may be used to estimate the somatic condition and subsequent spawning success of gravid female sea lampreys. We examined the predictive utility of the model for 46 of the females recovered from the streams.

[POSTER]

Olden, J.D.¹ and N. E. Mandrak² ¹ Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO, 80523, USA, olden@lamar.colostate.edu, 970.491.2414 ² Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington, ON, L7R 4A6, CAN, mandrakn@dfo-mpo.gc.ca, 905.336.4842

A HIERARCHICAL UNDERSTANDING AND PREDICTION OF FFSH SPECIES DISTRIBUTIONS IN ONTARIO

Knowledge of the current and future status of the biological diversity of aquatic ecosystems is among the main challenges confronting fisheries ecologists in the new millennium. Consequently, efforts to understand the major environmental drivers

shaping landscape patterns in fish distributions, and placing this understanding in a predictive framework has become increasingly important. We used recursive-partitioning techniques to create hierarchically-structured classification trees for lake trout (*Salvelinus namaycush*), northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieu*) and walleye (*Stizostedion vitreum*), and for co-occurring groups of these fishes across 8,237 lakes of Ontario. Classification trees used a suite of environmental variables describing lake morphology and water chemistry, lake trophic conditions, climate and zoogeographic history, to generate landscape predictions of species occurrence. We found that cross-validated trees exhibited high predictive power for both individual species (correct classification: 88-91%) and for assemblage types (63%). The classification trees recognized the importance of unique sequences of hierarchically-constrained local, regional and zoogeographic environmental conditions, supporting the notion that current fish distributions are a result of both contemporary and historical environmental filters that act at various spatial and temporal scales. Projection of model predictions across Ontario indicated that the spatial predictability of species presence (model sensitivity), absence (model specificity) and occurrence (overall correct classification rate) varied both taxonomically and spatially. We discuss the importance of these findings in light of the potential management and conservation implications of species distribution models. Interestingly, spatial variability in model predictions exhibited a historical signal, in that the legacy of past glaciation affects our current understanding and prediction of species distributions. Given the multiplicity of spatial and temporal scales in which environmental factors act to structure fish species distributions, we feel that recursive-partitioning approaches may offer an attractive means for hierarchically integrating both contemporary and historical forces when predicting the spatial organization of fish communities at landscape scales.

[SAT, 8:50-9:10]

Orihel, D.¹, P. Blanchfield², M. Paterson², H. Hintelmann³ and C. Gilmour⁴. 1 Department of Zoology, University of Manitoba, Winnipeg, MB (email: OrihelD@dfw-mpo.gc.ca); 2 Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, MB; 3 Environment and Resource Studies, Trent University, Peterborough, ON; 4 Estuarine Research Center, Academy of Natural Science, St. Leonard, MD.

AN EXPERIMENTAL APPROACH TO DETERMINING THE RELATIONSHIP BETWEEN ATMOSPHERIC MERCURY DEPOSITION AND MERCURY LEVELS IN FRESHWATER FISH.

Over the last 150 years, mercury levels in the atmosphere have increased 3-fold due to industrial activities such as fossil fuel burning. Mercury in the atmosphere is circulated worldwide and returned to the earth's surface primarily through rainfall. Mercury deposited to freshwater systems is known to bioaccumulate in aquatic food webs, resulting in elevated levels of mercury in fish, which can pose a serious health risk for the wildlife and humans who consume them. The regulations for mercury emissions to the atmosphere are being re-evaluated, and a greater understanding of the relationship between atmospheric mercury deposition and methyl mercury concentrations in fish is required. In June-September 2002, a mesocosm-level experiment was conducted at the Experimental Lakes Area, Ontario, to determine the effect of various mercury-loading rates on mercury concentrations in aquatic biota. Eleven 10m-diameter mesocosms were installed over the littoral sediments of an oligotrophic lake. Mercury loading in the mesocosms was manipulated by adding doses of isotopic mercury (²⁰²HgCl₂); the loading rates to the series of mesocosms (0-107mgTHg/m²) encompassed the range of wet deposition of mercury presently experienced worldwide. Mesocosms were stocked with 1+ year-old yellow perch (*Perca flavescens*), an opportunistic omnivore. Over the course of the 10-week experiment, mercury levels in biota and their habitat were regularly monitored; periphyton, zooplankton, zoobenthos, fish, air, water, and sediment samples were collected. The results of this experiment will provide us with a better understanding of the relationship between mercury concentrations in aquatic biota, particularly fish, and the loading rate of atmospheric mercury to freshwater systems, which will allow us to evaluate the effectiveness of current control measures and to better manage the risks of mercury exposure to wildlife and humans.

[FRI, 16:20-16:40]

Patrick, K., J. Gunn, M. Futter and E. Snucins. Department of Biology, Laurentian University, Sudbury, Ontario (email: kl_patrick@nickel.laurentian.ca)

TIMING OF LAKE STRATIFICATION IN CLEAR AND COLOURED LAKES

The duration of ice cover and the stratification period in clear and coloured lakes was examined in 64 lakes in Northern Ontario to determine how the length of time between lake thaw and lake stratification significantly affects the end of summer thermal structure of a lake and how lake clarity influences this process. A simple model for predicting ice cover was developed using water temperature data measured continuously with a data logger at 1m and 2m below the surface during the winter. Ice off dates were predicted to have occurred when the daily average temperature was greater than 1°C at 1m and 2m depths and the variance of the daily average temperature was greater than 0.065 at both depths. Temperature profiles were measured at 0.25m intervals twice a week throughout the spring to determine date of stratification. A relationship between DOC and secchi readings was developed to classify lakes into two broad categories. Coloured lakes have a DOC > 2 mg·L⁻¹ and clear lakes were classified with a DOC < 2mg·L⁻¹. End of season thermal structure of each lake was measured within the final week of August 2002 and compared to the timing of lake stratification. Data from previous studies in 1997 (late spring), 1998 and 1999 (early springs) were used for comparison. This model will be used to predict the effect of variation in winter ice cover on the thermal habitat volumes for cold-water biota.

[FRI, 16:40-17:00]

Paterson¹, A.M., R. Quinlan^{2,3}, J.P. Smol³, B.J. Clark¹ and P.J. Dillon⁴; 1Ontario Ministry of the Environment, Dorset Environment Science Centre, P.O Box 39, Dorset, Ontario, P0A 1E0 (e-mail: andrew.paterson@ene.gov.on.ca); 2Paleoenvironmental Assessment Lab, Department of Geology, University of Toronto, Toronto, Ontario, M5S 3B1; 3Paleoecological Environmental Assessment and Research Lab, Department of Biology, Queen's University, Kingston, Ontario, K7L 3N6; 4Environmental and Resource Studies, Trent University, Peterborough, Ontario, K9J 7B8.

ESTIMATING PRE-DEVELOPMENT HYPOLIMNETIC OXYGEN IN CANADIAN SHIELD LAKES: COMPARING THEORETICAL AND PALEO-INFERENCING MODELS

The ability to predict hypolimnetic oxygen concentrations in lakes is of great interest to aquatic scientists and lake managers because of the link between concentrations and biological stress, and the importance of oxygen in regulating oxidation/reduction reactions. Estimates of baseline or pre-development concentrations can be used to evaluate the impacts of recent anthropogenic disturbances on long-term oxygen concentrations in lakes. We used two models that vary widely in approach to predict end-of-summer volume-weighted hypolimnetic oxygen (VWHO) in Canadian Shield lakes. First, we used a published multiple regression model to estimate fall oxygen profiles in more than 40 oligo-mesotrophic lakes in south-central Ontario. The Trophic Status Model was also used to generate pre-disturbance total phosphorus (spring overturn) values required for the model. A second approach used an inference model that predicts VWHO in stratified lakes from subfossil chironomid remains. The paleoecological model was developed from 59 lakes in south-central Ontario using weighted-averaging regression ($r^2_{\text{jack}} = 0.57$; root mean squared error of prediction = 2.07 mgL⁻¹). The two models are compared in their abilities to predict present-day (measured) VWHO, and in their estimates of pre-disturbance concentrations. Advantages, disadvantages, and discrepancies between the two approaches are discussed.

[SAT, 13:40-14:00]

Dave Pearson, Laurentian University, Ramsey Lk Rd., Sudbury, ON P3E 2C6 (Email: dpearson@laurentian.ca)

ST. BARBARA MEETS ST. ANDREW: A GEOLOGICAL PERSPECTIVE ON CANADIAN LAKES.

Ten "Great Lakes" lie along an arc at the outer edge of the Canadian Shield. From Great Bear Lake to Lake Ontario, these prominent and often deep basins were scoured by the Laurentide ice sheet where crystalline rocks meet more easily eroded sedimentary strata. They were also the focal points of a widespread proglacial lake system that covered over half the Shield with melt water when thousands of cubic kilometres of ice melted between 14,000 and 6,000 years ago. Inside the arc of "Great Lakes" is a broad upland zone of crystalline igneous and metamorphic Shield rocks, studded with over two million lakes in small rock basins. Amongst them are a few in the craters of meteorite impacts, but most of the lake basins were excavated under warm ice by quarrying processes that exploited fractures, fault systems and less resistant rock types. They often form large-scale patterns that reflect the two to four billion year old geological history of the bedrock, sometimes inherited from deformation in the roots of long eroded mountain ranges or the squeezing of belts of ocean floor volcanoes. The flat lying, much younger sedimentary rocks of the Hudson Bay Lowland, covered by the sediments of the post-glacial Tyrrell Sea, form a central geomorphological zone that includes only a few lakes. Fringing the Shield, overlapping the arc of "Great Lakes", is an apron of glacial sediment in drumlin fields and moraine deposits with its own patterns of lakes. The faults and thrust sheets of the long-lived Cordilleran mountain belt along the west coast control many mountain lakes while others lie in the alpine cirques and high valleys. The more eroded and subdued topography of the Appalachian mountain belt, underlying the Maritime.

[FRI, 10:00-10:40]

Peres-Neto, P.R. and P. Magnan. Département de chimie-biologie, Université du Québec à Trois-Rivières, Trois-Rivières, Québec.

DOES SWIMMING DEMAND INDUCE PHENOTYPIC DIVERGENCE? PATTERNS IN MORPHOLOGICAL INTEGRATION WITHIN AND BETWEEN TWO CHARR SPECIES.

Environmentally induced changes in the developmental process of a given genotype are denominated phenotypic plasticity, and in certain cases they may constitute adaptive solutions for coping with environmental heterogeneity. Several lake fishes present morphological differences between individuals that inhabit the littoral zone and opened waters. This dichotomy in habitat choice sets different ecological demands, especially while searching for food. In fact, in many species, variation in morphology between littoral and pelagic forms seems to match the phenotypic expectations for increased performance in the selected habitat. For instance, in the search for prey, morphologies adapted to the more complex littoral habitats are expected to increase manoeuvrability whereas pelagic morphologies should increase steady swimming in order to find patches of prey scattered in open water. Much of the direct evidence indicating that habitat choice can induce phenotypic variation in lake fishes comes from a few experiments designed to evaluate the influence of pelagic and littoral feeding environments on phenotypic variation. However, these studies show contradictory evidences whether diet alone can induce the expected phenotype. In spite of the predictions regarding differences in swimming pressures under divergent habitat selection, there is hardly any evidence of its role in driving phenotypic divergence. In this study we present the results of an experiment designed to assess whether differential swimming pressures can drive the phenotypic differences found between the benthic and pelagic

forms in Arctic and brook charr. These two congeneric species present different levels of phenotypic divergence between the pelagic and littoral forms, and hence their comparison may prove useful for understanding how phenotypic integration and phenotypic divergence are connected. Specifically, we ask how the patterns related to phenotypic integration change across water velocity treatments within species; and how the patterns of phenotypic integration regarding swimming pressures compare across species.

[SAT, 16:40-17:00]

Persaud, A.D., M.T. Arts and N.D. Yan. Department of Earth and Environmental Sciences, Lehigh University, 31 Williams Drive, Bethlehem, PA, USA, 18015 (Email: adp7@lehigh.edu)

PHOTORESPONSES OF LATE INSTAR CHAOBORUS PUNCTIPENNIS LARVAE.

In light of their vulnerability to UVR, we examined the photoreponses of late larval instars of *Chaoborus punctipennis* to different combinations of UVA (320–400 nm), UVB (300–320 nm) and PAR (400–700 nm) to determine whether the larvae can detect and/or avoid UVR. To accomplish this, we exposed late instar *C. punctipennis* larvae to a directional light source of UVR only (peak wavelength of 360 nm), PAR only or PAR plus various wavebands of UVR. We examined negative phototaxis for 10 min at a quantum flux of 2.62×10^{13} quanta s⁻¹ cm⁻² (S.D.= 3.63×10^{12} quanta s⁻¹ cm⁻²). In the dark, larvae stayed close to the surface of the experimental vessels. Under all treatments containing PAR the larvae exhibited negative phototaxis and occupied the bottom of the vessels. Under UVR only, the larvae occupied the middle of the water column. These results suggest that late instar *C. punctipennis* larvae may either be unable or have limited ability to detect and avoid UVB and short UVA wavelengths.

[POSTER]

McConnachie, J and E. Petticrew Faculty of Natural Resources and Environmental Studies, University of Northern British Columbia, Canada *ellen@unbc.ca

THE EFFECT OF SEASONALLY VARIABLE ORGANIC MATERIAL ON SUSPENDED SEDIMENT STRUCTURE IN A SALMON-BEARING STREAM

It is well-documented that fine-grained sediment (<63mm) in suspension moves predominantly as particle aggregates (or flocs), which are bound together by some combination of physical, chemical, and biological forces. The biological component is seemingly the most important factor regulating flocculation in freshwater systems. Flocculated sediment exhibits altered hydrodynamic characteristics (e.g., particle size, density and settling rate) compared to individual particles, which have significant implications for salmon-spawning environments. This study investigates the hypothesis that variability in floc structure in these systems is largely due to temporal variation of organic matter source and supply. A seasonal approach was used to characterize suspended sediment structure as well as the environmental factors contributing to flocculation. A definite temporal pattern of variation was found for stable isotopes of carbon and nitrogen and color, which is related to source and supply of organic matter. A similar trend was noted for total and dissolved organic carbon, suspended particulate matter, and shear stress, which is strongly correlated to discharge. Variation in sediment structure is likely attributed to a combined effect of both of these organic and hydrologic processes.

[POSTER]

Pick¹, F. R. & P.B. Hamilton². 1. Ottawa-Carleton Institute of Biology, University of Ottawa, Ottawa. 2. Canadian Museum of Nature, Aylmer, Que.

WHO TAKES CARE OF THE RIVER? EXPERIENCES WITH A COMMUNITY INITIATIVE: THE RIDEAU RIVER ROUNDTABLE.

We assume that regional, provincial and/or federal governments are responsible for and care for our waterways. While it is true that elected bodies have legislative powers over waterways, are they really the caretakers? Who is actually responsible to find, report and rectify problems affecting flowing waters? In the case of the Rideau River, now a national Heritage River, the answer is many agencies, but no one agency takes the lead in managing the river at the ecosystem level. The Rideau River Round Table (RRR) is "self-mandated" to oversee the "health" of the Rideau. As a non-profit, citizen's NGO, the RRR is collating information across all government agencies, initiating clean-up and education activities, as well as developing a report card for the governing bodies of the waterway. In the future, committed interest groups can and will be the focal point of environmental stewardship with a mandate of linking activities among private and governing bodies and demanding accountability. However, if environmental management and stewardship is to have a scientific basis, how will scientists fit in to this process? The Rideau River Biodiversity Project, a research based scientific model with citizen-driven directives is one example of a science-citizen union.

[FRI, 14:40-15:00]

Pinel-Alloul, B. and Gelinas, M. 3.GRIL - Département de sciences biologiques, Université de Montréal, Montréal, Québec.(email: bernadette.pinel-alloul@umontreal.ca)

FORMATION AND MAINTENANCE OF DEEP CHLOROPHYLL MAXIMA IN THREE LAURENTIAN LAKES (QUÉBEC), IN RELATION TO PHYSICO-CHEMICAL GRADIENT AND ZOOPLANKTON DISTRIBUTION:

To understand the formation and the trophic importance of deep chlorophyll layers in lakes, we used a recent in situ fluorometric method (Fluoroprobe bbe) to determine the depth distribution of total chlorophyll, and four groups of algae (greens, blue-greens, diatoms, cryptophytes) in three Laurentian lakes (Québec) during summer 2002. Lakes were similar by their catchment and lake morphometry but differed in the intensity of human uses. We use a multi-parameter probe (Hydrolab Surevor 4) to analyse depth gradients in temperature, oxygen, pH, and specific conductance. Light gradients were estimated with a Licor-1000. Crustacean zooplankton was collected in three depths (mid-epilimnion, depth of the DCM, and mid-hypolimnion) using a Schindler-Patalas trap with a 150 µm mesh size net. Water quality varied among lakes and with depth. pH ranged from 6.2 to 8.5, conductance from 35 to 515 µS.cm⁻¹, TP from 6 to 37 µg.L⁻¹, TN from 252 to 1279 µg.L⁻¹, and COD from 2.5 to 4.5 mg.L⁻¹. We found deep chlorophyll maxima (DCM) in each lake, but their depth and algal composition varied from lake to lake. In the more oligotrophic Lake Violon, without any disturbance in its catchment, DCM was always observed at 10-m deep and composed only of cryptophytes. In the hardwater Lake St-Adèle, with intense land use in its catchment, DCM were observed at 7-m and 13-m, and were caused respectively by mass development of diatoms and greens above the thermocline, and cryptophytes in the deep layers. In lake Morency, DCM occurred at 10-m, and was composed mainly of diatoms. Relationships between the characteristics of the DCM patterns and depth gradients in nutrients, light and zooplankton grazers will be explored.

[SUN, 8:50-9:10]

Dolors Planas & Serge Paquet GRIL-Université du Québec à Montréal, C.P. 8888, Succ. Centre ville, Montréal, Qc, H3C 3P8 (email : planas.dolores@uqam.ca)

PHYTOPLANKTON COMMUNITY RESPONSE TO WATER QUALITY CHANGES FOLLOWING WATERSHED PERTURBATION BY WILDFIRES AND LOGGING

Phytoplankton respond rapidly to modifications in lakes water quality. Natural and anthropogenic watershed perturbations that change the nutrient and light regime (by increasing the DOC loading) can limit or enhance the success of some phytoplankton species. Changes in phytoplankton community structure could impact, by a bottom-up effect, the zooplankton and fish communities of lakes. We already know that wildfires and logging alter total phytoplankton biomass. The objectives of this study are to verify: i) if the phytoplankton community structure was modified by the type or/and intensity of watershed perturbation, and ii) what the resilience of the community is to perturbation. The phytoplankton data that we will use are from 38 lakes (16 unperturbed, 7 logged and 9 burnt) in the Northern Quebec Boreal region. The perturbed lakes were sample from year-1 to year-6 after perturbation. Watersheds that have not been perturbed (i.e., by wildfire or insect outbreaks) have been sampled for at least the last 60 years.

[SAT, 9:30-9:50]

Prepas, E., S. Pinder, M. Serediak, and J.Burke. Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E1(email: spinder@ualberta.ca)

A COMPARISON OF THE EFFECTS OF WILDFIRE ON PHOSPHORUS AND INORGANIC NITROGEN EXPORT IN STREAMS DRAINING WATERSHEDS ON THE WESTERN BOREAL PLAIN

A 1998 wildfire in the Virginia Hills, Alberta, affected both phosphorus (P) and inorganic nitrogen (IN, nitrate plus ammonium) export in streams draining two burnt watersheds for at least three years (monitoring ongoing). Effects on P export were more dramatic and could be attributed to higher particulate P loading, in part due to higher surface runoff during summer storms. Compared to two reference streams, total P (TP) export coefficients in burnt streams were 1.7, 3.0 and 3.4 times as high in years 1, 2, and 3 after fire, respectively. Whereas particulate P comprised only 65% of TP export in reference streams after fire, it comprised 84% of TP export in burnt streams. Although there was a trend for higher IN export coefficients after fire in burnt streams, differences from reference stream values were not significant ($P < 0.05$) until year 3, when IN export from burnt streams was approximately double that in reference streams. Differences in nitrate export were more pronounced in year 3 and ammonium in year 2. These post-fire stream responses on the western Boreal Plain differ from those seen on the eastern Boreal Shield, where, in general, the P export response is minimal and limited to about two years after fire. Further, IN export responds more dramatically to fire disturbance in Shield watersheds, but recovers quickly, sometimes within one year. Differences in post-fire response between the Boreal Plain and Boreal Shield can be attributed in part, to differences in soils and climate. The relatively thick overburden of P-rich soils on the Boreal Plain contribute to high P export following fire and the relatively dry climate impedes vegetation (and IN) recovery.

[FRI, 16:20-16:40]

Post, J.R. Division of Ecology, Department of Biological Sciences, University of Calgary, Calgary, AB (email:jrpost@ucalgary.ca)

MULTIPLE STRESSORS AND THE INVISIBLE COLLAPSE OF RECREATIONAL FISHERIES Evidence is mounting that a number of high profile Canadian recreational fisheries have collapsed. The mechanisms responsible for these collapses have in some cases been elucidated. It appears to be the cumulative impact of several stresses including fishing effort, angler spatial behaviour, density-dependent catchability, angler response to restrictive regulations and food web

processes that are involved. Several of these stresses involve depensation and are therefore likely to accelerate the rate of collapse as population densities decline. Publication of an article entitled "Canadian Recreational Fisheries: The Invisible Collapse?" that quantified these mechanisms has attracted Canadian and US media and a deluge of public and fishery agency responses. These ranged from "this isn't news, we have known it for years" to "fishing is better than it has been for decades" and "finally someone has had the guts to tell it as it is" to "those as...le academics should get out of their ivory tower". It is clear that there is a general lack of understanding of the dynamical consequences of these multiple stressors within the general public and some management agencies and that this is counterproductive to good management of recreational fisheries.
[SAT, 13:20-13:40]

Perce Powles and Ian Sandeman, Trent University, Peterborough, ON

OBSERVATIONS ON THE GROWTH AND LIFE HISTORY OF THE BROOK SILVERSIDE, *LABIDESTHES SICCULUS*, IN CENTRAL ONTARIO. Summer growth of brook silversides obtained from sagittal daily increments was virtually linear, with no significant difference in growth rates between male and female fish. Fish reached 65 mm TL in about 70 days in 2001. Fish in Rice Lake, (near Peterborough) which overwintered, ranged from 62-78 mm TL, with from 35-55 daily increments apparent past the winter annulus. Our studies based on otoliths, confirm earlier conclusions based on scales and length frequencies, that the species is indeed an "annual", with overwintering fish dying the following summer. The longest recorded survivor showing a winter annulus was a fish taken in September. Most mature fish disappeared from the sampling by the end of June. Back-calculated hatch periods in 2001 extended from late May to end of August. A regression of sex ratio on lake temperature 10 days pre-hatch, suggested that females were developed at lower temperatures than males. However, the relationship was weak, and so evidence for ESD (environmental sex determination) in the species cannot be strongly supported without further investigations.

[POSTER]

Pratt, T.C. Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Sault Ste Marie, ON
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HABITAT-SPECIFIC ABUNDANCE, BIOMASS, AND PRODUCTION ESTIMATES USING UNDERWATER LINE TRANSECTS

I used underwater visual line transects to estimate the habitat-specific abundance, biomass, and production of littoral zone fishes. Distance sampling abundance estimates were compared to traditional mark-recapture estimates in six Ontario waterbodies in an effort to validate the estimates of both techniques. In some cases there was good agreement in the abundance estimates, but not always. Confidence intervals were always wider with distance sampling estimates, but these estimates had the benefit of allowing abundance to be separated into specific habitat types. In two of the lakes, three line transect surveys were performed (June, August, October) with concurrent habitat-specific fish collections to allow estimates of habitat-specific biomass and production. Preliminary analyses indicate that adult fish densities vary significantly among habitat types (beaver lodges>vegetated areas>rock substrates>open areas). Interestingly, habitats with high adult biomass are not necessarily important in the production of age-0 fish.

[SAT, 8:30-8:50]

Proboszcz, S. and C. Guy. Division of Biology, Kansas State University, Manhattan, Kansas (email:stanprob@ksu.edu)

SPOTTED BASS COVER STRUCTURE USE IN AN EXPERIMENTAL STREAM

Spotted bass *Micropterus punctulatus* are an important sport fish and top-level predator native to southeastern Kansas streams, however they occur at relatively low densities. A common method used to enhance salmonid populations is to improve lotic habitat by installing habitat structures. The effects of habitat-enhancement structures have not been evaluated for spotted bass populations. This study was conducted to evaluate use of habitat-enhancement structures (half-log, rootwad, and undercut bank), by age-0 spotted bass in an experimental stream. Three habitat structures and a no-structure area were randomly arranged in an experimental stream. Fish were observed for two days after structure placement. Light intensities and current velocities were measured for each habitat arrangement. Laboratory results were similar to natural stream habitat use by adult spotted bass. For example, habitat structure was used significantly more ($P < 0.05$) than open water. Half-log was used significantly more ($P < 0.05$) (47 %) than both rootwad (26 %) and undercut bank (23 %). Light intensity and current velocity were important variables influencing habitat use. For example, use of half-log structure was a function of low velocity and light intensity. These results suggest half-log structure may provide the most suitable cover for age-0 spotted bass.

[SUN, 8:30-8:50]

Purchase¹, C.F., N.C. Collins¹, B.A. Henderson², and G.E. Morgan³. 1Department of Zoology, University of Toronto at Mississauga, Mississauga, Ontario; 2Lake Huron Research Unit, Ontario Ministry of Natural Resources, Owen Sound, Ontario; 3Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Ontario.
(email:cpurchas@credit.erin.utoronto.ca)

TEMPERATURE EFFECTS ON POPULATION DYNAMICS OF YELLOW PERCH

Yellow perch (*Perca flavescens*) represent an economically important commercial and recreational fishery in certain areas of North America. An understanding of the relationships between life history parameters and environmental variables is necessary to determine the effects of climate change on this resource. We investigated the effect of temperature on population dynamics of yellow perch by comparing life history parameters of perch from ~ 50 lakes. These were sampled over much of northeastern and south-central Ontario, and encompassed an atmospheric growing degree day (>5°C) range of ~1200-2000. Life history parameters (growth, maturation, reproductive investment) were calculated for each population on a sex specific basis. Growth of yellow perch was faster in warmer lakes. Faster growing populations matured earlier and had a higher relative fecundity. If natural mortality follows expected patterns, southern Ontario populations have higher intrinsic rates of increase, and thus higher sustainable fish mortality rates than those in the north. Based on temperature alone, global warming is expected to increase the maximum sustainable harvest rates for yellow perch.

[FRI, 16:40-17:00]

¹Quinlan, R., ²A.M. Paterson, ³J.P. Smol, ¹M.S.V. Douglas and ²B.J. Clark. ¹Department of Geology, University of Toronto, ²Dorset Environmental Sciences Centre, Ontario Ministry of Environment, ³Department of Biology, Queen's University

USING DIFFERENT CRITERIA TO CALCULATE HYPOLIMNETIC OXYGEN CONCENTRATIONS: IMPLICATIONS FOR ENVIRONMENTAL ASSESSMENT AND LAKE MANAGEMENT.

In the limnological literature, different methodologies are used to calculate the extent of the hypolimnion, and consequently the concentration of dissolved oxygen (DO) in the hypolimnion. For example, one method involves defining the top of the hypolimnion as the first strata below the thermocline where temperature change is less than 1 °C in 1 m. Another method involves creating a temperature profile and defining the top of the hypolimnion as the intersection point between two straight lines, one that follows the temperature curve at the thermocline, and one from the deepest strata. Calculation of hypolimnetic DO concentrations can also be affected by the sampling resolution of oxygen and temperature profiles. In this study we calculated hypolimnetic DO concentrations from 80 lakes located in south-central Ontario. With end-of-summer DO-temperature profiles we used different criteria for defining the hypolimnion, and used different sampling resolution (1 m strata vs. 2 m strata), when calculating DO concentrations. We then compared results, based both on individual profiles and on multiple-year averages. Some methodologies produced lower calculated DO levels, which could influence the classification of lakes in terms of lake trout (*Salvelinus namaycush*) management. As some lakes had relatively long time series of data (up to 20+ years), we also compared the impact of using different criteria on the interpretation of long-term changes in hypolimnetic oxygen.

[POSTER]

Ramcharan CW, Dept. Oceanogr., Louisiana State University, Yan ND, Dept. Biology, York University. (cramcha@LSU.edu)

CAN HERBIVOROUS ZOOPLANKTON CONTROL ALGAE BIOMASS?

An enduring question in limnology is how strongly populations of phytoplankton are controlled by the community of herbivorous zooplankton. The frequency with which grazers have been found to control algae seems to vary considerably among published studies. Ideally, a survey of grazing rate estimates from many different waterbodies could perhaps answer the question of grazer control. A similar approach is to estimate community clearance rate for a variety of different lakes. Over many years, the Ontario Ministry Of the Environment has amassed a dataset of individual zooplankton body lengths collected from many lakes. We used published allometric models to estimate individual grazing rates and then summed these to yield community clearance rates for a total of 2,370 lake/dates of data. Not surprisingly, clearance rate was strongly (auto-) correlated with biomass and also varied with taxonomic composition of the herbivore assemblage. There were, however, three notable results: (1) Clearance rates sufficient to deplete algae occurred rarely. (2) Cladocera were usually more important grazers than copepods. And, (3) contrary to common belief, large *Daphnia* were not responsible for substantial grazing pressure. Overall, our results suggest that algae populations in oligotrophic lakes may be more controlled by nutrient dynamics than by losses to herbivory.

[SAT, 9:30-9:50]

Reid, S. and C. Wilson. Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario
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DEVELOPMENT OF MTDNA MARKERS FOR IDENTIFICATION OF MOXOSTOMA SPECIES IN ONTARIO RIVERS.

To date, the understanding of the ecology, distribution and status of redhorse species in Ontario rivers has been limited by difficulties associated with species identification (especially larval and juvenile redhorse). As several species found in Ontario are of considerable conservation concern (COSEWIC- listed), non-lethal identification methods are valuable and necessary to monitor the persistence and viability of remaining populations and to help with the identification of habitats in need of special protection (e.g. spawning and juvenile rearing areas). Molecular genetic techniques have emerged as a powerful set of tools for the conservation and management of endangered species. We collected tissue samples from adult redhorse of each species from different drainages across their range in southern and central Ontario. MtDNA sequences from ATPase 6 and 8, and cytochrome b regions were identified and tested for their ability to discriminate between the six species and confirm the

existence of new populations. The utility of these regions to describe within and between redhorse population genetic structure is also discussed.

[POSTER]

Reist, J.D. Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, R3T 2N6. (reistj@dfo-mpo.gc.ca)

ARCTIC AQUATIC ECOSYSTEM SCIENCE: A MISSING COMPONENT IN CANADA'S CLIMATE CHANGE ACTION STRATEGY.

The mean surface air temperature of the Arctic (60°N to pole) is predicted to increase by up to 5°C by 2100 in comparison to the 1990-1999 mean (warmest on record), far greater than either the global or temperate average changes. Other predicted changes include shifts in precipitation, increased climate variability, high regional heterogeneity, and a host of second- and third-order effects of these on aquatic habitats. Similarly, contaminant loadings, industrial development, exploitation and surface ultraviolet irradiance will likely increase over the same time. Such changes will inevitably cascade to affect arctic aquatic ecosystems, fish, fisheries and the people who depend upon them. The current emphasis on assessment of potential impacts from single factors, and the development of mitigative/adaptive strategies implies that arctic aquatic systems are well enough known to allow the prediction of reasonably accurate first- and higher-order effects. In general, our knowledge of the structure, function and potential responses for arctic aquatic ecosystems, biota, and functional processes is poor. This gap precludes reasonable forecasting of anything but a few simple first-order effects, and then these only qualitatively. Quantitative prediction is virtually impossible for any system. Continued reliance upon southern-based science, the present norm for most interpretation and prediction of arctic climate change impacts, is naïve and short-sighted due to fundamental differences between northern and southern biota and their ecosystems. Similarly, importing 'southern' adaptive solutions to most other arctic fish and fishery problems has failed and climate change will be no exception. Thus, northern-based solutions are required. This entails the need to conduct comprehensive and long-term research locally to understand the systems and their biota, understand the role and potential changes in forcing variables, integrate the effects of all impacts, and manage these. This, in turn, requires comprehensive and integrated multi-disciplinary long-term research studies which are adequately funded for example arctic aquatic systems.

[SUN, 10:50-11:10]

Reist, J.D.¹ and N.E. Mandrak². ¹Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, R3T 2N6 (e-mail reistj@dfo-mpo.gc.ca); ²Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, L7R 4A6 (e-mail mandrakn@dfo-mpo.gc.ca).

CHANGES IN THE FRESHWATER FISH FAUNA OF ARCTIC CANADA: 1973 TO PRESENT.

The freshwater fish fauna of the Canadian Arctic is probably the most poorly known of any major drainage in Canada. Freshwater Fishes of Canada (1973) listed 59 species as present in the Arctic and northwestern Hudson Bay drainages. Since then, several changes have resulted in the fauna which present consists of 62 species including: deliberate introduction of cutthroat trout by British Columbia (+1 species); recognition that bull trout and deepwatersculpin are present (+2 species), and blackfin cisco are absent (-1), as a result of taxonomic revision; new recorded occurrences of leopard dace and coho salmon (+2); and, nomenclatural shifts for four species (no net change to total). Since 1973, other changes in our understanding of arctic freshwater fishes include limited additional information on distributions, increased biological information for some exploited taxa in some areas in support of fishery management, and recognition of the type and increasing magnitude of threats to many taxa. Despite the intervening 30 years, little focussed work has occurred in the north and most biological understanding of arctic fish is still transferred by analogy from the south, primarily through compendia such as Freshwater Fishes of Canada. Current threats likely to result in increasing impacts in the future include: climate change, contaminant loadings, industrial development, human population increase and increasing exploitation pressures. At present most arctic populations of all species appear to be relatively secure, however, the deepwater sculpin and shortjaw cisco are listed by COSEWIC on the basis of status in southern populations. A perennial problem in the north is the lack of knowledge specific to the local fish faunas which occupy a vast and ecologically diverse area. Thus substantive research is required for all species if we are to meet obligations for impact assessment, and conservation and sustainability goals.

[14:40-15:00]

Rennie, M.D., Collins, N.C., Henderson, B. and Shuter, B. Department of Zoology, University of Toronto at Mississauga (e-mail mrennie@utm.utoronto.ca).

EVALUATING BIOENERGETIC ACTIVITY COSTS IN YELLOW PERCH POPULATIONS USING THE MERCURY MASS BALANCE MODEL.

The importance of energy allocated to activity as a life history parameter of organisms has been long recognized, but has remained a difficult parameter to measure accurately. As a result, activity parameters are often greatly oversimplified or excluded entirely from ecological models of bioenergetics and life history. This paper reports progress on a study designed to evaluate sources of error in estimates of consumption and bioenergetic activity costs obtained with a mercury mass balance bioenergetics model for two populations of central Ontario yellow perch. Here, I specifically address whether differences in activity could account for differences in growth trajectories between these two populations, and between sexes within each

population. I measured growth and mercury concentrations in fish and food twice during the 2001 growing season. Growth estimates used in the bioenergetic calculations were based on differences between adjacent age classes collected at one time. Separate estimates for the two fish collections allowed me to assess the precision of growth and consumption estimates based on differences between adjacent age classes. In addition, differences in activity estimates between the two lakes will be compared with direct measurements of activity made by snorkeling.

[SAT, 10:30-10:50]

Rennie, M.D. and Collins, N.C. Department of Zoology, University of Toronto at Mississauga (e-mail mrennie@utm.utoronto.ca).

DO ENVIRONMENTAL FACTORS AFFECT MERCURY CONCENTRATIONS IN BENTHIC INVERTEBRATES?

Mercury mass balance models for fish consumption are more sensitive to variation in prey methylmercury concentrations than any other parameter in the models. Because of the complexity of analytical methods for methylmercury, its concentrations in prey are either estimated from literature values or from total Hg concentrations. A great deal of variation in total Hg, methylmercury, and the proportion of total Hg: methylmercury has been documented in benthic organisms and plantivorous fish across different aquatic environments. Estimates of these parameters must account for this variability in order to generate accurate and precise model outputs. Environmental factors such as water colour and pH have been shown to explain up to 73% of the variation in zooplankton methylmercury concentrations (Wescott and Kalff, 1996). Using the literature and two years of invertebrate and water chemistry data I collected from two lakes, I determine whether variation in methylmercury concentrations in benthic invertebrates is related to and might be predicted from environmental variables routinely measured by researchers and government agencies.

[POSTER]

John D. Reynolds Centre for Ecology, Evolution and Conservation, School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ, UK (Email: Reynolds@uea.ac.uk)

THE BIOLOGY OF RARITY AND EXTINCTION RISK IN FISH SPECIES

Fish species are arguably the most threatened class of vertebrates. They are also the most controversial group when it comes to assessing extinction risk, especially for marine species. Life histories might be expected to predict vulnerability, through their fundamental connections with ecology and population dynamics. However, comparative studies of a wide variety of taxa have found contradictory results. I will explore the reasons for these conflicting findings and then focus on new comparative analyses of marine and freshwater fish species. Differences among taxa in body size and age at maturity are correlated as predicted with differences in range sizes and threat status of freshwater fishes. These life history traits also predict responses of marine populations to fishing mortality, as well as maximum population growth rates and recovery. In contrast, fecundity has low explanatory power in most analyses. Indeed, contrary to some expectations, the species that are most sensitive to fishing pressure often have the highest fecundity. Many marine species have declined by more than 95%, and some have become extirpated over large parts of their ranges. These findings therefore address recent controversies concerning the vulnerability of fishes to extinction, and they reveal the benefits as well as limitations in using life histories for prioritising species in conservation assessments.

[FRI, 8:25-9:05]

Ricciardi, A. Redpath Museum, McGill University, Montreal, Quebec (tony.ricciardi@mcgill.ca)

INVASIONAL MELTDOWN IN AQUATIC ECOSYSTEMS: PATTERNS, IMPACTS AND IMPLICATIONS

Species invasions are often treated as isolated events whose effects are independent of one another. However, a growing number of studies demonstrates that introduced species can interact in ways that alter or magnify each other's ecological impact. Through direct and indirect mutualisms and commensalisms, one invader may promote the population growth and range expansion of another invader, with cascading repercussions in the food web. Multiple invasions may thus act synergistically, i.e. their joint impact may be greater than the sum of the effects of invaders acting alone, with potentially serious consequences for biodiversity and fisheries management. Evidence of this phenomenon is found in a broad range of aquatic ecosystems including the Great Lakes, the St Lawrence River, the Potomac River, and the northwest Atlantic coast. It suggests that ecosystems subject to a high frequency of invasions will become increasingly disrupted by unanticipated synergies—a process termed “invasional meltdown”. This being the case, even a modest reduction of invasion rates through vector controls could yield substantial benefits.

[FRI, 13:40-14:00]

Richardson, J.S. and M.D. McArthur. Dept of Forest Sciences, University of British Columbia, Vancouver, BC, V6T 1Z4 (e-mail: jrichard@interchange.ubc.ca).

VARIATIONS IN THE QUALITY OF ORGANIC MATTER SUPPORTING STREAM FOOD WEBS

Organic matter inputs to aquatic systems, particularly small streams, can contribute a large proportion of the fixed energy used in their food webs. However, the source of that organic matter may have a large influence over the nutritional value to consumers. In general, organic matter from coniferous species is considered to be of lower quality than that from most

deciduous species, but few species of conifers have been contrasted. One group of consumers feeds primarily on coarse particles of organic matter, and we found that hemlock was less often consumed by typical detritivores than alder or western red cedar. Cedar had more orthoclaadiine midges and fewer mayflies than alder. Loss rates of the three species were alder > hemlock and cedar. Loss rate studies were done in summer and autumn, and during summer hemlock lost mass more quickly than cedar, but that relation reversed in autumn, indicating some phenological effect, probably of particular consumers. One of the most abundant forms of organic matter in small streams is dissolved organic carbon (DOC), largely originating from groundwater inputs. DOC can vary considerably in quality, and we used leachates of 5 species of leaf litter to determine quality based on an assay of bacterial productivity using [3H]-leucine uptake. We found whole leachates, corrected for DOC concentration, ranked for their support of bacterial productivity as alder > vine maple > red cedar > Douglas-fir > hemlock. Bacterial growth rates on most leachates were greatest after one hour, and then declined in a negative exponential pattern. The DOC less than 10 kDa supported lower bacterial growth rates than DOC from whole leachates on a per mg DOC basis, indicating that larger molecules were better substrates. The DOC C:N atomic ratio was the best predictor of bacterial growth ($r^2 = 0.84$). Disturbance, such as forest harvest, and succession can lead to large changes in riparian vegetation and the types of organic matter inputs, which likely add a large qualitative aspect to the nature of detrital-based food webs, which hasn't yet been addressed.

[SAT, 9:30-9:50]

R. M. Rideout¹, E. A. Trippel² and M. K. Litvak¹ 1Department of Biology, and Centre for Coastal Studies and Aquaculture, University of New Brunswick, Saint John, NB, E2L 4L5 2Fisheries and Oceans Canada, Biological Station, St. Andrews, NB, E5B 2L9

EFFECT OF EGG BATCH NUMBER ON EARLY LIFE HISTORY TRAITS OF HADDOCK, *MELANOGRAMMUS AEGLEFINUS*.

Low survivorship of larvae acts as a bottleneck in both the culture and recruitment of haddock, *Melanogrammus aeglefinus*, a serial spawning gadid that releases several batches of eggs at discrete intervals throughout the spawning season. We monitored pairs of spawning haddock to determine if possible changes in gamete and larval quality throughout the spawning season contribute to low larval survivorship. Eggs were collected on a daily basis, measured, weighed and incubated at 5°C to determine hatch rates. We selected subsamples of larvae from early, middle and late batches which were grown under identical rearing conditions. We followed growth, survival and morphological development of larvae from these three batch times. Egg size and dry weight decreased throughout the spawning season but did not influence hatch rate. Batch number significantly influenced larval morphology but this in turn did not influence larval survivorship through the first 20 days after hatching.

[POSTER]

Robertson¹, M. J., D. A. Scruton² and J. A. Brown¹. 1Biopsychology Programme, Memorial University of Newfoundland, St. John's, NF, A1C 5X1. 2Department of Fisheries and Oceans, Box 5667, St. John's, Newfoundland, A1C 5X1 (email: robertsonmj@dfp-mpo.gc.ca).

SEASONAL EFFECTS OF SUSPENDED SEDIMENT ON THE BEHAVIOUR OF ATLANTIC SALMON PARR

Short-term increases of stream suspended sediment levels can occur as a result of forestry, mining and hydro operations. Experiments were conducted in an artificial stream to determine the effect of such increases on the behaviour of wild-caught Atlantic salmon parr (mean \pm S.E. fork length, 139.3 \pm 1.5 mm) during the fall (12.8-14.1°C) and winter (3.1-3.8°C) seasons. The introduction of suspended sediment initiated a feeding response, as fish emerged from instream cover to feed on small aggregates of sediment drifting in the water column. Observations of feeding and territorial behaviour declined as the concentration of suspended sediment exceeded \sim 42 NTU (nephelometric turbidity units) from a background level of \sim 14 NTU. Fish in the fall trials displayed a fright response at sediment levels exceeding \sim 22-42 NTU. This fright response involved shoaling and moving frantically around the stream tank, as the fish apparently tried to abandon the turbid water. Similar fright behaviour was not observed in winter. Seasonal differences in the way fish respond to suspended sediment may be related to short term energy requirements. In fall, when feeding and accumulating lipid reserves is important for subsequent survival, fish may try to abandon turbid water. In winter, when conserving lipid reserves is crucial for survival, searching for less turbid water may not be worthwhile. The results from this study may help in providing guidelines for the protection of salmon populations in naturally non-turbid streams.

[FRI, 13:40-14:00]

Robertson¹, M. J., D. A. Scruton², K. D. Clarke² and J. A. Brown¹. 1Biopsychology Programme, Memorial University of Newfoundland, St. John's, NF, A1C 5X1. 2Department of Fisheries and Oceans, Box 5667, St. John's, Newfoundland, A1C 5X1 (email: robertsonmj@dfp-mpo.gc.ca).

DIET AND INTERHABITAT MOVEMENT OF RADIO-TAGGED ATLANTIC SALMON PARR IN WINTER.

Radiotelemetry was used to investigate movement of Atlantic salmon parr in Stoney River, Newfoundland during the early winter (Nov/Dec, 6.0 \pm 0.1°C) and late winter (Jan/Feb, 0.8 \pm 0.0°C) of 2000 and 2001. Overall, diel movement rates (/h) within fluvial habitats was 2.4 times greater in early than in late winter. Additionally, diel movement increased with fish fork length in early winter while no trend was apparent in late winter. In early winter, the pattern of diel movement was different

between years. In 2000 (7.1-9.2°C), early winter movement rates were high throughout the diel cycle. While in early winter 2001 (2.3-9.3°C), the diel pattern was similar to the late winter pattern, with lowest movement rates occurring during the day. As water temperature in early winter 2001 approached late winter levels, temperature may have been responsible for the late winter diel movement pattern observed. Interhabitat movement, between lacustrine and fluvial habitats, was also higher (3 times) in early than in late winter. Furthermore, in early winter, a greater proportion of fish (15/25) utilized the largest lacustrine habitat (Stoney Pond) than in late winter (1/27). In summary, tagged fish in early winter displayed a high level of activity throughout the diel cycle and moved into Stoney Pond. These behaviours are expected to maximize energy intake and allow fish to gain the resources necessary for winter survival. All tagged fish in early winter had free flowing milt and were therefore assumed to be precocial parr. The increased movement of larger fish during this period may reflect the greater need to replenish post-spawning energy loss. In late winter, tagged fish had low activity levels, moved predominantly during hours of darkness (civil twilight and night) and avoided Stoney Pond. These behaviours should conserve energy and minimize predation risk.

[POSTER]

Rolland, A. and Bird, D. Université du Québec à Montréal, Département des Sciences Biologiques. 1200, rue Saint Alexandre, Montréal, Québec, Canada. H3B 3H5 (email : rolland.anne@internet.uqam.ca)

EFFECTS OF ENVIRONMENTAL FACTORS AND COMPOSITION OF CYANOBACTERIAL COMMUNITY ON THE OCCURRENCE OF HEPATOTOXIC CYANOBACTERIAL BLOOMS IN EASTERN TOWNSHIPS, QUEBEC

Cyanobacterial mass occurrences or water blooms are a major problem and are observed in eutrophic lakes and reservoirs around the world. Many water bodies in Quebec provide a good environment for cyanobacterial growth. Cyanobacterial blooms can be accompanied by the production and release of hepatotoxins, which are responsible for animal and human poisoning. One of them, the cyclic heptapeptide microcystin, is known to be a potent tumor promoter and is a serious concern in drinking and recreation water supplies. In order to elucidate the role of taxonomic and environmental factors in toxin production, we sampled two eutrophic lakes and two reservoirs on a bimonthly basis in Eastern Townships region of Quebec between May and October 2001. Microcystin content was determined using a colorimetric protein phosphatase inhibition assay, and physicochemical factors were measured. We also paid attention to changes in species composition of the cyanobacterial community to know whether toxicity level could be attributed to the presence or the absence of certain species. At present, our results suggest that variations in toxicity level should be attributed not only to the abundance of cyanobacteria but also to changes in cyanobacterial composition. Furthermore, total phosphorus concentration appears to modulate microcystin production.

[POSTER]

Rosenfeld, Jordan. Fisheries Research Section, Province of British Columbia, 2204 Main Mall, Vancouver V6T 1Z4 (jordan.rosenfeld@gems4.gov.bc.ca)

ESTIMATING SPATIALLY EXPLICIT GROWTH RATE POTENTIAL FOR JUVENILE TROUT IN A COASTAL STREAM

Simple bioenergetic models for drift-foraging fishes can be used to estimate Growth Rate Potential (GRP) as a function of potential energy intake (from invertebrate drift abundance) and estimated swimming costs at any given focal point in a stream. To develop spatially explicit estimates of GRP topography and understand how the distribution of GRP differs between habitat types in small coastal streams, we measured velocity and depth at all points on a 20 x 20 cm grid superimposed on 5 pools, 5 riffles, 5 runs, and 5 glides in a small (3m channel width) coastal cutthroat trout rearing stream. The effects of changes in discharge on the distribution of energetically favourable habitats was also assessed by measuring velocities and drift at both high and low flows.

[SAT, 9:10-9:30]

Richard Rowe, Ontario Ministry of Natural Resources, North Bay Ontario.

LONG TERM TRENDS AND RECENT EFFORTS TO REHABILITATE THE LAKE NIPISSING WALLEYE FISHERY .

Lake Nipissing is a large (87,400 ha.) mesotrophic lake in northeastern Ontario. The walleye population of Lake Nipissing has been fished at levels close to or exceeding sustainable harvests for the past thirty years. The number, biomass and mean size of harvested walleye have steadily decreased. Declining walleye abundance has not been reflected in angler success rates. The age structure of this population is skewed towards young fish. Walleye mature at a young age and fecundity has increased. The sex ratio of mature fish is now skewed towards males. In 1999 new angling regulations were implemented in an effort to reduce harvests and protect mature fish. Angler possession limits were reduced from six to four, open water and winter angling seasons were shortened, and a protected slot size, 40 cm – 60 cm was implemented. A series of workshops involving local stakeholders and fisheries assessment specialists from across North America was held in 1999 in order to develop a new walleye assessment program for Lake Nipissing. Since then, assessment has focused on quantifying yields and developing indices to measure the success of the new regulations. Angler creel surveys and fall walleye netting has been conducted annually in order to track changes in the population.

[FRI, 16:40-17:00]

Rowe, S. and J.A. Hutchings. Department of Biology, Dalhousie University, Halifax, Nova Scotia, B3H 4J1, Canada (email: rowes@is2.dal.ca)

THE MATING BEHAVIOUR OF ATLANTIC COD

Atlantic cod (*Gadus morhua*) had been fished for hundreds of years and was one of the most important commercial fish species worldwide until the recent collapse of many populations. Amazingly, even now we know very little about this species' reproductive behaviour. Our research employed a quantitative approach to understand causes and consequences of variation in the mating system of Atlantic cod at the individual and population levels. We incorporated both detailed behavioural studies in the laboratory and observations of cod captured in the commercial fishery. Preliminary observations indicate tremendous variation in reproductive behaviour and mating success both within and between populations. Furthermore, variation in reproductive behaviour and mating success appears to be related to the ability of males to produce sound. Knowledge of Atlantic cod spawning behaviour will likely contribute to better understanding of population dynamics and improved ability to predict the impact of fishing on cod populations.

[SAT, 15:20-15:40]

D. Roy¹, M. Docker¹, P. Hehanussa², G. D. Haffner¹, and D. Heath¹ ¹Great Lakes Institute, University of Windsor, Windsor, Ontario, Canada, ²Research Development Center for Limnology, Indonesian Institute of Science, Cibinong, West Java, Indonesia. Email: royf@uwindsor.ca

GENETIC EVIDENCE OF ADAPTIVE RADIATION IN A CONTINENTAL ISLAND LAKE.

Like the African Cichlids, the Telmatherinid fishes of Lake Matano, Sulawesi Island, Indonesia, are characterised by a variety of subtly different morphotypes. These morphotypes have been tenuously described as different species based largely on colouration patterns, and highly overlapping morphological characters (Kottelat 1991). Telmatherinids are endemic to Lake Matano which has a long stable hydrological history, and until recently, been virtually isolated. Lake Matano is also rather small (164 km²) with a relatively simple piscian community. These factors combined provide an excellent opportunity to track and possibly document speciation and adaptive radiation. In this study, we use morphometric features and partial sequences of the 16S ribosomal subunit in the mitochondrial genome to explore the amount of divergence and diversity both within, and among, the different fish genera endemic to this lake. We hypothesize that, of the endemic fish genera, the Telmatherinid genus is the most diverse and has the highest amount of intrageneric divergence. While morphometric features fragment the endemic fish community at the genus level in a predictable manner, they fail to resolve intrageneric differences. Derived 16S phylogeny, however, resolves both inter- and intrageneric differences. Average pair-wise genetic distances between sequences reveal that Telmatherinids are indeed more genetically diverse and divergent than the other fish genera endemic to this lake. These results suggest that Telmatherinids may be under stronger selective pressure and are exhibiting adaptive radiation in this system.

[FRI, 14:20-14:40]

Lars G. Rudstam (email Rudstam@cornell.edu), Anthony J. VanDeValk, Connie M. Adams, Jeremy T. H. Coleman, John L. Forney, Milo E. Richmond. Cornell Biological Field Station and Department of Natural Resources, Cornell University, Bridgeport, NY 13030, and New York Cooperative Fish and Wildlife Research Unit USGS-BRD and Department of Natural Resources, Fernow Hall, Cornell University, Ithaca, NY 14853

DOUBLE-CRESTED CORMORANT PREDATION AND THE POPULATION DYNAMICS OF WALLEYE AND YELLOW PERCH.

Double-crested cormorants (*Phalacrocorax auritus*) increased dramatically in both North America and Europe during the 1990s. The potential effects of this increase on fish populations are debated intensively. In Oneida Lake, New York, cormorants were first observed nesting in 1984 and had increased to over 360 nesting pairs by 2000. Concomitant with this increase in piscivorous birds was a decrease in the adult walleye (*Stizostedion vitreum*) and yellow perch (*Perca flavescens*) populations. Analysis of a 40-year data series shows higher mortality between age 1 and adults for both species in the 1990s compared to the previous three decades. Cormorant diet selection and abundance was investigated from 1995 to 2000 using a combination of cast pellets, regurgitants, and stomach analysis. Walleye and yellow perch were a major portion of the cormorant diet during these years (40 to 82% by number). Estimates of total number of fish in the 1994 to 1998 year classes consumed by cormorants as sub-adults were similar to the number lost due to increased mortality of those age groups and ranged from 21 – 60% of predicted recruitment to age 4 for walleye and 9 – 121% of predicted recruitment to age 3 for yellow perch. Exploitation rates by cormorants on adult walleye (age 4+) was low (1.1% per year), but higher for adult yellow perch (age 3+, 7.7% per year). A population model shows that the decline in yellow perch could be attributed to increased mortality of sub-adults and adults, but that the decline in walleye was the result of both increased mortality from age 1 to age 3, and decreased number of age 1 fish. Our analysis suggests that predation by cormorants on sub-adult percids is causing the decline in the yellow perch population and contributing to the decline in the walleye population in the lake. This impact of bird predation on percid populations in Oneida Lake occurs because cormorants feed on larger fish that are beyond the size range where compensatory mechanisms are important.

[SAT, 14:20-14:40]

Lars G Rudstam, Department of Natural Resources, Cornell University, Ithaca, NY (email: Rudstam@cornell.edu).

COMPARISONS BETWEEN HYDROACOUSTICS AND TRADITIONAL SAMPLING GEAR - DO WE STILL NEED TO TOUCH THE FISH?

Despite continued development and decrease cost of hydro acoustics, fisheries scientists working in lakes have been slow to adopt the technique as a standard sampling tool. This may be partly because the method is far from perfect, and anything that have an acoustics density different from the water medium will give rise to an echo and may be counted as fish. Further, there is still no possibility of determining fish species with acoustics. Nevertheless, recent advances include a better appreciation for the variability in fish target strength and therefore better acoustics size estimates, as well as a better understanding of limitation and effects of bubble production. I will discuss results from comparisons between estimates of abundance and size made with acoustics and standard sampling (gill nets, trawls and Miller larval fish samplers) using examples from surveys of alewife and smelt populations in Lake Erie, Lake Champlain and New York Finger Lakes and surveys of larval perch and other young-of-year fish from Oneida Lake.

[SAT, 9:50-10:10]

Rusak, J. A., T. K. Kratz, B. J. Benson, P. M. Montz, T. M. Meinke and S. R. Carpenter. Center for Limnology, University of Wisconsin – Madison, Boulder Junction, WI (jarusak@wisc.edu)

CLIMATE WARMING IMPACTS ON WATER TEMPERATURES AND ZOOPLANKTON DYNAMICS

Although relationships between global warming and freeze and thaw dates of temperate lakes have been observed, documenting the effects of recent climate change on lakes during the ice-free period has been difficult. Here, we present 20-year records of water temperature from 7 temperate lakes that demonstrate the effects of climatic warming on epilimnetic thermal structure among a regional set of lakes. Mean water temperatures were coherent among lakes, indicating climatic responsiveness, and also showed an increasing trend over this long-term record. Although this warming trend did not appear to have a pronounced effect on annual primary and secondary production, climatic variability did appear to alter zooplankton community dynamics, indicating the potential for restructuring of lake food webs with predicted future warming trends.

[FRI, 17:00-17:20]

Maria Pia Aguilera Salas, Edward J. Maly (mp_agui@alcor.concordia.ca , malyed@vax2.concordia.ca) Department of Biology, Concordia University, 1455 de Maisonneuve West, Montreal, QC.

DISTRIBUTION PATTERN OF *HESPERODIAPTOMUS SHOSHONE* AND *LEPTODIAPTOMUS COLORADENSIS* AND ITS EFFECT ON THEIR MATING AND REPRODUCTIVE SUCCESS.

It was the main objective of this study to establish the spatial distribution of *Hesperodiaptomus shoshone* (Forbes SA) and *Leptodiaptomus coloradensis* (Marsh). I then attempted to determine whether mating and reproductive success (proportion of females carrying spermatophores, the proportion of females carrying clutches and the proportion of males attaching spermatophores) was affected by spatial distribution. The final goal was to determine whether there was a size difference between individuals within and outside aggregations and a corresponding clutch size difference. Samples were taken from four ponds located at Mexican Cut, Colorado. Results indicated that *H. shoshone* had a patchy distribution while *L. coloradensis* showed a random pattern in its dispersal. Further analyses were only performed on *H. shoshone*. Mating success was higher for both males and females within aggregations. Female reproductive success followed the same pattern. Females within aggregations were significantly larger, but no difference was observed among males and clutch size was significantly larger for females within aggregations. The distribution of *H. shoshone* may in part be attributed to physical processes and local pressures such as predation and food allocation. From an adaptive standpoint, their distribution patterns seem to increase the frequency of mating encounters, thereby enhancing the mating and reproductive success of individuals found within these patches.

[SAT, 9:10-9:30]

J.C. Schulenburg¹, P.J. Dillon¹, K.M. Somers^{1, 2}, J.G. Winter^{1, 2}, R.A. Reid², and C. Paterson¹. ¹Trent University, 1600 West Bank Drive, Peterborough, Ontario, Canada, K9J 7B8, ²Ontario Ministry of the Environment, Dorset Environmental Science Centre, Dorset, Ontario, Canada P0A 1E0 (e-mail: jschulenburg@trentu.ca)

DETERMINING THE IMPACTS OF GOLF COURSE DEVELOPMENT ON THE BENTHIC MACROINVERTEBRATE COMMUNITIES IN STREAMS ON THE PRECAMBRIAN SHIELD

The transformation of land use from forest to golf course is dramatic and involves changes to the terrain that can impact not only the streams within the altered area, but also downstream. The Precambrian Shield is particularly sensitive to such changes because of its shallow soils that overlay relatively insoluble silicate bedrock. Clear cutting, burning, laying of imported sand and turf grass, installing ditches and retention ponds, and application of fertilizers and pesticides are some of the activities that occur during construction of a golf course that may affect the physical and chemical quality of streams and the biological community that inhabit them. The hypothesis that we tested is that changes in physical and chemical parameters due to golf course construction and operation on the Precambrian Shield alter the structure of benthic macroinvertebrate community and

reduce biodiversity. Impacts on the benthic macroinvertebrate community structure were assessed using rapid bioassessment and the reference-condition approach. Macroinvertebrate indices, a riparian bank quality index, and water chemistry parameters are compared to determine the factors that alter macroinvertebrate communities during golf course development on the Precambrian Shield.

[SAT,15:20-15:40]

Selbie, D.T., Paleoecological Environmental Assessment & Research Laboratory (PEARL), Queen's University, Kingston, Ontario (selbied@biology.queensu.ca), Lewis, B., Alaska Department of Fish & Game, Ketchikan Alaska, Finney, B.F., School of Fisheries & Ocean Sciences, University of Alaska at Fairbanks, Fairbanks, Alaska & J.P. Smol, Paleoecological Environmental Assessment & Research Laboratory (PEARL), Queen's University, Kingston, Ontario

A MULTI-PROXY PALEOLIMNOLOGICAL ASSESSMENT OF LONG-TERM POPULATION DYNAMICS IN THE ENDANGERED SNAKE RIVER SOCKEYE SALMON (*ONCHORYNCHUS NERKA*) RETURNING TO REDFISH LAKE, IDAHO

The Columbia River Basin has experienced many human-induced changes in the past century, many of which have had negative impacts on this system and its tributaries. Perhaps the most controversial, as well as economically, culturally and ecologically important taxon affected in this system, has been the Pacific salmon. Sockeye salmon (*Oncorhynchus nerka*), in particular, have been extirpated or endangered in much of their previous range throughout the Pacific Northwest. In 1991, following a petition by the Shoshone-Bannock Tribes, the Snake River Sockeye Salmon was listed as endangered. These fish spawn a remarkable 1,448 km inland at an elevation of 1,981 m, and run a gauntlet of both natural and anthropogenic stressors, including 8 main-stem dams on the Columbia and Snake rivers. Influences from the "4 H's" identified as causes of southern salmon declines (i.e. habitat degradation, harvest pressures, hatchery-raised fish and hydroelectric developments) result in a multi-stressor effect on returning salmon, simultaneously making causal linkages to decline difficult. Furthermore, little data exist on long-term salmon productivity beyond contemporary escapement estimates (ca. 1950's), when significant stock degradation had already occurred. Using isotopic ($\delta^{15}\text{N}$) and biological (diatom, zooplankton) proxy data from stratigraphically intact sediment cores collected from Redfish Lake, Idaho, we have reconstructed salmon returns over the past 500 yr. Sharp declines in inferred spawner returns towards extinction occur ca. 1910. This is concurrent with the construction of Sunbeam dam on the Salmon River, just downstream from Redfish Lake, constructed to power the Yankee Fork gold dredging operation. Prior to this shift, population dynamics are thought to be related to ocean-climate variability.

[POSTER]

Sharma, S.¹, Jackson, D.A.¹ and E.T. Howell². 1 Department of Zoology, University of Toronto, Toronto, Ontario M5S 3G5. 2 Ontario Ministry of Environment. Environmental Monitoring and Reporting Branch, Etobicoke, Ontario. (Email: ssharma@zoo.utoronto.ca)

SPATIAL AND TEMPORAL EXAMINATION OF WATER QUALITY AND FISH COMMUNITY RELATIONSHIPS IN THE EASTERN LAKE ERIE BASIN.

Lake Erie has experienced extensive changes in water quality conditions and community structure over the past decade. As a result, there has been a substantial decline in the walleye (*Stizostedion vitreum vitreum*) population, an important sport and commercial fish in the region. Environmental monitoring surveys were conducted in the eastern basin of Lake Erie over a nine month period in 2001 to acquire a detailed assessment of water quality conditions by collecting near-continuous and discrete measurements of selected water quality and physical parameters over a survey track extending the nearshore and lower reaches of tributaries. Additionally, nearshore fish community data were gathered across the same region. Using these data, a direct visual assessment of fish habitat suitable for the fish community is possible on both a spatial and temporal scale. Correspondence analysis was employed to test the similarity of biological and environmental data sets. Small-bodied fishes were found to be associated together on one end of the correspondence analysis axis. On the opposite end of the axis, larger, more predatory species were found to be associated together. Therefore, the relationships between physical habitat, water quality and chemistry can be associated with the nearshore fish assemblages to evaluate environmental remedial options in order to enhance the production of the target fish species.

[SUN, 8:50-9:10]

Shepherd, T. and M. Litvak. Department of Biology, University of New Brunswick, Saint John, NB, E2L 4L5

QUANTIFYING AREA OCCUPIED BY FISH POPULATIONS

Quantifying the area over which a population of fish is distributed is important to conservation and management efforts. Despite this, definition of a single, unbiased measure of area has proved elusive. In this study, we show how current methods of quantifying area are biased and may lead to false conclusions about how area occupied co-varies with biotic and abiotic factors. We introduce a measure of area that avoids a number of problems that affect other measures. Our measure of area is based on the idea that the area occupied by a population is defined by the proportion of samples in which individuals are found (occurrence). A problem with this approach is that due to sampling error, individuals will not always be captured in areas where they occur. Thus samples in which no individuals are captured are composed of both true zeros (structural zeros) and sampling zeros (statistical zeros). Separation of zero samples into structural and statistical zeros is necessary to properly

quantify occurrence but has proved elusive in the past. By introducing the idea of spatial reference scale, this process becomes relatively straightforward. Defining the appropriate reference scale may be done using a priori knowledge of fish behaviour or post hoc using a measure of the range of spatial auto-correlation. We show the utility of our measure through comparisons with other measures of area quantified from spatial models of a hypothetical population and from the Georges Bank Yellowtail flounder (*Limanda ferruginea*) population.

[SAT, 9:50-10:10]

B.J. Shuter Aquatic Research and Development Section, Ontario Ministry of Natural Resources, and the University of Toronto, 25 Harbord Street, Toronto, Ontario, M5S 3G5

IMPACTS OF CLIMATE CHANGE ON FRESHWATER ECOSYSTEMS AND FISH POPULATIONS: LESSONS FROM CASE STUDIES OF ONTARIO LAKE TROUT, WALLEYE AND SMALLMOUTH BASS

Climate change is expected to have significant impacts on freshwater fisheries in Canada. Fisheries and fishers will have to adapt to major changes. Significant impacts will be felt on both the overall productivity of individual ecosystems and the allocation of that productivity among native and invading species. In this paper, case studies of lake trout, walleye and smallmouth bass populations in Ontario are used to demonstrate the sensitivity of fish populations to temporal and spatial variations in climate. These descriptions of sensitivity are then used to illustrate how quantitative tools may be developed to provide regional forecasts of the potential impacts of climate change on freshwater fisheries. Such regional predictions of ecological impacts are needed in order to properly assess tradeoffs between the costs associated with protection from change, and those associated with adaptation to change.

[SUN, 10:30-10:50]

Eimer Sim, Office of the Auditor General / Bureau du vérificateur général; Office of the Commissioner of the Environment and Sustainable Development; Bureau du Commissaire à l'environnement et au développement durable; 240 Sparks St.; Ottawa, Ontario; (613) 946-0939; Fax: 941-8286; simem@oag-bvg.gc.ca

INVASIVE SPECIES - A DESTRUCTIVE FORCE HAS MET LIMITED RESISTANCE-A 2002 REPORT OF THE OFFICE OF THE AUDITOR GENERAL

Canada is assailed by invasive species that pose significant threats to both our ecosystems and our economy. In October 2002 the Commissioner of the Environment and Sustainable Development published a report on the issue of invasive species. The objective of this audit was to determine whether the federal government has mounted an effective response to the invasive species problem since signing the International Biodiversity Convention in 1992, and particularly since finalizing the Canadian Biodiversity Strategy in 1995. We looked at a number of national and international plans for dealing with invasive species. In our view, to manage the problem effectively, the federal government needs to know which invasive species pose the greatest threat to Canada's environment and economy and the pathways by which they arrive, who will do what to respond, and how effective those responses have been so that corrective action may be taken as necessary. Because it is the lead department for Canada's biodiversity strategy, we looked to see whether Environment Canada on behalf of the federal government has that information or has put in place the basic tools it needs to acquire it. Since ship ballast water is the most important source of unintentional introductions of aquatic invaders, we also examined how the federal government is managing those species and that particular pathway. We looked at whether Fisheries and Oceans Canada has the basic information necessary to manage aquatic invaders and whether Transport Canada has ensured that there is adequate legislation and enforcement to control their introduction or escape into Canadian waters from ship ballast. We found that Canada's federal government has not responded effectively to the threat posed by invasive species. Ten years after the federal commitment to prevent their introduction or to control or eradicate them, the number of invasive species in Canada continues to grow. No single department has the big picture or has the overarching authority to ensure that federal priorities are established and acted on. The federal government has not established the capability to gauge progress on its commitment to deal with invasive species and cannot demonstrate that its actions over the past decade have changed prevailing trends.

[FRI, 14:40-15:00]

X. Wang, R. E. Smith, Department of Biology, S. Schiff, R. Elgood, Department of Earth Sciences, University of Waterloo (e-mail: rsmith@sciborg.uwaterloo.ca)

DISSOLVED OXYGEN AND THE PHOTOSYNTHESIS: RESPIRATION BALANCE IN LAKE ERIE (EASTERN BASIN)

The balance between primary production and community respiration in freshwater ecosystems, an important aspect of carbon and energy flow, is a subject of debate. Several studies, dealing mainly with smaller lakes, have concluded that respiration substantially exceeds photosynthesis in oligotrophic and mesotrophic systems. In this study we used the distribution of stable oxygen isotopes ($^{18}\text{O}/^{16}\text{O}$) in dissolved oxygen and water, together with careful measurements of dissolved oxygen (DO) concentrations, to infer the balance between respiratory uptake and photosynthetic production of oxygen in the large and oligotrophic Eastern basin of Lake Erie. Data reported here were collected from four cruises from early April to mid-July in 2002, corresponding to early spring isothermal to summer stratification conditions. Both nearshore (<20 m depth) and offshore stations were included. Vertical profiles of DO concentrations were measured by a high-precision Winkler method. CF-IRMS

(continuous flow isotope ratio mass spectrometer) was used for analyzing $^{18}\text{O}/^{16}\text{O}$. Temperature and chlorophyll profiles were measured using a SeaBird CTD/fluorometer package. Temperature steadily increased in the surface mixed layer during the study period. DO concentrations varied among stations, but were slightly above saturation in April. DO was higher in May, and higher again in June, with values up to 168% saturation. The pattern suggested a significant seasonal accumulation of DO, relative to saturation values, possibly due to increased photosynthesis resulting from increasing temperature, chlorophyll concentrations and day length. DO concentrations, on average, were somewhat lower again in mid-July (about 84-110% saturation). The ^{18}O content of the DO varied among stations and, in later cruises, depths, but in the surface mixed layer it declined from about 25‰ in April to 21‰ in June. The isotopic trend provided strong evidence that photosynthesis, which tends to diminish the relative $^{18}\text{O}/^{16}\text{O}$ content of DO, was responsible for the accumulation of excess DO from spring through early summer. We are continuing the study to determine the annual development of DO concentrations and isotopic signatures. Influences of variable isotopic discrimination in plankton metabolism, and of varying isotopic signatures in water, on interpretation of $^{18}\text{O}/^{16}\text{O}$ data will be discussed.

[SUN,8:30-8:50]

Snucins, E. Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, Ontario (email: esnucins@vianet.on.ca)

THE NORDIC METHOD: A NEW TOOL FOR FISH COMMUNITY ASSESSMENT IN ONTARIO'S BOREAL SHIELD LAKES.

Standardized methods are necessary for temporal and spatial comparison of fish monitoring data. A number of them have been developed in Ontario, but each targets particular species or habitats and none was designed to inventory whole-lake fish communities. However, there exists an international standard for fish community assessment, the Nordic Method, that was developed in Scandinavia, a region with lakes similar to those on Ontario's Boreal Shield. It uses specially designed multi-mesh gill nets that sample both benthic and pelagic habitats in a depth-stratified random sampling design to provide whole-lake estimates of species richness, relative abundance and biomass, and size structure of fish assemblages. I describe the method and the results from two years of performance evaluation in Ontario's Boreal Shield lakes, including side-by-side comparisons with Ontario's standard methods. The results suggest the Nordic Method is a promising new tool for fish community assessment in Ontario's Boreal Shield lakes.

[SAT, 9:30-9:50]

Sotiropoulos, M., W. Tonn, and L. Wassenaar. Department of Biological Sciences, University of Alberta, Edmonton, AB and National Water Research Institute, Saskatoon, SK (email: bill.tonn@ualberta.ca)

COMMUNITY COMPOSITION AND STABLE ISOTOPE ANALYSIS OF POND FOOD WEBS IN THE WHOOPING CRANE NESTING AREA.

The food webs of remote ponds in Wood Buffalo National Park have remained unstudied since their 1954 discovery as the breeding habitat for Whooping Cranes. Preliminary observations showed that cranes foraged consistently and selectively in ponds that contain small fishes, suggesting that fish play an important trophic role. Multivariate analyses of 36 ponds indicate that invertebrate communities in ponds with fish are distinct from those in fishless ponds, with the former commonly lacking invertebrate predators and cladocerans. To compare fish and fishless food webs and establish the trophic positions of fish and cranes, we sampled primary producers, invertebrates, fishes, and locally collected crane feathers from three pairs of ponds (fish and fishless) for stable isotope analysis (SIA). Benthic diatoms were the primary energy source driving higher trophic levels in both fish and fishless ponds. Although omnivory was widespread, SIA showed that fish, when present, were consistently at higher trophic positions than invertebrates. Differences in $\delta^{13}\text{C}$ between invertebrates in fish and fishless ponds were due to differences at the primary producer level, perhaps reflecting differences in pond pH. Values of $\delta^{15}\text{N}$ for feathers put cranes at or above the trophic position of fish, but $\delta^{13}\text{C}$ values suggested that the wintering-ground diet may be contributing to some of the signatures. The identification of community patterns and feeding interactions within these nesting ponds should assist biologists in assessing suitable habitat for Whooping Crane conservation.

[POSTER]

Sprules, WG and A Blukacz. Department of Zoology, University of Toronto at Mississauga, Mississauga, ON L5L 1C6, C. Gubala and S. Milne, JC Headwaers Inc., Oakville, ON (gsprules@cyclops.erin.utoronto.ca)

EFFECTS OF SPATIAL PROCESSES IN LAKES ON TROPHIC INTERACTIONS

Organisms in lakes show a wide variety of spatial distributions across a continuum of scales. These distributions are caused by organism responses to physical forces such as wind and currents, vertical gradients in temperature and light, location of suitable habitat, and prey and predators. The efficiency with which material moves from the base to the top of a food web must depend on the spatial context within which organisms live, yet little is understood of these constraints. We have been collecting extensive spatial information on physical and biological features of inland lakes with a view to describing spatial patterns of organisms in relation to lake features, modelling spatially-explicit trophic interactions, and developing management approaches based on this information. A suite of integrated sensors including hydro-acoustics (120 and 710 kHz), and an Optical Plankton Counter were deployed three times per year on three Ontario lakes to profile lake bathymetry and spatial

distributions of fish, zooplankton and sediment type. In addition, key nutrients, photosynthesis, chlorophyll concentration and temperature were measured at fixed stations. Fish and zooplankton samples were collected for instrument calibration. Interesting results to date indicate that zooplankton concentration in the water column is related to the character of benthic sediments, that algal production alone is inadequate to support zooplankton consumption in all lakes, only a small fraction of zooplankton production is consumed by planktivores in all lakes, and in one lake there is evidence that pelagic fish prey are insufficient to support lake trout growth.

[SAT, 8:30-8:50]

Stephenson, J.M. and A. Morin. Department of Biology, University of Ottawa, Ottawa, Ontario (email: jstephen@science.uottawa.ca).

THE SUBURBIA PARADOX, OR WHY DON'T FISH RESPOND LIKE ALGAE AND BUGS?

In order to evaluate potential patterns in benthic algal, invertebrate and fish biomass in streams along an anthropogenically disturbed land use gradient, forested and non-forested land use was quantified within a 100-meter buffer at a 1-km distance upstream of several prospective sampling sites within the National Capital Region of Canada. Benthic algal and invertebrate biomass was determined from replicate cobbles collected at 38 stations along an optimal forested gradient during summer 2001 and summer 2002. Fish biomass was also quantified at each site using the three run removal method within a 10-meter section of each stream. Preliminary analysis of summer 2001 data suggests that algal and invertebrate biomass increase with non-forested land use, whereas fish biomass is not related to land use. Mechanisms for patterns in biomass will be explored using nutrient data and invertebrate and fish carbon signatures to track algal and detrital food sources along the forested gradient.

[SUN, 10:50-11:10]

St-Jacques¹, J.-M., B.F. Cumming¹, K.R. Laird¹, and J.P. Smol¹. ¹Paleoecological Environmental Assessment and Research Lab, Dept. of Biology, Queen's University, Kingston, Ontario, Canada.

DROUGHT VARIABILITY IN THE NORTH AMERICAN GREAT PLAINS DURING THE LAST 1500 YEARS

Drought is endemic to the North American Great Plains, causing severe economic consequences in this extremely important agricultural region. However, accurate instrumental climatological data only exist from 1895. The tree-ring derived drought record exists from ca AD 1600 and has been spatially highly extrapolated to the Prairies. Limited paleolimnological, archeological and eolian activity records extend back for two millennia, but either at a relatively coarse resolution or with dating uncertainty. This lack of monitoring data inhibits our understanding of drought in this region, particularly that of the frequency and duration of intense, widespread, multi-annual droughts and their temporal comparison to climate events in other geographic areas. To address this question, we propose to undertake a paleolimnological assessment of a prairie lake that is varved, i.e. one with well-preserved annual sediment layers. Much research to date has demonstrated that climate can affect a lake's salinity and nutrient status, which in turn affects algal communities. Research has also shown that drought impacts terrestrial vegetation, and hence the regionally-produced pollen which is transported to and preserved in lake sediments. Therefore, by studying siliceous algal microfossils, i.e. diatom frustules, and pollen preserved within sediment varves, we hypothesize that it will be possible to reconstruct past droughts. We propose three primary goals for this project: (1) Develop a drought record using diatoms and pollen preserved in lacustrine varved sediments that will extend the high-resolution climate record, at present only possible from tree-ring records, at least another 600 years from 1600 AD, while maintaining the high quality dating of the dendrological records. (2) The reconstructed drought record will be compared to the tree-ring record, in order to assess the tree-ring record's tendency to lose low frequency signals due to necessary statistical manipulations. (3) It will attempt to answer whether or not the Little Ice Age (AD 1300-1850), a significant Northern Hemisphere climate event, was wetter or drier than the Medieval Warm Period (AD 900-1300) on the Northern Great Plains. This project will contribute to understanding the climate, specifically drought periodicity, duration and intensity, of this vitally important agricultural area whose long-term history is very little known.

[POSTER]

Sylvie St.Jean, Division of Fisheries and Oceans-Moncton and Carol L. Reinisch Marine Biological Laboratory, Woods Hole, Mass. creinisc@mbl.edu

BLUE MUSSEL LEUKEMIA IN PICTOU HARBOUR, NOVA SCOTIA

Blue mussels (*Mytilus edulis*) are ubiquitous throughout Atlantic Canada and are a vital component of the fisheries industry. These molluscs are continuously screened for pathogens and tumors by CFIA (Canadian Food Inspection Agency) to document the health of cultured populations. Mussels also develop fatal leukemias, which have been detected by histopathology. Monoclonal antibodies specifically raised against *Mytilus* leukemia cells were used for tumor detection (Noel et al, 1991. *Aquaculture and the Environment*). For the first time, we report that a monoclonal antibody (1E10), raised to leukemia cells of the soft shell clam *Mya arenaria*, (Miosky et al, 1989. *J. Invertebrate Pathology*) detects leukemia in *Mytilus edulis*. Specifically, 1E10 detects transmembrane cell surface glycoproteins (Stephens et al, 2001. *Comp. Biochem. Physiol.*) suggesting that both *Mytilus* and *Mya* express the same cross-reactive epitopes on the tumor cells. Having documented the utility of 1E10 as a diagnostic reagent, we have deployed 1500 *Mytilus edulis* at 15 sites in Pictou Harbour to determine the effect of human and industrial waste on the development of leukemia. Thus far, at least 70% of the mussels tested have

moderate to heavy disease. Further analyses are in progress to determine the severity of disease, and the precise relationship between the location of the animals and pollution source. Pinpointing the type of pollution associated with the leukemia remains a cornerstone in identifying and eliminating environmental carcinogens. The use of the 1E10 antibody to detect leukemia in *Mytilus edulis* will now be extended to numerous industrial sites in eastern and western Canada to determine the impact of specific pollutants on the leukemic process.

[SAT, 16:40-17:00]

Stott, W., and M.K. Burnham-Curtis. Great Lakes Science Centre, USGS, Ann Arbor, MI, USA 48105. wstott@usgs.gov
Burnham-Curtis, M.K., National Forensics Laboratory, US Fish & Wildlife Service, Ashland, OR, USA 97520

MITOCHONDRIAL AND MICROSATELLITE DNA VARIATION AMONG BROOK TROUT POPULATIONS FROM LAKE SUPERIOR.

Brook trout are the only indigenous stream dwelling salmonid remaining in the Lake Superior basin. Some of the rivers flowing into Lake Superior still harbour self-sustaining populations but others have suffered severe declines due to habitat degradation and overfishing. Both river resident and lake-run forms of brook trout are the target of management actions by resource managers in the United States and Canada. Any plan to restore or maintain biodiversity requires an understanding of life history, genetic population structure, stresses, and effects of past management actions. In the current study information about the genetic variation found in Lake Superior brook trout was collected to help formulate management plans to preserve both life history variants. Samples for genetic analysis were collected from throughout Lake Superior, including remnant populations of river and lake dwelling forms, samples from above and below river barriers, and from Isle Royale. Hatchery stocks used in Lake Superior were also analyzed to determine the contribution of hatchery fish to spawning runs. Both mitochondrial and microsatellite DNA variation was examined. Most of the genetic variation was found within in sample populations for both marker systems. Mitochondrial DNA variation is consistent with origins from the Mississippian refugium. No geographic patterns that are consistent with modern day distributions were observed with the mitochondrial DNA while patterns did arise when microsatellite DNA data were considered. The Isle Royale samples were distinct from the rest of the lake samples and genetic distance among Lake Superior tributaries was related to the distance among river mouths. Differences in patterns of variation could be seen above and below barriers. These patterns could be the result of stochastic effects or be the effects of stocking a genetically dissimilar strain of brook trout. No haplotypes were associated with the coaster form of brook trout from Lake Superior using either microsatellite or mitochondrial DNA.

[FRI, 13:40-14:00]

Strecker, A. and S. Arnott. Department of Biology, Queen's University, Kingston, Ontario (email: strecker@biology.queensu.ca)

THE EFFECTS OF AN INVASIVE INVERTEBRATE PREDATOR, *BYTHOTREPES LONGIMANUS*, ON ZOOPLANKTON COMMUNITIES IN LAKES RECOVERING FROM ACIDIFICATION

Freshwater ecosystems worldwide are endangered by the stresses imposed by human activity. During the past century, sulphur dioxide emissions from metal smelters resulted in the acidification and biological impoverishment of thousands of lakes in North America. International agreements have resulted in emission reductions, improvements in lake pH, and subsequent biological recovery of some lakes. Biological recovery, however, may be influenced by additional stresses, such as the invasion of exotic species. *Bythotrephes longimanus* is a large cladoceran that invaded the Great Lakes in the 1980's from Eurasia. It has since spread into many Canadian and American inland lakes. A field experiment was conducted to test the effects of the invasion of *Bythotrephes* on recovering zooplankton communities in Killarney Wilderness Park near Sudbury, Ontario. Experimental enclosures were deployed in Kakakise Lake and consisted of 1-m diameter, 8-m deep clear plastic bags, suspended from a wooden frame at the lake surface. The experiment had two treatments: *Bythotrephes* (presence, absence) and zooplankton community (recovered, non-recovered). Preliminary results showed a decrease in the abundance of small-bodied zooplankton in both the recovered and non-recovered enclosures that received the *Bythotrephes* treatment. Large-bodied zooplankton which characterize recovered communities persisted throughout most of the experiment. These results will have important implications for the management of recovering lakes and invasive species by providing insight on the effects of an invasion as an additional obstacle to biological recovery.

[SAT, 15:40-16:00]

Suski, C. D., S. S. Killen, and B. L. Tufts. Department of Biology, Queen's University, Kingston, Ontario, Canada, K7L 3N6 (email: suski@biology.queensu.ca) J. D. Keiffer. Department of Biology, University of New Brunswick, PO Box 5050, Saint John, New Brunswick, Canada E2L 4L5 S. J. Cooke and D. P. Philipp. Center for Aquatic Ecology, Illinois Natural History Survey, and Department of Natural Resources and Environmental Sciences, University of Illinois, 607 E. Peabody Dr., Champaign, Illinois, USA, 61820.

PHYSIOLOGICAL CHANGES IN LARGEMOUTH BASS DURING ANGLING TOURNAMENTS

In response to the growing popularity of live release angling tournaments targeting largemouth bass, numerous studies have attempted to monitor survival following these events. To date, however, there exists limited information about the underlying physiological changes in fish that result from tournaments. The subject of this presentation, therefore, is to outline the

physiological changes that occur in largemouth bass during live release tournaments, and describe the relative physiological significance of the different sections of a live-release angling tournament towards the observed levels of disturbance. During the summer of 2000, several bass tournaments in Ontario were visited to obtain tissue and blood samples from fish following weigh-in procedures. Analyses showed that plasma cortisol levels and plasma osmolarity of tournament-caught fish were significantly greater than control individuals. Tournament fish did not show signs of chloride loss or heat shock protein expression, but did show significant depletions of energy stores. A second study was conducted in which largemouth bass were sampled as part of a tournament simulation designed to ascertain the relative contribution of each section of a tournament towards the observed physiological disturbance. For this, fish were sampled for blood, white muscle and cardiac parameters following 5 different treatments presented in a cumulative manner: resting control, angling simulation, livewell confinement, weigh-in simulation and recovery. Results showed that, under the conditions simulated, the greatest source of physiological disturbance during an angling tournament is the weigh-in, and six hours of livewell confinement actually promoted recovery from the exercise. Taken together, these results suggest that disturbances experienced by largemouth bass caught in angling tournaments is within their physiological limits, and efforts should be made by tournament organizers to minimize the amount of disturbance arising from the weigh-in portion of the tournament.

[SAT, 14:40-15:00]

Swanson, H.K., Johnston, T.A., Schindler, D.W., Cunjak, R.A., Bodaly, R.A., and D.M. Whittle. Department of Biology, University of Alberta, Edmonton, Alberta. (email: heidis@ualberta.ca)

TIME SINCE INVASION, LAKE PRODUCTIVITY, AND LAKE SIZE AS DETERMINANTS OF THE EFFECT OF RAINBOW SMELT (*OSMERUS MORDAX*) ON MERCURY DYNAMICS IN BOREAL LAKES

Rainbow smelt is an anadromous fish species native to coastal regions of North America. Glacial relict populations are also native in many freshwater lakes of eastern Canada. Accidental and intentional introductions have allowed rainbow smelt to extend its freshwater range westward through the Great Lakes drainage basin, and, more recently, into the Mississippi and Hudson Bay drainage systems. Previous research has shown that rainbow smelt feed at a higher trophic level than most native forage fishes in the lakes that they invade. This effectively lengthens the food chain to top predators and should lead to higher concentrations of biomagnifying contaminants, such as mercury, in both the smelt themselves and their predators (e.g., northern pike, walleye, lake trout). Studies testing this prediction, however, have shown that the trophic elevation of smelt does not necessarily result in elevated mercury concentrations. Consequently, the incidence and magnitude of predator mercury increases following invasion vary among invaded lakes. In this study, we attempt to elucidate the pattern of this variable response and relate it to lake productivity, lake size, and time since invasion. To accomplish this, we compare growth rates, trophic position, and mercury concentrations in rainbow smelt and native forage fish species over a wide geographic area from western Quebec to northern Manitoba. We examine how the trophic position and mercury concentration of rainbow smelt relative to other members of the forage fish community varies among lakes with respect to lake size, productivity, and time since invasion. Our results are used to predict which native forage species may be negatively impacted by smelt invasion, and which lakes are most susceptible to predator mercury concentrations following smelt invasion.

[SAT, 14:40-15:00]

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PALEOLIMNOLOGICAL RECORDS OF SOCKEYE SALMON ABUNDANCE AND CLIMATE CHANGE FROM KODIAK ISLAND, ALASKA: A LONG-TERM PERSPECTIVE TO ASSESSING THE IMPACTS OF PAST CLIMATE VARIABILITY ON FISH

Pacific salmon populations experience tremendous fluctuations in their annual abundance. In recent years, there has been increasing recognition of the importance of large-scale patterns of interdecadal scale climate variability (i.e. regime shifts) in influencing salmon variability. Despite this, the majority of existing climate and fisheries records are relatively short, and exist only during the period of intensive fisheries utilization, making it difficult to assess the long-term impacts of climate on Pacific salmon stocks. One approach to obtaining information on both climate and fish populations at more relevant time scales is through the use of paleolimnology, which uses information archived in lake sediments to reconstruct records of past variability. We have recently developed a multi-proxy approach to reconstructing past sockeye salmon escapements, and several sockeye salmon runs have been reconstructed on Kodiak Island, Alaska, for the past 500-2000 years. However, to date, no high-quality climate records exist for the North Pacific prior to ~500 years ago. By conducting paleolimnological analyses on independent records of small, climate-sensitive non-anadromous lakes adjacent to major sockeye salmon nursery lakes, we can infer regional climate change, and provide an overview of past salmon variability from Kodiak Island in the context of climatic variability. Chironomid communities from Lake 445, a small non-salmon lake, show shifts that are synchronous with past changes in salmon populations and mirror changes in dendrochronological-based sea surface temperature reconstructions for the North Pacific. This illustrates the strong regionalized influence of climate on salmon stocks, and suggests that

chironomid communities can be used to obtain information on past climate beyond the limit of historical or dendrochronological based methods.

[SUN, 8:50-9:10]

Rémy D. Tadonlèké, Dolors Planas & Marc Lucotte GEOTOP-Université du Québec à Montréal, C.P. 8888, Succ. Centre ville, Montréal, Qc, H3C 3P8 (email: c1714@er.uqam.ca)

BACTERIAL COMMUNITIES AND THEIR RELATIONSHIPS TO PHYTOPLANKTON PRODUCTION AND DISSOLVED ORGANIC CARBON IN HYDROELECTRIC RESERVOIRS OF DIFFERENT AGES, CENTRAL QUEBEC

Heterotrophic bacteria play a central role in the biogeochemical processes in aquatic systems and are now recognized as major consumers of organic matter in these environments. Bacterial activity in aquatic systems is influenced by dissolved organic carbon (DOC) quantity and quality. In man-made reservoirs the DOC quality may depend on the age of the reservoir. We measured bacterial abundance and production in four hydroelectric reservoirs of different ages (2, 7, 23 and 35 years) and in the surrounding lakes, to determine whether the relationship between sources of DOC and bacterial activity depend on the age of the reservoir and if it differs between reservoirs and lakes. Results are discussed in terms of (i) lakes versus reservoirs comparisons, and (ii) importance of autochthonous versus allochthonous DOC in driving bacterial activities.

[SAT, 16:00-16:20]

Taillon¹, D. M. Fox², and L. Carl³. ¹Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON (email: dtaillon@trentu.ca). ²Environmental and Resource Studies Program and Department of Biology, Trent University. ³Ontario Ministry of Natural Resources, Peterborough, ON.

PRODUCTION AND SPATIAL DISTRIBUTION OF WALLEYE (*STIZOSTEDION VITREUM*) EGGS ON REHABILITATED AND NATURAL SPAWNING SITES.

Increased shoreline development has caused a reduction in walleye spawning habitat in many lakes in Ontario, and in combination with overharvesting, has led to drastic population declines throughout the province. To address the loss of spawning habitat, gravel and small boulders have been used to create new spawning sites or rehabilitate degraded ones, but few studies have examined the effectiveness of this technique. In this study, four rehabilitated spawning sites in Pigeon Lake, Ontario were compared with unaltered portions of these sites and four natural sites in other parts of the lake with respect to degree of use by walleye and walleye egg production. Egg nets 0.34 m in diameter were buried in the substrate to collect eggs; these were counted and examined to determine viability. Results from pre-tests in 2001 indicated that close to 90% of eggs were found in water less than 0.75 m deep, and approximately 60% in water less than 0.50 m deep; sampling effort in the spring of 2002 was distributed accordingly. Preliminary results from the second year of study indicate that spawning activity varies greatly within and among site types. Walleye readily used three of four rehabilitated spawning sites, as well as three of four natural sites. Overall, egg production appears greater at rehabilitated sites than at adjacent unaltered areas.

[SUN, 9:30-9:50]

Taylor, N and C. Walters Fisheries Centre, The University of British Columbia, Vancouver, British Columbia (email: n.taylor@fisheries.ubc.ca)

ONTOGENETIC HABITAT SHIFTS BETWEEN LAKES BY THE PIGMY PIKEMINNOW OF SOUTH CENTRAL BRITISH COLUMBIA

Aquatic ecologists typically treat fish populations as individual unit stocks with little movement between lakes. We have discovered that pigmy northern pikeminnow (*Ptychocheilus oregonensis*) in two drainages of south central British Columbia have obligate rearing in 'nursery lakes'. Adults in headwater lakes spawn only in warm outlet creeks and after hatching, newly emerged fry cannot swim upstream and are carried downstream to warmer shallower lakes. They apparently rear in these lakes and then disperse back to lakes upstream at age 3 or 4. The result of this organization is that drainages have one or two lakes where all of the recruitment for that drainage occurs and contrary to expectations, very strong linkages between lakes.

[SAT, 10:50-11:10]

Tremblay, A., Lambert, M. and Varfalvy, L. Hydro-Québec, Montréal.

CO₂ FLUXES FROM NATURAL LAKES AND HYDROELECTRIC RESERVOIRS IN CANADA

Actually, there is a debate world wide, concerning the role of the reservoirs in the greenhouse gases (GHG) fluxes and their contribution in the increase of GHG in the atmosphere. Increasing the number of measurements will reduce significantly the uncertainties around a representative mean flux from natural systems as well as from reservoirs. Using an inexpensive floating chamber with a NDIR instrument (Non-Dispersive Infrared) Hydro-Quebec, in collaboration with Manitoba Hydro and BC Hydro have measured gross fluxes of CO₂ from several reservoirs and natural lakes. The gross fluxes measured in situ in four Canadian provinces will be presented and compared with data available from the scientific literature for boreal regions.

[SAT, 15:40-16:00]

Tremblay, G.¹, M. Legault² and P. Sirois¹ 1Département des sciences fondamentales, Université du Québec à Chicoutimi, 555 boulevard de l'Université, Chicoutimi, QC G7H 2B1. 2Direction de la recherche sur la faune, Société de la faune et des parcs du Québec, 675 boul. René-Lévesque Est, 11ième étage, Québec, QC G1R 5V7 (genevieve.tremblay@sympatico.ca)

THE IMPORTANCE OF RAINBOW SMELT (*OSMERUS MORDAX*) IN THE DIETS OF LANDLOCKED ATLANTIC SALMON (*SALMO SALAR*) AND WALLEYE (*STIZOSTEDION VITREUM*) IN LAKE SAINT-JEAN

The lake Saint-Jean is one of the most important lake in North America for landlocked Atlantic salmon. During the last decade, the abundance of this salmonid has decreased significantly. This decline is associated with a diminution in rainbow smelt stocks, the principal source of food of landlocked Atlantic salmon. Our objective was to evaluate the importance of rainbow smelt in the diets of landlocked Atlantic salmon and walleye in lake Saint-Jean in order to assess the impact of predation on the abundance of this forage fish. A voluntary program involving sport fishermen was established to collect the stomachs of landlocked Atlantic salmon (1997 - 2002) and walleye (2001 – 2002). The analysis of gut content was done in the laboratory. Preliminary results showed an important decline of rainbow smelt in the diet of landlocked Atlantic salmon since 2001. Smelts represented a very small fraction of gut contents of walleye (1 – 2 % in volume). Results suggest that walleye is less selective than landlocked Atlantic salmon and have likely a minor impact on rainbow smelt stocks in lake Saint-Jean.

L'IMPORTANCE DE L'ÉPERLAN ARC-EN-CIEL (*OSMERUS MORDAX*) DANS LES DIÈTES DE LA OUANANICHE (*SALMO SALAR*) ET DU DORÉ JAUNE (*STIZOSTEDION VITREUM*) AU LAC SAINT-JEAN.

Le lac Saint-Jean est reconnu comme le « Royaume de la ouananiche ». Au cours des dix dernières années, l'abondance de ce salmonidé d'eau douce, très apprécié des pêcheurs sportifs, a chuté de façon significative. La diminution des stocks de ouananiche est reliée à une baisse de l'abondance des populations d'éperlan arc-en-ciel, sa principale source alimentaire. L'objectif de cette étude était d'évaluer l'importance de l'éperlan arc-en-ciel dans les diètes de la ouananiche et du doré jaune, afin de mesurer l'impact de la prédation sur l'abondance de ce poisson fourrage au lac Saint-Jean. L'échantillonnage a été effectué grâce à un programme volontaire de récolte des estomacs de ouananiches (1997 à 2002) et de dorés jaunes (2001 et 2002) auprès des pêcheurs sportifs. L'analyse des contenus stomacaux a été effectuée en laboratoire. Les résultats préliminaires montraient que la quantité d'éperlans retrouvée dans les estomacs des ouananiches a diminué de façon importante depuis 2001. Chez le doré jaune, l'éperlan arc-en-ciel ne représentait qu'une infime partie de son régime alimentaire, soit de 1 à 2% du volume. Les résultats suggèrent que le doré jaune serait moins sélectif que la ouananiche dans sa diète et qu'il aurait peu d'influence sur les stocks d'éperlans du lac Saint-Jean.

[POSTER]

Tyler Tunney^{1,2}, Tom Kleinboeck^{1,2}, Ed Snucins^{1,2} and John Gunn^{1,2,3} *Department of Biology, Laurentian University*¹ *Cooperative Freshwater Ecology Unit*² *Ontario Ministry of Natural Resources*³ (Email: tdtunney@yahoo.ca, tkleinboeck11@hotmail.com)

SEASONAL VARIATION IN THE CATCHES OF SMALLMOUTH BASS (*MICROPTERUS DOLOMIEUI*) AND YELLOW PERCH (*PERCA FLAVESCENS*) IN NORDIC MULTI-MESH GILL NETS.

Spatial and temporal comparisons of fish catch data require the use of standardized sampling protocols. NORDIC multi-mesh gill nets are the principle gear for sampling fish species in Scandinavia. We are in the process of developing and testing this method for application in Ontario's Boreal Shield lakes. In Scandinavia the standard sampling period is late July through August (Appleberg 2000). This sampling period was chosen to eliminate biases associated with spawning and water temperature effects on fish behaviour. During the summer of 2002, between late June and early September, we examined seasonal variation in NORDIC catches of smallmouth bass and yellow perch in two lakes near Sudbury, Ontario. Our initial analysis suggests that seasonal variation will affect the performance of this gear for species such as smallmouth bass but not for yellow perch. The mean catch per unit effort (#/net) for smallmouth bass did not differ between sample periods, but mean biomass/net was significantly ($P < 0.05$) higher in early summer (June 24-27 and July 2-8) than mid summer (July 29-August 1). The depth distribution of smallmouth bass shifted from shallow to deeper water as the summer progressed. Yellow perch catches (biomass/net and #/net) did not change significantly between the four sampling periods. These seasonal consistencies in yellow perch catches and the consistency in smallmouth bass catches after mid-July suggest an extension of the sampling window into early September may be appropriate for Ontario.

[POSTER]

M. A. Turner¹, D. L. Findlay¹, H. Baulch¹, E. M. Watkins¹, L. L. Hendzel¹, and D. McNicol² E-mail: turnermi@dfo-mpo.gc.ca 1Experimental Lakes Area, Fisheries and Oceans, 501 University Cresc., Winnipeg, Manitoba, Canada, R3T 2N6. 2Canadian Wildlife Service, Dept. of Environment, 49 Camelot Dr., Nepean, Ontario, Canada, K1A 0H3.

RESILIENCE OF BENTHIC ALGAL ASSOCIATIONS IN A BOREAL FOREST LAKE RECOVERING FROM ACIDIFICATION

We challenged the hypothesis that recovery of benthic algal associations from acidification would be rapid and would proceed along a mirror image of the changes caused by acidification. To examine this hypothesis, we studied a small boreal lake (L302S) in northwestern Ontario, Canada, during the lake's decade-long pH recovery following a previous decade of experimental acidification. During the lake's acidification remarkable structural and functional transformations of the

associations had been observed. Throughout the pH recovery phase, benthic energy flow (metabolism) remained disrupted. Carbon limitation of the photosynthesis of epilithon (biofilm on rock surfaces) was reversible, but the acidification-induced increase in rates of epilithic respiration continued though rates declined from their peak. Major taxonomic shifts persisted during pH recovery despite the robustness of epilithic taxonomic diversity. Acid tolerant coccoidal blue-greens dominated and persisted during the early stages of pH recovery. Filamentous blue-greens reappeared in lower abundances as the pH increased above 5.0, while the diatoms that had dominated during severe acidification remained during much of pH recovery. There was also a reversal of the improvement in food quality that had occurred during acidification as a result of the decline in the stoichiometric ratio of epilithic carbon to phosphorus. Acidification-induced metaphytic blooms of filamentous green algae persisted at higher pH than their onset pH. In conclusion, although we confirmed that the benthic algal associations recovered rapidly in several details during pH recovery, their recovery trajectories sometimes differed from their corresponding acidification trajectories. The limits on resilience of benthic algal associations following the relaxation of acidification stress have important implications for the restoration of littoral food webs. They also emphasize that pH recovery of lakes does not automatically imply biological recovery.

[SAT, 8:50-9:10]

Tyndale, S.T. (1); Letcher, R.(2) and Heath, D.D.(1). Great Lakes Institute for the Environment (GLI), University of Windsor, 401 Sunset Ave., Windsor, Ontario, Canada, N9B-3P4 (email: styndale@scn.org). (1) Department of Biological Sciences, (2)Department of Chemistry and Biochemistry

WHY ARE SALMON EGGS RED? – EGG CAROTENOIDS AND EARLY LIFE DISEASE RESISTANCE IN CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*)

Salmonids use dietary carotenoid compounds in the pigmentation of their flesh, skin, and eggs as well as other organs & tissues. It is these compounds that impart the characteristic yellow, orange, pink or red colouration, often used as a marker of commercial marketability. Recent experimental and epidemiological studies in several species have shown correlations between carotenoids and disease resistance, immune system function, as well as reduction in the rates of cancers and other “multi-cause” conditions. The aquaculture industry has long viewed intensity of colour to be an indicator of egg quality for many salmonid species. Recent experimental studies, however, have shown no correlation between egg carotenoids and rates of fertilization or general offspring survival (typical indicators of egg quality). In this study mature chinook salmon (*Oncorhynchus tshawytscha*) were caught from the wild, or raised in captivity. After stripping, some unfertilized eggs were preserved in 5% formalyn. Carotenoids present were extracted, quantified and qualified using RP-HPLC, verified by LC-MS and LC-MS-MS. Eggs from the same females were fertilized and raised in captivity, with rates of freshwater mortality tabulated by family. An experimental subset of each family’s offspring was inoculated with either live vibrio anguillarum (causative agent of vibriosis disease), or a blank control. Mean time hours to 50% mortality for each family was used as an estimator of early life disease resistance. Astaxanthin was the primary carotenoid in all eggs. No correlation was found between egg astaxanthin and freshwater survival; however, a significant positive correlation was found between egg astaxanthin concentration and early life vibriosis disease resistance among families. This is the first qualitative study of chinook salmon egg carotenoids and correlated early life disease resistance known to date.

[SAT, 16:20- 16:40]

van Poorten, B.T. and J.R. Post. Department of Biological Sciences, University of Calgary, Calgary, Alberta (email: bvanpoor@ucalgary.ca)

DESCRIPTION OF RATES OF ANGLING PRESSURE AND POPULATION RESPONSES ON A PREVIOUSLY UNEXPLOITED RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) POPULATION

Virtually all rainbow trout populations throughout the world experience some level of angler exploitation, particularly those in North America. Cabin Lake in Jasper National Park, which has been closed to fishing since a one-time stocking in 1927, was recently opened to angling in an attempt to shift angling effort from declining native stocks in adjacent lakes in the park to lakes with introduced non-native fishes. This provided us with the opportunity to view the angler dynamics as well as the response of the population to the introduction of angling. Here, we present the outcome of the first year of fishing through a complete creel census. Initial catch rates were high corresponding with high angling effort for the first few weeks. Catch per unit effort decreased almost immediately after opening, while effort by anglers appeared to follow a similar trend to the catch rates, with a two- week time lag. Catchability, often thought of as stable through time, is found to decrease as the cumulative number of fish caught and released increases. This raises some interesting questions surrounding the mechanism driving catchability in populations. Findings from the fishery in Cabin Lake are contrasted with those of other lakes in Western Canada and implications for future management are discussed.

[SAT, 16:00-16:20]

Vascotto, K., B. Shuter and D. Jackson. Department of Zoology, University of Toronto, Toronto, Ontario (email:kris.vascotto@utoronto.ca)

VARIATION OF LIFE HISTORY AND BEHAVIOR OF THREE INTRODUCED LAKE HERRING POPULATIONS DERIVED FROM A SINGLE STOCK.

A large amount of variation in life history traits has been reported for lake herring (*Coregonus artedii*) across its range. Some question has been raised as to whether the observed variation is the result of an overlap of post-glacial relict species, high plasticity, or simply *C. artedii* being a species complex. This study seeks to describe the observed variation of three herring populations originating from a single source. Lake Opeongo, Tea Lake, and Smoke Lake are lakes located in the Algonquin highlands of Ontario stocked with herring in 1948. Each of the three lakes possesses unique physical, chemical and community properties that have acted to shape the herring population over the last five decades. The herring populations were sampled during the summer months of 2001/2002 through standardized netting and acoustic projects. Results indicate a large difference in both behavioral and life history patterns present. Observed asymptotic sizes ranged from 146 mm through to 210 mm, with each population showing unique growth trajectories as determined from otolith aging. Furthermore, each population also exhibited unique patterns of vertical distribution relative to temperature and dissolved oxygen as observed through day/night acoustic surveys. This presentation will center about a description of these populations and the factors affecting this variation. [POSTER]

Venturelli, P. and W. Tonn. Department of Biological Sciences, University of Alberta, Edmonton, Alberta (email:paulv@ualberta.ca)

CAN NORTHERN PIKE AFFECT MACROINVERTEBRATES? EFFECTS OF AN INTRODUCTION ON A FISHLESS, BOREAL PLAINS LAKE.

Lakes containing only northern pike (*Esox lucius*) are common in boreal Alberta. Populations persist partly because pike can survive on a macroinvertebrate diet. Population variability, however, can be high, often associated with winterkill (and recovery). An earlier, comparative study suggested that populations of certain macroinvertebrates respond to these fluctuations in pike populations. To experimentally mimic post-winterkill recovery of such populations, we introduced pike into a small, fishless lake to a density of ~35 kg/ha in May 2001. Over the subsequent summers, we assessed effects of this introduction on the abundance and mass of littoral macroinvertebrates. Diets of pike were dominated by leeches, but also contained amphipods, odonate larvae, coleoptera larvae, trichopterans, and dipteran larvae. Relative to monthly samples of macroinvertebrates from the lake, pike consumed larger taxa and larger individuals within each taxon. Preliminary comparisons of pre- and post-introduction macroinvertebrate samples suggest that predation by pike also reduced the abundance of more common prey. Our findings demonstrate the short-term response of boreal lake foodwebs to a common, natural disturbance and suggest a possible consequence of introduction or invasion of pike in these systems. [SAT, 13:20-13:40]

Vinebrooke, R.D.¹, K. Cottingham², J. Norberg³, S.I. Dodson⁴, M. Scheffer⁵, U. Sommer⁶, and S.C. Marberly⁷ ¹Freshwater Biodiversity Laboratory, Department of Biology, University of Regina, Regina, Canada S4S 0A2 (email: rolf.vinebrooke@uregina.ca) ²Department of Biological Sciences, Dartmouth College, Hanover, NH 03755 USA ³Department of Systems Ecology, Stockholm University, 106 91 Stockholm, Sweden ⁴Group of Aquatic Ecology, 6700 DD Wageningen, The Netherlands ⁵Department of Zoology, University of Wisconsin, Madison, WI 53706 USA ⁶Institut für Meereskunde, Kiel, Germany ⁷Institute of Freshwater Ecology, Far Sawrey, Ambleside, Cumbria LA22 0LP, UK

DOES RESISTANCE DEPEND ON SPECIES CO-TOLERANCE IN MULTIPLE-STRESSED AQUATIC ECOSYSTEMS?

Understanding the impacts of global change and multiple stressors on biodiversity and ecosystem function is one of the most challenging problems in modern ecology. Ecosystem resistance to a single stressor relies on tolerant species compensating for sensitive competitors and maintaining a shared function, such as primary production. Subsequently, resistance to additional stressors should increasingly depend on species having positively correlated tolerances (i.e., co-tolerance). Although the high diversity within certain aquatic functional groups (e.g., phytoplankton) can buffer them against single stressors, we hypothesize that multiple stressors exert synergistic negative effects on species richness and ecosystem function when a trade-off (i.e., negative correlation) exists between species tolerances of the different stressors. Model simulations of differential species tolerances and competitive species interactions within a guild of consumers demonstrate that resistance to multiple stressors declines as a function of the trade-off between species tolerances. In addition, the dependence of resistance on species co-tolerance is strengthened by species richness in closed systems and weakened by species colonization rate in open systems. Consequently, interactive effects of multiple stressors on aquatic ecosystems will be context-dependent, differing between functional groups and combinations of stressors. Our findings suggest that the increasing multiplicity of novel combinations of stressors will amplify the adverse impacts of global change on aquatic biodiversity and ecosystem function. [SAT, 14:20-14:40]

Vis, C., Hudon, C., and Carignan, R. Département de sciences biologiques, Université de Montréal, Montréal, Québec (email: chantal.vis@umontreal.ca)

EFFECTS OF CHANGING WATER LEVELS ON EPIPHYTE BIOMASS AND PRODUCTIVITY IN A LARGE FLUVIAL LAKE

Important fluctuations in the discharge and water levels of the Great Lakes – St. Lawrence River system in recent years have drawn attention to the possible environmental consequences of changing water levels on this system. We studied epiphyte

community dynamics (biomass and productivity) over a 2-year period with contrasting water levels in Lake St. Pierre, a large fluvial lake of the St. Lawrence River (QC). During a year with low water levels, areal epiphyte productivity increased as a result of increasing macrophyte biomass and more favourable light conditions. Although the seasonal pattern of epiphyte biomass was similar between years, the biomass of filamentous algae increased under low water levels. The relative contribution of epiphytes to global productivity increased with decreasing water levels and the type of community present (filamentous vs. attached) was altered.

[SAT, 11:10-11:30]

Weeber, R.W., S.W. Bowman and D.K. McNicol. Canadian Wildlife Service (Ontario Region), Ottawa, Ontario (email: Russ.Weeber@ec.gc.ca)

INFLUENCE OF CURRENT AND PROJECTED CHEMICAL AND PHYSICAL ATTRIBUTES ON MACROINVERTEBRATE AND FISH COMMUNITIES OF SMALL ACID-SENSITIVE ONTARIO LAKES

Atmospheric inputs of acidifying pollutants have been shown to affect changes in the composition and structure of food chains in sensitive lake and wetlands. In 1981, the Canadian Wildlife Service – Ontario Region (CWS – OR) began describing acid rain effects on lake food chains and wildlife in central and northern Ontario and, in collaboration with other federal departments, initiated a broad scale biomonitoring program in 1987. The objective of the program was to document the progress of acid rain control and assess whether control measures were sufficient to protect and improve the ability of sensitive lakes and wetlands to support healthy biotic communities. During the period 1987 – 2001, CWS-OR collected macroinvertebrates, small fish and amphibian larvae from study areas in the Muskoka (n=20 lakes), Sudbury (n=22) and Algoma (n=24) regions in central Ontario. Commonly occurring macroinvertebrates included amphipods (*Crangonyx richmondensis*, *Hyalolella azteca*), odonate larvae (*Aeshna eremita*, *Libellula julia*), caddisfly larvae (*Playtycentropus amicus*, *Banksiola crotchi*), and hemiptera (*Sigara macropala*, *Notonecta insulata*). Common fish included dace (*Phoxinus* spp.), fathead minnow (*Pimephales promelus*), creek chub (*Semotilus atromaculatus*), pearl dace (*Semotilus margarita*), common white sucker (*Catostomus commersoni*), brook stickleback (*Culaea inconstans*) and yellow perch (*Perca flavescens*). The presence of selected common macroinvertebrates and fish were modelled as functions of sampling year, geographic location, and lake physical and chemical attributes. Model selection was conducted using Akaike's Information Criterion (AIC), with inferences based on multiple models for some taxa. Using those models which were best supported by the data, patterns in predicted species occurrence will be presented relative to observed and projected values of important lake attributes.

[FRI, 14:00-14:20]

Brian C. Weidel, Clifford E. Kraft, Daniel C. Josephson Cornell University, Department of Natural Resources, Ithaca, NY 14853. (email:bcw3@cornell.edu)

FISH COMMUNITY RESPONSE TO REMOVAL OF NATURALIZED SMALLMOUTH BASS IN AN OLIGOTROPHIC LAKE

Introductions of non-native smallmouth bass (*Micropterus dolomieu*) have limited the abundance and diversity of native soft-rayed fishes, altered the trophic status of lake trout, and reduced brook trout biomass in northeastern U.S. and Canadian waters. This study is designed to demonstrate whether the impact of a widely-introduced non-native fish predator (smallmouth bass) can be reversed in a large (270ha) oligotrophic New York lake. Historical accounts indicated, and recent research projects have confirmed, that the introduction of smallmouth bass in Little Moose Lake (~1950) had adverse effects on the native fish community. In the spring of 2000 through the fall of 2001, a total of 19,529 smallmouth bass were removed from Little Moose Lake, predominately by boat electrofishing. Pre-removal population estimates indicate that at least 90% of the adult smallmouth bass population has been removed. Abundance indices (CPUE) of native littoral prey fish and crayfish species have increased following the reduction of the smallmouth bass population. Predation risk, measured by tethered creek chubs (*Semotilus atromaculatus*), has significantly declined for native littoral prey fishes. We expect improved growth and increased abundance of native char and prey species due to reduced predation and interspecific competition by smallmouth bass.

[SAT, 14:00 -14:20]

Weir, L.K., J.A. Hutchings, I.A. Fleming and S. Einum. Department of Biology, Dalhousie University, Halifax, NS, Canada; Coastal Oregon Marine Experiment Station, Oregon State University, Newport, Oregon, USA; Norwegian Institute for Nature Research, Trondheim, Norway. (email: lweir@dal.ca)

SPAWNING BEHAVIOUR AND FERTILIZATION SUCCESS OF MALE ATLANTIC SALMON OF FARMED AND WILD ORIGIN

Escaped farmed Atlantic salmon represent a means of introgression of foreign genes into wild populations. Field and experimental studies have indicated that adult farmed individuals interbreed with wild fish. In addition to adult anadromous fish, mature male Atlantic salmon parr also contribute genetic material to subsequent generations. Thus, mature male parr of farmed origin represent an additional means by which foreign genes may enter wild populations. To examine the relative success of mature fish of different origin, we observed their spawning behaviour in four experimental arenas. Equal numbers of mature male parr of farmed, hybrid and wild origin were placed in arenas containing both wild and farmed females, and

either wild or farmed adult males. To assess relative fertilization success of the different types of fish, we excavated nests after spawning had occurred and performed microsatellite genetic analysis to assign paternity. We found differences in aggression, activity and spawning behaviour between anadromous males of different origin as well as among farmed, hybrid and wild mature male parr. Differences in fertilization success between anadromous male types and among mature male parr of different origin will also be discussed.

[SAT, 9:50-10:10]

Gordon A. Wichert, Natural Heritage Information Centre, Ministry of Natural Resources, Peterborough, Ontario (email: gordon.wichert@mnr.gov.on.ca)

CHARACTERIZING AQUATIC DIVERSITY IN THE GREAT LAKES WATERSHED

The Great Lakes Aquatic Conservation Blueprint is intended to guide the identification and to inform the selection of aquatic protected areas in the Great Lakes basin (Canadian side) by implementing criteria related to setting conservation targets and objectives. The final list of areas for protection should ensure the conservation of a high diversity of aquatic habitat and species in the Great Lakes Ecoregion. An automated system was developed to delineate and characterize aquatic habitat in the Great Lakes basin. Physical variables were extracted from digital spatial layers to delineate streams and inland lakes into ecological units based on features such as surficial geology, connectivity, size and position in the watershed. These variables are thought to be related to watershed formative processes, and relevant to various life-cycle processes and the dispersal of aquatic species. Slope, catchment area, surficial geology, land cover and other features characterized ecological sampling units. Using these data, patterns of aquatic habitat were identified within the Great Lakes watershed. Spatial distributions of representative and rare species were over-laid with physical habitat attribute data and biophysical associations were explored. The final process to design and select areas for protection will be informed especially by biophysical, but also social, ethical, economic and political constraints, and perceived threats to ecosystem sustainability.

[SAT, 9:30-9:50]

Chris Wilson, Aquatic Research and Development Section, Ontario Ministry of Natural Resources, Trent University, Peterborough ON chris.wilson@mnr.gov.on.ca

APPLYING LANDSCAPE GENETIC TOOLS TO AQUATIC RESOURCE MANAGEMENT

Genetic issues have become increasingly important for sustainable resource management. Maintaining the genetic resources and adaptive potential of species and populations is well recognized as an essential element of management and conservation. For fisheries management, genetic analysis of stock structure and mixed-stock analysis of commercial and recreational fisheries are regularly employed as information tools to help ensure the sustainability of harvested populations. These direct applications are complemented by studies of historical and geographic genetic structure within species, which are also relevant for identifying spatial structure of genetic biodiversity. These studies in turn provide essential information for such diverse management issues as evaluating the success of stocking efforts, estimating long-term effective population sizes, and providing insights into the status of species or populations of conservation concern. Individual-based analyses such as individual assignment tests permit the identification of source populations, enabling precise descriptions of dispersal and contrasts between historical and contemporary gene flow. While these data are clearly valuable, describing spatial pattern in species of interest should be considered a springboard for further research or management efforts rather than an end product. Merging population genetic tools with spatial analyses provides a 'landscape genetics' approach to understanding the historical and environmental influences on spatial genetic structure and diversity of aquatic species. Combined population- and individual-level approaches to spatial genetic structure using high-resolution genetic markers such as microsatellite DNA and mitochondrial DNA sequences are proving to be highly effective in resolving influences on spatial structure and diversity, as well as revealing some effects of human activities on the resident genetic biodiversity. Examples of how data from neutral genetic marker systems (isozymes, mitochondrial DNA and microsatellite DNA) are being employed to support species restoration efforts will be presented. Synergistic studies combining genetic data with life history, habitat and/or land use information are increasingly making genetic markers practical tools for identifying and managing aquatic biodiversity at hierarchical geographic scales.

[SAT, 11:10-11:30]

Wilson, C. (1), N. Mandrak, (2), J. Casselman (1), and N.R. Lovejoy (3). (1) Aquatic Research and Development Section, Ontario Ministry of Natural Resources, Trent University; (2) Department of Fisheries and Oceans, Burlington; (3) Department of Zoology, University of Manitoba.

MITOCHONDRIAL PHYLOGEOGRAPHY AMONG GREAT LAKES POPULATIONS OF THE DEEPWATER SCULPIN, *MYOXOCEPHALUS THOMPSONI*.

The deepwater sculpin, *Myoxocephalus thompsoni*, is considered a 'glaciomarine relict' from the Pleistocene, although its phylogeographic history is uncertain. Although deepwater sculpin disappeared from Lake Ontario several decades ago, the capture of several specimens in recent years may indicate their recovery or re-establishment. To resolve the genetic origins of the recent Lake Ontario specimens, several regions of the mitochondrial genome were sequenced, comparing specimens of *M. thompsoni* from Lake Ontario, Lake Huron and Lake Michigan. The marine fourhorn sculpin, *M. quadricornis*, was used as an

outgroup for comparison. The low level of sequence variation and phylogeographic divergence among lakes suggests a single postglacial origin for Great Lakes populations of *M. thompsoni*, and highlights the need for higher-resolution genetic markers to track the genetic structure and dynamics of this re-emerging deepwater species. (e-mail: chris.wilson@mnr.gov.on.ca)
[POSTER]

Winter, J., L.Heintsch and L. Nakamoto. Biomonitoring Section, Environmental Monitoring and Reporting Branch, Ministry of Environment, 125 Resources Road, Toronto, Ontario M9P 3V6 (EMAIL: WINTERJE@ENE.GOV.ON.CA)

LONG TERM ALGAL MONITORING PROGRAMMES IN ONTARIO

Phytoplankton samples are collected and analyzed for four long-term monitoring programmes in Ontario conducted by the Ministry of Environment. We monitor trends in nearshore water quality of the Great Lakes and Lake Simcoe by regular sampling of untreated water from 21 (18 Great Lakes and 3 Lake Simcoe) municipal water intakes since the late 1970s. We also sample 8 open lake stations on Lake Simcoe. Several lakes on the Precambrian Shield have been sampled as well since the 1970s. The focus for 8 core lakes in Muskoka and Haliburton is on monitoring acid deposition, nutrient enrichment, species introductions and climate change, and for 5 lakes in the Sudbury area (with 6 more since 1993) on tracking the recovery of acid damaged, metal contaminated lakes. We archive all samples after processing, and data are entered into a database. Patterns of distribution of phytoplankton genera in relation to environmental variables were determined for lakes in the Muskoka and Haliburton area from 1980 to 1996 using canonical correspondence analysis. Phytoplankton genera were highly correlated with a gradient in calcium ($r = 0.75$) and alkalinity ($r = 0.44$). Taxa characterizing the gradient included the diatoms *Synedra* spp. and *Cyclotella* spp. and the cyanobacteria *Lyngbya* spp. and *Aphanothece* spp. at the higher end, and the Chrysophyceae *Bicosoeca* spp. and *Chrysosphaerella* spp. at the lower end. A second gradient was correlated with trophic status indicators total phosphorus ($r = 0.25$) and secchi depth ($r = -0.36$). Taxa characterizing this gradient included the Chrysophyceae *Synura* spp. and *Chrysochromulina* spp. and the desmids *Euastrum* spp. and *Pediastrum* spp. at the higher end, and at the lower end the Chlorophyceae *Sphaerocystis* spp. and *Crucigenia* spp., the cyanobacteria *Coelosphaerium* spp. and the chrysophyte *Rhizochrysis* spp. As well as continuing our long term monitoring programmes, we propose to develop protocols for rapid bioassessment using attached algal communities in the littoral zones of lakes. We also plan to evaluate and develop protocols for biomonitoring using algae in rivers in association with our Provincial Water Quality Monitoring Network.

[SAT, 8:30-8:50]

Wootton, B. C.¹, D. O. Evans², C.C. Wilson.² 1. Watershed Ecosystem Graduate Program, Trent University, Peterborough, Ontario. 2. Ministry of Natural Resources and Trent University, Peterborough, Ontario.

SPATIAL ECOLOGY OF BROOK TROUT (*SALVELINUS FONTINALIS*) IN SMALL PRECAMBRIAN SHIELD STREAMS IN SOUTH-CENTRAL ONTARIO.

Small groundwater fed streams on the Precambrian shield of south-central Ontario have been identified as important spawning, nursery, feeding, and over-wintering habitats for brook trout (*Salvelinus fontinalis*). This study investigated habitat use and movements in eight tributaries of Fairy and Peninsula lakes, near Huntsville, Ontario. The streams mouths are located 0.7 to 10 km from each other on the interconnected lakes and are accessible to fish via the lakes throughout the year. Directional weirs and backpack electrofishing were used in the streams to capture brook trout. In spring and summer 2001 several hundred brook trout were marked with fin clips and/or tagged with PIT tags. Fall 2001 recapture rates averaged 19.0% 2001 and 3.7% summer 2002. Most recaptures were small in size and captured near tagging site suggesting that larger adults emigrate to the lakes. Recent lake surveys, however, have failed to capture brook trout and no fishery is known to exist. Straying between streams was not observed, although the potential exists as emigration appears to be common. The small body size of mature adults and observations of stream spawning suggests that populations are primarily stream resident. Northern pike and smallmouth bass inhabit the lake and may act as a biological barrier to inter-stream movement except for larger individuals which were occasionally observed in the streams during spring and fall and may exhibit natal stream fidelity when spawning. A concurrent genetic study of the same populations analyzing multilocus microsatellite DNA genotypes indicated high levels of historical gene flow but contemporary hierarchical isolation between tributary stream populations. This suggests that these stream populations once comprised a metapopulation, which more recently has become highly fragmented. Small stream populations such as these are vulnerable to local extinctions through catastrophic habitat disturbances, but are otherwise relatively resistant to disturbance provided that adequate flow and cool temperatures are available. Biotic as well as physical barriers to migration and gene flow between streams within the Fairy-Peninsula lakes basin, however, pose a serious risk to the long term persistence of these stream populations.

[SAT, 11:10-11:30]

Wonham, M.I., C. Harley^{1,2}, and M. O'Connor³. 1University of Washington, Department of Zoology, Seattle, WA, USA. Current address: Centre for Mathematical Biology, University of Alberta, Edmonton, Alberta T6G 2G1 (mwonham@ualberta.ca). 2 Hopkins Marine Station, Pacific Grove, CA, USA. 3 Brown University, Providence, RI, USA.

POSITIVE INTERACTIONS AMONG MUFLAT INVADERS: DOES FACILITATION LEAD TO "INVASIONAL MELTDOWN"?

Introduced species can affect both native species and other invaders. Between invading species, positive interactions (+/+ mutualisms and +/- commensalisms) will tend to facilitate invasions, negative interactions (-/- antagonisms and -/0 amensalisms) will tend to inhibit them, and the effect of mixed interactions (+/- exploitations) will depend on the order in which species invade. Facilitation between invaders has been proposed as a mechanism to explain the pattern of increasing invasion rates and impacts (“invasional meltdown”, sensu Simberloff and Von Holle 1999). Notably, facilitation has been reported both between species with a co-evolutionary history, and between those meeting for the first time. Here, we report positive impacts of an invasive Asian mud snail, *Batillaria attramentaria* (Brugière 1792), on an intertidal community in Padilla Bay, Washington state. By providing habitat, *Batillaria* increases the presence of native hermit crabs, *Pagurus* spp., as well as four other invaders: an epifaunal Atlantic gastropod, *Crepidula* SP., and Asian anemone, *Diadumene lineata*, and the Asian parasitic trematode, *Cercaria batillariae*. In addition, its presence increases densities of an introduced Asian mud snail, *Nassarius fraterculus*, and percent cover of the introduced Asian eelgrass, *Zostera japonica*. We documented no effects of *Batillaria* on infaunal densities, which may reflect low power in the sampling design. “Invasional meltdown” encapsulates the premise that facilitative interactions between pairs of invaders lead to accelerating (1) numbers and (2) impacts of invasions (Simberloff and Von Holle 1999). Since history does not record the exact arrival dates of these invaders, the role of their positive interactions in contributing to an accelerating invasion rate is unknown. On the other hand, since *Batillaria* appears to encourage greater population densities of other invaders, it presumably allows their total effects to be greater than they would otherwise. Thus, *Batillaria* may contribute to the second component of invasional meltdown, increased overall invader impacts. [FRI, 14:00-14:20]

Wonham, M. Centre for Mathematical Biology, University of Alberta, Edmonton, Alberta T6G 2G1 (mwonham@ualberta.ca)
REDUCING THE RISK OF AQUATIC SPECIES INVASIONS VIA BIOLOGICAL SUPPLY SHIPMENTS.

The commercial supply of live organisms is an essential resource in our educational and scientific research programs. It is also a potential pathway of species introductions. A wide variety of live organisms are currently available from biological-supply companies. Since many specimens are collected from the wild, live non-target species may be inadvertently shipped as well. In the present case study of marine and aquatic invasion risk, seven species of marine algae and freshwater plants were ordered from Carolina Biological Supply Company. In each shipment, non-target algae and invertebrates visible to the naked eye were counted and identified to phylum or class. Overall, at least 11 non-target invertebrate and algal species and over 800 individual live organisms were collected. The risk of invasion associated with these shipments depends on their fate once they have been delivered. However, none of the shipments contained information on handling or disposal of the package and contents. One of the keys to risk-reduction is public education. A series of educational and outreach initiatives are recommended for biological supply shipments, including: an instructional flier, general print and web-based information on the problem of introduced species, catalog notes identifying species’ native and introduced ranges, and an educational classroom kit on the biology and ecology of introduced species. A sample shipment flier is proposed. [POSTER]

Yan, N.D., Department of Biology, York University, Toronto, ON, and Dorset Environmental Science Centre, Ontario Ministry of the Environment and Energy (email: nyan@yorku.ca); R. Girard, Ontario Ministry of the Environment and Energy, and P.J. Dillon, Trent University

COMPLEX, LONG-TERM CHANGES IN MEAN CLADOCERAN BODY SIZE IN DORSET LAKES: EFFECTS OF AN INVADER, DE-ACIDIFICATION AND NUTRIENTS?

Mean Cladoceran body size has been quite useful in accounting for patterns and processes in pelagic food web ecology; however, we have few long-term assessments of mean Cladoceran body size in temperate lakes. Summarizing close to 100,000 body length measurements we show that there has been a 20% increase in mean Cladoceran body size in eight Dorset-area lakes over the last two decades. Long-term trends in body size are evident in six of the eight lakes, with body size generally increasing in five of these lakes. The patterns in these increases are lake-specific. In Harp, Dickie and Crosson lakes, increases in mean Cladoceran body size were attributable to changes in species composition, not to changes in the sizes of each species. In Harp Lake, the invading spiny water flea, *Bythotrephes*, has eliminated several small Cladoceran species, and two large species have increased in abundance. In Dickie and Crosson lakes, mean Cladoceran body size was negatively correlated with long-term changes in TP concentrations. Mean cladoceran body size also increased over time in Plastic and Heney Lakes, two clear-water lakes that are recovering from acidification; however, in these lakes the body size of several species, particularly *Holopedium*, *Daphnia*, and *Diaphanosoma* has increased over time. It is clear that Cladoceran assemblages in temperate lakes in the Dorset area are not currently stable. They are in flux in at least two ways, in species composition and in body size of species. An examination of environmental correlates indicate that multiple explanations for these changes should now be sought and evaluated. [SAT, 13:40-14:00]

Yanick, J.F., and D.D. Heath. Biology Program, University of Northern British Columbia, Prince George, BC, and Great Lakes Institute for Environmental Research & Department of Biological Sciences, University of Windsor, Windsor, ON. (email: dheath@uwindsor.ca).

GENETICS OF A FAILED INVASION EVENT: MYTILUS IN GEORGIA STRAIT, BC

The high rate of marine species introductions has highlighted concerns about invasion events in marine invertebrates. To examine the invasion dynamics of blue mussels (*Mytilus* spp.) in Georgia Strait, British Columbia, mussels were collected from 1994 to 1998 at 10 sites along the east coast of Vancouver Island and the lower mainland of BC. DNA was extracted and the mussels were genotyped using three published diagnostic species markers. The native mussels (*M. trossulus*) are hybridizing with the introduced species (*M. edulis* and *M. galloprovincialis*); however, the frequency of the introgressed genotypes declined precipitously during the sampling period, indicative of a “failed” invasion. Detailed analysis indicate that the Georgia Strait *Mytilus* hybrid zone is unstable temporally, spatially, and genetically (unpredictable departures from Hardy-Weinberg equilibrium across space and time), and does not agree with any one of the existing hybrid zone models. The instability of the hybrid zone, however, suggests that the introgressed mussels may not be well suited to the area and they are dependent on sporadic introductions. The introgression of alien alleles in the Georgia Strait blue mussel community documented here appears to be a short-term effect, and therefore is likely a negligible threat to the native mussel population or intertidal ecosystem at this time. However, a change in environmental conditions could alter this balance and provide the conditions necessary for a successful invasion, given continued introduction pressure.

[FRI,15:20-15:40]

Young, J. D., N. D. Yan, and S. A. Boudreau, Biology Department, York University, Toronto, ON (email: jdyoung@yorku.ca)

A COMPARISON OF BYTHOTREPES ABUNDANCE AND BIOLOGY FROM 16 CANADIAN SHIELD LAKES

The spiny water flea, *Bythotrephes*, was first observed in the Great Lakes in 1982. This invasive species has now been detected in 50 Canadian Shield lakes, since many of these lakes provide habitat suitable for it. We performed a survey of 16 of these invaded lakes, varying in size and species composition, to observe differences in *Bythotrephes* abundance and biology. Each lake was sampled with vertical hauls taken at 10 stations on one occasion between July and September, 2001 using a large, macrozooplankton net. Physical parameters such as temperature, secchi depth and water quality data were measured. Average *Bythotrephes* density differed significantly among the 16 lakes, and this was not attributable to the date of sampling. Lakes with greater total phosphorus concentration and mean or maximum depth supported a larger *Bythotrephes* population. Populations of *Bythotrephes* in Europe tend to be found more frequently in clear lakes with low TP. We tested a refuge hypothesis with those lakes containing pelagic fish zooplanktivores (cisco and smelt). Lakes with a putative warm water refuge, i.e. where the top of the hypolimnion was deeper than the euphotic zone, had greater *Bythotrephes* abundance than lakes without this refuge. There were also differences in mean instar body length among lakes. Both abundance and instar size distributions of *Bythotrephes* appear to differ among recently invaded Canadian Shield lakes in a manner correlated with resource availability and risk of predation.

[FRI, 16:40-17:00]

Young, B.W. and D.D. Heath. Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Ontario (email: evogenetics@hotmail.com).

POTENTIAL IMPACT OF CLIMATE CHANGE ON THE INCIDENCE OF PRECOCIOUS MATURATION IN CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*): RELATION TO DEVELOPMENTAL RATES AND SIZE/WEIGHT THRESHOLDS.

Male chinook salmon “choose” one of two alternative life history pathways, males may spend 1 year in the ocean and return to spawn as small, precocious, sexually mature 2 year olds (jacks), or they spend multiple years at sea and spawn at a much larger size (hooknose). Substantial evidence exists to support a general correlation between growth rates and precocious maturation in fish. It has been hypothesized that the strategy choice may occur early in life, and is based upon a size threshold. The primary line of evidence for this has been the observed relationship between accelerated growth rate in salmon hatcheries and observed increases in jacking rates. To examine the relationship between freshwater growth & size in more detail we PIT (passive integrated transponder) tagged chinook salmon fry at approximately 4 months post-hatch. Six hundred fry consisting of 150 fish derived from 4 separate families were weighed, tagged, and then reared together through to sexual maturation of the jacks. Fish were weighed approximately every 2 months. No relationship between growth parameters and subsequent precocious maturation was observed within the freshwater stage. However, growth/size may not be the only determinant of life history strategy and factors such as developmental rates may play an equal or even more prominent role in maturation decisions. Thus, data from a temperature accelerated vs. non-accelerated rearing experiment is also presented to demonstrate the positive effects of developmental rates on incidence of precocious maturation. The results from both experiments are discussed in relation to the expected increase in water temperatures associated with global warming.

[SUN, 9:30-9:50]

Yingming Zhao and Brian J. Shuter: Department of Zoology, University of Toronto, Toronto, ON, M5S 3G5. (email: ymzhao@zoo.utoronto.ca) Michael L. Jones: Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI, 48824 Charles K. Minns: Fisheries & Oceans Canada, Bayfield Institute (GLLFAS), Burlington ON, L7R 4A6

OPTIMAL THERMAL OPTICAL HABITAT SUPPLY FOR WALLEYE (*STIZOSTEDION VITREUM VITREUM*) POPULATIONS IN LAKE ERIE

Lake Erie has been well known as one of the fisheries resource abundant lakes. The aquatic ecosystem in the lake, however, has experienced dramatic changes over the last twenty years since the invasion of two exotic mussels (*Dreissena* spp), the voracious filter feeders. The tremendous ability of the mussels to feed on phytoplankton resulted in drastic changes in the water clarity and thermal structure in Lake Erie. Walleye (*Stizostedion vitreum*) is a coolwater species and has a preference for a dim light environment due to its special visual structure. As one of the most economically valuable species in Canada's inland water, walleye in Lake Erie, therefore, are more influenced by the changes in those physical parameters of the waterbody. Based on observed data, we calculated the optimal thermal optical habitat volume (TOHV) for walleye populations in three basins of Lake Erie. The results showed a significant change in TOHV in all three basins after the invasion of the mussels. Those changes can be used to explain why and how the abundance of walleye populations in three basins have experienced large fluctuations.

[SUN, 9:10-9:30]

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PRIMARY ENVIRONMENTAL SURVEY ON ECOLOGICAL ASPECTS OF HARAZ RIVER IN NORTH OF IRAN

In point of view of environmental aspects, Haraz river with the 148 km length and 50-500 meter wide is one of the most important river in the north of Iran with 40 Km distance from Tehran. In other side, the river finally arrives to Caspian Sea. Haraz River is very important for our aquaculture development program in the country and at the moment, more than 17 hatchery and propagation rainbow trout farms along the river have been established and more than 23 farm will be construction in the near future. Total production of the farms would be exceeding to 30/000/000 egg-eye, 20/000/000 fry and more than 1/000 MT grow-out in current year. Meanwhile, mention farms that belongs to the private section, have occupied near 1000 person in relation field of the production process in the region. They success to export a part of production such as egg-eye to abroad. In our survey, we investigated Haraz river in point of view; chemical pollution such as pesticides, water physico-chemical changes, urban wastes, and hydrocarbon material. In other side, we categorized river phytoplankton, aquatic herbal and native fishes that be found in Haraz river. We used from our achievement information for directon of executive section planning and programming for reach to best quality production.

[SAT, 16:40-17:00]