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Abstracts for Oral and Poster Presentations

(alphabetical order by author)

- **POPULATION STATUS OF INNER BAY OF FUNDY ATLANTIC SALMON (*Salmo salar*).**

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Wild anadromous Atlantic salmon (*Salmo salar*) of the inner Bay of Fundy (iBoF) have declined 90% or more in abundance since 1989. Although the stock has historically varied in abundance, the current decline is more severe and the population is at a lower abundance than previously documented. Recognition of the distinct phenotypic features of these stocks dates to the 19th century. Early maturity, successive annual spawning, local migration and distinct genetic haplotypes characterize two distinct stocks within the iBoF. The population was estimated to have been as many as 40,000 adult salmon in some years, likely less than 500 adult salmon in 1998 and less than 250 in 1999. Annual recruitment to spawning of iBoF salmon stocks was not correlated with other Atlantic coast salmon populations. A reduction in repeat spawning survival and survival to first spawning placed the stock in a steep decline. Monitoring of juvenile salmon in the two largest rivers, Stewiacke River and Big Salmon River, as well as in six other rivers of the iBoF, has confirmed that the decline is extensive within iBoF rivers. River-specific population extinction has been noted. Since 1990 no fisheries have been permitted to harvest iBoF salmon and a listing under the COSEWIC has been initiated. [**Sat PM2**]

- **ANALYSIS OF OPTICAL QUALITY, MITOCHONDRIA AND ANATOMY OF LENSES OF FOUR TELEOST SPECIES.**

Bantseev, V., K.L. Moran, and J.G. Sivak. School of Optometry, University of Waterloo, Waterloo, ON N2L 3G1

Purpose: To 1) Measure the optical quality 2) Examine the distribution of mitochondria in superficial cortical fibre cells and 3) Analyse suture structure in lenses of four teleost species.

Methods: Lenses from eyes of eel (*Anguilla rostrata*), carp (*Cyprinus Carpio*), trout (*Oncorhynchus mykiss*) and albino oscar (*Astronotus ocellatus*) were incubated for 24 h in 1.5 ml fish lens H10 medium. Those exhibiting damage, as evaluated by obvious opacities, were discarded. Lens focal properties were determined with a scanning laser system. Lenses were then labelled with 14 (M Rhodamine-123 for 25 min and embedded in 1% agarose in H10 for confocal microscopy analysis of mitochondria and suture structure. Results: Oscar lenses (n=8) showed a 0.09 mm average focal length variability (FLV), compared to 0.11 mm FLV in carp (n=11), 0.15 mm FLV in trout (n=33) and 0.58 mm FLV in eel (n=4). All four species had a "line" suture. Mitochondria were present in superficial cortical fibre cells approaching the sutures in all four species. Conclusions: 1) Oscar lenses demonstrated the highest optical quality, followed by carp, trout and eel. In the eye of the teleost fish the lens is the only refractive structure, since corneal power is neutralised by water (Sivak 1980; Sivak 1990). High FLV of eel lenses may suggest that vision for eels is not important as compared to oscar, carp or trout. 2) "Line" sutures observed in these four species, disagree with previous references to a "point" suture in fishes and this may suggest that sutures in fish lenses are species-specific. 3) The presence of metabolically active mitochondria in superficial cortical fibre cells approaching the sutures may suggest that superficial cortical fibre cells have an important metabolic property in the lens, as in mammals (Bantsev *et al.*, 1999). Supported by Natural Sciences and Engineering Research Council of Canada. [[Poster](#)]

- **THE IMPACT OF PISCIVOROUS BIRDS ON RAINBOW TROUT POPULATIONS IN LAKES.**

Beckmann, C., P. Biro and J.R. Post. Dept. of Biological Sciences, University of Calgary

The relative contribution of avian versus other sources of mortality on structuring freshwater fish populations is not well understood. We quantified the foraging rates of piscivorous birds among nine experimental trout populations created entirely through stocking into small pothole lakes. All lakes were stocked at the same density of age-0 trout (15,000/ha) and age-1+ trout (300/ha); four lakes were fertilized in order to increase plankton production for fish, and thus manipulate vulnerability to predators through reduced activity and higher growth rates in high food conditions. Lakes were surveyed regularly for the presence of piscivorous birds from July until late Sept, after which lakes were netted to determine mortality of fish. In addition, focal animal observations were made to determine foraging rates and success of specific bird species. Survey data and estimates of kill rates by specific birds were combined to yield whole-season mortality due to piscivorous birds. Birds which had the greatest impact were common loons and great blue herons. Those with lesser impact included pied-billed grebe, Foresters tern, belted kingfisher and osprey. The mean mortality of age-0 trout was 61% in low food lakes and 40% in high food lakes; birds accounted for 8% and 4% of this mortality, respectively. Mortality of age-1+ trout among populations fell into two groups: those with zero mortality and those with positive mortality. Lakes with zero mortality were never visited by loons and were very rarely visited by other birds capable of consuming larger fish. Those with positive mortality had frequent loon and heron visits and less frequent osprey predation. We conclude that bird predation on age-0 trout is a small proportion of the total mortality. Since we have not found evidence of starvation mortality of age-0 trout, we surmise that cannibalism by larger size-classes is therefore the predominant

source of age-0 mortality. By contrast, age-1+ mortality seems to be determined by bird predation, in particular loons. [Sat AM2]

- **VARIATION IN LAKE TROUT GROWTH RATES IN CANADIAN SHIELD LAKES WITH CONTRASTING FOOD WEB STRUCTURES.**

Bentzen, E., S.P. Good, and B.E. Hickie. Department of Biology, Trent University, Peterborough, ON

The average size of lake trout (*Salvelinus namaycush*) varies among Ontario Shield lakes. Lake trout diets are plastic, with some trout residing in lakes lacking deep water forage fish and hence are planktivorous while those residing in lakes with available forage fish are preferentially piscivorous. Planktivorous lake trout tend to be smaller and have less muscle lipid than piscivorous lake trout. Among piscivorous lake trout, those from lakes that include the benthic-pelagic invertebrate, *Mysis relicta*, tend to be larger than trout from lakes excluding mysids. A consequence of being a predator at the top of a long food chain is an increased probability of elevated body concentrations of organic contaminants that is attributed to enhanced bioaccumulation through longer food chains as well as larger body size and lipid content. It is not known how growth rates of lake trout vary among lakes of varying trophic structure but other studies have demonstrated that differences among fish growth rates may account for difference degrees of contaminant accumulation. Creel census and direct sampling age, length and weight data were collected from 25 lakes representing the three types of food webs for > 2000 lake trout in order to examine their growth rates as a function of food web category. Significant differences are observed in lake trout growth rates, both among and within food web categories. The importance of other factors including lake size are examined. [Sat PM1]

- **FISH BIODIVERSITY IN THE GREAT LAKES.**

Berends, M.P., and M.R. Gross. Department of Zoology, University of Toronto, Ontario.

Fish biodiversity has greatly changed in the Great Lakes. A review shows that exotics are found throughout the system as both predators and prey, and few native species are unaffected. Exotic chinook and coho Pacific salmon have largely replaced native top predators, and exotic alewife and rainbow smelt have largely replaced native prey species. Four species endemic to the Great Lakes are now globally extinct. An additional 11 species are extirpated from the Great Lakes but still occur elsewhere. At the same time, 26 'exotic' species are established in the Great Lakes. Therefore, at the species level, across the entire Great Lakes system, fish biodiversity has experienced an overall increase of 11 species (26 exotics minus 15 natives lost from the system). Individual lakes have of course experienced individual outcomes. Fish stocking has been a major source of the changes in biodiversity, accounting for the introduction of 40% of the exotics. Fish stocking raises many impact issues. [Poster]

- **COMMUNITY AND ENVIRONMENTAL EFFECTS ON WALLEYE (*Stizostedion vitreum*) LIFE HISTORY VARIATION.**

Binks, J., and G.E. Morgan. Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, ON

Walleye life history parameters were compared to fish community, physical and chemical data for 86 lakes sampled in northeastern Ontario using regression and multivariate analyses. There was a positive relationship between the relative abundance of smallmouth bass (*Micropterus dolomieu*) and walleye pre-maturation growth rate. There was no relationship between the relative abundance of smallmouth bass and walleye. Environmental variables associated with smallmouth bass relative abundance were then examined to determine other possible factors that might explain this relationship. Growing degree days was significantly correlated with smallmouth bass relative abundance when using the entire data set. However, there was no significant relationship when using only lakes with bass present. This suggests a functional relationship between walleye pre-maturation growth and the smallmouth bass relative abundance. Principal component factor analysis was used to determine the influence of community and environmental factors on walleye life history characteristics. Community factors appeared to influence walleye throughout their life whereas environmental factors appeared to influence pre-maturation growth. Implications for walleye management in northeastern Ontario will be discussed. [[Poster](#)]

- **POPULATION CONSEQUENCES OF BEHAVIOUR: DENSITY-DEPENDENT MORTALITY IS MEDIATED BY ADAPTIVE FORAGING ACTIVITY FOR YOUNG FISH IN WHOLE-LAKE EXPERIMENTS.**

Biro, P.A. and J.R. Post. Dept. of Biological Sciences, University of Calgary, Calgary, AB T2N 1N4

Recent laboratory and theoretical studies suggest the futility of attempts to characterize animal populations as being regulated either by predators or by food. If, for instance, depletion of food is density-dependent and leads to greater foraging activity, then visibility and encounter rates with predators must also increase. Such increased foraging activity while under risk of predation provides a novel and very general mechanism for density-dependent mortality. To date, it has been explored only in the laboratory or theoretically. We tested this hypothesis by experimentally manipulating the density of young rainbow trout (low/high) and the size-structure of adult trout predators (small only/small+large) in a replicated 2(2 factorial experiment using 8 lakes. We found that mortality over the growing season was strongly density-dependent, greater in the presence of large adults and highest in populations at high density and containing large adults. Individual activity (proportion of time moving) and the proportion of each population that was continuously active was significantly related only to density; high-density populations had the greatest activity rates. Young trout in high-density populations also used deeper (riskier) habitats sooner and to a greater extent than populations at low density. We found no evidence for density-dependent food (zooplankton) depletion; rather, relatively small differences in zooplankton biomass of shallow refuge areas among lakes explained significant variance in mortality within a given treatment. This study illustrates the importance of combining behavioural and population ecology approaches to gain a mechanistic understanding of important population-level processes (population regulation). [[Sat PM1](#)]

- **FACTORS AFFECTING THE REPRODUCTIVE SUCCESS OF FEMALE BROOK TROUT.**

Blanchfield, P.J. and M.S. Ridgway, Fisheries & Oceans Canada, Freshwater Institute, Winnipeg, MB

Behavioural observation is much more widespread in the study of mammalian and avian mating patterns than for fish, in which we are often limited by the inability to observe the interactions of individuals on the breeding grounds. This is particularly true of salmonines, in which population size and breeding location often make acquiring data on individuals difficult. Here we report on measures of female reproductive success from an intensively studied population of lacustrine brook trout (*Salvelinus fontinalis*). Female reproductive success is a function of egg survival, which is dependent upon spawning site quality (groundwater flow), and brood loss due to superimposition by other females. Limited spawning sites, the use of multiple spawning sites by females and high variation in site quality, related to groundwater flow, together account for the high egg mortality (95%) observed for this lake population. The trade-off between spawning site selection and timing of spawning is also dependent upon female body size. An experimental manipulation revealed that smaller females delay spawning in the presence of large females as a tactic to avoid brood loss. The combination of behavioural and site quality measures provides new insight into the limited availability of spawning habitat for lacustrine populations. [[Sat PM1](#)]

- **METAALICUS - A WHOLE-ECOSYSTEM EXPERIMENT TO DETERMINE THE RELATIONSHIP BETWEEN ATMOSPHERIC DEPOSITION OF MERCURY AND MERCURY CONCENTRATIONS IN FISH.**

Blanchfield, P.J., C.L. Podemski, M.A. Paterson, J.W.M. Rudd, C.A. Kelly and R. Harris. Fisheries & Oceans Canada, Freshwater Institute, Winnipeg, Manitoba

Mercury is the most common contaminant in fish in Canada and the United States. For example, 99% of fish consumption advisories in Ontario are due to mercury contamination. Despite the massive amounts of scientific information published on mercury contamination of ecosystems, there remain very basic questions about the environmental behavior and effects of this element. A critical uncertainty is whether a reduction in atmospheric mercury emissions will reduce mercury concentrations in fish. METAALICUS is a whole-ecosystem experiment in which mercury inputs to a headwater lake and its watershed will be increased. The mercury will be added as stable, non-radioactive isotopes of inorganic mercury (Hg(II)). The power of using isotopes lies in the ability to follow the newly deposited mercury separately from the background mercury. This approach will allow us to directly answer for the first time what happens to fish mercury concentrations when there is a change in atmospheric mercury deposition. Here we report on the bioaccumulation of methylmercury into benthic organisms, plankton and fish from pilot studies simulating increased atmospheric deposition of mercury. [[Poster](#)]

- **WATERSHED HYDROLOGY AND THE HABITAT OF BROOK TROUT IN LAKE ECOSYSTEMS.**

Borwick, J.A.¹, and M.D. Ridgway². ¹Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON, ²Aquatic Ecosystems Science Section, Harkness Laboratory of Fisheries Research, Ontario Ministry of Natural Resources, Peterborough, ON

There is a known relationship between groundwater upwelling and brook trout (*Salvelinus fontinalis*) spawning needs; however, the extent of young-of-year (YOY) use of similar groundwater sources, such as seeps and inflows, is relatively unknown. A field survey of naturally reproducing brook trout lakes in Algonquin Park was therefore undertaken to determine what typical nursery habitat YOY utilize in different seasons. This was done by locating all forms of groundwater related nursery habitat (inflows, outflows, and seeps) on 16 lakes in the Park. Habitat width, depth, and temperature were measured. A visual sampling method was used to identify YOY presence or absence in these habitats. Preliminary results indicate that the mean number of nurseries, inflows, seeps, and outflows per lake were 11.5, 5.7, 4.9, and 1, respectively. Of the combined 171 nursery habitats surveyed within all lakes (50% inflows, 41% seeps, and 9% outflows) 35.7% of these were used by YOY in the spring of the year compared to only 16.8% used in the summer. Only 42.7% of potential nurseries were identified on the current Ontario Base Maps (OBM). Mean nursery depth, width, and temperature of YOY habitats in spring were 0.27m (◆ 0.22), 2.02m (◆ 1.68), and 11.6◆C (◆ 3.25), respectively. Conversely, summer YOY habitats had a mean depth of 0.19m (◆ 0.15), mean width of 1.67m (◆ 1.23), and a mean temperature of 15.2◆C (◆ 3.23). All of these physical mean characteristics were significantly different from those of nurseries without YOY brook trout. Further analysis into the relationship between groundwater sources and YOY will be performed using a geographic information system (GIS) approach to determine the spatial extent of these groundwater habitats and the sub-catchment characteristics needed to sustain them. This information may assist fisheries and forestry managers in conserving naturally reproducing populations of *S. fontinalis* and the basins that sustain them. [[Poster](#)]

- **OPTIMAL GUARDED AREA IN THE CONVICT CICHLID.**

(*Cichlasoma nigrofasciatum*). Breau, C., and J.W.A. Grant. Department of Biology, Concordia University, Montréal, QC

Optimal territory size models assume that the costs of defence increase as territory size increases, whereas the benefits of defence increase in a decelerating way with increases in territory size. There have been many tests of these models using animals defending relatively permanent feeding territories. However, optimal territory size models have rarely been applied to the defense of ephemeral patches of resources such as a brood, a mate, or a food patch. I tested the predictions of the optimal territory size models using convict cichlids (*Cichlasoma nigrofasciatum*) defending ephemeral patches of food. I manipulated the guarded area around a food patch by varying the distance of vegetation (in which the intruders could successfully hide from the defender) from the edge of the food patch while monitoring the costs and the benefits of the defender. As expected, the costs (chase radius and chase rate) and the gross benefit (number of pellets eaten) initially increased with guarded area. However, the weight gain of the defender did not vary with guarded area. The number of pellets eaten was positively correlated with the

defenders \diamond weight gain and negatively correlated with chase rate. This experiment supports the idea that the size of the guarded area affects the defenders exclusivity to the patch and its defence costs. [[Poster](#)]

- **CAN WE ACCURATELY ESTIMATE FISH ABUNDANCE USING HYDROACOUSTIC?**

Brind'Amour, A., and D. Boisclair. Département de sciences biologiques, Université de Montréal, Montréal, QC

The use of horizontal scanning hydroacoustic in order to determine fish abundance and spatial patterns has been a useful adaptation in shallow waters. It allows large volume of water to be sampled very quickly, without interfering with fish behaviour. Although it's large utilization, one problem still remains. The estimation of the fish abundance is not accurate. Difficulties to estimate the fish real abundance lie in the fact that depending on the fish position and distance from the beam, resulting echoes are variable. As the distance from the fish targets increases, chances are that the surface of the water will be hit and that wave echoes will also be receive. As some authors use the relative fish abundance as a surrogate, experimental data are needed. The aim of our study was to describe and quantify the relationship between the fish relative and real abundance with varying distances. To do so, we hung 20 fish on a straight wire and we beamed them every five meters, until we reached a distance of 30 meters from them. Then, we added 20 more fish and repeated the experiment. Preliminary results show an increase in fish echoes as the distance increases, probably due to the effect of waves. Is it possible to correct for the wave impact? Could we separate the acoustic cone to evaluate abundances at distinct distances? More analysis is to come. [[Poster](#)]

- **EFFECTS OF SILT ON CARDIAC OUTPUT OF RIVERINE AND LACUSTRINE ROCK BASS.**

Bunt, C.M., S.J. Cooke, J.F. Schreer, and D.P. Philipp. Center for Aquatic Ecology, Illinois Natural History Survey, Champaign, IL 61820

Rock bass (*Ambloplites rupestris*) are a widespread centrarchid species with both riverine and lacustrine populations. After precipitation events, rivers often carry elevated silt loads, while lakes generally remain free from suspended silt and sediment. To examine the physiological effects of silt on rock bass, we conducted a series of experiments using 12 fish from Lake Opinicon and another 12 from the Grand River, Ontario. Each fish was surgically implanted with an ultrasonic Doppler flow probe around the ventral aorta. After recovery, replicated treatment groups were exposed to incremental increases in silt load (made from a bentonite slurry) while cardiac output (i.e., heart rate x stroke volume) was measured simultaneously. Results from the experiments were used to: 1) identify and characterize physiological responses by rock bass to varying silt loads; 2) illustrate differences in physiological responses between riverine and lacustrine rock bass; 3) propose hypotheses related to evolutionary adaptations to silt; and 4) describe potential fisheries management implications related to our findings. [[Poster](#)]

- **GENETIC CHARACTERIZATION OF AN ALTERNATIVE LIFE HISTORY STRATEGY IN CHINOOK SALMON (*Oncorhynchus tshawytscha*).**

Busch, C.R., and D.D. Heath. Department of Biology and the Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON

Male chinook salmon (*Oncorhynchus tshawytscha*) may mature a year before females of the same cohort, demonstrating an alternative life history strategy, "jacking". In wild and commercial stocks, jacks have been excluded from breeding because of their small size at maturation. This selection could represent a loss of genetic variation to the stock. The goal of this study was to characterize the genetic component to jacking using microsatellite loci as linkage group markers. We masculinized 2000 chinook salmon fry to produce male phenotype, XX and XY fish, and used a PCR-based Y-chromosome marker to select jacks and non-jacks of each genotypic sex for genetic analysis. We found one microsatellite locus that had a strong relationship with the jack phenotype in both the XX and XY males. In addition, we found weaker associations at other microsatellite loci in the XY males only. The evidence for microsatellite locus linkage disequilibrium described here will allow future mapping of the genes responsible for jacking. Such a genetic map will aid in determining the genetic consequences of including or excluding jacks from controlled breeding programs, either in wild or cultured stocks. [[Poster](#)]

- **STABLE ISOTOPE ANALYSIS OF TWO BROOK CHARR FORMS (*Salvelinus fontinalis*) IN RELATION WITH FISH MORPHOLOGY AND DIET COMPOSITION.**

Caron, M., G. Cabana, and P. Magnan. Département de chimie-biologie, Université du Québec à Trois-Rivières, QC G9A 5H7

Lakes of the Northern hemisphere have two functional habitats represented by the shallow littoral and the pelagic zones. Previous studies have shown that brook charr (*Salvelinus fontinalis*) exhibit a trophic polymorphism while feeding from these two habitats. This variation in diet has been related to differences in spatial distribution (radio-telemetry), body morphology, and coloration pattern. The goal of this study was to investigate the differential use of benthic and pelagic prey by the littoral and open-water forms respectively with stable isotope analysis ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) as long-term integrators of the diet. We have found a substantial and significant difference in $\delta^{13}\text{C}$ between the isotopic signature of pelagic prey (zooplankton) and littoral benthic invertebrates ($\approx 8\text{‰}$). There was a clear inter-individual variation in feeding habits revealed by stomach content analysis. However, stable isotope analysis (SIA) suggested that brook charr mostly depend on benthic prey. Thus, some individuals spending time in the open-water zone appear to derive little energy from zooplankton and obtain most of their energy by feeding occasionally on benthic invertebrates. In spite of this low variance in the isotopic signature between the two forms, a significant difference in pectoral length was observed between littoral and pelagic individuals. [[Poster](#)]

- **EFFECTS OF CLIMATE AND GLOBAL WARMING ON YEAR-CLASS STRENGTH AND RELATIVE ABUNDANCE OF SMALLMOUTH BASS IN EASTERN LAKE ONTARIO.**

Casselman, J.M.¹, D.M. Brown², J.A. Hoyle³, and T.H. Eckert⁴. ¹Ontario Ministry of Natural Resources, Research, Science and Technology Branch, Glenora Fisheries Station, Picton, ON, ²Ontario Federation of Anglers and Hunters, Peterborough, ON, ³Ontario Ministry of Natural Resources, Lake Ontario Fisheries Management Unit, Glenora Fisheries Station, Picton, ON, ⁴New York Department of Environmental Conservation, Lake Ontario Fisheries Unit, Cape Vincent, NY.

Smallmouth bass in eastern Lake Ontario have shown extreme fluctuations over the past two decades. Relative year-class strength and July-August water temperatures were highly significantly, similarly correlated for both Ontario and New York waters ($r^2 = 0.47$). Relative year-class strengths did not differ significantly for the 24-year period 1973-1996, with regular strong year-classes followed by several weaker ones; 1989 to 1994 was a notable exception, with only weak year-classes. Strongest year-classes came from El Niño years (1973, 1983, 1995) and weakest from La Niña years (1985, 1989, 1976). The weakest year-class was 1992, when the eruption of Mount Pinatubo caused decreased water temperatures. Relative abundance of 4-to-10-year-olds, predicted from year-class strength and survival rates, peaked in the mid- to late 1980s, approximately 4.0x greater than when the population was weakest, from the mid- to late 1990s. Low temperatures in the early 1990s caused by Pinatubo reduced year-class strength, which dramatically reduced abundance in 1995-1999, 4-7 years later. The 1995 year-class initiated a resurgence in both waters that commenced in 1999 and is predicted to extend until at least 2003. Global warming will substantially increase smallmouth bass recruitment and abundance. Summer temperatures increased significantly (0.9°C) over the past several decades, associated with a 2.0x increase in year-class strength; an increase of 1.0°C will increase abundance by 2.5x and 2.0°C by 6.0x. [**Fri PM1**]

- **SPERM TRAITS AND BODY CONDITION OF MALE BLUEGILLS.**

Casselman, S.J., and R.D. Montgomerie. Dept of Biology, Queen's University, Kingston, ON K7L 3N6

Though there has been some recent interest in the variation in sperm traits among males of a population, reasons for this variation have not yet been determined. In this paper we look at the relation between sperm morphology and behaviour (swimming speed and longevity) and the condition of breeding male bluegills in Lake Opinicon, Ontario. Sperm traits varied significantly more among than within males suggesting that some aspect of male quality might influence sperm morphology and behaviour. We show that sperm traits of males nesting in the centre of colonies differ from those of males nesting on the perimeter and we attempt to relate this variation among individuals to male age and body condition. [**Poster**]

- **QUANTITY OF FISHERIES DATA AND UNCERTAINTY IN STOCK ASSESSMENT AND MANAGEMENT.**

Chen, Y., School of Marine Sciences, 225 Libby Hall, University of Maine, Orono, ME

Understanding the dynamics of fisheries stocks is essential in developing optimal management strategies. This is often obtained through fitting mathematical models to fisheries data to estimate

vital fisheries parameters and their uncertainties. Among the factors that may affect estimating fisheries parameters is the quantity of fisheries data. The quantity of fisheries data tends to be positively related to the economic and social values of fisheries. It can be grouped into two categories: diversity of the data, defined as the number of sources from which data are collected, and amount of the data, defined as the number of observations made from fisheries. Although it has recently been recognized that the quantity of fisheries data can have a great impact on the quality of stock assessment, few studies have been done to quantitatively evaluate the uncertainty resulting from the quantity of fisheries data. In this study, using an abalone fishery as an example, I evaluate the impacts of the data quantity on stock assessment and management. This study suggests that the lacks of historical information and data diversity increase the uncertainty and bias in stock assessment and subsequently complicate the identification of optimal management strategy. Strategies are proposed for fisheries studies to reduce such an uncertainty and bias. [Fri PM1]

- **HABITAT FACTORS AFFECTING FISH COMMUNITY STRUCTURES: AN ECOLOGICAL NOTE ON SOUTHWESTERN ONTARIO STREAMS.**

Chowdhury, M.A.K., and F.W.H. Beamish. Department of Zoology, University of Guelph, Guelph, ON

Fish community structures were studied in 28 locations of four tributaries (seven sites from each of Speed, Eramosa, Nith, and Connestoga) of the `Grand River, Ontario. Effect of instream and regional habitat characteristics on fish assemblages was also studied. In total, 39 species were observed in these four rivers, 16 of which were common to three rivers except the Speed River, where, rainbow darter (*Etheostoma caeruleum*) and common shiner (*Notropis cornutus*) were the most abundant species in all three rivers, whereas greenside darter (*E. blennioides*) was dominant only in the Eramosa and Nith rivers. Only three species were observed to be dominant in the Speed River, and these are - fantail darter (*E. flabellare*), mottled sculpin (*Cottus bairdi*) and finescale dace (*Chorosomus eos*). Among the instream habitat characteristics, it was observed that width, depth, velocity, macrophyte cover, pool-riffle ratio, and vegetation cover were affecting fish community structures significantly ($P < 0.05$). Almost all the selected regional habitat variables (e.g. altitude, dams, agriculture, urban development, and buffer strip) were found to significantly affect both fish assemblages and instream habitat variables ($P < 0.01$). Among these variables, dams had the most affect on fish assemblages, specifically so in the Eramosa River. [Fri PM2]

- **CISCOE de FUMAGE: A LIFE HISTORY SYNTHESIS OF BLOATER CHUB (*Coregonus hoyi*).**

Clemens, B.J.¹, and S.S. Crawford². ¹Department of Zoology, University of Guelph, Guelph, ON, ²Chippewas of Nawash First Nation, Wiarton, ON and Axelrod Institute of Ichthyology, University of Guelph, Guelph, ON

Since its description in 1872, the bloater chub (*Coregonus hoyi*) has survived as the only major representative of a once-thriving complex of endemic deepwater ciscoes in the Great Lakes. The other species in this complex suffered the combined effects of overexploitation and ecological

disruption - leading to virtual, if not complete, extinction. Bloater chub populations survive in the deeper waters of the Great Lakes, where they appear to carry on a significant role in ecosystem structure and function. From a tropho-dynamic perspective, bloater chub feed relatively close to the bottom of the aquatic food web (e.g. *Mysis*, *Pontoporeia*), and have been estimated to comprise up to 75% of planktivore biomass on a lakewide basis. Historically, bloater chub was probably a key forage species for lake trout (*Salvelinus namaycush*) - a native salmonine that has proven difficult for Great Lake fisheries managers to 'rehabilitate' after widespread collapses in the 1940s and 50s. From a fisheries perspective, bloater chub still represents a significant component of commercial harvests, especially in the Upper Lakes (Huron, Michigan, Superior) where bloater chub TACs may exceed 20% of the total (all species combined). Given how important bloater chub may be to Great Lakes ecosystems and fisheries, there is surprisingly little known about them, their life history and basic ecology. During the period 1960-1999, a total of 182 publications appeared in the primary literature on lake whitefish (*Coregonus clupeaformis*); compared to a scant 39 (21%) publications on bloater chub. We present our review of the available information on the life history and ecology of bloater chub populations, focusing on their migratory movements, predator and prey relations, as well as their response to changes in fishing activity. We develop alternate ecological hypotheses to be used in contingency modeling of bloater chub fisheries. [Sat AM1]

- **DOES RADIO-TAGGING AFFECT THE STRESS PHYSIOLOGY OF ATLANTIC SALMON SMOLTS?**

Connors, B. K.¹, V.M. Mathilakath², and R.S. McKinley¹. ¹Waterloo Biotelemetry Institute, ²Department of Biology, University of Waterloo, Waterloo, ON N2L 3G1

Biotelemetry is used extensively to evaluate the behaviour and movements of juvenile fish. Physiological, morphological and behavioral changes are commonly associated with downstream migration of smolts, but these changes vary with species and also with the timing of migration. Therefore, the objective of the study was to determine if the stress response associated with the radio transmitter implantation varied with the timing of seaward migration. Fish were sampled each week over a 5 week period and environmental variables (temperature, flow, photoperiod) along with physiological parameters (plasma glucose, lactate, Na⁺, Cl⁻, cortisol, gill Na⁺+K⁺ - ATPase and liver glycogen) were monitored. Furthermore, groups of fish, collected either at the beginning, peak or end of migration, were implanted surgically with dummy radio transmitters (Lotek Engineering Inc., model MCFT 3KM; 17 ♦ 10 mm, 1.4 g in air, ranging between 1.7 - 5.4 % body weight). Their physiological response to tagging was monitored over a 24 hour period. There were no significant changes in glucose, lactate, Na⁺ or Cl⁻ during the migration, however, there was a significant decrease in plasma cortisol concentration and condition factor with time of migration ($p < 0.05$). The cortisol response was similar at all three time points during migration with cortisol levels significantly higher at 1 or 3 hours post-tagging ($p < 0.05$). Our results indicate Atlantic salmon smolts, regardless of the time of migration, respond to tagging by elevating plasma cortisol concentration, but the levels return to pre-stress values within 24 hours post-tagging. [Sat AM2]

- **LIVWELL RETENTION OF SMALLMOUTH BASS: OPPORTUNITIES FOR MINIMIZING STRESS AND ENHANCING RECOVERY.**

Cooke, S.J.¹, D.P. Philipp², D.H. Wahl², and J.F. Schreer³. ¹Queen's University Biological Station, Elgin, ON, ²Department of Natural Resources and Environmental Sciences, University of Illinois and Center for Aquatic Ecology, Illinois Natural History Survey, Champaign, IL, ³Department of Biology, University of Waterloo, Waterloo, ON

Competitive angling events for black bass are very popular in North America. The majority of these events are catch-and-release and therefore require that fish be held in livewells for extended periods of time until the fish are brought to the weigh-in. During this time, the biomass and numbers of individuals held in the livewell vary. Despite many studies examining initial and delayed hooking mortality following competitive angling events, no studies have investigated the behavioral and physiological effects during smallmouth bass livewell confinement. We studied several aspects of livewell confinement to both understand the behavioral (locomotory activity) and physiological (cardiac output) consequences. Simulated tournament conditions revealed that cardiac output and activity of individual fish increase with increasing livewell density, placing a greater demand on livewell oxygen conditions. The repeated handling of fish during tournament angling, including culling, addition of fish and other livewell disturbances, and the final tournament weigh-in, which adds several minutes of air exposure, further adds to already heightened stress levels. We propose simple measures that can be adopted by anglers, competitive angling event organizers, and boat manufacturers to minimize the effects of these practices on fish and to facilitate a rapid and complete recovery. [[Poster](#)]

- **NEST CHOICE BY MALE ROUND GOBY, *Neogobius melanostomus*.**

Corkum, L.D., and K.L. Stammer. Department of Biological Sciences, University of Windsor, Windsor, ON

Multiple spawning habits and parental care of nests by males explain the rapid, successful recruitment of the nonindigenous round goby in the Great Lakes. In an attempt to manipulate nesting behaviour of gobies, we conducted a laboratory experiment to determine nest size preference and the likelihood of nest occupancy as a function of male size in clear and darkened artificial nests. Small (150 mm²), medium (300 mm²), medium-large (450 mm²), and large (600 mm²) artificial nests made of tiled sides and clear Plexiglas tops with a 5 x 5 cm entrance were placed in the centre of a wading pool (area: 0.55 m²) containing aerated dechlorinated water. Each nest was positioned within a large nest so that fish could not distinguish among nest sizes unless the interior was explored. All nests were initially covered with tiles. We added one round goby to the centre of a pool (n=40), recorded the time until a fish entered a nest, and monitored which nest was occupied every 30 min for 6 h. Once a fish entered a nest, tiles were either removed to expose the clear top (n=20) or left in place (n=20). There was a significant, but weak, positive relationship between body size (total length) and time to occupy nests ($R^2 = 0.10$, $P=0.044$). Gobies eventually abandoned nests with clear coverings, but remained in nests that were darkened. Gobies that abandoned nests were significantly smaller than those that remained in nests ($t=2.45$, $p=0.01$). There was no significant difference in mean body size of gobies that occupied the 4 nest sizes ($F=0.67$, NS). We anticipate that artificial nests can be used in the field to manipulate reproductive habits of the round goby in ways that will reduce their interactions with native fishes. [[Poster](#)]

- **BREEDING ECOLOGY OF PACIFIC SALMON IN LAKE ONTARIO.**

Craine, I., M.P. Berends, and M.R. Gross. Department of Zoology, University of Toronto, Ontario.

The chinook and coho Pacific salmon produced by hatcheries in Lake Ontario were initially presumed to have no wild production and thus be carefully controlled. Moreover, it was assumed that they would have limited impact on native species within the Lake Ontario ecosystem. However, thousands of mature adult Pacific salmon are now entering the stream watershed to spawn. Full control of these non-native species by hatcheries is no longer possible. Because of their high economic importance, and their potential impact on native species and the ecosystem, we have initiated a study of their colonization. Our research objectives include both the study of recruitment potentials and ecosystem impacts. Specifically, we are studying: (1) breeding biology; (2) habitat use; and (3) interactions with native species. The anticipated benefits of this research are: (1) significant improvement to Pacific salmon management in Lake Ontario; (2) protection of native species; (3) a model knowledge-base for the effects of intentionally introduced exotics; and (4) the education of Canadian society at large. Collaborators include: OMNR, GLFC, NYDEC, GLU, CNF and researchers funded by the NYSGI to assess salmonine populations within the lake. This multi-institutional and disciplinary approach should provide unique insights into the ecology of Pacifics in Lake Ontario. [[Poster](#)]

- **IMPLICATIONS OF LIFE HISTORY REVIEW FOR MANAGEMENT OF LAKE WHITEFISH (*Coregonus clupeaformis*) FISHERIES IN LAKE HURON.**

Crawford, S.S.^{1,2} and J.A. Holmes¹. ¹Axelrod Institute of Ichthyology, University of Guelph, Guelph, ON, ²Chippewas of Nawash First Nation, Wiarton, ON

Lake whitefish (*Coregonus clupeaformis*) is a paradoxical species in the sense that we are so familiar with them as supporting freshwater fisheries, yet we have little shared understanding of their life history, their ecological relationships with abiotic and biotic perturbations, and their responses to fisheries management programs. Ironically, it may have been the vast quantities of information collected about lake whitefish that discouraged us from attempting a comprehensive review of our ecological knowledge about this important species. The Chippewas of Nawash and the University of Guelph have established a collaborative research program that focuses on the Nawash fisheries in Lake Huron, the lake whitefish populations that support these harvests, and the ecological processes that affect fisheries management decision-making. In order to provide a solid foundation for this research program, we have undertaken a thorough ecological review of the available life history information on lake whitefish, with a particular focus on Great Lakes populations. Aside from documenting observations and interpretations available in the primary and technical literature, we have synthesized this information into explicit hypotheses regarding the key abiotic and biotic factors that affect lake whitefish population dynamics. We present a summary of these hypotheses, and demonstrate their relationships with other collaborative research projects currently focusing on Lake Huron fisheries ecology, including: - Development of population models to evaluate alternate harvest strategies - Implementation of non-fishery

sampling programs to quantify population status - Evaluation of the effects of the Bruce Nuclear Power Development on lake whitefish populations - Comparative analysis of lake whitefish and bloater chub population dynamics - Risk evaluation of disease transfer between introduced and native fish populations. [Sat AM2]

- **ENERGETIC AND MORPHOMETRIC PATTERNS IN MIGRATING FRASER RIVER SOCKEYE SALMON: THE ROLE OF MIGRATORY DISTANCE AND ELEVATION**

Crossin, G.T. and S.G. Hinch. Department of Forest Sciences, University of British Columbia, Vancouver, BC V6T 1Z4.

Adult sockeye salmon (*Oncorhynchus nerka*) rely on energy reserves developed at sea to fuel upriver migrations to spawning grounds and complete sexual maturation. Depending on the stock, Fraser River sockeye travel distances of 50 to 1200 km, and ascend elevations ranging from near sea-level to 1200 m to reach spawning grounds. In 1999 and 2000, we collected sockeye from five major stocks at various points along their river migrations. We calculated energy content of somatic, visceral and gonadal tissues and took several morphometric measurements to examine whether energetic state and morphology of sockeye is influenced by migratory difficulty. Sockeye travelling to high and distant spawning grounds began their migration with higher levels of somatic energy and were smaller and rounder than those travelling to lower, less-distant grounds. The former were also less sexually developed at the start of migration, a possible means to conserve energy needed for migration. Migratory difficulty (a composite index of distance and elevation) was strongly correlated with initial energetic state and was a stronger predictor of en-route energy-use than migratory distance or elevation individually. Energy-use data from migrating sockeye in the 1950s show similar stock-specific trends, but initial energy densities are currently much lower than that reported 40 years ago. Inter-decadal patterns in ocean productivity, river flows and temperatures may be responsible for these differences. [Sat AM2]

- **CONSERVATION GENETICS OF COASTER BROOK TROUT**

D'Amelio, S. and C.C. Wilson. Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON

Coaster brook trout are potadromous life history variants that spend a portion of their adult life in Lake Superior. Although considered by some to comprise an evolutionary significant unit (ESU), the biology and life history of coaster brook trout are largely unknown. Overharvesting and habitat loss have extirpated coasters from most of their range; remaining extant populations are largely restricted to Nipigon Bay. Heavy historical stocking of hatchery brook trout has posed an additional threat to the genetic integrity of these fish. Though coasters utilize the lake for their adult life, they migrate into tributary rivers to spawn and can therefore potentially interact with typical river-resident brook trout. We are using microsatellite DNA markers to determine the uniqueness of coasters as a genetic stock as well as their degree of interaction (matings) and relatedness with river-resident brook trout. Samples collected to date include Lake Superior coasters and resident brook trout from six rivers known to be utilized by coasters during

spawning, as well as the Nipigon hatchery strain of brook trout which has been heavily stocked in the area. These data will resolve the genetic identity of coaster brook trout and their relatedness to river-resident populations, and provide essential information for their future management and conservation. [[Sat PM1](#)]

- **DISPERSAL OF QUEEN CONCH (*Strombus gigas*) FROM KEY NURSERY GROUNDS: IMPLICATIONS FOR DESIGNING NO-TAKE FISHING RESERVES**

Danylchuk, A., K. Baldwin, and M. Rudd. School for Field Studies, Center for Marine Resource Studies, South Caicos, Turks & Caicos Islands, British West Indies.

In response to concerns regarding declining queen conch stocks in the Turks and Caicos Islands, a no-take fishing reserve, the East Harbour Lobster and Conch Reserve (EHLCR) was established in 1993. As with any no-take fishing reserve, the anticipated benefits of the EHLCR include an increase in abundance of queen conch within the reserve and subsequent spill-over (i.e., dispersal) to fished areas. Preliminary results of a spatial population analysis confirm that the density of conch in the EHLCR is higher than in similar habitats outside the reserve. Our results also indicate that conch in the EHLCR originate from a shallow nursery ground comprised of benthic algae and coral rubble, and then disperse to deeper areas dominated by seagrasses as they grow. Unfortunately, the current reserve boundaries do not appear to promote the spill-over of conch into fished areas as they disperse. Extensive sandbars run adjacent to two borders of the reserve, offering no suitable, contiguous adult habitat. Moreover, the remaining marine border abuts another protected area where fishing is prohibited and the offshore boundary rapidly exceeds the depth range for queen conch. Despite the limited potential for spill-over, the EHLCR may still support the local fishery by protecting breeding adults and enhancing larval recruitment to fished areas downstream, but this hypothesis remains to be tested. [[Poster](#)]

- **STATUS-DEPENDENT REPRODUCTIVE ACTIVITY IN MALE FATHEAD MINNOWS (*Pimephales promelas*): INFLUENCE OF POPULATION DENSITY**

Danylchuk, A.J.^{1,2}, and W.M. Tonn¹. ¹Department of Biological Sciences, University of Alberta, Edmonton, AB, ²School for Field Studies, Center for Marine Resource Studies, South Caicos, Turks & Caicos Islands

Reproductive activity of male fathead minnows can be affected an individual's social status within a population. Because social status is a product of encounters among conspecifics and population density may influence the frequency of encounters among individuals, the reproductive activity and associated traits may be density-dependent. To test this hypothesis, we examined the development of male secondary sexual characteristics, which reflect reproductive activity, in four populations that differed in density. Early in the spawning season, the expression of secondary sexual characteristics was similar for small and large males in lower density populations, but size-dependent in populations with higher densities. However, this size-dependency decreased as the spawning season progressed, likely reflecting a shift in reproductive tactics by small males as larger, dominant individuals finish reproducing. Since the study lakes had similar thermal and nutrient regimes, it is unlikely that these non-social

environmental factors contributed greatly to differences in the expression of these traits. We suggest that population density influences the reproductive tactics of male fathead minnows, likely through its effect on their social environment. [Sat PM1]

- **PREDICTING FISH COMMUNITIES FOLLOWING WETLAND RESTORATION**

Davis, J.A., and D.A. Jackson. Department of Zoology, University of Toronto, Toronto, ON.

Cootes Paradise is a 250 ha marsh located on the western end of Lake Ontario. A combination of stresses have contributed to its degradation over the last century. The result of which has been a drastic change to habitat features required by fish for critical life stages. Efforts are being made to reduce stressors on Cootes Paradise and to enhance habitat. Of the restoration efforts initiated, most notable is the Fishway, which significantly reduces the number of adult carp entering the marsh each spring. Some changes to fish communities have occurred since the barrier became fully effective in 1997. In addition to determining the effect of the Fishway on the fish community of Cootes Paradise, we are interested in knowing how continued restoration measures will influence future fish communities. Though several studies have described relationships between fish and their habitat, none have used this information to predict changes to fish species as a response to restoration initiatives in wetlands. Using information collected on other coastal marshes in Lake Ontario, we can determine the relationships between fish communities and their associated marsh habitat. This information may then be used to determine potential trajectories of change and make predictions about the possible ecological outcomes of restoration measures. [Fri PM1]

- **REACTION OF RUFFE TO AN ELECTRICAL BARRIER AT VARIOUS VOLTAGE AND PULSE SETTINGS**

Dawson, H.^{1,*}, J. Savino², and U. Reinhardt¹. ¹Department of Biology, Eastern Michigan University, Ypsilanti, MI, ²U.S. Geological Survey, Great Lakes Science Center, Ann Arbor, MI.

Examples of nonindigenous aquatic species introduced into the Great Lakes basin include the sea lamprey, round goby, and ruffe. Efforts are currently underway to prevent their spread into other waterways. The ruffe, *Gymnocephalus cernuus*, is speculated to have arrived via ship ballast water to the Lake Superior in the mid-1980's. Since then it has found its way into Michigan waters as far east as Ontonagon. Electrical barriers are currently being tested as a way to block their passage through waterways, preventing their spread into new water bodies. In the lab and in field experiments round gobies, *Neogobius melanostomus*, were used to test appropriate voltage and pulse settings for application into larger scale barriers such as one that could be used in the Illinois Waterway. Round gobies have already found their way into the Illinois Waterway, so the challenge is to find an effective barrier preventing other nonindigenous species passage into the waterway. This contribution reports on results of lab experiments testing the reaction of ruffe to an electrical barrier with varying voltage and pulse settings. [Poster]

- **AGE-0 SEA LAMPREY EMERGENCE, DISPERSAL, AND MOVEMENTS: THE POTENTIAL FOR COMPENSATORY MECHANISMS**

Derosier, A.L., and M.L. Jones. Michigan State University, East Lansing, Michigan USA.

Factors regulating sea lamprey populations are relatively unknown. Compensatory mechanisms are density-dependent, demographic responses of populations that tend to reduce population growth or survival at high densities and increase growth or survival at low densities.

Understanding the degree to which compensatory mechanisms regulate sea lamprey populations will allow managers to better target and predict control efforts. Although sea lamprey have been widely studied, little is known about their first year of life. We investigated three aspects of age 0 sea lamprey ecology: emergence from nests, dispersal during first growing season, and how densities affect larval movements, to examine if conditions that would promote density-dependent regulation exist at this early life stage. Larval emergence was examined in the field and in the laboratory. We found a strong control of age 0 larval emergence by temperature that was not dependent on when eggs were deposited. Larval emergence occurs over a relatively short period, with over 50% of larvae emerging within a 2 to 5 day period, suggesting the potential for concentration of larvae in feeding habitats and thus for density dependence.. The dispersal and distribution of age 0 larvae were investigated in the field using an adaptive sampling approach that increased the efficiency of enumerating age 0 larvae, given their highly aggregated distribution. Again, if larvae are concentrated in habitats near nesting sites, the potential for density-dependence is large. Our results indicate that larvae are not clumped near nesting sites; they were just as likely found within 50 m of a nest as 300 m downstream. Other researchers have examined the effect of density on growth, but most of these experiments have been in closed systems, either in aquaria in laboratories or cages in the field. Sea lampreys are not sessile animals, however, and can move if conditions become unfavorable. Therefore, we examined how densities affected larval movements. These experiments are on-going, however preliminary results show no significant differences of movements between high and low densities. [[Poster](#)]

- **INFLUENCE OF A LARGE FJORD LAKE ON THE MIGRATORY PATTERNS OF ATLANTIC SALMON SMOLTS**

Dietrich, J., and R. A. Cunjak, Department of Biology, University of New Brunswick, Fredericton, NB

Spring and summer migratory patterns of Atlantic salmon smolts through a fjord lake in western Newfoundland were studied over three years using mark-recapture experiments. It was hypothesized that the change in physical conditions encountered by smolts upon entering the lake, from the nursery (inlet) stream, would delay migration. Differences of up to 8 o C between the inlet stream and the fjord lake were observed during the period of highest migratory activity from the inlet stream. The distance from the mouth of the nursery stream, through the lake, to the outlet river is approximately 3 kilometres. The peak in migration was 3- 4 weeks later for smolts exiting the lake than those leaving the inlet stream. In all three years, smolts exiting the fjord lake were significantly larger and appeared more advanced in smoltification (i.e. silver, darker fins, loss of parr marks) than smolts entering the lake from the nursery stream. However age analysis has shown the modal age of smolts captured in both locations to be 3 years with a slightly higher percentage of age 4 smolts captured exiting the fjord lake. Smolts marked in the nursery stream were recaptured in the outlet stream, proving the successful navigation of the

fjord lake. Elapsed time from marking to recapture indicates a delay in migration of smolts. However, variability in time spent navigating the lake suggested the differences were individual-based rather than a function of group responses (i.e. schooling behavior). [Fri PM2]

- **EFFECT OF TEMPERATURE ON THE LIFE HISTORY OF JAPANESE MEDAKA (*Oryzias latipes*), INDEPENDENT OF GROWTH**

Dhillon, R.S.¹, and M.G. Fox². ¹Watershed Ecosystems Graduate Program, Trent University, ²Environmental and Resource Studies Program and Department of Biology, Trent University, Peterborough, ON

According to life history theory, ectotherms reared in warmer temperature regimes mature earlier due to faster juvenile growth rates. However, it is unknown whether these effects occur in the absence of accelerated growth rates. The purpose of this study is to determine how temperature affects life history of Japanese medaka (*Oryzias latipes*), independent of growth. The first phase of the experiment will investigate phenotypic changes induced by constant elevated temperatures using fish controlled for growth. Fish were divided into three temperature treatments and two feeding regimes: 27 °C, fed ad libitum (N=40), 30 °C fed ad libitum (N=40), 30 °C "fixed growth ration" (N=40), 33 °C fed ad libitum (N=40), and 33 °C "fixed growth ration" (N=40). The "fixed growth ration" refers to a controlled food quantity that equates growth rates in all temperature treatments to that of the 27 °C ad libitum treatment. Preliminary results support the hypothesis that fish reared in warmer thermal regimes mature earlier and at a smaller size, and that these effects are independent of growth. Using a similar protocol as the first phase, the second phase of this experiment will examine the effects of temperature on life history independent of growth, however, in a fluctuating thermal regime. It is hypothesized that - as was the case for the experiments conducted under a constant temperature regime - fish exposed to warmer mean thermal regimes will mature earlier and at a smaller body size than fish exposed to a lower mean temperatures. Both experimental phases will be accompanied by bioenergetic and fecundity measurements to compare energy allocations in somatic and reproductive growth in the different thermal regimes. [Fri PM1]

- **GENETIC COMPARISON BETWEEN SYMPATRIC LIFE HISTORIES OF *Oncorhynchus mykiss* (ANADROMOUS STEELHEAD AND FRESHWATER-RESIDENT RAINBOW TROUT) IN BRITISH COLUMBIA**

Docker, M.F. and D.D. Heath. Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON

Anadromous steelhead and freshwater-resident rainbow trout have very different life histories and physiology, but the genetic relationship between them is uncertain. The level of genetic divergence between the two migratory types is a critical conservation and management issue: is there high gene flow between them or do they represent distinct lineages which should be managed separately? Sympatrically-occurring steelhead and rainbow trout were collected from five major river systems in British Columbia, and approximately 1300 bp from the mitochondrial genome and 270 bp of the nuclear growth hormone II gene were sequenced. Growth hormone

intron D showed three or four 4-bp repeats but the frequency of the two length variants was not related to life history type or watershed. The mitochondrial 16S rRNA and cytochrome b sequences were invariable; there were nucleotide substitutions in the ND3 and D-loop genes but they did not distinguish steelhead from rainbow trout. Haplotype frequencies were significantly different among watersheds, however, so that geographic location accounted for genetic variation better than did life history type. Although this suggests that steelhead and rainbow trout are genetically interrelated rather than members of two distinct lineages, the need for higher resolution DNA markers to better quantify the level of recent gene flow between them will be discussed. [[Fri PM2](#)]

- **MOVEMENTS OF AN INVADER IN THE SAINT JOHN RIVER SYSTEM: THE MUSKELLUNGE, *Esox masquinongy***

Doherty, C. and R.A. Curry. New Brunswick Cooperative Fish and Wildlife Research Unit Biology Department, University of New Brunswick, Fredericton NB

The muskellunge is a recent invader in the Saint John River system. It is likely that the invasion resulted from stockings in a Quebec lake during the 1970's. In the two decades, muskies have migrated down the Saint John River system reaching and passing the Mactaquac Hydroelectric dam. This invading fish is of interest due to its predatory nature, fast growth and ability to grow large. There are some concerns regarding the possible impacts of muskie on the native fish community, particularly the severely depleted Atlantic salmon population. The objective of this study is to begin to investigate the ecology of this new fish in the Saint John River system. Tracking of muskellunge movement above and below Mactaquac dam, via radio telemetry, will give insight into the activity level and preferred habitat in the river. The potential forage fishes are being collected to determine food web structure. Muskies downstream of the dam have maintained residency in close proximity to the dam. This is possibly due to the high availability of forage fish such as juvenile gasperau present near the dam. The muskies above the dam have moved upstream distances of >30 km within 17 days of being released at the dam. [[Poster](#)]

- **THE VARIATION IN EARLY GROWTH HISTORY AND AGE AT MATURITY IN TWO SMALLMOUTH BASS POPULATIONS IN ALGONQUIN PROVINCIAL PARK, ONTARIO**

Dunlop, E., B. Shuter, and H. Rodd. Department of Zoology, University of Toronto, Toronto, ON

The variation in early growth history and age and size at maturity of two smallmouth bass (*Micropterus dolomieu*) populations located in Algonquin Provincial Park was studied. Provoking Lake is known to have a dense population of slow-growing individuals while those in Opeongo have more typical growth rates. It is predicted that the two populations may have a different age or size at maturity. To understand this, male nest guards were caught in the spring of 2000 from both upwind and downwind sites in Opeongo and Provoking. By using back-calculations of scales, the variation in growth history of different sized and aged male nesters could be determined both within and between each lake. Contrasts were made between males caught in the seemingly poor upwind sites versus the preferred downwind sites. Preliminary

results suggest that males spawn at a smaller size but similar age in Provoking as compared to Opeongo. This may be a result of possible density-dependent effects. In the fall of 2000, males and females from both lakes were caught using trap-nets, aged, and assessed for maturity. Differences between the actual size and age at maturity as obtained from sampling nesters and between predicted maturity determined through internal examination will be discussed. Predictions are that only a proportion of the individuals whose gonads are classified as mature actually spawn. Implications for fisheries management including indices of production and yield will be examined. [Fri PM1]

- **A COMPARISON OF THE SWIMMING AND CARDIAC PERFORMANCE OF FARMED AND WILD ATLANTIC SALMON THROUGHOUT THE SPAWNING SEASON**

Dunmall, K.M.¹, J.F. Schreer², B. Finstad³, and R.S. McKinley¹. ¹Waterloo Biotelemetry Institute, Department of Biology, University of Waterloo, Waterloo, ON, ²Department of Biology, University of Waterloo, ³Norwegian Institute for Nature Research, Trondheim, Norway

Farmed Atlantic salmon, *Salmo salar*, frequently escape from the aquaculture industry and interact with wild populations. Assessing the impact of these interactions involves a comparison of the performance of introduced and wild salmon, as this measure is directly linked to the survival of these fish. The present study compared the swimming and cardiac performance of the principal salmon strain for the Norwegian aquaculture industry to their founder population from the River Namsen both before and after the spawning season. Cardiac output, heart rate, and stroke volume were monitored throughout the swimming performance challenge by placing Doppler flow probes around the ventral aorta of the fish. The swimming performance of wild salmon was significantly greater than that of the farmed salmon only after the spawning season. The cardiac output of both farmed and wild salmon increased with exercise; however, these rates of increase differed depending on the type of fish and the time during the spawning season. Generally, farmed salmon increased cardiac output more rapidly with exercise after spawning, as compared to their rate of cardiac output increase during the pre-spawn swim trials, whereas wild salmon showed a slight reduction in the rate at which cardiac output increased with exercise post-spawning. This suggests that less blood flow was necessary to achieve a greater swimming performance in the post-spawning wild salmon than in the farmed fishes. These differences in swimming and cardiac performance suggest that wild salmon may be better equipped to survive the energetic demands of the upstream migration and spawning. [Sat AM2]

- ***IN SITU* ANALYSIS OF FEEDING MOTIONS OF JUVENILE ATLANTIC SALMON IN RELATION TO TURBULENT FLOW STRUCTURES**

Enders, E.¹, T. Buffin-Bélanger², D. Boisclair¹, and A.G. Roy². ¹Département de sciences biologiques, Université de Montréal, QC, ²Département de géographie, Université de Montréal

Numerical habitat models have been developed to estimate the quantity and the quality of riverine habitats for fish. However, estimation of the energetic consequences of a fish preferential location within a river is impeded by the lack of knowledge on the effects of flow turbulence on fish behaviour. Juveniles of Atlantic salmon (*Salmo salar*; parr) live in river

reaches characterised by a highly turbulent flow. In these environments, flow turbulence is associated with a wide range of instantaneous velocities and shear stresses which may affect fish behaviour. The behaviour of parr can be described by a series of intermittent attacks towards drifting prey separated by periods of rest on the downstream end of a chosen clast, defined as the 'home rock'. It has been suggested that the structure of turbulence in gravel-bed rivers consists of a temporal succession of fast and slow moving wedges of fluid having periods of several seconds. The costs of habitat utilisation by fish such as parr could be greatly reduced if fish would perform their attacks preferentially during the passage of slow speed wedges. The purpose of our work was to assess the relationship between the feeding behaviour of parr, as revealed by the sequence of attacks and the structure of the turbulent flow. Parrs in the Sainte-Marguerite River were filmed using subaquatic video-cameras while flow velocity was recorded using an array of three electromagnetic current meters positioned near the fish. Our results (1) confirmed the existence of intermittent high and low speed wedges, (2) confirmed that fish behaviour is affected by different levels of turbulence such as fish in more turbulent flow are less active, and (3) suggest that fish do not prefer low speed wedges for their feeding attacks but may react on other flow characteristics. [[Sat PM1](#)]

- **GENETIC RELATEDNESS OF EARLY AND LATE RUN SOCKEYE SALMON (*Oncorhynchus nerka*) FROM THE KLUKSHU RIVER, CANADA, USING MICROSATELLITE MARKERS**

Fillatre, E., and D. Heath. Department of Biology and Great Lakes Institute for Environment Research, University of Windsor, Windsor, ON

The Klukshu River, Yukon Territory, supports the only source of sockeye salmon (*Oncorhynchus nerka*) for subsistence and sport fishers in the Yukon Territory. Klukshu River sockeye stock return from early June to September, with a bimodal distribution characterized as "early" and "late" runs. Over the last 23 years, a significant decrease in run size has been observed in the Klukshu River, especially for the early run. We collected DNA samples from early and late run sockeye from 1995 to 2000 for genetic analysis of the early versus late run fish. Preliminary results suggest that the two runs are genetically differentiated based on data from five microsatellite DNA loci. Significant differentiation among run years was also observed. Management implications of these findings are particularly relevant given the international nature of the Klukshu sockeye stock. [[Poster](#)]

- **HOME RANGE OF ADULT LAKE TROUT IN LAKE OPEONGO, ONTARIO**

Flavelle, L.S.¹, R.S. McKinley¹, M.R. Ridgway², and T. Middel². ¹Waterloo Biotelemetry Institute, Department of Biology, University of Waterloo, Waterloo, ON, ²Harkness Laboratory of Fisheries Research, Algonquin Park, ON.

The description of home ranges for lake-dwelling salmonids is important for the determination and protection of key habitat areas. Movements of adult lake trout have been under investigation in Lake Opeongo, Algonquin Park for three consecutive years. Over this time period, a total of twenty-four fish have been successfully implanted with acoustic transmitters. Positions of individuals were obtained twice daily during daylight hours in all ice-free seasons. Two

consecutive years of data are available for eight individuals, and three consecutive years for one individual. The objective of this research was to determine the extent of home range of adult lake trout in a large lake system and to examine the factors affecting that home range. In the year 2000, physical variables were monitored using temperature recording data loggers and surface light intensity meters. In addition, weekly temperature, oxygen and light profile data were collected. The relationship between the positions of tagged individuals and these abiotic parameters and substrate characteristics, determined through previous hydroacoustic surveys, were investigated. Inter-annual and seasonal variation in extent of home range in relation to these environmental variables will be discussed. [Sat AM2]

- **A COMPARISON OF THE ESTIMATES AND PRECISION OF SAMPLING OBTAINED USING TWO DIFFERENT FISH HABITAT ASSESSMENT METHODS IN LAKES**

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The purpose of this study was to examine two different fish habitat assessment methods for use in lakes including their repeatability between two observers, how well habitat estimates from each compare, and the amount of sampling required to obtain precise estimates of habitat features. The two methods differed in their sampling intensity and levels of precision. The transect sampling method sampled habitat by means of transects composed of 1m² quadrats and the littoral zone cruise surveyed the entire littoral zone (area from shore to the 2 m depth contour). Transect sampling required more time and effort than the littoral zone cruise but yielded more precise habitat estimates with less sampling. For a 20% precision level, 2% of the littoral zone area must be sampled using the transect sampling method. The precision of the littoral zone cruise is related to the composition of habitat types within the littoral zone. Rare habitat types require a greater sampling effort than those habitat types in abundance. Costs and variances associated with each of the sampling methods are different. The choice of which method to use should be dependent on the objectives of the sampling program. [Poster]

- **BROOD-SPECIFIC MORTALITY PATTERNS IN SMALLMOUTH BASS: QUANTIFYING UNDERLYING MECHANISMS WITHIN AND AMONG YEARS**

Friesen, T.F. and M.S. Ridgway. Ontario Ministry of Natural Resources, Peterborough, ON.

Earlier research has sought to demonstrate the importance of prey density and predation as mechanisms governing the abundance of larval and early juvenile fish. In Lake Opeongo, *in situ* enclosure experiments employing gradients in prey density and intra-specific competitors, and the lack of any response of foraging behaviour of young-of-the-year to brood size, suggest that food resources may not be a limiting resource governing their production while under parental care. However, brood-specific mortality rates are high and variable, with relatively few males contributing to the production of young. In addition, brood-specific instantaneous mortality rates are negatively related to growth, suggesting that losses followed a pattern relating smaller body

size to increased likelihood of mortality. In Lake Opeongo, nesting male density is low and consistent in location from year-to-year. Broods exhibit daily expansion and contraction around the nest site, but the spatial distribution of nesting males effectively isolates broods into separate cohorts. We used fine scale observations of individual smallmouth bass broods to determine the relative influence of male size, seasonal timing of spawning and brood size in governing survival in young bass while under parental care. Understanding how early brood-specific mortality patterns are influenced by fine scale responses to these factors will provide mechanistic insights into the production dynamics of smallmouth bass. [Sat AM2]

- **INFLUENCE OF MOON PHASE ON THE SPATIAL PATTERNS OF FISH OF LAKE D'ANNECY (FRANCE)**

Gaudreau, N.¹, J. Guillard², and D. Boisclair¹. ¹Dept of Biology, University of Montreal, Montreal, QC; ²I.N.R.A., Thonon-les-Bains, France

Knowledge of fish abundance is important in ecology to understand the functioning of lakes. The interactions of fish with other aquatic organisms will be influenced by fish abundance. However, not only fish abundance, but also spatial and temporal distribution patterns of fish might be necessary to understand trophic interactions. Knowledge of fish distribution patterns is also necessary to develop adequate sampling designs for fish abundance. The influence of moon phase on the number of fish performing daily horizontal and vertical migrations has already been shown. Our objective was to verify the influence of moon phase on the spatial patterns of fish. We used a hydroacoustic system to assess fish distribution patterns in Lake d'Annecy (France). We sampled once during the day and once during the night, on each of the four moon phases in September 1997. Seventeen transects were performed to cover the whole lake. Preliminary results suggest that the distribution pattern of fish during the full moon is different from the other moon phase. Using the acoustic size of the echoes recorded, we will attempt to verify if the pattern observed during the full moon originates from fish of a different size than those detected during the other moon phase. [Sat PM2]

- **SIZE SEGREGATION OF ATLANTIC REDFISH WITH DEPTH**

Gauthier, S., and G.A. Rose. Fisheries Conservation Chair, Memorial University of Newfoundland, St. John's, NF, A1C 5R3

We tested the hypothesis that Atlantic redfish shoal in size group according to depth. Sampling was performed using a Campelen bottom trawl along transects located on the Continental shelf of Newfoundland (Nafo div. 3Ps) at depths of 100 to 600 m. Data were collected in July 1996, January 1997, and in March and June 1998. Information from other sources (published and unpublished data) were also analyzed. Preliminary results indicate that redfish shoal in relatively narrow size groups and that larger individuals are usually found in deeper areas. Small-scale patterns of distribution seem to vary according to season and are more likely controlled by oceanographic conditions (e.g. temperature and currents). Understanding size selective distribution patterns in redfish could be an important aspect of fisheries management. [Poster]

- **GROWTH AND FORAGING RATES IN RELATION TO HABITAT USED BY YOUNG-OF- THE-YEAR ATLANTIC SALMON (*Salmo salar*)**

Girard, I.L., J.W.A. Grant, and S.O. Steingrimsson. Department of Biology, Concordia University, Montreal, QC

We studied the ontogeny of habitat use and growth rate of 222 individually tagged young-of-the-year Atlantic salmon (*Salmo salar*) in Catamaran Brook, a third order tributary of the little Southwest Miramichi river in New Brunswick. We compared the habitat characteristics (water column depth, current velocity, substrate size and cover from aerial predators) of the foraging locations used by fish with representative locations in the stream. A canonical discriminant analysis identified two key variables that differentiated between the habitat that was used by the fish and that available in the stream: fish apparently preferred fast current velocities (6-48 cm s⁻¹) and deep water (20-39 cm). Curiously, the fish in the preferred sites did not forage more frequently or grow faster than those in less preferred sites. In addition, the habitat used by the fish changed little over the season as they grew from 33.05 mm to 63.00 mm. [Sat PM2]

- **THE TEMPORAL VARIATIONS IN PISCIVOROUS AND PLANKTIVOROUS FISH ABUNDANCE DURING THE NOCTURNAL MIGRATION IN A LAKE**

Girard, P., and D. Boisclair. Département des Sciences Biologiques, Université de Montréal, Montréal, QC.

Temporal variations of the abundance of planktivorous and piscivorous fish were studied in a small oligotrophic lake in the Lower Laurentian region of Québec. Hydroacoustic sampling was done following an horizontal scanning approach which consists of directing the transducer of the hydroacoustic system from a boat located at 15 to 50 m from shore towards the littoral zone. The complete perimeter of the lake was insonified during six consecutive surveys beginning at 23:00 h. A sampling was also done during the day. Planktivorous and piscivorous fish were differentiated using target strength analyses. Fish relative abundance (FRA; targets/100 m³) in the pelagic zone of the lake studied was estimated for each of the 8 sections of 100 m of perimeter of the lake. The results show that both planktivorous and piscivorous fish perform daily horizontal migrations. FRA of planktivorous fish averaged 0,19 targets/100m³ during the day and 1,25 targets/100m³ during the night. Corresponding values for piscivorous fish were 0,005 and 0,07 targets/100 m³. We found no significant relationship between FRA of planktivorous and piscivorous fish ($r^2 = 0,0001$ to 0,336). However, the spatial heterogeneity of the piscivorous fish (Coefficient of Variation of FRA) seems to decrease in the course of the nocturnal migration (CV from 66,5% to 28,3%), while that of the planktivorous fish increased (CV from 10,9% to 21,1%). Our observations suggest the existence of spatially mediated refuges even in habitats lack of physical structure. [Fri PM1]

Résumé

Les variations temporelles des distributions des poissons planctivores et des poissons piscivores ont été étudiées dans un lac des Basses-Laurentides. Un système hydro-acoustique fut utilisé en installant la sonde sur un bateau situé à une distance variant de 15 à 50m du rivage et en la

pointant vers le littoral, permettant ainsi un balayage horizontal. Six tours consécutifs, débutant à 23h00 furent effectués. Un échantillonnage fut aussi effectué durant le jour. La discrimination des piscivores et des planctivores s'est fait en analysant la puissance des échos. L'abondance relative des poissons (FRA; cibles/100m³) fut estimée pour chacun des 8 transects de 100m du périmètre du lac étudié. Les résultats ont démontré que les deux niveaux trophiques effectuaient des migrations nocturnes vers la zone pélagique. Les FRA moyennes des planctivores était de 0,19 cibles/100 m³ pendant le jour et de 1,25 cibles/100m³ pendant la nuit, alors que celles des piscivores étaient de 0,005 le jour et 0,07 la nuit. On remarque aussi l'absence de relation entre les FRA des planctivores et des piscivores ($r^2 = 0,0001$ to $0,336$). Cependant, l'hétérogénéité spatiale de la distribution des piscivores (coefficient de variation de la FRA) semblent s'estomper au cours de la nuit (CV de 66,5% à 28,3%), alors que celle des planctivores augmentent (CV from 10,9% to 21,1%). Nos résultats suggèrent donc l'existence de refuges spatiales mêmes dans des habitats où il y a peu de structures physiques. [Fri PM1]

- **ISSUES IN GREAT LAKES FISH DISEASE MONITORING**

Good, C. and M. Thorburn. Department of Population Medicine, University of Guelph, Guelph, ON

There are numerous uncertainties concerning disease and its effects on wild and feral fish populations. These include the: (1) prevalence of important pathogens; (2) modes of pathogen transmission among individual fish and fish populations; (3) factors necessary to promote clinical disease outbreaks in infected populations; and (4) overall effects of disease on wild populations. In the face of these uncertainties, Great Lakes fisheries management agencies have developed disease monitoring programs to screen hatchery fish for important pathogens, in an attempt to avoid potential harm to wild populations through stocking infected fish. We review the current hatchery disease monitoring program in Ontario and research that we have conducted to identify potential improvements to this program, and discuss possible future approaches to disease monitoring aimed towards resolving uncertainties such as those listed above. [Sat PM2]

- **PREDATION-RISK OF AGE-0 ATLANTIC COD WITH RESPECT TO EELGRASS PATCH CHARACTERISTICS**

Gorman, A.M.¹, D.C. Schneider², and R.S. Gregory². ¹Department of Biology, Memorial University of Newfoundland, St. John's, NF, ²Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NF

Post-settled age 0 Atlantic cod (*Gadus morhua*) seek refuge from predators in structurally complex habitats such as eelgrass (*Zostera marina*). Although predator density in eelgrass is higher than in sandy environments, predation rates are lower since complexity reduces predator efficiency. Using a tethering technique in Newman Sound, Newfoundland, we examined relative predation rates in eelgrass patches from 1 to 60 m². Predation rates increased with patch area in coves that had intermediate levels of predation (57-67%). Therefore, natural predation rates from small-scale field or lab work cannot always be scaled directly from small habitat areas to large areas. Both age 0 cod and their predators (sculpin *Myoxocephalus scorpius*, cunners *Tautoglabrus adspersus*, age 1+ rock cod *Gadus ogac*, and age 1+ conspecifics) often inhabit

the edges of eelgrass patches. To quantify the spatial scale at which the eelgrass edge is significant to predation, we also tethered an 8m area at the edges of an eelgrass meadow. No edge effect between the eelgrass and sand habitats could be determined due to low overall predation (5%) at the study site. Results from both studies indicate that predator guild and habitat configurations must be considered prior to extrapolating predation from small to large spatial scales. [[Poster](#)]

- **THE ABILITY OF SLIMY SCULPIN (*Cottus cognatus*) TO REFLECT LOCAL ENVIRONMENTAL CONDITIONS**

Gray, M.A., R.A. Cunjak, and K.R. Munkittrick. Department of Biology, University of New Brunswick, Fredericton, NB

When choosing a sentinel fish species to look at environmental impacts there are certain characteristics that are desirable in order to attribute responses to local conditions. Site fidelity and mobility are of primary importance for establishing sustained exposure to the potential impact. Fish abundance and capture success must also be sufficient for statistically relevant sample sizes to be collected and without the collection itself impacting the natural populations. For this reason, the use of a small, non-game fish species is particularly advantageous, as there is no exploitation pressure on the sentinel species. The slimy sculpin is a potential candidate for sentinel investigations due to reported limited home ranges, restricted mobility, and moderate to high abundance in cool-water systems. These assumptions were tested by investigating slimy sculpin in the Little River and Catamaran Brook; two cool-water systems in New Brunswick with varying surrounding land-uses (forestry and agricultural, and forestry only, respectively). Different marking techniques were used to assess movement and growth of sculpin. Passive integrated transmitters (PIT tags) were inserted in sculpin and panjet marking was utilized to assess site fidelity and recapture of released fish. Electrofishing of enclosed sites was completed to determine the capture success and efficiency for sculpin collections to validate the movement studies and to examine potential effects of habitat variability. Stable isotope analysis (carbon and nitrogen) was used to measure the relative similarity of fish tissues and localized food sources. Preliminary data showed that there were significant differences in the nitrogen signatures from sculpin inhabiting the two land-use regions, which may reflect the modified nitrogen signature of commercial fertilizers used in agricultural activities. Results confirmed that indeed, sculpin had limited home ranges and were ideal candidates for environmental monitoring due to their ability to suitably reflect local conditions. [[Fri PM1](#)]

- **DIRECT FIELD TESTS OF COMPETITION AMONG POSSIBLY DIVERGING STICKLEBACK TAXA**

Gray, S., Department of Zoology, University of Guelph, Guelph, ON

Ninespine (*Culaea pungitius*) and brook (*C. inconstans*) sticklebacks coexist across part of their ranges. These closely related species share similar life history traits, and reportedly utilize almost identical resources, primarily the littoral areas of lakes. We found both species inhabiting the littoral habitat of some lakes and only brook sticklebacks in others. It is conceivable that they not only share but compete for resources where they coexist. This stickleback system provides an

ideal setting for studying: 1) ecological mechanisms of coexistence between two closely related species; and, 2) mechanisms of evolutionary divergence between species. We predict that if competition for resources is significant, then divergence of traits associated with resource use will be found in stickleback species where they coexist (sympatry) compared to lakes containing only one stickleback species (allopatry). Preliminary morphometric analyses indicate that the sympatric brook stickleback populations tend to have traits specialized for a more benthic mode of existence than do their allopatric counterparts in nearby lakes. We used manipulative experiments to directly test the effect of competition on both sympatric and allopatric populations of brook sticklebacks in the wild. Short term growth rate of brook sticklebacks was used to assess competitive effects in experimental allopatric and sympatric treatments. We predict that morphological shifts in the sympatric populations has allowed both species to exist by reducing competition. [Sat PM2]

- **CAN LARGE SCALE QUESTIONS BE ANSWERED WITH SMALL SCALE FIELD SAMPLING?: JUVENILE ATLANTIC COD IN COASTAL HABITAT**

Gregory, R.S., D.C. Schneider, J.A. Brown, and J.T. Anderson. Memorial Univ. of Newfoundland, Ocean Sciences Centre and Fisheries and Oceans Canada, St. John's, NF

In Newfoundland, age 0 Atlantic cod (*Gadus morhua*) settle from the pelagia as early juveniles into vegetated coastal habitat less than about 10 m deep. However, attempts to qualify "good habitat" beyond this generalization have proven difficult. Small scale field studies involving habitat selection are often plagued with high variance, which may obscure ecological processes operating at larger spatial and temporal scales. We found that small-scale studies were effective during investigations of larger scale processes involving habitat selection, when the larger scale habitat mosaic was known. These investigations suggest that although vegetated seabeds are preferred over unvegetated ones by settling age 0 Atlantic cod, it is unlikely that measuring percentage cover of preferred habitat alone in any given area will sufficiently estimate juvenile cod habitat quantity or quality. [Fri PM2]

- **THE RELATIVE PERFORMANCE AND TRANSFERABILITY OF HABITAT SUITABILITY AND PROBABILISTIC INDICES TO PREDICT FISH DISTRIBUTION PATTERNS IN RIVERS!**

Guay, J-C.¹, D. Boisclair¹, M. Lapointe², and M. Leclerc³. ¹Université de Montréal, Département de sciences biologiques, Montréal, QC, ²McGill University, Department of Geography, Montreal, QC,

³Institut National de la Recherche Scientifique (INRS-eau), Québec, QC

Numerical Habitat Models (NHM) have been developed to predict fish habitat quantity, quality and distribution under different flow regimes found in rivers. These models depend on the estimation of an Habitat Quality Index (HQI) at the scale of fish microhabitat. One of the problems of NHM is that mathematical constructs to estimate HQI in one river may not be applicable to other rivers. Hence, HQI are not transferable among rivers. The most common measures of HQI are based on indices of preference of fish for specific ranges of water depth,

current speed and substrate composition (referred to as Habitat Suitability Indices; HSI). Recent studies indicate that another approach based on a multivariate logistic regression model fitted to presence-absence data of fish distribution provides a more powerful index to predict fish habitat quality (referred to as Habitat Probabilistic Indices; HPI). The purpose of our work was to test the relative performance and transferability of NHM based on HSI and HPI. Both HSI and HPI were developed in the Sainte-Marguerite River and used to predict habitat and fish distribution in The Escoumin River. NHM based on HSI explained 25% of the local variations of fish abundance in The Escoumin River. However, NHM implemented with HPI explain 84% of the observed variations of fish abundance in this river. Our results suggest that HPI not only performs better when predicting fish distribution patterns but that this index may be easier to transfer among rivers. [Fri PM2]

- **PERSPECTIVE OF THE PREDATOR-PREY RELATIONSHIP THROUGH DIFFERENT SPATIAL SCALES USING HORIZONTAL HYDROACOUSTIC SCANNING APPROACH**

Guénard, G. and D. Boisclair. Département des Sciences Biologiques, Université de Montréal, Montréal, QC

We sampled fish spatial distribution using the horizontal hydroacoustic scanning approach in an oligotrophic lake from the Laurentian region of Québec. We classified fish echoes in two classes of target strength. Fish from -32 to -42 dB were expected to represent piscivores (lake trout *Salvelinus namaycush* or brook charr *S. fontinalis*) and targets from -44 to -52 dB were presumed to be planktivores (hybrids of finescale and redbelly dace *Phoxinus eos* x *P. neogaeus*). Fish relative abundance (FRA number of echoes/100 m³) was estimated by dividing the perimeter of the lake using three different strategies: dividing the perimeter of a the lake in sections having a length of 15, 60 or 120 m. Regardless of the length of the section used, we found no statistically significant correlation between FRA of piscivores and planktivores. Those results suggest that there are no spatial association between a predator and its prey in a natural sustainable predator-prey system. We argue that any closely associated predator-prey pattern could caused the extinction of the prey population. [Fri PM2]

- **INCORPORATING SPATIAL UNCERTAINTY INTO ST. MARYS RIVER SEA LAMPREY CONTROL DECISIONS**

Haeseker, S.L., and M.L. Jones. Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824-1222

Connecting Lake Superior to Lake Huron, the St. Marys River represented the last remaining uncontrolled sea lamprey population in the Great Lakes. But in 1998 and 1999 a control programme was implemented which included adult trapping, sterile male releases, and the application of Bayer, a lampricide, to localized areas of high larval densities. The high density areas were located using a laborious systematic sampling approach over a period of four years. However, the distribution of larval lamprey within the river is not static, and this spatial uncertainty can impact the effectiveness of Bayer applications. We used a lamprey population simulation model within a decision-analytical framework to examine the effects of spatial

uncertainty on optimal decision making within the St. Marys control programme. Several years of georeferenced larval abundance data were analyzed in order to characterize the spatial uncertainty in larval distributions. We found that incorporating spatial uncertainty into the decision-making process led to lower estimates of the expected effectiveness of Bayer applications. Uncertainty in larval distribution and other aspects of sea lamprey population dynamics should be incorporated in future control decisions on the St. Marys River. [**Fri PM2**]

- **MOLECULAR GENETIC STRUCTURE AND MANAGEMENT OF STEELHEAD TROUT POPULATIONS IN BRITISH COLUMBIA**

Heath, D.D.¹, S. Pollard², and C. Herbinger³. ¹Great Lakes Institute for Environmental Research and Department of Biology, University of Windsor, Windsor, ON; ²Ministry of Fisheries BC, Victoria, BC; ³Marine Gene Probe Laboratory, Department of Biology, Dalhousie University, Halifax, NS

Steelhead trout, *Oncorhynchus mykiss*, (the anadromous form of rainbow trout), are declining over much of their range around the Pacific rim. Management and conservation of steelhead are problematic due to their complex life history and small populations. We collected tissue samples for DNA extraction from 494 steelhead from 8 tributaries and two mainstem sites within three watersheds in northern British Columbia. We scored six highly polymorphic microsatellite loci for all fish and population genetic analysis revealed significantly genetic differentiation ($F_{ST} = 0.039$; 95% confidence = 0.030 - 0.053). Most of the genetic variation was at the individual level (95.6%), although tributary level (3.09%) and watershed level (1.31%) effects were also significant. Genetic distance was correlated with geographic distance within watersheds indicating probable genetic equilibrium. Examination of overall genetic structure suggested previously unsuspected cross-headwater transfers of fish. Seven of the eight tributary populations fit a regression line of mean heterozygosity versus juvenile rearing habitat area. The one anomalous population had a much lower heterozygosity than expected, and was tentatively identified as the population of greatest conservation concern. We propose genetic diversity versus habitat area regression analysis as a potentially valuable conservation and management tool. [**Sat PM2**]

- **EFFECT OF SURPLUS ENERGY ON THE MATURATION OF WALLEYE: INDIVIDUAL AND POPULATION EFFECTS**

Henderson, B.A.¹, and G. Morgan². ¹Ontario Ministry of Natural Resources, Lake Huron Fisheries Research Unit, Owen Sound, ON N4K 3E4, ²Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, ON P3E 2C6.

The role of individual and population indices of surplus energy on maturation and spawning stock sizes. Walleye were sampled from 79 water bodies in Ontario (Sept-November, 1996-99). Age, forklength (mm), round weight (g), sex, maturity, ovary weights, fecundity, and visceral fat (g) were recorded. The index of surplus energy (VFI) was derived as the arcsine square root transformation of the ratio of visceral fat (g) to round weight (g). VFI, conditional on forklength and round weight, were significantly related to maturity (conditional logistic regression), particularly evident at ages 2 and 3+ for males, and at ages 4 and 5+ for females, when variation

in the probability of maturity is greatest. Maturity before and after these transitional ages (menarche) was less evidently related to VFI. The proportion of mature 4 and 5+ year-old females was significantly correlated with the average VFI for the population ($r^2 = 0.80$, $N=25$ lakes with at least 10 females at ages 4 and 5+). Surplus energy was unrelated to lake attributes (area, depth, perimeter, TDS, clarity, GDD). We suggest that annual variations in surplus energy exceed the variation imposed by the attributes of the lakes. Measures of surplus energy could be used to predict the potential recruitment of walleye, dependent upon the proportion of the females spawning annually. [Sat AM1]

- **DAILY ACTIVITY PATTERNS AND HABITAT USE OF JUVENILE ATLANTIC SALMON (*Salmo salar*) IN WINTER**

Hiscock, M.J.¹, D.A. Scruton³, and J.A. Brown². ¹Biopsychology Programme and ²Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NF, A1C 5S7, ³Department of Fisheries and Oceans, Box 5667, St. John's, NF, A1C 5X1

Radiotelemetry was used to investigate daily activity patterns and habitat use of juvenile Atlantic salmon (*Salmo salar*; mean fork length (◆ SE), 14.2 (◆ 0.3 cm and mean weight ((◆ SE), 26.3 (◆ 1.8 g). Sixteen individuals, with surgically implanted transmitters, were tracked daily using a hand held H-antenna to determine position and habitat use (i.e. water depth, bottom and mean column water velocities, substrate and cover). Daily activity patterns were recorded throughout the diel cycle using fixed receiver stations and underwater antennas placed adjacent to individual cover stones. Data collected from the fixed stations allowed departure times and, in some cases, duration of departure from cover stones to be determined. The results indicate that individuals prefer deeper microhabitats with cobble/boulder substrate. Thirty seven daytime departures and 47 nighttime departures were recorded. The mean departure time from cover was 17:41 and departure times were not random. The duration of departure was significantly greater during the night than during the day. [Poster]

- **SEX DETERMINATION IN GUPPIES: GENES AND ENVIRONMENT**

Hodgins, K., and M.R. Gross. Department of Zoology, University of Toronto, Ontario.

Biologists are becoming increasingly aware that genes and environment may interact in sex determination of fish. The goal of this research is to understand the effect of temperature on a genetic sex-determination mechanism in guppies (*Poecilia reticulata*). Our study tests three questions: (1) is temperature a cue in sex determination? (2) is the cue used by juveniles, or (3) is the cue used by mothers? Virgin females were reared in cold and warm water, mated to males, and alternated between cold and warm water for gestation. After birth, some progeny were transferred into the opposite temperature environment. The resulting data are sufficient to test all three questions. First, contrasting sex ratios within warm- and cold-water treatments of both the mothers and their offspring reveals the influence of temperature. Second, the influence of timing is seen by contrasting sex ratios between progeny with different time periods before transfer. Third, contrasting sex ratios of progeny with different maternal rearing history elucidates the influence of mother. Preliminary results indicate that cold water induces a female-biased sex

ratio, that transfer time has no effect on sex determination, and that offspring utilize temperature as a cue to develop into the sex with higher fitness. [[Poster](#)]

- **DISTRIBUTION AND ABUNDANCE OF WHITEFISH NEAR DOUGLAS POINT, LAKE HURON**

Holmes, J.¹, S. Crawford^{1,2}, D.L.G. Noakes¹, D. Wismer³, and C. Gubala⁴. ¹Axelrod Institute of Ichthyology, Department of Zoology, University of Guelph, Guelph, ON, ²Chippewas of Nawash First Nation, Wiarton, ON, ³Ontario Power Generation-Nuclear, Environmental Affairs, Toronto, ON, ⁴SATL - University of Toronto at Mississauga, Mississauga, ON

Hydroacoustic surveys were conducted near Douglas Point, Lake Huron, in the spring and fall to determine the response of lake whitefish and round whitefish to the Bruce Nuclear Power Development. Fish observed in water depths of 9-15 m tended to be uniformly distributed throughout the water column; small targets (-60 to -80 dB) were pelagic (gizzard shad) whereas larger targets (-30 to -50 dB) were benthic (round whitefish, longnose sucker). At depths > 15 m, fish were within 10 m of the bottom and most were large targets (-30 to -50 dB). Lake whitefish and burbot comprised 35% and 44% of the individuals captured at depths of 20-30 m. Round whitefish were common near the Bruce B NGS discharge, accounting for 76% of the fish captured in the spring. In contrast, white sucker (50%), gizzard shad (18%) and longnose sucker (13%) were the dominant species in the Bruce A NGS discharge. Fish biomass increases in a south-north direction in the study area and was greater at depths < 20 m. These trends are consistent with the predominant current and wind patterns at the site. Because round whitefish are found at shallower depths than lake whitefish, the potential interactions between round whitefish and the Bruce Nuclear site may be greater than for lake whitefish. [[Sat PM2](#)]

- **CONTRASTS IN THE SEAWATER TOLERANCE OF FRESHWATER AND ANADROMOUS INCONNU**

Howland, K.L., W.M. Tonn, and G. Goss. Department of Biological Sciences, University of Alberta, Edmonton.

We compared the hypoosmoregulatory capacity of juvenile freshwater and anadromous inconnu reared under common laboratory conditions by exposing them to two experimental treatments: 1) direct transfer from freshwater into 10, 15 or 25 ppt seawater, and 2) transfer to 25 ppt seawater after a 2-wk acclimation period at 15 ppt. Saltwater adaptability was assessed by following mortality and changes in plasma [Na⁺] and [Cl⁻], and in gill Na⁺-K⁺-ATPase activity up to 8 d post-transfer. Both populations regulated plasma ions following a direct transfer from fresh to brackish water (10-15 ppt), but suffered osmoregulatory collapse with 100% mortality in 48 h when directly transferred to 25 ppt. Acclimation to brackish water improved hypoosmoregulatory capacity in both populations, with acclimated fish showing smaller increases in blood plasma ion concentrations, higher Na⁺-K⁺ ATPase activity, and lower mortality than non-acclimated fish following transfer to 25 ppt seawater. Acclimation to 15 ppt allowed anadromous inconnu to maintain pre-treatment plasma ion levels, whereas these levels increased in acclimated freshwater inconnu. Furthermore, acclimation eliminated post-transfer mortality among anadromous inconnu, but not in the freshwater form. These results indicate that

juvenile anadromous inconnu are able to adapt physiologically to seawater of at least 25 ppt and that freshwater inconnu have diminished saltwater tolerance relative to the anadromous form.

[Sat AM2]

- **MEASUREMENT OF FATIGUE AND RECOVERY USING EMG TELEMETRY IN RAINBOW TROUT (*Onchorhynchus mykiss*) EXPOSED TO ACUTE CHLORINE STRESS**

Hunter, K.J., and R.S. McKinley. Waterloo Biotelemetry Institute, Department of Biology, University of Waterloo, Waterloo, ON

Environmental stress can often elicit the escape response, which can induce fatigue upon the animal. The time to fatigue is affected by the fish's level of stress before the environmental stressor affected the fish. The objective of this study was to examine the effect of chloramine on time to fatigue in rainbow trout using EMG telemetry. Time to fatigue can be monitored in the lab by following levels of blood lactate, glucose, and pH. The levels of these blood parameters and chloramine levels were correlated to conduction velocity, measured with hardwired EMG, and to the output of the current EMG transmitters, as would be necessary for field experiments. The fish were exposed to 0mg/L, 0.5mg/L, and 1mg/L chloramine and subjected to forced swimming. Results suggest that increased chloramine exposure causes decreases in swim performance as indicated by lower EMG based conduction velocities. Chloramine exposure failed to yield significant correlation to the direct output of the current EMG transmitter. Therefore EMG telemetry can, with some modification to its present form, be utilized to detect acute chloramine exposure. [Sat AM2]

- **LIFE HISTORY AND CONSERVATION BIOLOGY OF MARINE FISHES: PERCEPTIONS AND CAVEATS**

Hutchings, J.A., and S. Rowe. Department of Biology, Dalhousie University, Halifax, NS

Some criteria used to assign populations and species to categories of extinction risk may seriously over-estimate these risks for marine fishes. Contemporary perception is that marine fishes may be less vulnerable to extinction than other taxa because of great natural variability in abundance, high fecundity, rapid population growth rate, and high resilience to population decline. Intuitive as these perceptions may be, their merit has not been examined empirically. Exploratory analyses of fish data worldwide suggest that contemporary perceptions of the susceptibility of marine fishes to extinction warrant reconsideration. [Fri PM1]

- **THE PHYSIOLOGICAL RESPONSE OF DIPLOID AND TRIPLOID BROOK TROUT (*Salvelinus fontinalis*) TO EXHAUSTIVE EXERCISE**

Hyndman, C.A.¹, J.D. Kieffer¹ and T.J. Benfey². ¹Department of Biology, UNB Saint John, NB, ²Department of Biology, UNB Fredericton, NB

The focus of this study was to identify and compare the physiological responses to exhaustive exercise in diploid and triploid brook trout. To quantify this, we measured plasma lactate,

glucose and osmolality and white muscle energy stores (glycogen and ATP) and muscle lactate before, immediately following exercise and recovery at 2 and 4 hours post-exercise. In addition, oxygen consumption and ammonia excretion rates were determined before and after exercise. Overall, diploid and triploid trout showed similar metabolic and respiratory responses (both magnitude and time to recover) to exercise. For example, both plasma lactate and muscle lactate levels increased substantially following exercise and the recovery rates for these metabolites were similar for both triploid and diploid trout. Similarly, oxygen consumption rates increased with exercise and these rates returned to resting levels by 30 minutes post-exercise in both groups of fish. The results of this study suggest that larger cell size and greater number of chromosomes characteristic of triploidy neither affects the magnitude of the physiological response, nor the ability of a triploid to recover from anaerobic exercise stress. [Sat AM2]

- **EFFECT OF VISUAL ISOLATION ON TERRITORY SIZE AND POPULATION DENSITY OF JUVENILE RAINBOW TROUT (*Onchorhynchus mykiss*)**

Imre, I.¹, E.R. Keeley², and J.W.A. Grant¹). ¹Biology Department, Concordia University, Montreal, QC; ²Idaho State University, Pocatello, Idaho.

Visibility is often suggested as an important factor affecting the territory size of visually oriented animals but the conclusions of the few studies investigating this relationship are equivocal. We re-examined experimentally the relationship between visibility and territory size in order to test the hypothesis that increasing habitat heterogeneity results in a reduction in territory size and consequently in higher population densities. Equal densities of young-of-the-year rainbow trout (*Oncorhynchus mykiss*) were stocked in two experimental treatments with high habitat heterogeneity and a control treatment. Habitat heterogeneity in the experimental treatments was increased by placing larger cobbles or plywood rectangles onto the substrate of experimental stream channels. At the end of the 10 day experiment, population density, territory size, growth and final survivor density were quantified and compared between the experimental and control treatments. We found no significant differences between treatments in population density, growth or number of survivors. This study does not support the suggestion that increasing habitat heterogeneity results in higher population densities of juvenile salmonids. [Sat PM1]

- **INDEX OF BIOTIC INTEGRITY VS. MULTIVARIATE STATISTICAL APPROACHES: A CASE STUDY USING GREAT PLAINS STREAM FISH COMMUNITIES**

Jackson, D.A.¹, Marsh-Matthews, E.², and William J. Matthews². ¹Department of Zoology, University of Toronto, Toronto, ON; ²Department of Zoology, University of Oklahoma, Norman, OK

Fish communities are used as indicators of environmental quality throughout the world, although methodological approaches differ greatly in how the species composition data are used. Two contrasting approaches are the index of biotic integrity (IBI) based on a multi-metric approach and the multivariate approach incorporating various multivariate analytical methods, i.e., ordination and cluster analysis. Both methods begin with the same data set but summarize the information in very different approaches. Despite the numerous studies using one or the other

method, and the various papers emphasizing the advantages of one method over the other, there are virtually no formal comparisons of the approaches based on the same data. We carry out such a comparison using stream fish communities sampled from a large geographic region of the Great Plains in the United States. We contrast results from within individual ecoregions and from pooled ecoregions to identify commonalities and differences between the two approaches. [Fri PM1]

- **SEASONAL AND DIEL VARIATION IN LAKE TROUT (*Salvelinus namaycush*) ACTIVITY AND IMPLICATIONS FOR GILLNET CATCHABILITY**

Janoscik, T.¹, N.P. Lester², and N.C. Collins¹. ¹Biology Group, University of Toronto at Mississauga, Mississauga, ON, ²Ontario Ministry of Natural Resources, Aquatic Ecology Ecosystems Science Section, Peterborough, ON

We examined seasonal and diel differences in lake trout activity to estimate encounter probabilities associated with gillnet sampling. Individual lake trout were tagged with sonic transmitters and tracked continuously for 2 hour periods during the spring and summer in Opeongo Lake, ON. GPS coordinates and time were recorded at 5 minute intervals to estimate instantaneous displacement rates. Daytime tracking in spring and summer revealed that lake trout display greater displacement rates more frequently in the summer and move over a wider range compared to the spring. Diel variation in lake trout activity was examined with respect to time of day in the summer. Lake trout exhibited greater displacement rates and greater temporal variation in activity within the 2 hour tracking periods during the day compared to night. The relationship between lake trout activity and surface light intensity will also be presented. Implications of lake trout activity levels and movement patterns for gillnet catchability will be discussed. [Poster]

- **GROW BIG OR GO HOME: A DIRECT TEST OF FITNESS TRADE-OFFS USING PUMPKINSEED SUNFISH FORMS**

Jastrebski, C., Department of Zoology, University of Guelph, Guelph, ON

Trophic specialization by some northern freshwater fishes to shallow water and open water lake environments suggests that divergent selection may be acting on traits related to resource use. One prerequisite for divergent selection is that performance in one habitat comes at the expense of performance in another habitat. We used a manipulative field experiment involving shallow and open-water forms of pumpkinseed sunfish (*Lepomis gibbosus*) to test if tradeoffs in performance can occur between lake habitats. Short term performance was measured as growth rate within littoral and open water enclosures. Fitness related tradeoffs were determined by relating habitat-specific performance to individual phenotype. We predict that tradeoffs in feeding efficiency will result in the higher fitness of forms specialized for a particular habitat compared to forms from the alternate habitat. [Fri PM2]

- **TEMPORAL CHANGES IN THE FECUNDITY-SIZE RELATIONSHIP OF ATLANTIC COD, *Gadus morhua***

Jewett, T. M. and J. A. Hutchings, Dalhousie University, Halifax, NS

Despite its importance to reproductive rate and life history, there are few data on the reproductive potential of Atlantic cod, *Gadus morhua*, and no information on its spatial and temporal variability. We quantified age- and size-specific metrics of fecundity for cod from several areas, ranging from the Gulf of St. Lawrence south to Georges Bank. Temporal differences in southern Gulf of St. Lawrence cod were examined by comparing fecundity data from the late 1990s with those from the 1950s (Powles 1957) and the late 1970s (Buzeta & Waiwood 1982). We explore the degree to which spatial and temporal differences in fecundity reflect environmental or adaptive variation. [**Fri PM1**]

- **STATISTICAL METHODS FOR EXAMINING FISH DENSITY AND HABITAT RELATIONSHIPS**

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River pollution, fish densities, habitat restoration work and fisheries resource management all play an important role in determining whether or not wildlife that rely on the river will be able to survive. Important components in any river restoration program include river habitat typing and fish/habitat relationships. Habitat typing of streams is an important consideration associated with habitat restoration work and fisheries resource management. The main objective of the analysis is to identify quantitative associations between fish utilization and specific physical characteristics of sampled rivers and streams. Identification of key habitat variables known to influence fish populations across several different basins, subbasins and streams can be used to help identify, prioritize and plan river restoration projects. Model selection methods using various information matrix criteria will be discussed. [**Poster**]

- **COMPARATIVE REPRODUCTIVE LIFE HISTORY CHARACTERISTICS OF WALLEYE AND SAUGER IN LAKE WINNIPEG, MANITOBA**

Johnston, T.A.¹, W.C. Leggett¹, and W. Lysack². ¹Fish Ecology Lab, Department of Biology, Queen's University, Kingston, ON, ²Fisheries Branch, Manitoba Conservation, Winnipeg, MB

Walleye (*Stizostedion vitreum*) and sauger (*S. canadense*) are closely related freshwater percids and the two most economically valuable species in the Lake Winnipeg commercial fishery. Though relative abundances of these two species vary over the lake as a whole, both occupy similar habitats and are harvested using the same size-selective gear (gill nets). Sustainable management strategies for these two species must account for differences in their reproductive life histories in order to set harvest guidelines that protect the reproductive portion of both stocks. Management has often treated the two species as one. But how similar are they? Can sauger be considered small walleye? We compared key life history characteristics of both species, including growth patterns, maturity schedules, time of spawning, fecundity, egg size, and egg composition to determine whether differences between these two species were simply size-based. Results will be assessed in terms of current and alternative management strategies. [**Fri PM2**]

- **EFFECTS OF RAINBOW SMELT INVASION ON MERCURY CONCENTRATIONS OF PREDATORY FISHES IN LAKES OF NORTHWESTERN ONTARIO AND MANITOBA**

Johnston, T.A.¹, W.C. Leggett¹, R.A. Bodaly², R.R. Doucett³, and R.A. Cunjak³. ¹Fish Ecology Lab, Department of Biology, Queen's University, Kingston, ON, , ²Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, MB, ³Department of Biology, University of New Brunswick, Fredericton, NB

Rainbow smelt rapidly expanded their range through lakes of the Hudson Bay drainage in northwestern Ontario and Manitoba during the 1980s and 1990s. In some of these lakes, smelt have become very abundant and are now a preferred forage species for the resident piscivorous fishes. Because previous research has shown that rainbow smelt feed at a higher trophic position than most native forage species, we hypothesized that predator populations of these lakes should have experienced an upward trophic shift, and an increase in concentrations of biomagnifying contaminants, such as mercury, when smelt entered these food webs. We tested this hypothesis by sampling lake trout, walleye and northern pike from both smelt-invaded and non-invaded lakes that had been sampled for fish mercury analyses prior to the smelt invasion. In most of these lakes, mercury levels in predatory fishes have declined over the past ~ 20 years. However, this decline was less pronounced in smelt-invaded lakes than in non-invaded lakes; this suggests that smelt had a positive influence on predator mercury levels. This effect was strongest in walleye and weakest in lake trout. We are now comparing current 15N/14N ratios of predatory fish muscle between smelt-invaded and non-invaded lakes to assess trophic changes accompanying the smelt invasion. [[Sat AM1](#)]

- **GENETIC STUDIES OF AMERICAN LOBSTER (*Homarus americanus*)**

Jones, M.W.¹, E.L. Kenchington², P. Prodohl³, P.T. O'Reilly¹, A. McPherson⁴, and C.T. Taggart⁴. ¹Department of Biology, Dalhousie University, Halifax, NS; ²Department of Fisheries and Oceans, Dartmouth, NS; ³The Queen's University of Belfast, Belfast, N. Ireland; ⁴Department of Oceanography, Dalhousie University, Halifax, NS

Effective management of exploited species requires the identification of separate management units and an understanding of the degree to which they are reproductively isolated. Despite the economic importance of American lobster to the Atlantic Canadian fishery, little is known about population structuring in this species. As part of an ongoing, three species (Atlantic herring, haddock and American lobster) research programme, we obtained tissue samples from 100 embryo-bearing female lobster at each of 32 sampling locations covering the entire range of American lobster. We are using microsatellite loci to infer population structuring and test existing models of larval movement. We will present ongoing research and report preliminary results on the population structuring of American lobster. [[Poster](#)]

- **TEMPERATURE INDUCED CHANGES OF EARLY LIFE-HISTORY TRAITS OF ATLANTIC COD (*Gadus morhua*) LARVAE**

Jordaan, A., and L. Kling. School of Marine Sciences, University of Maine, Orono, ME

Cod spawn on Georges Bank from January through June with eggs being released on the Northeast corner. Eggs and larvae drift with the residual flow in a clockwise pattern around the bank. Recently, it has been discovered that large scale fluxes of cold, fresher water from the Scotian shelf are episodically crossing over the Northeast channel and are being incorporated into the Georges Bank circulation pattern. More importantly, this water contains significant numbers of gadid eggs indicating that perhaps some cod originate from Canadian waters, which is 2-4°C colder. Temperature is the most significant environmental parameter effecting aquatic cold-blooded organisms and is known to effect size or stage at hatch in marine fish larvae. In order to access this potential and the subsequent influence of temperature on early larval life, three batches of cod eggs were incubated and reared in 4 constant temperature regimes (between 1 and 12°C). Observations on development, growth and survival were made approximately every 4 degree days. Development stages were based on established landmarks critical to survival. Measurements of standard length, body depth and yolk-sac area were also taken. Gut fullness and condition of the larvae as they progress through the endogenous feeding period and begin exogenous feeding will be discussed in relation to temperature. [Poster]

- **ECOTYPIC VARIATION IN MORPHOLOGY OF RAINBOW TROUT FROM BRITISH COLUMBIA**

Keeley, E.R.¹, E.A. Parkinson², and E.B. Taylor³. ¹Dept. of Biological Sciences, Idaho State University, Pocatello, Idaho; ²B.C. Ministry of Fisheries, Vancouver, BC; ³Dept. of Zoology, U.B.C., Vancouver, BC

Rainbow trout populations in British Columbia differ dramatically in life-history characteristics that may vary according to the ecotype occupied by a population. We studied native populations of rainbow trout, distributed over a wide geographic area, to determine if morphology of rainbow trout varies according to ecotype. Our study indicates that a significant proportion of the morphological variation present between rainbow trout populations is related to ecotypic conditions. We found that populations appear to vary most dramatically in morphology depending on whether the population occupies a stream or lake environment. In addition, the presence of competitor fish species and the trophic level occupied by rainbow trout also seem to influence morphological variation. [Sat AM1]

- **PREY SIZE OF SALMONID FISHES IN STREAMS, LAKES AND OCEANS**

Keeley, E.¹, and J. Grant². ¹Department of Biology, Idaho State University, Pocatella, Idaho, ²Concordia University, Montréal, QC

The growth rate of salmonid fishes is typically fastest in oceans, intermediate in lakes and slowest in streams. We compiled literature data to test whether differences in the prey size eaten by salmonids in the three habitats could account for these differences in growth rate (i.e. the prey size hypothesis). In all three habitats, salmonid fishes exhibited ontogenetic niche shifts from feeding primarily on invertebrates when small to fishes when large. Contrary to the prey-size hypothesis, invertebrates eaten in streams were larger than those in lakes or oceans, whereas fish eaten in oceans were smaller than those eaten in streams or lakes. Consistent with the prey size

hypothesis, salmonids began eating fish at a smaller size in oceans (8 cm), than in lakes (15 cm), than in streams (27 cm). However, the size at which salmonids became predominantly piscivorous (31 cm) did not differ significantly between habitats. We suggest that the differences in the growth potential of the three habitats is partly related to the size at which fish first enter the diet. [[Sat AM1](#)]

- **ANTHROPOGENIC INFLUENCES ON FISH COMMUNITIES OF THE GULL RIVER DRAINAGE, ONTARIO**

Kelly, E.¹, and N.E. Mandrak². ¹Department of Biological Sciences, University of Alberta, Edmonton, AB; ²Department of Biological Sciences, Youngstown State University, Youngstown, OH

Fifty-seven lakes in the Gull River drainage, located in the Haliburton Highlands of south central Ontario, were sampled to determine if historical, environmental and anthropogenic factors structure fish communities. All factors were found to significantly affect the distribution of fishes in this drainage; however, principal component analyses indicated that anthropogenic factors had the strongest influence. Sampling revealed the inter-basin transfer of some cyprinids, and it is probable that intra-basin transfers of fishes have also occurred. Several game species have been stocked throughout the drainage to increase angling opportunities. Interactions (e.g. competition, predation) between native and introduced species are known to affect fish community structure. These relationships were examined using the Ochiai similarity coefficient. Introduced piscivorous species were shown to negatively impact some small native fishes as a result of predation. Species-area curves demonstrated that larger lakes have fewer species than expected. This lower species richness is likely related to high cottage densities, which result in loss of littoral zone habitat due to practices such as beach making. Cumulatively, these factors have been found to negatively affect fish communities in lakes in the Gull River drainage. [[Poster](#)]

- **WINTERKILL CASCADE: TOP-DOWN EFFECTS OF FISH ON LITTORAL FAUNA IN BOREAL PLAINS LAKES**

Langlois, P.W., W.M. Tonn, E.E. Prepas, A. Danylchuk, and C.A. Paszkowski. Dept. of Biological Sciences, University of Alberta, Edmonton, AB.

Top-down effects of fish predation on freshwater invertebrates are well established in pelagic zones of lakes. However, studies of fish impacts on littoral macroinvertebrates are less clear-cut, and/or often involve experiments of limited spatial scale or habitat complexity. During overlapping studies of the macroinvertebrate- and fish-assemblages in a set of lakes in the boreal forest of northern Alberta, we documented severe winterkills of northern pike, yellow perch, and white suckers in two lakes, and the beginnings of a recovery in one of them. We sampled the lakes before and after the winterkills, quantifying the responses of littoral macroinvertebrate assemblages to these natural disturbances. The macroinvertebrates and fish of two reference lakes with similar fish assemblages were sampled over the same period. Multivariate community analyses revealed strong relationships to both limnological (bottom-up) factors and fish, i.e., invertebrate assemblages reflected environmental differences among lakes in lakes that were not

disturbed, or in pre- winterkill years, but were clearly altered in response to the winterkill and partial recovery of fishes. Responses of invertebrate taxa to changes in fish density were selective, being most consistent and strongest in taxa identified in previous studies as common prey of the resident fishes. Dynamics of other, less common prey were not consistently related to changes in fish densities. A dramatic increase in the recruitment of amphibian metamorphs emerging from lakes following winterkill was also noted. Despite high productivity and a depauperate fish fauna dominated by generalist species, effects of winterkill in these lakes can cascade down to littoral communities. Therefore, we suggest that winterkill is an important process that must be considered by ecosystem managers employing a "natural disturbance paradigm". [Sat AM1]

- **DO RAINBOW TROUT (*Oncorhynchus mykiss*) BIOMAGNIFY AND BIOTRANSFORM CHIRAL POLYCHLORINATED BIPHENYLS (PCBs) and ORGANOCHLORINE PESTICIDES ENANTIOSELECTIVELY?**

Lau, F.¹, C.S. Wong¹, M. Clark¹, S.A. Mabury¹, and D.C.G. Muir². ¹Department of Chemistry, University of Toronto, Toronto, ON, ²National Water Research Institute, Environment Canada, Burlington, ON

Many organochlorine xenobiotic compounds that accumulate in fish and other biota are chiral. Although they were released into the environment as racemates, they may be present enantioselectively as a result of differential bioprocessing of enantiomers in organisms. Because enantiomers of chiral compounds have different biological and toxicological properties from each other and from the racemic mixtures, information about the behaviour of individual enantiomers is crucial in determining risks posed by these compounds to aquatic food webs. Accordingly, the bioaccumulation and biotransformation of chiral PCBs 95 and 136, and chiral pesticides alpha-hexachlorocyclohexane (a-HCH) and trans-chlordane were examined in immature rainbow trout in the laboratory to determine if these processes are enantioselective in this species. Trout fed target compounds in contaminated food rapidly and preferentially eliminated (-)-trans-chlordane in liver, leading to an overall accumulation of the (+) enantiomer in whole-body trout after 20 days. No significant enantioselectivity was observed for the PCB congeners and a-HCH after a 40-day feeding of contaminated food, and several weeks of subsequent feeding with clean food. These results are consistent with published field measurements of nonracemic trans-chlordane in fish, but not consistent with nonracemic chiral PCBs measured in wild-caught fish, suggesting that enantioselective biotransformation of PCBs in fish occurs, but over a longer time period than our laboratory experiment to date. [Poster]

- **EELGRASS INCREASES ABUNDANCE AND REDUCES PREDATOR RISK IN JUVENILE COD: AN EXPERIMENTAL FIELD MANIPULATION**

Laurel, B.J., R.S. Gregory, and J.A. Brown. Memorial University of Newfoundland, Ocean Sciences Centre, St. John's, NF

Age 0 Atlantic cod (*Gadus morhua*) and Greenland cod (*Gadus ogac*) associate with eelgrass habitat in coastal areas. In 1995-00, we investigated the significance of eelgrass to young cod in a large-scale field manipulation experiment. In 1999 we removed eelgrass from two dense

eelgrass sites and added simulated eelgrass at two sites without eelgrass. We compared fish abundance in these sites with 8 control sites, between and within years. We observed a ~300-fold increase at enhanced sites and a corresponding decrease at removal sites. These results support the assumption that eelgrass is actively selected by young cod during settlement from the pelagia and may be critical to early survival. Ongoing investigations of how eelgrass influences distribution of juvenile cod are being conducted through underwater observations and predator risk experiments. Results suggest that eelgrass reduces predator encounter rates with juvenile cod despite simultaneously increasing predator densities. [Sat PM1]

- **EVALUATION OF THE PATTERNS OF STEAM FISH COMMUNITY DISTRIBUTION IN BOREAL FOREST CATCHMENTS: IMPLICATIONS FOR FOREST MANAGEMENT**

Mackereth, R. and K. Armstrong. Centre for Northern Forest Ecosystem Research and Northwest Science and Technology, Ontario Ministry of Natural Resources, Thunder Bay, ON

Stream fish populations throughout Ontario's boreal forest are vulnerable to habitat disturbance, such as sediment and nutrient flux created by forest management activities. Our research focuses on examining the impact of forest management activities on fish habitat and fish communities in different sized catchments in Northwestern Ontario. Fish species richness declines higher up a drainage system, ranging from an average of 6 species in 100 km² catchments to an average of 1 species in 1 km² catchments. Within a catchment area, there is a degree of variability in the number of species present which appears to be associated with valley segment characteristics and not site specific habitat conditions nor forest harvesting activities. Analyses have focused on brook trout (*Salvelinus fontinalis*) which is the only species to occur in all catchment sizes with the smallest streams containing brook trout (mainly young-of-year) or no fish. Their distribution through the stream system was irregular and had no clear association with habitat variables measured at the reach scale. Population nodes appeared to be associated with broad, flat valley segments. In a bedrock dominated landscape, these occur in areas of surficial geological deposits which are associated with groundwater/surface water interactions. The results suggest that valley segment characteristics, such as flood plain profile and riparian vegetation structure, may be useful in predicting the risk of disturbance to stream fish habitat, or the fragmentation of stream fish communities, posed by forest harvest activities. [Fri PM1]

- **MANAGEMENT IMPLICATIONS OF LIFE HISTORY VARIATION IN NORTHERN PIKE (*Esox lucius*) POPULATIONS IN NORTHEASTERN ONTARIO**

Malette, M.D., and G.E. Morgan. Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, ON

A representative sample of northern pike populations across northeastern Ontario were sampled from 1994 to 1999 using Ontario's fall walleye index netting method. Lakes were selected based on surface area, climate, and transparency. All northern pike were biologically sampled for fork length, total length, round weight, sex, maturity, and ageing tissues (scales and cleithrum). Correlation analysis indicated that northern pike relative abundance was positively correlated to

the amount of littoral zone. Growth rate and asymptotic length were negatively correlated with relative abundance, and condition was negatively correlated with the amount of littoral zone for both males and females. Female annual mortality was negatively correlated with relative abundance. These predictive relationships will be used to identify quality fishery potential based on the observed variation in northern pike life history parameters. [[Poster](#)]

- **PREDICTING THE SPREAD AND IMPACT OF INTRODUCED FISHES IN ALGONQUIN PARK, ONTARIO**

Mandrak, N.E. Department of Biological Sciences, Youngstown State University, Youngstown, OH 44555

Most lakes in Algonquin Park originally lacked large cool- and warm-water piscivorous fishes (e.g. pike, walleye, basses). The first authorized introduction of smallmouth bass occurred in the late 1800's and continued into the mid-1900's. More recently, the unauthorized introductions of rainbow smelt, northern pike, rock bass, largemouth bass and walleye have led to the establishment of reproducing populations in many Algonquin lakes. The objectives of the current study are: 1) to identify Algonquin lakes susceptible to colonization by introduced species; and, 2) to identify current and potential impacts of these species on native fish communities. To identify lakes susceptible to colonization, separate discriminant function analyses (DFA), were used to predict the presence or absence of each introduced species in Algonquin lakes. Discriminant functions were derived based on eight trophic, five physical and five chemical parameters measured in 4,107 Ontario lakes (excluding Algonquin lakes), and applied to data for 227 Algonquin lakes. Lakes predicted to be suitable for an introduced species (i.e. predicted presence) were considered to be susceptible to colonization. To identify the potential impact of the introduced species, the distributional relationships between each introduced species and each native species was measured using the Jaccard similarity coefficient based on the Ontario lake dataset. Relationships between an introduced species and a native species with a low Jaccard coefficient were classified as predator-prey, competitive or other (e.g. sample bias). Lakes containing fish communities likely to be impacted by introduced species were ranked by number of potential introduced colonizers and number of native fishes negatively impacted (i.e. prey, competitor) by introduced species. [[Sat AM1](#)]

- **THE DEVELOPMENT OF A NATIONAL FRESHWATER FISH DISTRIBUTION DATABASE: AN UPDATE**

Mandrak, N.E. Department of Biological Sciences, Youngstown State University, Youngstown, OH

The development of a national freshwater fish database is a critical component of identifying and protecting Canada's freshwater fish biodiversity. It is a necessary precursor to analyses identifying patterns of biodiversity and the historical, environmental and anthropogenic processes that influence these patterns. It is also critical for the development of strategies by both federal and provincial governments to evaluate, conserve and protect freshwater fish biodiversity. The first phase of this project identified over 30 existing sources of fish distribution data. The ongoing second phase involves developing a single standardized database using the

available distribution records. Each record in this master database will be georeferenced and assigned a tertiary watershed code with the aid of a GIS. To date, close to 400,000 edited records from over 25 sources are in the master database. A map of all records indicates that coverage for the 10 provinces is generally good; whereas, coverage for the three territories is poor. Watershed-level distribution maps for each species are being produced to determine the accuracy and completeness of the database. Outliers will be examined for accuracy, and gaps may be filled using additional data or spatial interpolation techniques. The third phase involves conducting biogeographic analyses to identify patterns of freshwater fish biodiversity at a national scale and the processes that structure those patterns. [[Poster](#)]

- **ESTIMATION OF ENERGETIC COSTS ASSOCIATED TO FEEDING IN LITTORAL AND PELAGIC HABITATS BY JUVENILE BROOK CHARR, (*Salvelinus fontinalis*)**

Marchand, F.¹, P. Magnan¹, and D. Boisclair². ¹Université du Québec à Trois-Rivières, Trois-Rivières, QC, ²Université de Montréal, Montréal, QC

The main objectives of the present study were to estimate the activity budget, swimming characteristics (swimming speeds and angles of turn) and energetic costs of feeding in littoral and pelagic habitats by juvenile brook charr. We also estimated the profitability of littoral and pelagic habitats by implementing our estimations of energetic costs and benefits of foraging in each habitat, in the bioenergetic model used by Héroux and Magnan (2000). We used a portable underwater camera system in enclosures set in a lake of the Laurentian Shield to estimate the activity budget and swimming characteristics of fish in both habitats. Juvenile brook charr spend significantly more time in feeding and less time in a stationary position in pelagic than littoral enclosures. Mean time associated to swimming and number of aggressive interactions were not significantly different between both habitats. Mean swimming speed were not significantly different between littoral and pelagic habitats but the mean angles of turn were significantly higher in pelagic than littoral habitat. Mean swimming speed was positively related to zooplankton biomass in pelagic habitat. The mean energetic cost of foraging was not significantly different between the littoral and pelagic enclosures. The best predictors of energetic costs of foraging in the littoral habitat were the year, the Julian date and, fish density, which they explained 44 % of the variation. The energetic cost of foraging in the pelagic enclosures was negatively related to zooplankton biomass. However, when using our data together with other from the literature, the best predictors of energetic cost of foraging in the pelagic enclosures were still zooplankton biomass (-), but also fish density (+) and water temperature (-), which explained a total 28 % of the variation. Although the energetic costs of foraging were not significantly different between the two habitats, energy left for growth and standard metabolism was significantly higher in littoral than in pelagic habitat. Our results support the hypothesis that the littoral habitat is more profitable than the pelagic one for allopatric brook charr populations inhabiting lakes of the Laurentian Shield. The approach use in this study is one of the first attempt to evaluate energetic costs of feeding in fishes, directly in the field in different habitats. [[Poster](#)]

- **CONSERVING FISH BY CATCHING FEWER**

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Managers of commercially harvested fish stocks commonly use pre-specified values of fishing mortality rates and the total biomass of mature fish in the stock (spawner biomass) as guidelines for formulating scientific advice. This approach assumes that spawner biomass is proportional to both the potentially harvestable biomass and the reproductive potential of the stock. However, spawner biomass is proportional to neither when immature fish comprise a significant fraction of the commercial catch and when the reproductive potential of the stock is poorly represented by a quantity having units of mass. Accordingly, separate indices were developed to represent the potentially harvestable biomass and reproductive potential of the Barents Sea cod stock over a fifty-one year time period (1946-1996). Removals of biomass and reproductive potential by the commercial fishery were quantified in the same units. The proportional removal of potentially harvestable biomass by the fishery varied between 10 and 25% annually, whereas, the proportional removal of reproductive potential was between 20 and 60% annually. Both variables were positively correlated with fishing mortality rates, however, the proportional removal of reproductive potential increased more rapidly with increasing fishing mortality than did the proportional removal of potentially harvestable biomass. Thus, the long-term sustainability of the stock is at greater risk from high fishing mortalities than is indicated by the conventional biomass-based index of stock status. [[Fri PM2](#)]

- **HABITAT UTILIZATION IN A TROPICALLY POLYMORPHIC PUMPKINSEED (*Lepomis gibbosus*) POPULATION**

McCairns, R.J.S.¹, and M.G. Fox². ¹Department of Biology, Trent University, Peterborough, ON, ²Environmental and Resource Studies Program and Department of Biology, Trent University.

Internal and external morphometric analyses have demonstrated the occurrence of trophic polymorphism in several populations of pumpkinseed (*Lepomis gibbosus*). In addition to the typical pumpkinseed found in littoral habitats, a pelagic feeding morph has been found to inhabit rocky, open-water shoals in the absence of a competing congener (*Lepomis macrochirus*). Since previous morphometric analyses suggest that both forms are phenotypically adapted to feeding in distinct habitat types and on differing prey items, it is hypothesised that the morphs should demonstrate a preference for their respective habitat types. We conducted a reciprocal tag and transfer experiment on one polymorphic population over two field seasons. Preliminary results suggest a strong tendency for individuals to preferentially select their habitat of origin. Furthermore, recapture data suggest many fish exhibit site level fidelity prior to and throughout the spawning season. [[Poster](#)]

- **ADAPTIVE BEHAVIOUR OF INDIVIDUALS AND THE INTRAPOPULATION DIVERSIFICATION OF LAKE FISHES**

McLaughlin, R. L. Institute of Ichthyology and Department of Zoology, University of Guelph, Guelph, Ontario

The adaptive behaviour of individuals has been hypothesized to play an important role in promoting the diversification of populations of lake fishes into benthic and limnetic morphs. Using recently-emerged brook charr (*Salvelinus fontinalis*) in still-water pools along the sides of streams as an experimental model system, my collaborators and I have collected seven lines of evidence to support this hypothesis. First, recently-emerged brook charr repeatably exhibit either a sedentary or a mobile foraging tactic. Second, these tactics are related to water-column use and diet, with sedentary individuals consuming crustacean prey from the lower portion of the water column and mobile individuals consuming insects from the upper portion of the water column. Third, the charr compete locally for prey. Fourth, biochemical indices of growth rate have provided evidence of short-term, diversifying selection on activity. Fifth, data on water-column use, capture success, and stomach contents all indicate that feeding on crustacean and insect prey is mutually exclusive to some degree. Sixth, an adaptive decision-making model accurately predicted how the proportions of sedentary and mobile fish scale with pool size and how the spatial locations and orientations of sedentary and mobile fish differ within pools. Seventh, a laboratory experiment demonstrated that prolonged differences in activity can induce developmental differences in body shape. [Sat PM2]

- **IMPACTS OF LOW-HEAD BARRIERS ON STREAM FISHES: TAXONOMIC AFFILIATIONS AND MORPHOLOGICAL CORRELATES OF SENSITIVE SPECIES**

McLaughlin, R. L., L. Porto, and D. L. G. Noakes. Institute of Ichthyology and Department of Zoology, University of Guelph, Guelph, ON

The Great Lakes Fishery Commission is planning greater use of low-head barrier dams on stream tributaries of the Laurentian Great Lakes to control populations of parasitic sea lamprey, *Petromyzon marinus*. Recent research indicated these barriers can alter the species richness and composition of fishes in streams. Identification of taxa sensitive to the change in management tactics represents an important, initial step toward mitigating the impacts of the barriers. This study identifies potentially sensitive taxa (species, genera, and taxonomic families) using fish distributions from field surveys of 24 stream pairs from across the Great Lakes with each pair comprising a barrier (barrier present) and corresponding reference (barrier absent) stream. Eighty-one species from 49 genera and 16 taxonomic families were collected in our surveys. For 48 species from 34 genera and 12 taxonomic families, abundances above and below a real (barrier stream) and a hypothetical (reference stream) barrier location were compared using three measures of impact: an overall odds ratio, a common odds ratio following stratification by stream pair, and a Poisson regression model incorporating sampling effort. The three estimates of impact were correlated reasonably strongly at each taxonomic level despite differing in the data considered and the statistical assumptions made. Depending on the measure of impact, our analyses identified 13-19 species, 11-16 genera, and 5-7 families, whose distributions in barrier streams differed from those in reference streams. Although low-head barriers can impede the movements of fishes, some sensitive taxa were relatively more abundant above real barriers than expected from reference streams and our measures of impact were not strongly correlated with morphological predictors of swimming ability at any of the taxonomic levels considered. The mechanism of impact probably includes more than just interruption of fish passage. [Fri PM2]

- PATTERNS OF POPULATION STRUCTURE IN ATLANTIC HERRING (*Clupea harengus*): RECONCILIATION WITH THE RETENTION HYPOTHESIS

McPherson, A.¹, P. O'Reilly², M. Jones², C. Reiss³, and C.T. Taggart¹. ¹Department of Oceanography, Dalhousie University, Halifax NS, ²Department of Biology, Dalhousie University, Halifax, NS, ³Department of Biological Sciences, Center for Quantitative Fisheries Ecology, Old Dominion University, Norfolk, VA

Retention of larvae has been proposed as a mechanism that maintains putative distinctness of Atlantic herring populations. However, this hypothesis (Iles and Sinclair, Science 215:627-633) has been problematic to test due to difficulties characterizing physical processes at the necessary spatial scales. Further, population studies to date have found limited evidence of population structuring in Atlantic herring. Following the recent development of tetranucleotide microsatellite loci for Atlantic herring, population structure can be examined using spawning groups and larvae of Scotia-Fundy Atlantic herring. An attempt will then be made to reconcile the observed patterns with the predictions of the retention hypothesis. [**Sat PM1**]

- **DEVELOPMENT OF A HYDROACOUSTIC SURVEY METHOD TO MONITOR THE STATUS OF LAKE TROUT POPULATIONS IN ONTARIO**

Middel T.A.¹, N.P. Lester¹, and C.P. Gubala². ¹Aquatic Ecosystems Science Section, Harkness Laboratory of Fisheries Research, Ontario Ministry of Natural Resources, Peterborough, ON, ²The Scientific Assessment Technologies Laboratory, University of Toronto at Mississauga, Mississauga, ON

With more than 2000 lakes in Ontario containing populations of lake trout, sustainable management of this species, presents a challenge to fisheries managers in the province. While standardized index netting methods have been developed for the express purpose of assessing the status of these populations, these methods are labor intensive and restrict the number of lakes which can be assessed in a given time frame. Preliminary investigations to investigate the feasibility of using hydroacoustics to assess lake trout populations have been conducted and are ongoing in Lake Opeongo, a 50000 hectare, oligotrophic lake, located in Algonquin Provincial Park. Summer and fall diurnal hydroacoustic surveys were conducted in 2000 using a 120-kHz 7.5-degree split beam transducer in three of the four basins of Lake Opeongo. Using estimates of target strength for salmonid species obtained from existing literature we will compare acoustically derived density estimates of adult lake trout with estimates derived from mark recapture studies and an access point creel survey. [**Poster**]

- **PROJECTING REGIONAL IMPACTS OF CLIMATE CHANGE ON FRESHWATER FISHES**

Minns, C.K.¹, and B.J. Shuter². ¹Fisheries and Oceans Canada, Burlington, ON, ²Ontario Ministry of Natural Resources, Port Dover, ON

With support from the Climate Change Action Fund, methods for predicting the regional impacts of climate change on freshwater fishes are being developed. Climate change is expected to have

significant impacts on freshwater fishes in Canada and, fisheries and fishers will face major adaptation challenges. This project is focusing on two species, walleye (*Stizostedion vitreum vitreum*) and brook trout (*Salvelinus fontinalis*), representing lake and stream species respectively. These species occur widely in Canada but, for the present, the method development work is confined to Ontario. Regional predictions of ecological impacts are needed to allow the socio-economic trade-offs of prevention versus adaptation can be assessed. Making those predictions often requires much extrapolation beyond the boundaries usually considered acceptable in peer-reviewed science. The purpose of this presentation is to present an overview of the components and constraints that go into regional impact projections for freshwater fishes using elements from the current Ontario study. Impact modelling begins with small datasets that provide evidence of links between biological response (presence-absence, biomass, sustained yield, etc.) and environment factors (lake area, stream width, degree-days, summer maximum temperatures, secchi depth, etc.). These datasets must be augmented with landscape/regional parameters to allow the impact of non-local effects on response patterns to be considered. For example, it is necessary to consider the role of surficial geology as an overriding constraint on brook trout distribution. Similarly scaling algorithms must be developed to allow extrapolation from samples to whole regions, e.g. from a sample of walleye lakes to all walleye lakes in Ontario. Finally the impact models must be integrated with the modelled climate scenarios, The parameter augmentation, scaling, and integration activities widen the confidence intervals in impact estimates. A preliminary qualitative scheme for assessing these uncertainties against the uncertainties of climate change scenarios will be discussed. The challenges of regional to national assessments will be briefly explored. [Fri PM1]

- **MANAGEMENT OF WALLEYE (*Stizostedion vitreum*) POPULATIONS IN NORTHEASTERN ONTARIO**

Morgan, G.E., and M.D. Malette. Cooperative Freshwater Ecology Unit, Department of Biology, Laurentian University, Sudbury, ON

From 1994 to 1999 walleye were sampled from a representative group of 86 lakes using the fall walleye index netting standard. Lakes were classified according to surface area, climate, and transparency with a minimum of 2 lakes sampled for each possible combination. All walleye captured were counted and measured for fork length, total length, wet weight, visceral fat weight, and gonad weight. Sex and maturity of each fish was determined by internal examination. Mature ovaries and ageing tissues (scales and otoliths) were collected. There were significant differences between male and female walleye life history parameters. On average, male mortality was higher, asymptotic length was lower, size at maturity was smaller, and age at maturity was younger than females. Regression analyses indicated that walleye abundance was weakly correlated with lake size and pre-maturation growth (sexes combined) was correlated with water transparency. For males and females, size at maturity was positively correlated with pre-maturation growth. Male asymptotic length was positively correlated with pre-maturation growth and negatively correlated with adult mortality. Female asymptotic length was positively correlated with size at maturity and negatively correlated with adult mortality. Fecundity was positively correlated with pre-maturation growth. These relationships will be used to identify management approaches that are robust to the observed variation in walleye life history parameters seen in northeastern Ontario. [Sat AM1]

- **THE BIOENERGETIC BASIS FOR ANADROMY IN BROOK TROUT**
(*Salvelinus fontinalis*)

Morinville, G.R., and J. Rasmussen. Department of Biology, McGill University, Montréal, QC.

Brook trout (*Salvelinus fontinalis*) are a popular game fish species in northeastern North America. Like many salmonids, they may exist as anadromous (migrant) and freshwater (resident) forms. In some systems, individuals from the same population can adopt either life-history strategy. In such systems, a growth dichotomy is observed; when individual migrants (after life at sea) and residents of the same age class are compared, the former are much larger in size presumably due to a richer food supply at sea. In Québec, the sport fishery for the larger migrant brook trout (sea trout) is becoming increasingly popular. Unfortunately, there is no strategy for their sustainable exploitation. To ensure sustainable exploitation of sea trout, the identification of what makes migrants different from residents is necessary. The objective of the study is to investigate the energy allocation strategies of migrants versus residents. Estimating the energy intake and coupling this to growth allows for an analysis of the energetic performance of fish with different life-history strategies. Results indicate that in the year prior to migration, migrants have higher annual consumption rates, but lower growth efficiencies (ratio of growth to consumption) compared to residents. This translates into migrants exhibiting higher overall metabolic costs as less of the consumed energy is diverted to growth. These results indirectly give support to the notion that a link exists between metabolic costs and life-history strategies. [\[Poster\]](#)

- SHOULD GILBERT BAY COD BE MANAGED AS A LOCAL POPULATION?

Morris, C. J., and J. M. Green. Department of Biology, Memorial University of Newfoundland, St. John's, NF

We studied life history characteristics of a genetically distinctive cod (*Gadus morhua*) population in Gilbert Bay, Labrador. Gilbert Bay cod remain within Gilbert Bay year round despite access to other bays and the open coast. In summer, migratory cod move into Gilbert Bay and mix with the resident cod population. Length at age and length frequency data indicates that Gilbert Bay cod rebuilt during the fishing moratorium (1992 - 1998) on northern cod. Since 1998 fishing pressure on Gilbert Bay cod has been above historic levels due to the near absence of migratory fish on traditional fishing grounds, and appears to be depressing the population. Fishers in adjacent communities were interviewed and most suggested that Gilbert Bay be closed to commercial fishing. Although DFO has closed a portion of the bay to cod fishing, and proposals have been made to consider the bay a Marine Protected Area, Gilbert Bay cod remain affected by the management plan for northern cod. [\[Sat PM1\]](#)

SAMPLE SIZE FOR ESTIMATING AGE CLASS PROPORTIONS

Morrison, B.J.^{1,2}, J.J. Hubert¹, E.M. Carter¹, T.D. Nudds³, and S.S. Crawford^{2,4}. ¹Department of Mathematics and Statistics, University of Guelph, Guelph, ON, ²Axelrod Institute of Ichthyology, University of Guelph, ³Department of Zoology, University of Guelph, ⁴Chippewas of Nawash First Nation, Wiarton, ON

An important component of assessing a fishery is the analysis of its age structure. The results of this analysis are often used in age structured models or as indicators of changes in a fish populations age class structure. The purpose of this research was to provide an approach to determining the sample size required to precisely estimate age class proportions from commercial fishery samples. Data from the Chippewas of Nawash lake whitefish fishery was used for estimating age class proportions. Approximately 5% of the commercial catch of each vessel was haphazardly sampled for collections of scales and measures of length and weight. A simple random sub-sample was used to estimate the proportion of each age class within the commercial catch. The sample size required to precisely estimate these proportions was based on using large sample, simultaneous confidence intervals assuming the multinomial distribution. This multinomial approach allowed for an a priori statement of precision, smaller sample size and a narrower range of sample sizes across strata when compared to the age-length key approach. Increases in cost due to additional samples were minimal. It is recommended that the size of the primary sample be reduced so that more fish can be aged. The relation between sample size for age class proportions and that required for estimating mean length/weight at age is also discussed. [[Sat PM2](#)]

- **HABITAT PREFERENCES AND MOVEMENTS OF COASTER BROOK TROUT IN LAKE SUPERIOR**

Mucha, J.M., and R.W. Mackereth. Centre for Northern Forest Ecosystem Research, OMNR, Lakehead University, Thunder Bay, ON.

Named for their affinity to the nearshore waters of Lake Superior, coaster brook trout were abundant a century ago, but have been reduced to a few remnant stocks due to overfishing and habitat loss. Twenty brook trout were surgically implanted with radio transmitters and were located from June 1999 to October 2000. Locations were used to determine lake habitat used, stream habitat used for spawning and rearing of young, movement patterns, and home range sizes. Individual fish were also tracked at 4 hour intervals for a 24 hour period to determine diurnal movements. Locations within the lake were predominantly in areas less than 4 m deep and within 150 m of shore. Two distinct habitat types in the lake were utilized at different times of the year. From post-spawn to mid-July fish were located in shallow nearshore waters adjacent to bedrock or morainal landforms. Between mid-July and the time they ascend streams fish were located in nearshore areas with distinct drop-offs adjacent to areas of glaciolacustrine or alluvial surficial geology. Twenty-four hour tracking revealed coasters typically remained in deeper water or near cover throughout the day and moved to either very shallow waters or to another habitat area during the night. Range size of tagged brook trout varied considerably with some fish remaining in the same few kilometers of shoreline while others moved over 50 km throughout the year. Tagged coasters began ascending streams in late summer with all brook trout returning to the lake within the same week of mid-October. All 4 streams utilized by brook trout were characteristic of a moderate gradient with riffle-pool complexes, well sorted gravel, and available cover. These results suggest that coaster brook trout have specific habitat preferences in both the lake and stream. Identification and protection of these areas is necessary to maintain and rehabilitate these populations. [[Poster](#)]

- **MODELING EFFECTS OF THE COASTAL MARINE ENVIRONMENT ON RECRUITMENT ACROSS MULTIPLE STOCKS OF THREE SPECIES OF PACIFIC SALMON**

Mueter, F.J., B.J. Pyper, and R.M. Peterman. School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC

We modeled recruitment as a function of spawner abundance and environmental variables, while allowing for first-order autocorrelation, across 110 stocks of pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), and sockeye (*O. nerka*) salmon. Our primary objective was to test for and model the effects of coastal sea-surface temperature (SST), coastal sea surface salinity (SSS), and upwelling on early ocean stages of salmon. We found that coastal SST during the first few months of ocean residence was significantly and positively correlated with recruitment in northern stocks (Alaska) for all three species. In contrast, recruitment in the southern stocks (Washington and British Columbia) of pink and sockeye salmon was significantly and negatively correlated with SST. However, correlations between coastal SST and sockeye salmon recruitment in the southern stocks were strongest one year prior to outmigration, suggesting effects on the freshwater life stage of sockeye salmon, given that SST is highly correlated with air temperature in the region. We estimated effect sizes for the effect of SST on recruitment across southern and northern stocks respectively using multi-stock random-effects models. We conclude that there is a strong south-to-north gradient in the response of recruitment to SST. Recruitment of southern stocks appears to be lower in warm years, whereas recruitment of Alaska stocks tends to be higher in years in which early marine life stages experience warm coastal SSTs. We recommend including SST in models for forecasting salmon returns, particularly where the effect of SST on recruitment can be estimated across multiple stocks within a region. [Sat AM1]

- **PUTTING THE EXPERIMENT INTO 'EXPERIMENTAL' GILLNETS**

Muir, A.M.¹, S.S. Crawford^{1,2}, and P. Vecsei³. ¹Chippewas of Nawash First Nation, Wiarton, ON, ²Axelrod Institute of Ichthyology, University of Guelph, Guelph, ON, ³Department of Zoology, University of Guelph

The Chippewas of Nawash, like all institutions involved in fisheries management, require reliable information on the fish populations supporting their harvests (recruitment and pre-recruitment), as well as those non-target species that are incidentally captured during harvesting. While data collected from the fisheries are necessary for this objective, they are not sufficient - especially given the operational characteristics of the commercial fishing fleets and the life histories of dominant species in the Nawash harvest, lake whitefish (*Coregonus clupeaformis*) and bloater chub (*Coregonus hoyi*). In order to understand the population dynamics of these harvested species, it is also necessary to employ a biologically- and statistically- reliable method of sampling that is independent of the commercial fishery. One of the most common methods of fishery-independent sampling used in the Great Lakes is the use of multi-mesh gillnets; variously referred to as index, graded or 'experimental' nets. We provide a review and critical evaluation of multi-mesh gillnets and their historical uses as assessment tools in fisheries management. Specifically, we examine the advantages and limitations of using multi-mesh gillnets to

characterize measures of year class strength for: (a) targeted species prior to recruitment to the fishery; (b) targeted species after recruitment to the fishery; and (c) non-targeted species incidentally harvested. Based on this review, we propose a multi-mesh gillnet sampling program that is based on the statistical principles of adaptive sampling, and which is designed to: 1. develop explicit hypotheses regarding fish abundance and distribution, and then 2. conduct empirical tests of *a priori* predictions generated from these hypotheses. [Sat PM2]

- **MODELING THE EFFECT OF SPAWNING SITE LOCATION ON RECRUITMENT OF LAKE TROUT IN LAKE SUPERIOR**

Netto, J.K. and M.L. Jones. Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI

In Lake Superior, wild lake trout populations have increased due to the growth of remnant wild populations and spawning by stocked hatchery fish. It has been suggested that adult lake trout of hatchery and wild origin have different population characteristics, and hatchery lake trout have lower rates of spawning success. Lake trout of hatchery origin also tend to use available spawning habitat differently than wild lake trout. Using environmental and demographic data from the Minnesota shore of Lake Superior, we developed a spatially explicit age-structured model to explore possible mechanisms by which habitat attributes could affect lake trout recruitment. We used this model to determine whether lower spawning success rates of hatchery reared fish could be explained by differences in habitat use by hatchery and wild fish, and what habitat characteristics are necessary for restoration success at a regional level. Our analyses indicate that depth of spawning, proximity to shore, distance to suitable nursery areas, and the characteristics of adjacent habitat units are important factors for determining the productive potential of a spawning location. Model results suggest that spawning site location can account for differences in reproductive success, but these differences are dependent on the shoreline region and climate patterns. [Sat AM1]

- **QUANTIFYING JUVENILE ATLANTIC COD HABITAT ACROSS SPATIAL SCALES**

O, M., D. Schneider, and R. Gregory. Department of Biology and Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NF

Scaling the spatial dynamics of natural populations from smaller to larger scales is receiving a lot of attention in ecology recently. It is widely accepted that large-scale spatial patterns or processes cannot be directly rescaled from small-scale measurements. Ecological processes are often spatially allometric and do not scale proportionally with area. Eelgrass habitats are considered important nurseries for juvenile cod, providing refuge from being preyed upon. A map of eelgrass habitat in Newman Sound, Newfoundland was collected using CASI (compact airborne spectrographic imager) remotely sensed imagery. Borstad Associates classified the imagery using previously collected spectral signatures. We then obtained extensive groundtruth data to further calibrate the imagery. We quantified various measures of eelgrass habitat over a range of spatial scales, by changing the resolution of the imagery and applying a box-counting method. The scaling result was found to depend on 1) the criteria chosen to determine the

presence or absence of eelgrass habitat within a pixel (i.e. the threshold rule), and 2) the measure being analyzed (eg. proportion, total count, % cover, nearest neighbour). Because the ability to predict available habitat across spatial scales may depend on the criteria for habitat presence, it is important to choose biologically relevant rather than arbitrary measures of habitat. [Sat AM1]

- **ARTIFICIAL NEURAL NETWORKS AND THE DEVELOPMENT OF PREDICTIVE MODELS FOR TEMPERATE FISH COMMUNITIES**

Olden, J.D.¹, and D. A. Jackson². ¹Department of Biology, Colorado State University, Fort Collins, CO, ²Department of Zoology, University of Toronto, Toronto, ON

Understanding and predicting the dynamics of fish populations and communities is one of the main challenges confronting aquatic scientists. The development of empirical models quantifying the relationship between fish species and their environment is an importance process, although it is difficult task because species commonly exhibit complex, non-linear responses to habitat heterogeneity and biotic interactions. To deal with these complexities, we demonstrate the ability of a statistical technique, artificial neural networks, to model non-linear ecological patterns using a set of 286 temperate lakes located in south-central Ontario, Canada. We provide both explanatory and predictive insight into species-environment relationships by developing predictive models for fish species abundance, occurrence and community composition using micro- and macro-scale measures of lake habitat. The results show that species abundance is highly predictable based on near-shore habitat variables; as well both species occurrence and community composition can be classified with high success based on lake-wide measures of habitat. Models for species occurrence exhibit good generality in predicting occurrence in other lakes from an adjacent drainage (i.e., high geographic transferability), and by partitioning the performance of the models into measures such as sensitivity (ability to predict species presence) and specificity (ability to predict species absence), the predictive strengths and weaknesses can be assessed more readily. Finally, neural networks provide a useful approach to examine the independent and interactive effects of habitat and biotic factors on species abundance, spatial occupancy and occurrence. [Fri PM1]

- **AN ANALYSIS OF WALLEYE POLLOCK STOCK STRUCTURE IN THE BERING SEA AND NORTH PACIFIC OCEAN USING MICROSATELLITE DNA MARKERS**

O'Reilly, P.¹, M. F. Canino^{2,3}, K.M. Bailey², and P. Bentzen^{1,3}. ¹Marine Gene Probe Laboratory, Dalhousie University, Halifax, NS; ²Alaska Fisheries Science Center, NOAA, Seattle WA 98115; ³Marine Molecular Biotechnology Lab, School of Fisheries, University of Washington, Seattle, WA 98105

Previous published investigations of genetic structuring of walleye pollock (*Theragra chalcogramma*) populations in the North Pacific Ocean and Bering Sea have been based on either multiple low variability allozyme loci, or a single high variability mtDNA or microsatellite locus. Here, we report patterns of genetic structuring observed at 15 primarily tetranucleotide microsatellites among walleye pollock from the Western Pacific Ocean, Gulf of Alaska, Puget

Sound, and the Northwest and Southeast Bering Sea. The degree of temporal stability of observed spatial differences will also be discussed. [[Poster](#)]

- **POTENTIAL EFFECTS OF SELENIUM ON THE REPRODUCTIVE FITNESS OF SALMONIDS DOWNSTREAM OF AN ENDPIT LAKE**

Palace V.¹, [P. Siwik](#)², G. Sterling², R. Evans¹, C. Barons¹, and J. Holm³. ¹Dept. of Fisheries and Oceans, Winnipeg MB, ²Alberta Environment, Edson AB, ³University of Manitoba, Winnipeg MB.

[[Poster](#)]

- **POND EXPERIMENTS INVESTIGATING THE EFFECTS OF SMALL-BODIED FISH SPECIES ON GROWTH AND SURVIVORSHIP OF WOOD FROG LARVAE**

[Paszkowski, C.](#), B. Eaton, T. Gartner, and B. Gingras. Department of Biological Science, University of Alberta, Edmonton, AB

The stocking of large, piscivorous fish species has been implicated as one factor contributing to the widespread decline of amphibian populations, but the effects of smaller fish species is less clear. We examined experimentally survivorship to metamorphosis of wood frog (*Rana sylvatica*) larvae in the presence of fathead minnow (*Pimephales promelas*) and brook stickleback (*Culaea inconstans*), 2 fishes that commonly occur in small shallow lakes in northern Alberta. Over 12,000 newly hatched wood frog larvae were introduced into each of three 360 m² ponds that had been divided in half to create 2 replicates of 3 treatments: fishless, adult minnows present, or adult sticklebacks present. An unplanned treatment occurred as one of the fishless sections contained a few small fatheads that matured and bred, producing hundreds of fry. Trapping and visual surveys indicated that tadpoles disappeared rapidly from ponds stocked with adult fishes. Larvae in the presence of minnow fry survived well, but displayed reduced activity compared to larvae in the fishless section. We monitored metamorphs through pitfall-trapping and systematic searches. Six hundred and ten froglets were collected from the pond lacking adult fish, whereas only 9 and 28 emerged from the ponds with minnows and sticklebacks, respectively. The few metamorphs from ponds with fishes emerged later and were larger. Our results demonstrate that even small-bodied fishes affect wood frog larvae through predation or other negative interactions. Dramatic inter-annual variation in the densities of these fish populations, caused by winterkill, creates dynamic and unpredictable conditions for wood frog reproduction in small boreal lakes. [[Poster](#)]

- **DYNAMICS OF SIZE-STRUCTURED POPULATIONS: THE IMPORTANCE OF OVERWINTERING IN STREAM-DWELLING SALMONID POPULATIONS**

Paul, A.J.¹, and J.R. Post². ¹Fisheries Centre, University of British Columbia, Vancouver, BC, ²Dept. of Biological Sciences, University of Calgary, Calgary, AB

We present a physiologically structured population model to examine the importance of overwintering in stream-dwelling salmonid populations. A key aspect of our model, which separates it from other physiologically structured models, is that winter represents a starvation period imposed by the environment rather than demographics. At the individual level, the model predicts that mass-specific available energy (e.g., lipid content) can increase, decrease or remain constant with body size for individuals spanning multiple ages. However, within an age class mass-specific energy increases with body size. We present empirical data from bull trout (*Salvelinus confluentus*) that support this prediction. At the population level, the model predicts population cycles can arise from two different mechanisms, variability in overwinter survival of the youngest age class or variability in age- and size-at-maturity for adults. Variability in overwinter survival produces large amplitude population cycles characterized by the dominance of a few year classes and recruitment failure. In contrast, variability in growth produces lower amplitude population cycles without recruitment failure. Empirical data from two bull trout populations support the presence of population cycles and suggest cycles arise from a combination of growth suppression and year-class dominance. Finally, the presence of population cycles and the mechanisms by which they arise have important implications to the management of threatened species. [Sat AM2]

- **INFLUENCE OF FOOD WEB STRUCTURE ON THE BIOENERGETICS OF LAKE TROUT**

Pazzia, I.¹, M. Trudel², M. Ridgway³, and J.B. Rasmussen¹. ¹McGill University, Department of Biology, Montreal, QC, ²Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC. ³Aquatic Ecosystem Science Section, Ontario Ministry of Natural Resources, Peterborough, ON

Most fish species tend to feed on larger prey as their size increases. The lack of suitable prey during critical periods of their life can prevent them from shifting their diet to larger prey and also to reaching larger size. In this study, we compared the energy budget of lake trout (*Salvelinus namaycush*) populations with contrasting food webs. Non-piscivorous lake trout (NPLT) populations reached a much smaller size and grew at a much slower rate than piscivorous lake trout (PLT) populations. Food consumption rates were, on average, 2-3 times higher in NPLT when they were expressed on a gram wet basis. However, no significant difference in their energy intake was detected once consumption rates were corrected for differences in prey caloric content. Growth efficiency was about two times lower in NPLT compared to PLT, while their metabolic cost were higher. It is most likely that the increased metabolic costs were associate with higher foraging costs, since more feeding attempts must be made to acquire a given quantity of food when fish are feeding on smaller prey. These results are consistent with theoretical models of fish growth that have showed that lake trout must have access to larger prey, even if they are rare, to reach larger size. [Sat PM1]

- **EXPLORING THE MORPHOLOGICAL AND PHYLOGENETIC DIVERSIFICATION OF FISHES IN THE EASTERN BRAZILIAN STREAMS: A COMPARATIVE STUDY.**

Peres-Neto, P.R.¹, C.R.S.F. Bizerril², and D.A. Jackson¹. ¹Department of Zoology, University of Toronto, Toronto, ON, ²Department of Biology, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil.

The eastern Brazilian region presents the highest number of small streams and endemic taxa in South America, encompassing 285 species, of which 95% are endemic to this area. The hypotheses for the origin of the fauna are not conclusive. Both vicariance and dispersion seem to be relevant, and the fauna is mainly related to the Parana and São Francisco basins; the Amazon system contributes only a small number of taxa. Although the fauna in the area is highly diverse, environmental and morphological variation is limited, indicating that this region represents very selective environments to their fauna. In this study we contrast the morphological diversification, habitat use and phylogenetic relationships at the genus level for the eastern Brazilian fish fauna. In order to assess whether the morphological variation in this fish fauna is related more to historical components or to local adaptations, the phenotypic variation is partitioned into a phylogenetically heritable component and a residual component due to nonadditive phylogenetic and environmental effects. [**Fri PM2**]

- **A COMPARISON OF FOUR AGING TECHNIQUES FOR AGING THE BROOK TROUT, *Salvelinus fontinalis*, IN NEWFOUNDLAND**

Perry, R., and D. Keefe. Department of Forest Resources and Agrifoods, Inland Fish and Wildlife Division, Newfoundland and Labrador

In the province of Newfoundland both environmental consultants and government agencies still use scales as the calcified structure of choice for aging the principle game fish, brook trout, *Salvelinus fontinalis*. The use of scales has persisted due to their ease of collection and sampling of this structure is non-lethal to the fish. Recent work done by the Provincial Inland Fish and Wildlife Division indicates that the use of scales may be questionable; scales of brook trout may begin to fail as early as age two. Precision and relative accuracy of estimate ages from scales, whole and sectioned otoliths, and the new technique of acetate replication were measured in replicate trials on samples from brook trout, taken from interior Newfoundland. Using the four methods to age all sampled fish we compare the mean age to determine if bias exists. We compare and contrast the four techniques, using an Index of Precision to determine which technique gives the greatest precision. [**Poster**]

- **POTENTIAL GENETIC BENEFITS OF MATE SELECTION IN CHINOOK SALMON (*Oncorhynchus tshawytscha*)**

Pitcher, T.E.^{1,2}, A. Rubaszek², and Glenn Anderson². ¹Department of Zoology, University of Toronto, ²Parkview Hatchery, Markham, ON

Every year, millions of salmon and other fish are caught during the breeding season and stripped for artificial breeding purposes. After some time in captivity, the progeny produced are then released into natural watersheds in an attempt to support natural populations. These juveniles are derived from adults that did not choose each other, while in nature, mating is anything but random. Many breeding programs, including captive breeding programs for the rehabilitation of

endangered species, often neglect the potential benefits of natural mating dynamics, despite the fact that empirical studies and evolutionary theory demonstrate and predict, respectively, that mate choice enhances the viability and survival chances of offspring by selecting for "good-genes" or "compatible genes". To test whether mate choice can offer good-genes or compatible genes benefits, we crossed ten female and ten male Chinook salmon in a fully factorial breeding design, and reared the resulting 100 sib groups in replicates under controlled conditions. We then examined (among others) male and female morphology, levels of infertility, embryonic death rates, survival, and offspring mass in order to test the predictions of the good-genes and compatible genes hypotheses. [[Poster](#)]

- **USING MODELS AND DATA TO ASSESS ALTERNATE MANAGEMENT STRATEGIES FOR SUSTAINING RECREATIONAL FISHERIES**

Post, J.R.¹, C. Mushens¹, A. Paul¹, and M. Sullivan². ¹Division of Ecology, Department of Biological Sciences, University of Calgary, Calgary, AB, ²Natural Resources Service, Fish and Wildlife Division, Alberta Environment, Edmonton, AB

Regulations designed to protect recreational fisheries from overexploitation can fail. Regulations such as size and bag limits restrict harvest by individual anglers but not total harvest. A combination of hooking mortality and inadvertent and intentional non-compliance with regulations leads to fishing mortality that may not be sustainable if angling effort is sufficiently high. A size and age-structured model was developed to predict sustainable rates of exploitation in recreational fisheries under a variety of common regulations. As an example the model was applied to a bull trout fishery on in Lower Kananaskis Lake, Alberta which at the beginning of the 1990s was driven to a collapse of <50 adults by angling. The model predicts that a 40 cm minimum size limit would maintain viable populations at an annual effort up to 4 angler hours ha⁻¹, a 65 cm minimum size limit up to 10 angler hours ha⁻¹ and a complete catch and release fishery up to 18 angler hours ha⁻¹. The quality of the fisheries developed using these three alternate regulations as measured by catch, harvest, catch-per-unit effort and mean size in the creel varies substantially with the level of angler effort imposed. Uncertainty in catchability, hooking mortality rates and non-compliance rates would modify these predictions quantitatively but the qualitative predictions remain the same. If anglers respond dynamically to variation in the quality of fishing then the ability of size limit regulations to sustain fisheries is further compromised. The combination of life history and fishery traits such as slow growth, late age-at-maturity, low fecundity, longevity and high catchability render adfluvial bull trout susceptible to overfishing within relatively narrow bounds of angler effort. [[Sat AM1](#)]

- **THE INFLUENCE OF PREDATION RISK ON THE OVERWINTER MORTALITY AND ENERGETIC RELATIONSHIPS OF YOUNG-OF-THE-YEAR WALLEYE**

Pratt, T.C.¹, and M.G. Fox². ¹Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON, ²Environmental and Resource Studies Program and Department of Biology, Trent University

We investigated the role of body size and predation on the overwinter survival and energy reserves of young-of-the-year (YOY) walleye (*Stizostedion vitreum*). Walleye were reared in outdoor hatchery ponds in Westport, Ontario, for three overwinter periods (1997-98, 1998-99, 1999-2000) with prey and either predators (burbot or adult walleye) or no predators. We predicted that (1) smaller individuals of a YOY walleye cohort would have lower pre-winter energy levels, and would deplete them at a higher rate; (2) there would not be size-dependent overwinter survival in predator-free ponds, and (3) for YOY walleye reared with predators, physiological stress, in combination with size-selective predation on the smaller individuals, would lead to size-dependent overwinter mortality. Prediction 1 was not supported by lipid, protein, and specific energy content data, as no size-dependent energetic relationships were detected, and unexpectedly, smaller walleye gained more weight than larger walleye in the absence of predation risk. Prediction 2 was supported, while prediction 3 was not, as there was no size-dependent mortality on walleye reared with or without potential predators. YOY walleye reared in the presence of predators had significantly lower lipid and specific energy levels, and lost significantly more weight, than their predator-free counterparts. The absence of size-dependent metabolic costs and large pre-winter size in this species suggests that size-dependent overwinter mortality is uncommon in most walleye populations. [Sat PM1]

- **PERFORMANCE OF TWO FORMS OF LACUSTRINE BROOK CHARR, *Salvelinus fontinalis*, IN THE PELAGIC ZONE**

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

Interindividual variations in physiological performances are useful to assess the efficiency of nutrient transfer from food to fish but are poorly studied in fish polymorphism. Brook charr, *Salvelinus fontinalis*, exhibit a trophic polymorphism in lakes of the Canadian Shield. Some individuals are specialists better adapted to feeding in the littoral zone whereas others are specialists better adapted to feeding in the pelagic zone. The objective of the present study was to compare growth, lipids, proteins, and water content in the muscle of littoral and pelagic individuals when constrained to feeding on zooplankton of the pelagic zone. Forty individuals of each form were put in eight enclosures (3m x 4m x 2m deep; 6 mm mesh size) anchored in the pelagic zone of the lake for 76 days. These enclosures allowed water and zooplankton to circulate freely and zooplankton was the only available food. The proximate composition of fish was determined using standard procedures. Eleven ecomorphological descriptors were measured to assess relationships between form and function. Discriminant function analyses showed significant differences in morphology and biochemical composition between the two forms: pelagic individuals had higher protein concentration in their muscle and shorter pectoral fin than littoral ones. Possible differences in thermal preferendum, oxygen consumption, digestion, and swimming efficiency might explain the observed differences in the performance of pelagic and littoral individuals. Morphological and physiological plasticity might have occurred at different degree in enclosures. Data did not allow us to conclude whether differences were related to food acquisition and digestion or linked to the balance between protein breakdown and deposition in fish muscle. [Poster]

- **LIFE HISTORY VARIATION IN ONTARIO YELLOW PERCH (*Perca flavescens*)**

Purchase, C.F.¹, B.A. Henderson², and N.C. Collins¹. ¹Department of Zoology, University of Toronto at Mississauga, Mississauga, ON, ²Lake Huron Research Unit, Ontario Ministry of Natural Resources, Owen Sound, ON

As a lead-in to a larger scale survey, perch were obtained as by-catch from standardized OMNR fall walleye gill-netting surveys from 1994-99, including about 100 lakes. Length and weight were recorded for most of the fish captured (n=7067), and age was determined in lakes where perch were abundant. Small sample sizes currently limit analyses of some life history traits to < 20 lakes for yellow perch. Average catch per 2 hour daytime net set varied from 0.17 to 70.65 perch among the lakes where perch were present. Secchi depth (range 0.3 - 8.0 m) was not associated with size of fish at ages 0 to 4. Size at the end of the second summer of growth (age 1) was positively associated with average growing degree-days (range 1200 - 2068 GDD >5°C), but not for older age classes. Lake surface area (range 47.2 - >10,000 ha) was unrelated to size at age one, but positively correlated with size at ages 2 - 4, especially in lakes larger than 1000 hectares. Possible causes and implications of these relationships are discussed. [Sat AM1]

- **THE EFFECTIVENESS OF ISOLATED (DRY) PIPELINE WATER CROSSING TECHNIQUES TO MITIGATE SEDIMENT IMPACTS ON BROOK TROUT (*Salvelinus fontinalis*) STREAMS**

Reid, S.M.¹, S. Stoklosar¹, S. Metikosh¹, and J. Evans². ¹Golder Associates Ltd., Calgary, AB, ²Gas Research Institute, Chicago, IL.

It has been well documented that stream populations of brook trout are sensitive to sediment caused changes to habitat. In theory, isolated (dry) pipeline water crossing techniques (dam and pump and flume methods) minimize the amount of sediment released into watercourses by diverting flow around the construction site. However, few case studies have evaluated their effectiveness to mitigate the adverse effects of instream construction activities. We measured downstream suspended sediment concentrations during the construction of six isolated pipeline water crossings of brook trout streams in Minnesota, Nova Scotia and Ontario. In addition, sediment deposition rates, riffle habitats and fish abundance were monitored upstream and downstream of four of the crossings. Results of our monitoring studies indicate that isolated techniques can be very effective at: (1) minimizing increases to downstream suspended sediment concentrations during instream construction and, (2) preventing sediment caused effects on habitat and fish abundance documented downstream of past open-cut pipeline water crossings. For sensitive watercourses, isolated crossing techniques should be considered as an effective alternative to trenchless crossing techniques (e.g. Horizontal Directional Drilling). [Sat PM2]

- **OPTIMAL FORAGING IN JUVENILE SALMON UNDER PREDATION RISK: HOW ADDING BIOLOGICAL REALISM CHANGES A DYNAMIC FORAGING MODEL**

Reinhardt, U. Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197

The "Asset-Protection Principle" is based on a dynamic programming model and states that individuals should become more averse to predation risk as they accumulate fitness assets and as

the foraging season progresses. To test whether these predictions hold under biologically meaningful foraging parameters, I constructed a dynamic model of the optimal trade-off between foraging and predator avoidance in juvenile salmon. The model incorporates temperature and body-size dependent bio-energetic constraints typical for juvenile fish, which grow by orders of magnitude over a season. In its simplest form using seasonally constant growth potential and a linear over-winter survival function, my results equal those of an earlier published model. Adding a fitness function and environmental data from field studies accentuates the Asset-Protection effect and fundamentally changes the seasonal pattern of optimal effort. Simulation of typical poor feeding conditions in mid-summer yields the prediction of increased foraging in the spring in anticipation of worsening conditions. Increasing overall predation risk results in smaller fish at the end of the season with a trade-off between summer and winter survival. The model generates testable predictions for juvenile salmon and provides insights for other organisms subject to size-dependent or seasonally changing foraging dynamics. [[Poster](#)]

- **TESTING FOR PATERNAL EFFECTS ON EARLY LIFE HISTORY SUCCESS IN GEORGES BANK HADDOCK, *Melanogrammus aeglefinus***

Rideout, R.M.¹, M.K. Litvak¹, and E.A. Trippel². ¹University of New Brunswick, Saint John, NB, ²Biological Station, Department of Fisheries and Oceans, St. Andrews, NB

Maternal traits have been shown to have significant effects on the performance and survival of offspring through the early life stages of various marine teleosts. The possibility of the same type of effects due to paternity have not been thoroughly explored. The present study is a preliminary examination into the possible effects of paternity on morphology and survival through the yolk-sac larval stage for haddock, *Melanogrammus aeglefinus*, from Georges Bank. Eggs were manually stripped from two female haddock and fertilized with sperm from a series of males. Periodically, various body measurements were recorded on randomly selected larvae from each cross using a calibrated image analysis system. Results show a fast yolk-utilization rate for this species up until day 5 post-hatching, when most yolk had been utilized. Paternity appeared to contribute to various early life history traits, including hatching success and size at hatching. Time to starvation and differences in morphology during the yolk-sac larval stage are discussed with respect to family survivorship and haddock year class strength. [[Fri PM1](#)]

- **SPATIAL ECOLOGY AND DENSITY-DEPENDENT PROCESSES IN SMALLMOUTH BASS**

Ridgway, M., and B. Shuter. Harkness Laboratory of Fisheries Research, Aquatic Ecosystems Science Section, OMNR, Peterborough, ON

A long-term study of a northern smallmouth bass population has revealed little or no density-dependent effects during the parental care period. Nesting habitat is not a limiting resource for adult males. Despite these findings, there is a negative density-dependent relationship between the number of nesting males and the total male population. The long-term data also reveal density-dependent growth for 2-4 year old juveniles. This set of observations, along with data on the spatial movements and home range of young-of-year juveniles and adults, appears to link the life-history of bass to their spatial ecology. The key process appears to be a shift from

movements of juvenile bass to the acquisition of adult home ranges. This is the juvenile transition hypothesis. A brief discussion of the similarities between our hypothesis and the field work of Elliott on brown trout will be outlined. We conclude with an appeal for field-based behavioural ecologists to focus on movements, diffusion processes or other mechanisms that determine the spatial distribution of fish. [**Sat AM2**]

- **DEMOGRAPHIC ISSUES IN THE CONSERVATION OF STURGEON**

Robertson, C.T., and M.R. Gross. Department of Zoology, University of Toronto, Ontario.

Sturgeon populations have collapsed worldwide. Twenty-five of 27 species are classified as endangered, vulnerable or threatened, but limited understanding of demography is hindering conservation efforts. Our laboratory is investigating the demographic issues that arise from long lifespan, delayed maturity, intermittent spawning, and high fecundity. We recently developed matrix projection models for three sturgeon species that quantified population-level responses to perturbations in survivorship and fecundity at each age. We found that sturgeon have an 'elasticity profile' characterized by equally high survivorship elasticity across juvenile years and rapidly declining elasticity with each year after maturity. Unlike other modeled species, larval survivorship has no greater impact on population growth than other juvenile years, and the impacts of fecundity are negligible. These models challenge current conservation efforts focused on older adults. We are now studying the elasticity of two sturgeon systems on opposite demographic trajectories. Recent growth in the Hudson River shortnose sturgeon population may prompt its removal from the US Endangered Species Act, but low recruitment raises questions about population sustainability. Conversely, Caspian Sea sturgeon populations continue to decline, and current aquaculture practices may not be enough to prevent extinction. Collaborators include: M. Bain (Cornell), J. Repka (Toronto) and D. Secor (Maryland). [**Poster**]

- **EVIDENCE FOR SPAWNING SITE FIDELITY OF ATLANTIC COD FROM AN ACOUSTIC TAGGING STUDY**

Robichaud, D., and G. A. Rose. Fisheries Conservation, Memorial University of Newfoundland, St. John's, NF

That stock differences are recognizable within marine fish species implies that most adults exhibit fidelity to a spawning group. This can be achieved either through fidelity to the natal site (philopatry or homing) or to a spawning site that is adopted at maturity. Conventional tagging studies cannot determine the degree of site-fidelity exhibited by individuals because only a single release and recapture location are determined. Individually-coded acoustic tags were surgically implanted into 48 adult cod (21 male, 27 female) at one of the known spawning grounds in Placentia Bay, Newfoundland in April, 1998. Using a grid of listening stations, the distribution of tagged fish was monitored for three consecutive spawning seasons (1998-2000). 24 fish were relocated in the first year, 10 in second year, and 7 in the third, of which 43% were recovered in all three years. No fish were ever recovered in other parts of the bay, or at any of the other known spawning grounds. Recapture rates, adjusted for interannual variation in effort, and by the proportion of tags returned in the fishery, were very similar between the years. The adjusted recapture rate for the second year was 92.8% of that expected. That of third year was even

higher. This study provides direct evidence that some fish exhibit strong spawning-site fidelity, the proportion doing so, we argue, is astounding. Measuring the extent of site fidelity in cod is important when more than one stock occupies a management division, and when predicting the rate of repopulation of offshore regions. [Sat AM2]

- **A POSSIBLE NON-SEXUAL ORIGIN OF A MATE PREFERENCE: ARE MALE GUPPIES MIMICKING FRUIT?**

Rodd, H.¹, K. Hughes², G. Grether³ and C. Baril¹. ¹Dept. of Zoology, University of Toronto; ²Arizona State University West Campus; ³University of California at Los Angeles.

In theory, mate preferences can evolve through many different processes, some of which have nothing to do with finding a suitable mate. Most female guppies (*Poecilia reticulata*) show a preference for males with larger and more chromatic orange spots. The orange spots contain carotenoid pigments which must be obtained from the diet and are thought to be indicators of foraging ability and health. The leading hypothesis has been that the preference for carotenoid coloration evolved because it enabled females to obtain higher quality mates. Alternatively, the preference may have evolved as a side-effect of selection in some other context, such as food detection (orange food items do occur in the diet of wild guppies). We observed, in the field, that guppies of both sexes approached and nibbled discs painted orange more frequently than discs of other colors, and that populations varied in the strength of attraction to orange discs. Using laboratory-reared fish, we found that variation in attraction to orange discs explained most of the divergence among populations in the strength of female mate preference for carotenoid coloration. Thus, this mate preference may have evolved primarily originally in a foraging context. [Poster]

- **DETECTING ENVIRONMENTAL FILTERS IN COMMUNITY ECOLOGY: A QUANTITATIVE APPROACH**

Rodríguez, M.A. Département de chimie-biologie, Université du Québec à Trois-Rivières, QC

Identifying organismal traits which determine whether a species from the regional pool is included in a local community is major step toward understanding how environmental filters operate. Most studies of animal communities have relied on indirect means to establish which traits impinge upon distribution and abundance patterns. A quantitative procedure is proposed here that quantifies how single traits or combinations of traits influence species abundances in different environments. The procedure links a matrix of correlations between species abundances and trait values to a matrix of environmental variables by means of a linear canonical technique, such as redundancy analysis. The resulting ordination diagram allows one to visualize readily how the influence of specific traits changes along environmental gradients. An analysis of fish communities in floodplain lakes of the Orinoco floodplain, Venezuela, is presented to demonstrate the procedure. In addition to reproducing the major patterns of species-environment relationships established in earlier studies of these communities, the analysis uncovered environmental effects not detected previously. [Fri PM1]

- **FITNESS CONSEQUENCES OF HABITAT USE FOR JUVENILE CUTTHROAT TROUT: ENERGETIC COSTS AND BENEFITS IN POOLS AND RIFFLES**

Rosenfeld, J.S.¹, and S. Boss². ¹Fisheries Research, Province of British Columbia, Vancouver, BC, ²Department of Forest Sciences, University of British Columbia

In order to assess freshwater habitat requirements of juvenile anadromous cutthroat trout, we measured habitat preference and growth rates of young-of-the-year (yoy) and 1-2 year old fish confined to either pools or riffles. Habitat preference experiments indicate that yoy cutthroat trout prefer pools to riffles, despite normally occurring at lower ambient densities in pools. Growth experiments demonstrate that yoy fish grow in both pools and riffles, although growth rates were higher in pools. Larger juvenile trout grew on average in pools but consistently lost weight in riffles, indicating that pools are a habitat preference for yoy trout but a requirement for larger fish. A bioenergetic cost/benefit analysis (based on swimming costs and energy intake from invertebrate drift) indicates that energetics alone is sufficient to account for avoidance of riffles by larger trout, without having to invoke greater predation risk in shallow habitats. Energetics modelling demonstrates that the smaller size and energetic needs of yoy allows exploitation of habitats (e.g. pocket-pools in riffles) that are unavailable to larger fish. [Sat PM2]

THE MATING SYSTEM OF ATLANTIC COD

Rowe, S. Department of Biology, Dalhousie University, Halifax, Nova Scotia

The patterns and processes by which females and males of a species form their sexual relationships is known as the mating system. Despite being of theoretical interest and practical importance, the mating system of Atlantic cod *Gadus morhua* is poorly known; to date, only two studies have documented cod spawning behaviour. As well as demonstrating complex mating patterns, these studies have suggested the occurrence of behavioural and acoustic displays by males, mate choice by females, and alternative reproductive strategies. However, there is no information on the selective causes and consequences of these behaviours, nor whether the mating system is monogamous, polygynous, polyandrous, or promiscuous. My research employs a quantitative approach to fully understand causes and consequences of variation in the mating system of Atlantic cod at the individual and population levels. I will incorporate both detailed experimental studies in a 600 m³ tank in the laboratory and observations of cod in the wild.

[Poster]

- **INNOVATIVE TECHNIQUES FOR STOCK DISCRIMINATION AND PRODUCTION ESTIMATION IN GREAT LAKES PERCID FISHERIES**

Sale, P.F.^{1,2}, B.J. Fryer^{1,3}, B. Dixon^{1,4}, T.B. Johnson⁵, T.C. Pratt^{1,2}, K.J. Hedges², and M.A. Latimer². ¹Great Lakes Institute for Environmental Research, University of Windsor, ²Department of Biological Sciences, University of Windsor, University of Windsor, ³Department of Earth Sciences, University of Windsor, ⁴Department of Biology, University of Waterloo, ⁵Ontario Ministry of Natural Resources, Lake Erie Research Station

Lake Erie's percid fishes are highly valued by sport and commercial fishermen. Future walleye and yellow perch management will benefit from greater understanding of the factors driving variable recruitment events. The broad objective of our research is to develop natural tags that will allow the geographic origin of individual fish to be determined, and to use this information to determine the relative importance of specific spawning sites for stock replenishment. In particular, we are examining whether molecular genetic and microchemical techniques are capable of discriminating walleye hatched from different spawning locations within the shoals and rivers of Lake Erie and Lake St. Clair. Preliminary genetic results using the MHC complex suggest walleye stocks can be discriminated between genetically isolated populations (Bay of Quinte, Lake Ontario vs Hen Island Shoal, Lake Erie). We are currently using the MHC complex to compare walleye stocks from within Lake Erie. Preliminary otolith microchemical analysis has shown significant differences in trace element concentrations between individual fish. Further research on identifying the natal signatures of fish from known geographic locations is ongoing. By using these innovative techniques, we hope to be able to establish the relative spawning success of walleye from different locations across years, and evaluate reproductive success against the concurrent fluctuations of abiotic and biotic parameters thought to influence walleye recruitment. [[Poster](#)]

- **THE EFFECT OF HABITAT COMPLEXITY ON THE ABUNDANCE OF JUVENILE ATLANTIC COD (*Gadus morhua*) USING ARTIFICIAL REEFS**

Sargent, P.S., R.S. Gregory and D.C. Schneider, Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NF

Juvenile Atlantic cod (*Gadus morhua*) associate with high complexity features in the wild. We manipulated substrate complexity using tire/rebar reefs to test how vertical relief and rugosity affects juvenile cod abundance. Four pairs of 80 m transect lines were deployed in Newman Sound, Newfoundland, (one per pair), at the 15 m depth contour. Cod abundance was measured during SCUBA surveys September - October 1999 and July - September 2000. Eighty-five percent of the juvenile cod were observed on reef transects. Cod abundance was positively correlated with rugosity and presence of reefs. Cod abundance declined with distance from the reef. In three paired day and night SCUBA surveys juvenile cod abundance was highest at night with no obvious preference for higher complexity. Our results suggest that artificial reefs would be effective in increasing local juvenile cod abundance. [[Poster](#)]

- **PRELIMINARY COMPARISONS OF CARDIAC FUNCTION IN SEVERAL FISH SPECIES**

Schreer, J.F.¹, S.J. Cooke², K.M. Dunmall¹, C.M. Bunt², and D.P. Philipp². ¹Department of Biology, University of Waterloo, Waterloo, ON, ²Department of Natural Resources and Environmental Sciences, University of Illinois and Center for Aquatic Ecology, Illinois Natural History Survey, Champaign, IL

In most animals, physical or chemical stressors elicit an increase in metabolic rate and consequently an increase in cardiac output and one or both of its components, heart rate and stroke volume. While mammals and birds primarily increase cardiac output through elevation of

heart rate, fish are generally thought to modulate cardiac output principally through changes in stroke volume. It has even been suggested that among vertebrates there is an evolutionary trend from volume-modulated to frequency-modulated cardiac output. Within the fishes, only the highly advanced tunas have been regarded as frequency modulators, likely due to their high performance lifestyle. In an effort to expand our comprehension of cardiac function in fishes, we have collected data from three common families (Salmonidae, Percidae, Centrarchidae) under various conditions. Our preliminary findings indicate that frequency modulation is more prevalent than previously reported especially among centrarchids. [[Poster](#)]

- **ESTIMATING THE IMPACT OF WAVE EXPOSURE ON FISH DENSITY IN THE NEARSHORE ZONE**

Seifried, K.E., and N.C. Collins, Department of Zoology, University of Toronto at Mississauga., Mississauga, ON

A recent study conducted by Brown (1998) indicated a negative relationship between fetch and fish transect counts within 2.5 m of the shoreline of Lake Joseph. The data were incorporated into a GIS-based model which revealed that average fetch, rather than maximum fetch or wind-weighted fetch was the best predictor of fish density. The model also showed that most of the impact of wave exposure on fish density requires only small average fetches (less than 0.2 km), therefore truly protected locations that are predicted to allow higher fish densities are rare in even medium-sized lakes. Preliminary analysis of a DFO dataset from Great Lakes locations, which used a different method for fish density assessment, showed a similar nonlinear relationship with fetch. [[Poster](#)]

- **AGE 0+ COD ABUNDANCE INCREASES WITH HABITAT COMPLEXITY**

Simmonds, N.J., D.S. Schneider, and R.S. Gregory. Memorial University of Newfoundland, Ocean Sciences Centre, St. John's, NF

Juvenile cod (*Gadus* spp.) are distributed in shallow (<10 m) coastal waters, often in association with complex vegetative habitats, such as eelgrass (*Zostera marina*). Previous approaches have attempted to associate cod abundance and percent cover of habitat. However, these approaches often produce ambiguous results. We hypothesized that juvenile cod abundance increases with increases in habitat complexity. By using aerial photographs, we measured the area, perimeter, and perimeter: area ratio of habitat at 10 sites in Newman Sound, Newfoundland. These measurements were taken at 9 scales, giving us a scaling coefficient representing complexity of habitat at the site. Abundance measurements of age 0+ cod were then compared across sites of differing habitat complexity. Results indicate that juvenile cod abundance is correlated with the complexity, not the absolute amount, of habitat. [[Sat PM1](#)]

- **RAINBOW TROUT (*Oncorhynchus mykiss*): SAMPLED BY REPEATED CAUDLE PUNCTURE AND DORSAL AORTA CANNULATION**

Singer, T.D., G.N. Wagner, and R.S. McKinley. Waterloo Biotelemetry Institute, Department of Biology, University of Waterloo, Waterloo, ON

We investigated the effects clove oil and MS-222 had on the blood physiology of pre-spawning rainbow trout using two different sampling techniques. Other studies have demonstrated clove oil induces anaesthesia more rapidly while recovery times are extended compared to MS-222. Our studies confirmed these findings. In the first experiment we sampled each group of fish by repeated caudle puncture initially and at one of six time points up to 48 hours after treatment with anaesthetic. There were no significant differences with between the responses to the anaesthetics with the exception of the following parameters. Glucose at full anaesthesia, and lactate and sodium at full recovery were significantly raised in the clove oil treatment, while potassium levels at full recovery were significantly raised in the MS-222 treatment. Cortisol, glucose and lactate levels showed a typical stress response to both anaesthetics. Due to the significant increase of lactate at full recovery in the clove oil treatment we examined the blood oxygen partial pressure (PO₂) during exposure to clove oil and MS-222 in a second experiment. For the second experiment we sampled six fish for each anaesthetic using dorsal aorta cannulation and isolation boxes. We found blood PO₂ decreased significantly at full anaesthesia with the application of either anaesthetic. Contrary to our previous findings neither of the anaesthetics affected the glucose, cortisol, or lactate levels of the fish at any time point using dorsal aorta cannulation sampling. These findings will be discussed in light of the two sampling techniques. Our results do suggest clove oil should be considered an acceptable alternative to MS-222 for use as a fish anaesthetic. [Poster]

- **GROWTH RATE AND RECRUITMENT OF RAINBOW SMELT LARVAE, *Osmerus mordax*, IN LAC SAINT-JEAN**

Sirois, P.¹, and M. Legault². ¹Département des Sciences Fondamentales, Université du Québec a Chicoutimi, Chicoutimi, QC., ²Direction de la recherche sur la faune, Société de la faune et des parcs du Québec, Québec, QC

Rainbow smelt (*Osmerus mordax*) is the most important prey of landlocked Atlantic salmon (*Salmo salar*) in Lac Saint-Jean (Quebec, Canada). Interannual variations in the year-class strength of rainbow smelt have been identified to be a key factor affecting the production of landlocked Atlantic salmon. Fluctuations in the year-class strength of fish populations is recognised to be determined during the egg and larval stages. However, evidences of a link between events occurring during the early life history and recruitment are scarce, especially in freshwater. Our objective was to explore the link between larval growth and recruitment of rainbow smelt in Lac Saint-Jean. Annual surveys were conducted in early August in Lac Saint-Jean, from 1997 to 2000. Abundance of age-1 smelt was utilised as a measure of recruitment. Growth rate of young-of-the-year smelt was estimated by otolith microstructure examination. Preliminary results showed a 5-fold difference in recruitment between years. Analysis to come on the link between larval growth and recruitment may provide a promising tool to predict year-class strength fluctuations of smelt in Lac Saint-Jean from events occurring during the early life history. [Sat PM2]

- **METAPOPULATIONS IN COD: USING TAGGING DATA TO EMPIRICALLY CHALLENGE GENETIC STRUCTURE**

Smedbol, R.K.¹, C.T. Taggart¹, and R.L. Stephenson². ¹Department of Oceanography, Dalhousie University, Halifax, NS, ²Department of Fisheries and Oceans, Biological Station, St. Andrews, NB

A number of recent studies have reported the existence of genetic structure at various scales within the northern Atlantic cod (*Gadus morhua*) of Newfoundland and Labrador. We use mark-recapture data to develop an independent test of this structure. We assume that aggregations associated with the major offshore banks during the spawning season represent subcomponents of the northern cod stock complex. We use cod tagged offshore during the spawning season to determine: (1) the spatial distribution and degree of mixing of subpopulations inshore during the feeding season, and (2) the overlap (possible exchange of spawners) of offshore distributions during subsequent spawning seasons. Specifically, we estimate the proportional contributions of the offshore subpopulations to inshore areas during the summer. Using independent tagging experiments undertaken inshore during the feeding season, we then (3) test these estimates by determining the proportion of individuals that are recaptured on the various offshore spawning areas during the spawning season. Finally, in order to test the hypothesis that the genetic pattern should be correlated directly with offshore bank structure, we (4) determine the overlap among subpopulations of mean recapture location during spawning and compare this overlap to the published genetic distance (relative isolation) of subpopulations. We assume that the degree of overlap in recapture locations can serve as an index of the level of mixing between subpopulations. Thus, we expect the degree of overlap between two subpopulations to correlate negatively with the genetic distance (less overlap, greater genetic distance). [Sat AM2]

- **EFFECTS OF LIPID EXTRACTION ON THE STABLE ISOTOPE SIGNATURES (delta 13C and delta 15N) OF FISH: IMPLICATIONS FOR FOOD-WEB STUDIES**

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The use of stable isotopes in ecological research has advanced considerably in recent years, as have techniques for the analysis of stable isotopes. The current analytical technique is the use of continuous flow mass spectrometry, which measures both carbon and nitrogen isotopes from an individual sample. However, preparation techniques have not changed since earlier, single-isotope techniques were the norm. Common practice for carbon analysis includes acid washing and lipid extraction of the sample to remove inorganic carbon and reduce sample variability, respectively. However, preparation techniques developed for one element may have deleterious effects on other elements that are being analyzed simultaneously from the same sample, leading potentially to erroneous interpretation of ecological patterns. Our objective was to determine if lipid extraction would alter the stable isotope value of nitrogen in fish samples when using continuous flow mass spectrometry. Whole juvenile fathead minnows (*Pimephales promelas*), northern redbelly dace (*Phoxinus eos*), and brook stickleback (*Culaea inconstans*) and dorsal white muscle tissue from large fish were used in the analysis. For the latter, half the tissue from individual fish was dried and ground for analysis (no treatment) and the remaining muscle tissue was repeatedly exposed to a 1:1 chloroform:methanol solution (treatment), rinsed with distilled

water, and then dried and ground for analysis. Lipid extraction had a significant effect on the delta 15N values for all three species. Since delta 15N functions as a trophic level indicator, a 15N enrichment could effect the interpretation of the dietary composition/overlap of species, resulting in a misunderstanding of the structure and function of the system under study. Therefore, we suggest that lipid extraction be avoided during sample preparation unless samples are known to be highly variable in lipid content. [[Poster](#)]

- **ENERGY USE AND BEHAVIOUR OF UP-RIVER MIGRATING ADULT SALMON IN THE FRASER CANYON: ASSESSING THE EFFECTS OF RIVER FEATURES USING EMG TELEMETRY**

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Adult Pacific salmon (*Onchorhynchus* sp.) depend on energy reserves to complete their up-river spawning migrations. Little is known about how local river features such as flow patterns and bank characteristics affect salmon behaviour and consequently energy use during migration. In fall 1999, we used electromyogram (EMG) radio telemetry to describe activity levels and estimate energy use of 12 adult pink salmon (*O. gorbuscha*) during their up-river migration. Individuals were tracked continuously through a 7 km section of the Fraser Canyon. River reaches varied considerably in flow velocity and complexity, surface velocities ranged from 0.46 m/s to 2.08 m/s. In all reaches, fish tended to migrate in paths nearshore and seemed to use eddies and hydraulic features associated with boulders and river contours to facilitate passage. Both sex and river morphology affected energy use. Females had higher swimming activity levels than males and all fish increased their activity levels when river constrictions were encountered. In reaches with high velocity currents, average ground speeds (0.11m/s) were an order of magnitude lower than at sites with low velocity currents. In a previous study at the same sites, sockeye salmon demonstrated similar behaviours and energy use patterns to that exhibited by pink salmon. However, sockeye were not as impeded by high flows as were pink salmon, and sockeye were actively migrating during day and night whereas pink salmon were inactive at night. The relatively small body size of pink salmon may account for these interspecific differences in migration behaviour. [[Sat PM1](#)]

- **BIOLOGICAL REFERENCE POINTS FOR THE MANAGEMENT OF BAY QUINTE, LAKE ONTARIO WALLEYE**

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The walleye of the Bay of Quinte support important recreational, commercial, and aboriginal fisheries. The walleye population and fisheries declined since 1992 due to habitat and fish community change associated with oligotrophication. Harvest levels had been moderate but have not declined at the same rate as the walleye population and exploitation rate has increased. We used an age-structured computer model, calibrated to a 20-year time series of walleye population and fisheries survey information, to estimate total allowable catch (TAC). Two levels of exploitation were proposed, representing different trade-offs between risks to sustainability and

fisheries benefits. During 1977-1980, the adult walleye population was severely depressed but produced strong year-classes that led to recovery. Estimates of walleye spawning stock size during this depressed period were used to postulate a minimum spawning stock size. The minimum spawning stock size and exploitation rates were used to develop a conceptual model that provided a management framework to conserve and sustain the walleye population and fisheries. In the model, biological reference points were specified as a function of walleye population size. We provided a basis for determining annual TACs, defined a conservation limit, and a critical stock size at which we recommend the cessation of fishing. [[Sat AM1](#)]

- **IMPACT OF CLIMATE CHANGE ON RIVER WATER TEMPERATURES AND GROWTH OF JUVENILE ATLANTIC SALMON (*Salmo salar*)**

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Climate change in the Maritime Provinces is projected to result in a 2 to 6 °C increase in air temperature within the next 100 years. Higher air temperatures are expected to contribute to increased water temperatures, alterations in stream flow conditions, and ultimately reductions in available fish habitat. In the Miramichi River, New Brunswick, Atlantic salmon (*Salmo salar*) are located near the southern limit of its' distribution, making them sensitive to extreme environmental conditions. Recent increases in water temperature, approaching upper lethal limits may be adversely affecting growth of juvenile Atlantic salmon and reducing sea survival. This study used an existing database on air (1940-99) and water (1990-99) temperature to extend the water temperature time series from 1970-99. This data was used to examine the association between extreme hydrological conditions (high temperature and low flow) and size-at-age juvenile Atlantic salmon (1970-99) in the Miramichi Drainage Basin. Air temperatures in 1998 and 1999 were among the highest observed in the time series. Large deviations from monthly average temperatures were observed in the spring, fall and winter months of 1998 and 1999. Severity of drought conditions has increased in the Miramichi Drainage Basin, with lowest minimum summer and autumn discharges recorded in recent years. Mean annual fork length of small and large Atlantic salmon parr have decreased significantly (0.02 cm/year) since 1970 ($p < 0.006$). Mean fork length of small and large salmon parr are 5.5% and 6.5 % smaller, respectively, in 1999 than in 1970. This study will allow us to better understand the potential negative effects of climate change on important resources and provide guidance for the development of mitigative measures, such as the protection of cold water streams. [[Poster](#)]

- **TROPHIC POSITIONS AND MERCURY CONCENTRATIONS OF NATIVE FORAGE FISHES AND RAINBOW SMELT IN LAKES OF NORTHWESTERN ONTARIO**

Swanson, H.K.¹, T.A. Johnston¹, W.C. Leggett¹, R.A. Bodaly², R.R. Doucett³, and R.A. Cunjak³. ¹Fish Ecology Lab, Department of Biology, Queen's University, Kingston, ON, ²Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, MB, ³Department of Biology, University of New Brunswick, Fredericton, NB

Rainbow smelt are a recent invader to lakes of the Hudson Bay drainage in northwestern Ontario and have become a preferred forage species for the resident piscivorous fishes in many of these lakes. Previous research has suggested that rainbow smelt are more piscivorous and therefore feed at a higher trophic level than most native forage fish species. If so, they would be expected to accumulate higher concentrations of biomagnifying contaminants, such as mercury, than native forage species. We are testing these predictions by comparing trophic positions and mercury concentrations of rainbow smelt and native forage fishes in both the littoral and pelagic fish communities in a series of northwestern Ontario lakes. Trophic positions of the various species are being compared using stable C and N isotope ratios. Forage species are being examined in both smelt-invaded and non-invaded lakes to determine if smelt move into a trophic position that is unoccupied prior to their arrival or if they displace native forage species. These results will address key assumptions about how changes in the forage fish community may affect contaminant transfer to higher trophic levels. [Sat AM1]

- **REDUCING LIVE FOOD REQUIREMENTS FOR THE LARVICULTURE OF ATLANTIC COD (*Gadus morhua*): USING BEHAVIOURS TO COMPARE THE EFFECTS OF PREY DENSITY AND DURATION OF PREY AVAILABILITY**

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Larval Atlantic cod experience highly variable feeding conditions in the wild on both temporal and spatial scales, as well as with respect to quality and quantity of prey. The complexity, variability and inherent difficulty of modeling such systems has meant that there are few models available for larviculturalists, furthermore existing models may not apply to controlled systems. This work summarizes the results of a series of experiments, which focus on the effects of prey density and the duration of prey availability on growth, survival and behaviour of larval Atlantic cod. Larval cod were raised from hatch to 27 days in 30 litre glass aquaria with opaque black walls in a flow-through cold water marine system. In the first experiment, prey densities were set as high, medium or low (4000, 2000, and 500 rotifers/L) and varied over three ontogenetic periods defined by primary nutritional source (endogenous, switch from endogenous to exogenous, and exogenous). The results showed that prey density can be reduced during the early stages (1-5 days post hatch) of development without reducing growth or survival and with no quantitative effects on the five modal action patterns observed. This finding reconfirmed Hjort's 1914 "match-mismatch" hypothesis, in a laboratory setting. In the second set of experiments, the flow rates through the tanks were set at four levels (0.5, 2.0, 4.0 and 20 exchanges/day) which consequently modified the duration of prey availability. Higher flow rates resulted in an increased occurrence of foraging behaviours and prey captures in response to decreased duration of prey availability. However, the larvae were unable to increase their foraging rate sufficiently, resulting in decreasing growth, condition and survival with increasing flow rates. A component of this set of experiments included a treatment in which the flow rate was switched from 0.5 to 20 exchanges per day and vice versa. The larvae acclimated (increase in orient rate with increased flow and vice versa) to the new feeding conditions within 24 hours (two feeding periods) which implies that they are well adapted to the highly variable

environment in which they are evolving. These experiments demonstrate that it is possible to reduce the requirements for live food without compromising growth or survival. [Sat AM2]

- **REASSESSING THE STOCK IN THE STOCK-RECRUITMENT RELATIONSHIP: EFFECTS OF INTERANNUAL VARIATIONS IN THE STOCK QUALITY ON THE POPULATION FECUNDITY AND YEAR CLASS STRENGTH OF LAKE ERIE YELLOW PERCH (*Perca flavescens*)**

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The assumption that the spawning stock biomass is directly proportional to population fecundity may not be valid because of changes in age or size distributions and the associated size-related differences in fecundity, as well changes in the proportion of female fish actually maturing. In a model we used known interannual variations in body size, age distribution, and the proportion mature for yellow perch in western Lake Erie to investigate the potential influence of natural variation in each of these parameters on population fecundity. Natural variation in these 3 aspects of stock quality are not powerful enough to explain occasional appearance of huge year classes but they are sufficiently powerful to account for most of the more typical interannual variation in YCS between the strong year classes. Of the 3 aspects of stock quality assessed, among-year variation in size at age, with associated changes in fecundity was the most powerful determinant of variation in fecundity. Despite the model's ability to generate several-fold changes in fecundity, it could not explain more than 13% of the measured variation in 0+ CPUE for the period 1978-1990. Random errors in measurement of stock abundance or quality, or unmeasured variations in egg quality in the Lake Erie environment could potentially explain the low precision of the predictions. [Poster]

- **AN ENERGETIC ANALYSIS OF POLYMORPHISM IN LAKE WHITEFISH**

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Sympatric populations of dwarf and normal lake whitefish (*Coregonus clupeaformis*) commonly occur in north temperate and subarctic lakes. Dwarf lake whitefish (DLW) have a much lower growth, mature earlier, and have a shorter lifespan than normal lake whitefish (NLW). Furthermore, they are usually not found when cisco (*C. artedi*) are present, possibly due to competitive exclusion. In this study, we compared the energy budget of DLW, NLW, and cisco using food consumption rates estimated with mass balance models of chemical tracers. Our analysis showed that the energy budget of DLW and cisco were similar. DLW and cisco consumed on average 40-50 % more food than NLW. Growth efficiency of DLW and cisco were two to three times lower than NLW. These results suggest that DLW and cisco allocated a larger fraction of their energy budget to metabolism than NLW. Our analysis also suggests that the earlier maturation and shorter lifespan of DLW and cisco may be due to their higher metabolic rates. [Sat PM1]

On retrouve fréquemment des populations sympatriques de corégones nains (CNA) et normaux (*Coregonus clupeaformis*) dans les lacs tempérés et subarctiques. Les CNA ont une croissance plus faible, mûrent plus rapidement, et vivent moins longtemps que les corégones normaux (CNO). De plus, on ne les retrouve habituellement pas en présence de ciscos (*C. artedii*), possiblement due à la compétition. Dans cette étude, nous avons comparé le budget énergétique des CAN, CNO, et des ciscos à l'aide de taux de consommation estimés avec un bilan massique de traceurs chimiques. Nos analyses indiquent que le budget énergétique des CNA et des ciscos étaient similaires. Les CNA et les ciscos consommaient en moyenne 40-50 % plus de nourriture que les CNO. L'efficacité de croissance des CNA et des ciscos était deux à trois fois plus faible que celle des CNO. Ces résultats suggèrent que les CNA et les ciscos allouaient une plus grande proportion de leur budget énergétique au métabolisme que les CNO. Nos analyses suggèrent également que la maturation plus rapide et la courte longévité des CNA et des ciscos peuvent être attribuées à leurs demandes métaboliques plus élevées. [Sat PM1]

- **DIFFERENCES IN COMPETITIVE ABILITY AND MORTALITY RISK OF GROWTH-ENHANCED TRANSGENIC AND NON-TRANSGENIC SALMON**

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Coho salmon (*Oncorhynchus kisutch*) have been successfully genetically altered so that they produce growth hormone without regulation, allowing them to grow on average 11 times larger than control salmon after one year, with a maximum increase of 37 times. Accelerated growth seems to primarily be driven by increased appetites of the manipulated fish. If the transgenic salmon are to retain their growth advantage under natural conditions, we predict that they must also be more effective at competing for food than wild salmon, and willing to suffer higher mortality rates while foraging. These results may have important consequences should the transgenic salmon ever escape into native salmon populations. We tested this hypothesis with two experiments. The first measured the relative competitive ability of transgenic and control salmon using an unequal competitors ideal free distribution. Transgenic individuals were found to be superior at securing higher quality food resources. The second experiment examined mortality risk by providing transgenic and non-transgenic individuals with the option to feed in the presence of a predator. Data for this experiment is currently being analyzed and results will be presented at the conference. [Sat PM2]

- **SIZE SHIFTS OF CISCO (*Coregonus artedii*) OVER 40 YEARS OF SAMPLING IN LAKE OPEONGO: LINKS TO CHANGES OBSERVED IN THE INDIGENOUS LAKE TROUT POPULATION**

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A population of lake cisco (*Coregonus artedii*) introduced in 1948 to an oligotrophic lake in Algonquin Park was examined to determine if any changes had occurred in the size distribution over the course of 40 years of sampling using gill nets. Furthermore, changes in the size of maturity of the dominant predator (lake trout) was also examined to explore possible links

between the behaviors of these two populations. Lake trout data collected from a yearly creel survey indicates that the size at maturity for female lake trout rose from 41.5 cm in 1955 to 50.5 cm by the early 1960's and then decreased to reach 41.5 cm by 1990. From the collected evidence, the size of the lake cisco caught in gill net samples(0.75" mesh) collected between May 1st and July 31st of 1974 and 1999, changed from 15.0 cm to 10.4 cm($p < 0.0001$). Coincident with this change, size of lake cisco found in lake trout stomachs did not change from 1950 to 1980(15.9 cm) however, in the period of 1980 to 1994, the average size observed dropped to 13.3 cm. Preliminary research indicates no change in the weight-length relationship for cisco and no change in the scale diameter-length relationship for cisco during the period of the study. Future plans include investigating the causes of this size shift of the lake cisco as well as comparing ecosystems that underwent stocking during same time period. [[Poster](#)]

- **A NONINVASIVE TECHNIQUE FOR DETERMINING SEX OF LIVE NORTH AMERICAN STURGEONS**

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I have developed a technique to determine the sex of live adult sturgeons by examination of external morphology. We analyzed four North American sturgeon species: *A. fulvescens* (lake sturgeon), *A. oxyrinchus* (Atlantic sturgeon), *A. brevirostrum* (shortnose sturgeon) and *A. transmontanus* (white sturgeon). Males have a vent in the shape of a capital Y while females have an O - shaped vent. Accuracy was highest in live fish (82%), and significantly lower in dead fish (29%). Dead sturgeon usually have the rectum prolapsed via the cloaca so the vent and surrounding papillae are protruded, and thus the sexes are indistinguishable. [[Poster](#)]

- **SWIMMING KINEMATICS OF THE FLATFISH AMERICAN PLAICE**

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In the North Atlantic, several flatfish species are known to undertake vertical migrations away from the seafloor for the purpose of feeding, reproduction, or tidal-transport. Such excursions into the pelagic zone have raised interest regarding the adaptive value of different flatfish swimming strategies. In this study, we examined the swimming kinematics of steady cruising in American plaice (*Hippoglossoides platessoides*) under laboratory conditions. Measures of tail-beat frequency (f), tail-beat amplitude (A), and stride length were derived for fish (23 - 44 cm) swimming at 30 cm/s. Both f and A were dependent on fish length (L) according to $f = -0.034L + 2.512$ and $A = 0.190L - 1.010$ respectively. The swimming speeds achieved for given tail beat frequencies and the corresponding stride lengths were comparable to those of pelagic fishes, suggesting that this species is well adapted for pelagic swimming activity. [[Sat PM2](#)]

- **BREEDING PROTOCOLS FOR HATCHERIES AND FISH CONSERVATION**

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A long-term goal of our laboratory is to identify and clarify the scientific criteria for successful conservation hatcheries, and to develop a superior breeding protocol for these and other captive breeding programs. Our present research addresses the potential benefits of incorporating mate choice into breeding protocols. Current breeding programs involve an artificial choice of breeding pairs, and are designed to maintain genetic diversity at both the individual and population level, to minimize the effects of inbreeding depression, and to maximize long-term evolutionary potential, respectively. This approach neglects the potential benefits of natural mate choice for 'good genes' and 'compatible genes', which are important for maintaining adaptation, genetic diversity and population productivity. Therefore we are initiating a breeding study using guppies as a model organism to compare three protocols: (1) mean kinship, (2) random pairing, and (3) mate choice. The progeny produced from each line will be raised to adulthood, and measures of fitness and genetic diversity will be carried out to evaluate both population productivity and genetic quality. After several generations, progeny from each line will be reintroduced into sectioned areas of their Trinidadian home stream, in order to estimate the effect on fitness from alternative breeding protocols. [[Poster](#)]

- **SPATIAL ECOLOGY AND HABITAT USE BY BROOK TROUT (*Salvelinus fontinalis*) IN GYPSY BILL CREEK, A SMALL PRECAMBRIAN SHIELD STREAM IN SOUTH-CENTRAL ONTARIO**

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The objective of the study was to describe brook trout distribution and habitat use in a small headwater catchment in a rapidly urbanizing area in south central Ontario, and to evaluate the possible impact of landuse activities. Gypsy Bill Creek, comprised of 5 discrete branches drains a 10 km² catchment and empties into Fairy Lake near Huntsville, Ontario. The stream is approximately 4.5 km long with a median bankfull width of 1.52 m and an average depth of 0.13 m in the first order reach and a median bankfull width of 2.45 m and an average depth of 0.34 m where the stream empties into Fairy Lake. The stream is subject to multiple land use influences and stressors including: road crossings, culverts, urban development, and aggregate extraction. Stream surveys were conducted in summer 1999, summer 2000, and fall 2000 in 8 locations on the stream and its tributaries. Backpack electrofishing was used to sample fish on a total of 545 m of stream. Channel morphology was assessed using the Ontario Stream Assessment Protocol.

The stream had a significant input of ground water, temperatures varying from 7°C-25°C (during July and August). A total of 266 brook trout were captured. Densities varied from 0.014-1.41 fish per m² among the five tributaries. Distribution of brook trout year classes varied longitudinally along the stream, YOY being most abundant in the upper reaches. The median weight for brook trout in the upper reaches was 1.6 g and in the lower reaches was 33.5 g. Our findings indicate the potential significance of small unmapped tributaries on the Precambrian shield as critical nursery habitats for brook trout populations. We discuss the high risk of leaving such resources unidentified and unprotected. [[Poster](#)]

- GENETIC DIVERSITY AND SURVIVAL IN CHINOOK SALMON (*Oncorhynchus tshawytscha*) JACKS: IMPLICATIONS FOR MANAGEMENT AND CONSERVATION

Young, B. and D.D. Heath. Department of Biology and the Great Lakes Institute for Environmental Research, University of Windsor, Windsor , ON

Chinook salmon (*Oncorhynchus tshawytscha*) employ an alternative life history strategy, which consists of larger "hooknose" males who fight amongst themselves for access to fertilize the female's eggs; in addition to smaller precociously mature "jacks" who sneak fertilizations. Jacks occur both in natural and cultured chinook stocks and are considered detrimental to salmon farms and sports fishermen alike as a result of their small size and undesirable secondary characteristics. The traditional paradigm views the hooknose as the "normal" phenotype, and the jacks as a less fit, secondary phenotype. We tested the paradigm via an investigation into the relationship between the jack phenotype and survival, as well as genetic diversity. The expectation based on the traditional paradigm would be for jacks to have no consistent advantage over hooknose males in either survival or genetic diversity. We estimated genetic diversity (microsatellite and minisatellite) in jacks and non-jack males from three cohorts of chinook salmon. We determined survival rates for offspring of jack sired families vs. non-jack sired families in two of those cohorts. Preliminary results indicate that jacks show no evidence of lower fitness, relative to the hooknose males. The potential genetic contribution from jacks within natural and cultured stocks of chinook salmon will be discussed. [[Poster](#)]