

Canadian Conference for Fisheries Research (CCFFR) and annual meeting with Canadian Society of Limnologists (SCL)

**Conférence canadienne de la recherche sur les pêches (CCRP)
et assemblée annuelle de la Société Canadienne des Limnologues (SCL)**

**2002 Annual Meeting/Réunion annuelle
3-5 January/janvier 2002
Empire Landmark Hotel, Vancouver, British Columbia**

PRINTED ABSTRACTS WILL NOT BE AVAILABLE AT THE CONFERENCE (use these)

Adams B.K. and J.A. Hutchings

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Anadromous And Non-Anadromous Life History Strategies In Atlantic Salmon (*Salmo salar*)

Fishes of the family Salmonidae often exhibit alternative life history strategies within and among populations. Many populations of Atlantic salmon (*Salmo salar*) in Northeastern North America have both an anadromous and non-anadromous component. Microsatellite genetic markers, estimates of life history variation, and experiments examining reproductive success and behaviour were employed in an attempt to define the genetic, life history, and behavioural factors that may affect an Atlantic salmon's life history strategy. Preliminary results indicate no genetic differences between life history forms, suggesting that the individual choice of life history strategy may be conditional. .

[FRI. 15:40]

Adams, Julie and Pierre Magnan

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Thermal Preferences Of Two Forms Of Brook Trout, *Salvelinus fontinalis*

Brook trout, *Salvelinus fontinalis*, inhabiting oligotrophic lakes of the Canadian Shield exhibit trophic polymorphism, where some individuals are better adapted to feeding in the littoral zone and others are specialists at feeding in the pelagic zone. Individual differences in habitat preference are also related to functional differences in body morphology: littoral individuals have a stout body shape and long pectoral fins while pelagic individuals have a fusiform body shape and short pectoral fins. Recent work has shown that littoral individuals exhibited higher thermal preferences than pelagic ones when maintained in thermally stratified pelagic enclosures in the field. The objective of the present study was to compare the final thermal preference of littoral and pelagic brook trout in the laboratory. We raised littoral and pelagic strains from eggs to juvenile (1+) stages in similar conditions and estimated their final thermal preference in a horizontal gradient. We found no significant difference between the final thermal preference of littoral (11.5 °C) and pelagic (11.9 °C) brook trout ($p > 0.05$) when considering only the form (with acclimation temperature as covariable) in statistical analyses. However, a multiple regression analyses considering acclimation temperature, morphological characteristics, and sex of all individuals (as independent variables) and selected temperature (as the dependent variable) showed that 11% of the variation in selected temperature was explained by body width ($t = 2.822$; $p < 0.006$): individuals with large body width (characteristic of littoral individuals) selected higher temperatures. These results suggest that the final thermal preference could be in part related to trophic polymorphism in brook trout.

[POSTER]

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A Decision Analysis Of Adaptive Management Experiments For Whitefish Management In The Columbia River: Is It Worth Varying Flows To Reduce Key Uncertainties?

We developed a decision analysis and adaptive management model for mountain whitefish ([Prosopium williamsoni](#)) downstream of the Hugh Keenleyside Dam (HKD) on the Columbia River that explicitly accounts for uncertainties in (i) the stock-recruitment relationship, (ii) spawning (January) and incubation (March) flows in the Columbia and Kootenay Rivers, and (iii) foregone power revenues. The decision dealt with the benefits and costs of different spawning flows below the HKD because post-spawning flows often produce de-watering mortality of mountain whitefish eggs. We used Monte Carlo simulation for alternative experimental HKD flow operations and mark-recapture population abundance surveys to evaluate the value of collecting information on the egg-to-adult recruitment. With equal weighting on a wide range of alternative recruitment curves, the optimal HKD spawning flow was 55 kcfs. Adaptive management results revealed that active adaptive flow experiments that generated stronger contrast in flows were superior to passive (low contrast flow) experiments over a wide range of assumptions. With adaptive management, the optimal flow could increase up to 80 kcfs if the population turned out to be insensitive to egg mortality. Under this assumption, active adaptive management experiments were able to "pay for themselves" within 10 years. However, if the population turned out to be sensitive to egg mortality, adaptive management revealed the larger biological risks but the optimal flow remained unchanged from 55 kcfs. We also showed that experiments that only "look inward" on the treatment system have relatively low statistical power, highlighting the importance of simultaneously conducting monitoring on populations in reference systems. [\[SAT. 13:20\]](#)

Alfonso, Noel R. and Brian W. Coad.

Canadian Museum of Nature, ♦ P.O. Box 3443, Station 'D', Ottawa, ON K1P 6P4

DONALD EVAN McALLISTER ♦ 23 AUGUST 1934 - 17 JUNE 2001

Don McAllister was born in Victoria, British Columbia and received his degrees at the University of British Columbia (UBC) in Vancouver. His M.A. (1957) on sculpins was under Casimir C. Lindsey and his Ph.D. (1964) was under J. C. Briggs and R. H. Rosenblatt, both at the University of British Columbia. ♦ He was an Assistant Curator at the Institute of Fisheries at UBC in 1956 and, in 1957-1958, a Curatorial Assistant in the Division of Fishes, University of Michigan. ♦ Don was Curator of Fishes in the National Museum of Canada for 28 years (1958-1986), and under his tenure the collection ballooned from 4,638 specimens to about 410,000 catalogued specimens. This included 1618 type specimens (28 holotypes, 1576 paratypes, 4 neotypes, and 10 syntypes) [to May 1993]. ♦ He later became Senior Biodiversity Advisor and took early retirement in 1994. Don wrote a wide variety of articles and books for scientific and popular outlets. ♦ He also served as the founder and editor of two journals, *Sea Wind* and *Canadian Biodiversity* (later named *Global Biodiversity* in 1993 and *Biodiversity (Journal of Life on Earth)* in 2000). ♦♦ He published and edited over 620 scientific papers, books, popular articles and book reviews in his career of 45 years from 1957 to 2001. ♦ He had 119 separate collaborators but was first author on 90% of the publications. ♦ Areas of particular interest for Don during the first 30 years of his career centred on fishes, particularly Arctic marine fishes, sculpins, smelts, Pleistocene fossils, conservation of rare and endangered fishes, development of computers for museum work, conservation techniques for museum specimens, early application of GIS analysis to study biogeography and a computerised list of world fishes. ♦ The last 15 years were devoted mostly to biodiversity and conservation of natural resources. ♦ A bibliography of his works and an obituary will be published in *Canadian Field-Naturalist* and a memorial issue of *Sea Wind* will be published in 2002.

[\[POSTER\]](#)

Anderson, C. ♦ and G. Cabana

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Using Nitrogen Isotopes to Distinguish Diffuse from Point-Source Nitrogen Inputs into Riverine Food Webs: Can Fish Eat Pigs?

While investigating the use of nitrogen stable isotope ratios as a tracer of anthropogenic perturbations of nitrogen cycle at the watershed scale, we have sampled 83 riverine sites draining 12 watersheds with contrasting land uses in the St-Lawrence's lowlands in Quebec, Canada. The isotopic ratios ($\delta^{15}\text{N}$) of aquatic herbivores varied greatly among sites (+2 to +15 ‰) and increased significantly with total nitrogen concentrations in river water. Within ten of twelve watersheds, $\delta^{15}\text{N}$ increased monotonically or remained constant (in forested watersheds) from upstream to downstream sites. However, two rivers showed a surprising sharp decrease in herbivore $\delta^{15}\text{N}$ in the most downstream sections. Subsequent local investigations revealed that both rivers were affected by punctual particulate and dissolved organic matter discharges originating from animal-processing industrial effluents with low $\delta^{15}\text{N}$ values. Furthermore, comparably low $\delta^{15}\text{N}$ values were found in the whole food web (carnivorous invertebrates and fish) sampled downstream from the discharge sites, indicating an incorporation of massive allochthonous inputs of organic matter of animal origin into the ecosystem.

[SAT. 10:40]

Arndt, S.K.A.,¹ R.A. Cunjak and T.J. Benfey

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Effect Of Summer Floods And Spatial-Temporal Scale On Growth And Feeding Of Juvenile Atlantic Salmon

The objectives of this study were: (1) to determine how summer floods influenced feeding, growth, and energy reserves of juvenile Atlantic salmon, and (2) to describe short-term spatial and temporal variation in feeding and growth. Age-0 and age-1 salmon were collected from two New Brunswick streams during the growing seasons of 1992 and 1993. Changes over time were monitored from samples collected at the beginning, middle, and end of 10-day periods. Two control periods of relatively constant discharge were compared with two summer floods of a discharge magnitude which would occur once every two or three years, on average. Feeding rates were measured by weighing gut contents of sampled fish, and short-term changes in growth were assessed using the RNA:DNA ratio. Analysis of variance results showed that fine-scale spatial units (20 m length) may be more important than large spatial differences (upstream vs. downstream reaches) in explaining variation in feeding and growth. The amount of variance explained by day to day variation within the periods varied from zero to 19% for gut fullness and 1% to 25% for RNA:DNA. A large percentage of variance remained among individual fish after temporal and spatial factors were accounted for. This percentage was higher in age-0 fish (60%) than age-1 (40%), and tended to be greater during non-flood periods. Comparison of flood and control periods suggested that floods did not significantly reduce average feeding rates. RNA:DNA ratios provided some evidence that floods caused temporary reductions in growth rates (20-30%) of both year classes. RNA:DNA of YOY salmon recovered more quickly than age-1 parr after the flood peak. Juvenile salmon appear to be fairly resilient to floods of a magnitude that would occur as part of the "normal" life history for most cohorts.

[POSTER]

Beauchamp, K., B.A. Henderson and N.C. Collins
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Growth And Reproduction Of Lake Whitefish (*Coregonus clupeaformis*): Life History Strategies

Life history traits of lake whitefish (*Coregonus clupeaformis*) stocks in the Laurentian Great Lakes and in inland lakes were analyzed to identify patterns in growth, reproduction, and mortality. ♦ In the Great Lakes, lake whitefish stocks that are experiencing faster pre-reproductive growth mature at a smaller size and at an earlier age than those from slowly growing stocks. ♦ Fast growing lake whitefish from inland lakes, in contrast, reduce age at sexual maturity but maintain size at maturity. ♦ The age at which 50% of the stock is sexually mature is inversely related to the pre-reproductive growth rates. ♦ Pre-reproductive growth rates were estimated as the first derivative of the von Bertalanffy growth equation and were correlated with the size at age 2. ♦ Asymptotic length is inversely related to pre-reproductive growth. ♦ This trade-off occurs because less surplus energy is allocated to growth. ♦ Relative fecundity and the GSI of lake whitefish in the Great Lakes are positively correlated with pre-reproductive growth, suggesting that faster growing females in the Great Lakes may be allocating considerably more energy to reproduction with no added cost to survival. ♦ Precision and stability of the von Bertalanffy parameters, as estimates of growth and size will be addressed. ♦ We propose that the natural mortality of slow growing lake whitefish stocks, contrary to what is predicted by Pauly's (1980) empirical equation, could be greater than the natural mortality of faster growing stocks. ♦ Discrepancies in the Pauly (1980) regression equation for estimating natural mortality rates are discussed. ♦ We argue that lake whitefish are able to compensate for exploitation through density dependent induced changes in pre-reproductive growth consequently affecting reproduction and natural mortality.

[SAT.14:20]

Benckhuysen Justus J., Tim Slaney, and Carrier-Sekani Tribal Council 2
1 Aquatic Resources Limited, Vancouver, BC, 2 Prince George, BC

Lake Origin Of Endako River Kokanee Spawners

In 2000, growth characteristics, DNA, and scale laser ablation, of kokanee (*Oncorhynchus nerka*) from Burns Lake, Fraser Lake, Stellako River and Endako River were analyzed to determine the origin of kokanee spawning in the Endako River at the outlet of Burns Lake and the relationship between these stocks. ♦ Fish were sampled in from lakes August and from rivers in September of 2000. ♦ Scale growth measurements were made using a microfiche reader at 50 X magnification. ♦ T-test performed on mean distances of focus to seventh circuli, focus to first annulus, and number of circuli in first annulus indicate that there are two distinct kokanee populations in these systems - Burns Lake-Endako River, and Fraser Lake-Stellako River. ♦ DNA profiles produced from fourteen micro-satellite DNA markers and interpreted using a phylogeny tree program (UPGMA) and then GENECLASS 1.0 program to determine the probability that a fish was assigned to the appropriate predetermined population supports scale analysis. ♦ Samples were allocated to the incorrect classes in less than 1.0 % of cases. ♦ Laser ablation data were inconclusive. ♦ The results suggest that kokanee in Burns Lake spawn downstream of the lake and those in Fraser spawn upstream of the lake.

[POSTER]

Berthelot, H. and H. Gimet, Departement de chimie-biologie, Universit  du Quebec Trois-Rivi res, Trois-Rivi res (Quebec)

Comparison Of Growth In Whitefish Dwarf And Normal Morphotypes (*Coregonus clupeaformis*) Using Biochemical Indices

Trophic polymorphism occurs in populations of whitefish (*Coregonus clupeaformis*) in certain lakes of Quebec, whereby striking differences in the size of morphs are found. At age of maturity, two size classes can be observed, mainly a dwarf form (120-220 mm, TL), and a normal form (350-550 mm, TL). Other than size, studies have shown that the dwarf morph matures at the age of 2 and has a shorter life span than the normal morph, which matures at 4 years of age. In order to better understand the ontogeny of these differences, lactate dehydrogenase and pyruvate kinase activities (enzymatic indices of growth) were measured in dwarf, normal and hybrid morphs raised under identical laboratory conditions during the first year of growth. Enzyme activity levels, as well as growth rate were significantly higher in the dwarf compared to normal morph, while no differences were apparent between either hybrids and dwarfs, nor between hybrids and normals. The results suggest a mechanism by which differences in growth trajectories between morphs may arise during the first year of development.

[\[POSTER\]](#)

Bertolo, A. and P. Magnan

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The Role of Colonization Patterns and Engineering by Beaver in Structuring Fish Communities of Canadian Boreal Shield Lakes

We used a spatial survey of fish assemblage structures in 38 natural lakes in the Canadian Boreal Forest to determine the effects of lake and watershed morphometry, limnological and spatial variables on fish assemblage structure. Using multivariate ordination techniques, we first determined the structure of the fish community based on biomass data. In a second step, we related the observed patterns to species presence/absence data and established relationships between fish abundance and environmental (biotic and abiotic) factors. Fifty-eight percent of the variation in fish biomass was explained by the first two axes from a detrended correspondence analysis. The ordination revealed the existence of three types of communities: 1) communities dominated by white sucker (*Catostomus commersoni*) and/or brook charr (*Salvelinus fontinalis*) in which piscivorous fish are absent; 2) communities dominated by northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*) co-occurring with white sucker, and 3) more diverse communities in which walleye (*Stizostedion vitreum*), lake whitefish (*Coregonus clupeaformis*), northern pike, yellow perch, and white sucker co-occur with different patterns of dominance. Most of the variation in species distribution was attributed to spatial factors associated with colonization by species (i.e. differences in postglacial colonization patterns due to lake altitude may have caused the exclusion of piscivorous predators from some of the lakes) or to factors associated with extinction processes. Furthermore, the presence of beaver (*Castor canadensis*) dam at the lake outlet was associated with the absence of both lake whitefish and walleye. We suggest that this pattern could be attributed to some indirect effects of the presence of beavers, such as the 1) reduction of spawning grounds for both species following impoundment, 2) an increase in predation pressure by pike, which is a species that is favoured by the increase in structural complexity following impoundment, and 3) the reduced likelihood of colonization by some species (e.g. walleye). Fish predation is likely to be the major biotic factor responsible for the variation in biomass and size structure in both white sucker and yellow perch and for the variation in the biomass of small prey species, thus potentially having major consequences on the structure of the trophic dynamics of the whole lake.

[\[SAT.8:30\]](#)

Blackie, C.,* D. Weese and D.L.G. Noakes

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Age And Growth Of Lake Charr, *Salvelinus namaycush*, From Great Bear Lake, Northwest Territories, In Relation To Diet

Comparisons were made of age and growth among lake charr, *Salvelinus namaycush*, collected from Great Bear Lake during July and August of 2000. Individuals were characterized as to feeding type by stomach contents at the time of capture. Age and growth were compared for piscivorous and insectivorous charr to test the hypothesis of resource polymorphism in this species in this lake. Otolith increments were counted to determine age and otolith increment widths were used to estimate growth. Individuals ranged in age from 12 to 44 years, with no difference in the average age-at-capture between piscivores and insectivores. However, there was a highly significant growth difference between these groups for ages 0 to 19 years. Piscivorous lake charr had wider increments than did insectivorous charr, indicating greater somatic growth during that interval.

[\[POSTER\]](#)

Blanchfield, P.J.* , R.H. Hesslein and W. Jansen

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The Thermal Habitat Of Lake Trout In Small Boreal Lakes: Projected Implications Of Climate Change

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

[\[POSTER\]](#)

Bodtker, K.M.1, R.M. Peterman 1 and M.J. Bradford 2

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Comparison Of Estimates Of Optimal Spawner Abundance For Fraser River Sockeye Salmon (*Oncorhynchus nerka*) Based On Productivity Of Nursery Lakes And Stock-Recruitment Analyses, Taking Uncertainty Into Account

Recently, several researchers used information on productivity of rearing lakes to derive estimates of spawning escapement that should maximize abundance of juvenile sockeye salmon (*Oncorhynchus nerka*) in the lake. However, only one of these studies accounted for uncertainty and that was quite limited; the rest produced point estimates. Explicit consideration of the effects of uncertainty is now widely advocated and implemented in fisheries management. Therefore, we developed a systematic method of estimating optimal escapement for sockeye stocks based on productivity of nursery lakes that takes several sources of uncertainty into account. The method requires as input lake-specific estimates of photosynthetic rate and smolt weight at high smolt density. It uses parameter estimates from two empirical relationships to estimate maximum juvenile sockeye rearing capacity from photosynthetic rate and translate it into spawner requirements. Uncertainty in parameter estimates of both relationships is described by Bayesian posterior probability distributions. Compared to estimates of optimal spawner abundance produced from Bayesian stock-recruit analyses of Fraser River, B.C. sockeye stocks, this method based on lake productivity produced higher estimates for the optimal abundance of female spawners in all cases except one. In addition, estimates of optimal escapement based on lake productivity were slightly more precise than those based on Bayesian stock-recruit analyses in all cases except one.

[\[SAT. 8:30\]](#)

Bondar C.* and J.S. Richardson

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Indicator Species In Freshwater Streams: A New Approach To Biomonitoring

Predictable shifts in community structure in response to an environmental disturbance underlie the practice of biomonitoring. ♦ However, linking specific shifts to particular disturbances through causal processes has not been done. ♦ Stream macroinvertebrate community structure is a reliable indicator of environmental stress; however, despite the repeatable changes to macroinvertebrate community structure that occur, the species-specific interactions that cumulatively result in altered community structure are not well understood. ♦ This research will explore how individual species are affected by certain environmental perturbations resulting from forestry, both in terms of identification of the individual species most affected by a specific disturbance, and the life history stage of these organisms that is most susceptible. ♦ We will test hypotheses about the mechanisms that determine tolerance, and how the variation in tolerance affects community structure. ♦ The study will involve experimentation at two scales: whole stream (large-scale) experiments will be carried out in order to determine which species are most sensitive to specific environmental changes (i.e. the 'indicator' species) using the Dufrene and Legendre (1997) IndVal approach. ♦ Identification of indicator species is crucial to understanding how an entire community will respond to specific environmental perturbation. ♦ Small-scale experimentation will be carried out in stream channels (located in Malcolm Knapp Research Forest) on the indicator species identified from part 1. ♦ In these experiments the amount of UV radiation, nutrient concentration or sediment density will be varied in order to determine the upper tolerance limit of the indicator species to each. ♦ The effects of the perturbations will be studied seasonally in order to determine the life history stage of the indicator species that is most susceptible. ♦ In addition, density of the indicator species will be manipulated in order to assess both direct and indirect effects leading to community shifts. This research will contribute to a greater understanding of why changes to macroinvertebrate community structure occur in response to forestry practices, and enhance both the predictive capacity and understanding of biomonitoring models.

[\[POSTER\]](#)

Borwick, J.A.1, M.S. Ridgway 2 and J.M. Buttle 3

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Use Of Topographic Indices To Predict Potential Brook Trout Habitat In Lakes On The Canadian Shield

Brook trout are closely linked to the hydrology of the watersheds they inhabit. Groundwater inputs in the form of surface or sub-surface flow at lake and stream margins are important features of spawning and young-of-year (YOY) habitat. ♦ Landscape features such as topography can be used in a geographical information system (GIS) to map these areas of potential saturation and water accumulation with the use of a topographic index (TI). A TI was developed for Algonquin Park, Ontario, to identify potential brook trout habitat and associated sub-catchments that sustain them. ♦ A field survey of 21 lakes in the park with self-sustaining populations of brook trout was also undertaken to determine the distribution of hydrological features used by YOY brook trout. ♦ Large values of the topographic index (representing high inputs of groundwater) derived in a GIS environment were found to correspond closely to field locations of potential brook trout habitat in lakes. ♦ YOY use of the seepage and inflow habitats was seasonal with few being used in both spring and summer. ♦ This is possibly associated with their strong ($P < 0.01$) preference for

colder, shallower, and narrower habitats typical of small groundwater dominated inflows. The number of potential seepage and inflow habitats increases asymptotically with lake surface area. ♦ The asymptote of the relationship occurs at a lake surface area of 200 ha. ♦ Provincially, 93% of all brook trout lakes have a surface area of less than 200 ha. ♦ It appears that lakes greater than 200 ha have a lower density of seepage and inflow habitat per kilometer of shoreline. ♦ Over 50% of the potential lake shore habitats found in the field were not present on the Ontario map system. ♦ Knowledge of the spatial patterns of brook trout groundwater habitat use is therefore required to protect these areas from anthropogenic sources of disturbance. ♦ This large scale, GIS, and TI approach offers a means of predicting the location of potential habitat sites based on their physical characteristics.

[\[FRI. 16:40\]](#)

Boston, Christine M., Robert G. Randall, and Charles K. Minns
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Comparison Of Point And Line Transect Methods For Surveying Fish Assemblages In Littoral Habitats Of The Lower Great Lakes

Point and line-transect methods were compared as techniques for surveying the near shore fish assemblage in Lake Ontario during a three-month period in 2000. ♦ Fish were captured by boat electric fishing (pulsed direct current, 8 ampere, at 120 pps). The line transect was 100 m in length, and followed the 1.5 m depth contour close to the shoreline. ♦ Point sampling was conducted at random points along the 1.5 m transect, as well as in shallow (0.5 and 1.0 m) and deeper water (2.0 m) adjacent to the transect. ♦ The survey methods were compared at two different near shore habitats: an area with cobble substrate and no aquatic vegetation (Bluff) and an area with organic/silt substrate and moderate to heavy macrophyte cover (Bay). ♦ A total of 23 and 27 fish species were captured in the Bluff and Bay habitats, respectively. Indices of fish abundance and species richness were significantly correlated between the two methods. The proportion of samples with zero catch was higher for point (about 30%) than line sampling (<5%), but more point (60) than transect samples (7) were collected per day. ♦ Sample variance of fish catches was significantly and positively correlated with the sample mean for both survey methods, reflecting the contagious distribution of the fish in the near shore habitats. The field effort required to achieve a coefficient of variation of the mean of 0.20 was less for point sampling (about 3 h) than transect sampling (about 15 h). ♦ At 1.5 m depth, the average fork length of fish captured by point sampling was less than fish caught by transect sampling (Mann Whitney U test, $P < 0.05$). ♦ Fish catches decreased with water depth, while fish size increased with depth. ♦ The point-sample method was feasible and showed promise as a survey technique in the species-rich near shore areas of the Great Lakes. Fish and habitat data can be collected with high spatial resolution, and a large number of samples can be collected in a short time frame. ♦ Analyses of data collected in 2001 will be included in this presentation.

[\[POSTER\]](#)

Brind'Amour, A. and D. Boisclair

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Bias In Fish Relative Abundance Using Horizontal-Scanning Approach Due To Distance

Hydroacoustic has been used in many studies to assess fish density and their distribution patterns. ♦ Since in shallow lakes, vertical scanning approach does not allow a large volume of water to be insonified, horizontal scanning approach has been developed. ♦ Usually it is assumed that acoustic information gives

an accurate image of the fish density. However, the relation between real and acoustic density has rarely been verified. Moreover, that relation might be biased when the hydroacoustic beam crosses water surface, since echoes from the surface could be accounted for fish echoes. It has been suggested that this bias increases as the distance between the hydroacoustic system and the fish increases. The aim of our study was to describe and quantify the relationship between the real and acoustic density by varying the distance. To do so, we tethered fish on a straight wire and insonified them using the horizontal scanning approach. We kept constant the number of fish (20 and 40), but we varied the distance between the hydroacoustic system and the fish, ranging from 5 to 30 meters. We showed that as the distance between the transducer and the targets increases, the FRA is exponentially overestimated. This effect is mainly due to the surface reflection at the water-air interface (79%). We developed and validated a correction factor that, we believe, should be used whenever fish abundance is estimated by the horizontal-scanning approach.

[SAT. 10:40]

Busch, Christopher*¹, Daniel Heath¹, Andrew Hubberstey², and John Heath³
¹ Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Ontario; ² Department of Biological Sciences, University of Windsor, Windsor, Ontario; ³ Yellow Island Aquaculture, Campbell River, British Columbia.

Muscle Absorption/Loss In Sexually-Mature Chinook Salmon: The Apoptotic Link

Histological examination of maturing Chinook salmon (*Oncorhynchus tshawytscha*) has demonstrated a complete lack of inflammation and/or necrosis in cells surrounding the abdominal cavity in maturing salmon. This is despite a 30 % loss in abdominal wall thickness during maturation. We hypothesize that apoptosis, commonly referred to as programmed cell death, plays a major role in the re-absorption and redistribution of abdominal muscle tissue in maturing salmon. Although the endocrinological initiation of sexual maturation in salmon has received considerable attention, the mechanism of tissue re-absorption has not. We performed TUNEL staining on muscle sections taken from sexually maturing salmon sampled over 6 months before final maturation. Preliminary results indicate that smooth muscle absorption is correlated with increased levels of apoptotic cells in farm-raised chinook salmon. Our data clarifies the molecular mechanisms associated with maturation in both salmonids and possibly other species that undergo a similar physiological absorption of smooth muscle tissue during maturation (e.g. Lamprey). Furthermore, the apoptotic re-absorption of smooth muscle tissue in maturing salmonid holds promise as a possible model system for apoptosis research.

[POSTER]

Cabana, G., and Giroux, W.

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From Land to Water and Back: Tracing the Incorporation of Aquatic Secondary Production into Terrestrial Food Webs with Stable Isotopes.

Traditionally much of running-water ecology has been concerned with the influence of watersheds and riparian zones on the ecosystemic function of rivers. However, recent work has revealed that the importance of riparian habitats to terrestrial predators might be linked to the asynchronous inputs of terrestrial and aquatic secondary production (emergent insects) to these habitats during the year. As part of a multi-scale comparative study of the stable isotope ratios of aquatic biota (nitrogen, carbon, sulfur)

in relation to land use, we have identified several sites (◆ iso-ecotones ◆) where aquatic insects differ substantially in isotopic signals from adjacent riparian terrestrial insects. ◆ These sites allow us to trace the incorporation of secondary production (and water-born pollutants) originating from water into terrestrial food webs via consumption by terrestrial carnivores. ◆ Application of this technique to two large Quebec rivers showed that aquatic insects constituted as much as 80% of the diet of orb-weaving spiders collected more than 200 m from water.

[SAT. 11:00]

Carmack, E. Department of Fisheries and Oceans, Institute of Ocean Sciences, 9860 West Saanich Road, Sidney, British Columbia, V8L 4B2

Arctic Ocean Environmental Variability: Recent Observations and it◆s Potential Consequences to Biota

The goal of managing resources so as to conserve biodiversity requires of us a much greater understanding of what individual organisms require of their physical and geochemical environments in order to survive. ◆

In the Arctic this task must be met against a backdrop of rapidly changing conditions and constraints. ◆ Specifically, how do the extraordinary spatial and temporal variations in ice cover, temperature, light, freshwater content, turbidity, nutrients and currents in the Arctic Ocean define places or times critical to marine life? ◆ We begin with a general description of ocean currents including basin-wide flow, shelf circulation and shelf-basin interaction, followed by a review of changes that have been observed in the Arctic◆s climate system over the past decade. ◆ Speculations are then made on the consequences of a changing physical environment to geochemistry and biota. ◆ Specifically, in the Arctic Ocean at least two climate-scale contiguous domains are linked to ecosystems both bottom-up (e.g. changes in light and nutrient regimes) and top-down (e.g. the impact of fish and large predators on biodiversity) regulation. The first is the ~ 7 X 10⁶ km² seasonal ice zone which affects nutrient and underwater light regimes, and also provides a solid surface upon which large mammals travel, hunt and reproduce. ◆ The second is the ~ 10 X 10³ km long riverine coastal domain, driven by runoff and perhaps ice melt, which affects light and nutrient regimes and provides a pathway for migration and dispersal of marine biota.

[FRI 11:00]

Caron, M., G. Cabana and P. Magnan

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Benthic And Pelagic Feeding Behaviour Of Lacustrine Brook Trout (*Salvelinus fontinalis*) Revealed By Stable Isotope Analysis In Relation To The Presence Of Introduced Species

We studied inter-individual variation in the diet of brook trout (*Salvelinus fontinalis*) combining analyses of stomach contents and stable isotope ratios in 5 Canadian Shield lakes selected along a gradient of interspecific competition: two lakes contained allopatric brook trout populations (no interspecific competition), one lake contained brook trout and creek chub (*Semotilus atromaculatus*) (intermediate level of interspecific competition) and two lakes contained brook trout, creek chub and white sucker (*Catostomus commersoni*) (highest level of interspecific competition). In allopatric populations, 43% of brook trout individuals fed exclusively on benthic invertebrates compared to 48% in sympatry with creek chub and 13% in sympatry with chub and sucker. In lakes where the highest level of interspecific competition is present, the proportion of stomachs containing only zooplankton increased to 27% compared to 12% in a single species population. However, stomach content data constitute potentially only snapshots of the feeding behavior and stable isotope ratios (d¹³C and d¹⁵N) of fish and their prey may give a better picture of long term changes in diet for these communities. In lakes where carbon isotope could be used to discern pelagic from benthic feeding, brook trout showed that in the absence of competitor or in sympatry with

creek chub (intermediate level of interspecific competition), individuals derived their energy mostly from littoral benthic invertebrates. In sympatry with chub and sucker, brook trout $d^{13}C$ was more negative, indicating a shift in the diet towards a greater dependence on ^{13}C -depleted pelagic zooplankton, thus confirming the trends observed using stomach content analysis.

[SAT. 14:40]

Clarke, K. D., D. A. Scruton, J. H. McCarthy I, L. J. Cole, and R. A. Curry 2
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Brook Charr (*Salvelinus fontinalis*) Habitat Utilization And Production Within A Small Headwater System In Newfoundland, Canada: Adapting To Life Alone

The ecology of brook charr (*Salvelinus fontinalis*) was studied for six years, 1993-98, as part of a forestry fisheries interaction project conducted in the Copper Lake watershed, Newfoundland, Canada. ♦ Brook charr is the only fish species found in this small (13.5 Km²) headwater system and their production appears to be enhanced by utilizing all available habitats. ♦ Population dynamics and habitat utilization were studied by quantitative electrofishing (streams), multiple mark recapture (lakes) and through a tagging program which ran from 1994-1997. ♦ In general, lake habitats were used as rearing areas for larger adult charr, age 2-5 years, and small primary streams were used as spawning/nursery areas for charr aged 0 and 1 years. ♦ Utilization patterns were evident in the production estimates and P/B ratios calculated for each major habitat type. Production in the primary streams was associated with the quality and quantity of spawning habitat while production in lakes was associated with percentage of littoral habitat. ♦ P/B ratios were consistent with the different utilization patterns with higher ratios observed in streams as opposed to lakes averaging 0.98 (range of 0.73-1.42) and 0.53 (range of 0.34-0.73), respectively, over the course of the study. ♦ Habitat and production appear to be strongly linked in this low fertility watershed with each major habitat controlling production at different life history stages. ♦ This suggests that any alteration in one habitat would have an effect on the productive capacity of the population as a whole. ♦ Evidence from a storm event that reduced young of the year survival is presented to illustrate the inter-dependance of the major habitat types within this watershed.

[FRI. 15:40]

Costello, A. B.
Native Fish Research Group and Dept. of Zoology, University of British Columbia.

Mating Strategies In Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*): Implications For The Conservation Of Small Populations

The coastal cutthroat trout (*Oncorhynchus clarki clarki*) is a salmonid endemic to the Pacific Northwest. While perhaps one of the most widely distributed salmonids in the region (occupying a wide range of habitats from estuaries to headwater streams), surprising little is known about their basic biology. Interestingly, cutthroat trout populations show surprisingly high levels of genetic variation considering the typically small population sizes characteristic of the subspecies (often 10's to 100's of individuals). As part of a larger study, I am performing an intensive demographic and genetic investigation of a representative population in the wild to determine if the mating system in coastal cutthroat trout has evolved to compensate for their small, unstable population sizes. The site chosen for this study is Chonat Lake on Quadra Island, British Columbia. In January 2000, a fish fence was installed on the Chonat Lake inlet creek and monitored over the course of the spawning period to determine the number, composition and movement patterns of spawning adults in the system. Through genetic analyses of the relationships

between

spawners and young-of-the-year offspring, and between the stream resident, lake resident and anadromous components present in the population, I hope to determine whether: 1) many individuals contribute to mating, 2) whether multiple paternity is common, 3) if matings occur between age-classes, 4) if matings occur between divergent life-history forms, and 5) if reproductive straying from other populations occurs in this population. Results from the first year of sampling and genetic analysis will be discussed. This work has direct management implications for coastal cutthroat, a subspecies of conservation concern in the province, but will also be of interest to any working with small, fragmented populations or endangered species.

[SAT. 15:40]

Cote, D.¹, L.M.N. Ollerhead², D.A. Scruton², and R.S. McKinley¹

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Habitat Use Of Juvenile Atlantic Cod In A Coastal Area Of Newfoundland As Determined By 2-D Telemetry

Since the early 1990's increased efforts have been made to study the early stages of the Atlantic cod life cycle. Understanding ecological influences of young cod may provide important insights into the factors limiting production and the potential for negative anthropogenic impacts. While considerable progress has been made, little is known regarding the habitat use of older (age 2-3) juveniles and what knowledge exists is contradictory. We used a location finding acoustic telemetry system (resolution 1 m) to map ocean substrates and to continuously monitor the movements of 56 juvenile cod from 11 August to 20 December, 1999. Juvenile cod used complex substrates (boulder and kelp) to a greater extent than open (sand and gravel) substrates. Increased levels of use were found over kelp diurnally than nocturnally and more time was spent over sand and gravel substrates nocturnally. It is not certain whether older juveniles used open areas during these periods because of a reduced risk of predation or increased feeding opportunities. Although nocturnal inshore shifts in distribution occurred from August to October they were not significant. Associated water temperatures increased nocturnally during August and September but were not significantly different. Despite a recent study documenting increased swimming speeds over open substrates, we found no significant difference in the average change in direction between successive traces. This suggests that although swimming speeds may change, movement patterns used during foraging and/or predator avoidance may be similar over substrates of varying complexity.

[SAT. 9:50]

Crawford, S.¹, K. McCann² and A. Muir³

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Ecological Basis Of TAC Determination For Lake Whitefish (Coregonus clupeaformis) In Lake Huron

Following a 2000 Fishing Agreement between the Saugeen Ojibway, Canada and Ontario, the Chippewas of Nawash received and merged OMNR lakewide data on commercial fisheries for Lake Huron (Canadian jurisdiction), for the purpose of establishing TACs for species such as lake whitefish (Coregonus clupeaformis). The approach taken by Nawash was as follows: (1) provide a spatio-temporal hypotheses for the lake whitefish populations being harvested, (2) characterize the spatio-temporal patterns in historical

data on the lake whitefish commercial fisheries, (3)develop and implement the use of mathematical models to evaluate the current harvest levels, relative to productive capacity of the supporting populations. The available evidence supports the hypothesis that lake whitefish in Lake Huron exist as populations with basin-wide home ranges and seasonal migrations. ♦ Detailed spatio-temporal analyses of historical fishing effort and CPUE data support the hypothesis of distinct feeding and spawning grounds, especially in the Main Basin. ♦ We present what is believed to be a novel approach to using a mathematically discrete form of the Schaeffer biomass production model, to assign relative probabilities to alternate hypotheses of the lake whitefish population status. ♦ We discuss the key uncertainties revealed by our analyses, and the implications for our continued efforts to implement the principles of Adaptive Management for the decision-making regarding Great Lakes commercial fisheries.

[SAT. 14:00]

Crossin, G. and S. Hinch

UBC

Adaptive Energetics And Morphology Of Migrating, Adult, Fraser River Sockeye: The Role Of Migratory Distance And Elevation

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 how energetic condition 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 for conserving 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. ♦ Energetic data from migrating sockeye in the 1950s show similar stock-specific trends, but initial somatic 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. 11:40]

Curry, R. A. and C. Doherty

New Brunswick Cooperative Fish and Wildlife Research Unit, Canadian Rivers Institute, Biology Department, University of New Brunswick, Fredericton, NB. E3B 6E1

Home Ranges And Trophic Relationships Of Muskellunge Associated With A Dam And Reservoir: The Continuing Saga Of An Unwelcome, Introduced Predator

The muskellunge was introduced in the Saint John River system via stockings in a headwater lake located in eastern Quebec during the 1970 ♦s. In the past two decades, muskies have migrated down the system establishing several populations including one near the Mactaquac hydroelectric facility in Fredericton. ♦ The muskies are of concern because of their predatory nature and potential threat to the depleted Atlantic salmon stocks in the river. We radio tracked six muskies (69 to 94 cm FL) for one year. ♦ Two radio tagged muskies used home ranges of 80 to 90 km within the reservoir. ♦ One individual remained in the reservoir year round and one travelled upstream and into riverine habitat during summer. ♦ They wintered

in deep sections of the reservoir with decreased activity levels from January to April. ♦ In spring, they travelled to a common, upstream area of the river, and subsequently returned to the reservoir: one to an area used in the previous summer; one travelled through the reservoir and survived passage through the turbines or spillway at the dam. ♦ A third muskie also passed successfully through the dam. ♦ Downstream of the dam, home ranges were smaller ranging from <1 km to approx. 25 km and included a tributary for one individual. The four muskies spent considerable time at the base of the dam during the year with forays downstream in summer. ♦ Two wintered at the dam and two around bridges within the city of Fredericton (20 km downstream) and movements were restricted from January to April. ♦ In May, all muskies moved to an area of multiple, flooded islands 16 km downstream of the dam for < 14 days and then dispersed to sites used in the previous summer. ♦ Stable isotope analyses of the fish community downstream of the dam indicated that muskies consumed prey similar to striped and smallmouth bass. ♦ Their diets appeared to be dominated by white perch and YOY gaspereau. ♦ Atlantic salmon smolts may have been consumed to a lesser degree. ♦ Analyses from 2001 will confirm the trophic relationships and the potential threat to salmon smolts in the river.

[SAT. 16:40]

D'Amelio S.I, J. Mucha, R. Mackereth and C. Wilson

1 Watershed Ecosystems Graduate Program, Trent University, Peterborough
Ontario Ministry of Natural Resources

Tracking The Origins Of Coaster Brook Trout: Combining Telemetry And Genetic Profiles To Determine Source Populations

Radio tracking and genetic analysis are two potent technologies that are often applied to fisheries management. ♦ Although these research approaches are usually applied independently, combining these techniques can provide insights on fish origins, movement, and reproduction that could not otherwise be achieved. ♦ We applied both techniques to resolve the origins and habitat use of coaster brook trout, a Great Lakes fish that has declined drastically since the mid- 1800s. ♦ Two separate studies were initiated within Nipigon Bay (Lake Superior) to determine the habitat use of coaster brook trout using tracking data, and to resolve the relatedness of coasters to river-resident brook trout. Tracking data suggested that coaster brook trout utilize many tributaries of Lake Superior and that homing may occur, which was largely supported by the genetic data suggest that not all of the tributaries that coasters have been observed in are reproductively successful for these fish. Of 11 individuals tracked into rivers, 10 showed no significant difference ($p < 0.05$) from the river complex they were tracked to. ♦ Straying among rivers was largely limited to closely related populations, although one individual was tracked to a river which differed significantly from its natal source. ♦ These data significantly clarify the behaviour and habitat use of coaster brook trout, and provide an example of the power of these combined methodologies for the management and conservation of species and populations. .

[FRI. 15:20]

de Graaf, Ramona C. University of British Columbia, Department of Zoology

Seascape Effects on Local, Fine Scale Genetic Structure of Marine Nearshore Fishes: A Molecular Genetic Approach to Understanding the Dispersal of the Bay Pipefish (*Syngnathus leptorhynchus*)

The application of genetic tools in ecology has allowed biologists to understand much about the population structure of species including dispersal and recruitment rates. Molecular tools have provided a window into the world of many marine species that are inherently difficult to study due to high dispersal capabilities. ♦ To date, few genetic studies have been conducted to understand near-shore fish species and none have focused on eelgrass specialists such as the Bay Pipefish (*Syngnathus leptorhynchus*). The objective of this

study is to investigate the local, fine-scale population structure of the Bay Pipefish, an eelgrass specialist, to understand patterns of dispersal, recruitment and range requirements. High gene flow levels of many marine fishes, combined with wide species ranges, highly dispersive larval, juvenile and adult life history stages, confound many population genetic studies. ♦ The Bay pipefish, a seahorse relative, has life-history traits that are attractive for overcoming problems with understanding marine fish populations, including: live bearers; primarily eel-grass specialists; and assumed limited dispersal due to body form. This information will be applied to the protection of eelgrass beds within the framework of proposed marine protected areas around Vancouver Island, specifically within Pacific Rim National Park, Broken Group Islands Marine Reserve. ♦ As well, the effect of eelgrass bed size and fragmentation of this habitat will be investigated in terms of the genetic diversity of the species following a metapopulation analysis model. In the summer of 2001, Bay Pipefish were sampled from eelgrass beds located in Barkley and Clayquot Sounds and from the southern Strait of Georgia, British Columbia, Canada. ♦ Microsatellites will be developed to investigate the genetic population structure of this species.

[\[POSTER\]](#)

Desch[♦]nes, J. and M.A. Rodr[♦]iguez

D[♦]partement de chimie-biologie, Universit[♦] du Qu[♦]bec ♦ Trois-Rivi[♦]res, Trois-Rivi[♦]res, Qu[♦]bec

Influence Of Environmental Features On Fish Assemblages Across Multiple Spatial Scales In A River Basin.

Effects of environmental factors on fish distributions can depend strongly on spatial scaling, yet most studies have considered only a single spatial scale when relating environmental factors and fish distribution. We used redundancy analysis and hierarchical decomposition of variance to evaluate how environmental effects on stream fish assemblages varied across spatial scales. Fish abundances and environmental variables were quantified in 48 sites distributed among 18 stream tributaries of the Cascapedia River basin, Quebec, from mid-June to late August 2001. We examined variation in assemblage structure at three observational scales: (1) intra-site (among adjacent 15-m long sections in 75-m stretches; scale ~ 75 m), (2) intra-stream (among sites within a tributary; scale ~ 3 km), and (3) intra-basin (among tributaries; scale ~ 11 km). Environmental variables included in the analyses reflected both local effects (28 variables, e.g., current velocity, water depth, substratum type) and accessibility to stream sites (8 variables, e.g., distances to the river mainstem and to the river mouth, presence of obstacles to fish passage). The variables with strongest effects on assemblage structure, as determined by stepwise selection, were: distance to the Cascapedia River mainstem, presence of obstacles to fish passage, mean stream discharge, and bankfull width. Decomposition of variance indicated that 19% of variance in assemblage structure was intra-site (among sections), 28% was intra-stream (among sites), and 53% was intra-basin (among tributaries). Environmental variables accounted for 34% of total variance in assemblage structure. In contrast with the partitioning of total variance, only 2% of the variance accounted for by environmental variables was intra-site, 29% was intra-stream, and 69% was intra-basin. The results underscore the influence of observational scale on species-environment relationships, and suggest that prediction of fish assemblage structure in streams may be increasingly reliable at coarser spatial scales.

[\[SAT.8:50\]](#)

Dillion, P.J.¹ and M.C. Eimers²

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Effects Of Climate On Sulphate Fluxes From Forested Catchments In South-Central Ontario

Sulphate deposition in south-central Ontario has declined over the past 2 decades by ca. 45%. ♦ During this period, sulphate (SO₄) concentrations in headwater lakes and their inflows decreased, but the decrease was much less than expected based on the anticipated direct response of the catchments. ♦ For example, in Harp and Plastic Lakes, the decrease was 28 and 21%, respectively, while for many others, the decrease was even lower. ♦ Sulphate export in streams draining into the lakes greatly exceeded SO₄ input to

catchments from the atmosphere in most years, and we show that this difference quantitatively explains the delayed response of lake SO₄ concentrations. Furthermore, temporal patterns in mean annual SO₄ concentrations in streams were highly variable between years, but the patterns of all streams were very similar and were related to climate factors. Specifically, catchment export of SO₄ was greater, and stream SO₄ concentrations were higher, in years that had warm, dry summers, when streamflow in many catchments ceased for up to several months. Climate variables (e.g. temperature, precipitation) act on a regional scale and are likely responsible for the similar temporal patterns of SO₄ retention among these different catchments. In streams draining wetlands, an increase in sulphate export following drought has previously been related to wetland oxidation processes; however, in streams draining uplands, other processes must account for net SO₄ loss. Factors that affect SO₄ retention or export in catchments exert a strong influence on SO₄ concentrations in lakes and streams and need to be considered when evaluating the response of surface water chemistry to changes in sulphate deposition. Climate-related export of SO₄ from terrestrial catchments is delaying the recovery of acid-impacted surface waters, despite reductions in industrial emissions.

[FRI 14:20]

Elz, Anna and Eric B. Taylor

Looking Back In Time Through The Mitochondrial DNA Kaleidoscope: Origin And Demographic History Of A Dolly Varden (*Salvelinus malma*) And Bull Trout (*S. confluentus*) Hybrid Zone

Hybrid zones have been studied extensively over the last two decades, but little attention has focused on how historical processes contribute to their formation. A comparative phylogeographic approach incorporating nested clade and mismatch analyses of mitochondrial DNA (mtDNA) D-Loop variation is used to investigate the history of a Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) hybrid zone in northwestern North America. This system provides a unique opportunity to study the origin of a hybrid zone and investigate how life history traits related to dispersal may have caused differences in the demographic history of each species evident in their levels of genetic diversity.

Anadromous and freshwater populations of each species were sequenced throughout their range. Phylogenetic analysis confirmed the existence of previously described lineages and the paraphyletic relationship of two interspecific lineages suggestive of both allopatric and sympatric refugial histories. Separate nested clade analyses of each lineage and species are used to test the hypothesis that the zone of overlap is the result of secondary contact and sympatric range expansion. A diagnostic restriction polymorphism identified locales where "double invasions" of bull trout clades occurred on the coast of British Columbia which may explain intraspecific variation in life history traits and ecological niche partitioning. Comparisons of the mismatch distribution amongst life history types are made to test for bottlenecks and population growth following postglacial recolonization and between lineages to estimate the timing of expansion for each lineage. This study will contribute to understanding how historical and biological factors interact to shape the distribution and genetic diversity of aquatic fauna in a north temperate suture zone. Recognizing different evolutionary forces that produce divergent lineages within a species and identifying populations that may be sensitive to further reductions in population size are important for conservation initiatives.

[POSTER]

Enders, E.C.1, D. Boisclair 1 and A.G. Roy 2

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Effect Of Turbulence On The Costs Of Swimming In Juvenile Atlantic Salmon (*Salmo salar*)

Activity costs of salmonids are generally estimated through data obtained from forced swimming experiments where fish swim against a constant velocity flow. However, juvenile Atlantic salmon (Salmo salar; JAS) live in rivers characterised by a highly turbulent flow. In these environments, turbulence is associated with a wide range of instantaneous flow velocities and shear stresses which may affect fish behaviour and therefore the energetic costs for activity. At irregular time intervals the JAS undertake feeding motion. The energetic costs of some features of these movements, like accelerations and turns, are more likely to be described by spontaneous activity models. These models are obtained from experiments in non moving water, whereas JAS is confronted with a flow. Although costs of swimming in the return phase may be described by forced swimming models, these models do not take into account accelerations or turns. Accounting for the complexity of the movement and for the fact that it occurs in a turbulent flow may mean that it is necessary to develop a new model to estimate the energetic costs of swimming of JAS. The purpose of our work was to determine the energetic costs for staying and swimming in a turbulent flow. Instead of trying to measure the activity metabolism in the classical way against a constant flow, we created a turbulent flow in a respirometer chamber in order to estimate costs of swimming in turbulent flow conditions. Respirometry experiments with two average water velocities of 18 and 23 cm s⁻¹ and two different standard deviations of 5 and 8 cm s⁻¹ were conducted with fish ranging in size between 5 to 15g at 20°C. Our results confirmed that (1) fish swimming energetics is affected by different levels of turbulence such that, for a given average flow velocity, fish spend more energy as turbulence increases (2) there is an allometric relationship between fish weight and activity metabolism in a turbulent flow, and (3) suggest that a new model is needed to estimate the energetic costs of JAS in their turbulent environment. [SAT.13:40]

Ferguson M., K. Gharbi, C. Martyniuk, K. O'Malley, G. Perry, I. Somorjai, R. Woram and R. Danzmann
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The Architecture Of Fitness Traits In Salmonid Fishes: Genomic Approaches To Understanding The Genetic Basis Of Variation In Life-History Characters

Most traits of adaptive significance and of relevance to conservation biology are controlled by many loci (quantitative trait loci, QTL). We are searching for QTL controlling fitness traits in Arctic charr (Salvelinus alpinus), Atlantic salmon (Salmo salar) and rainbow trout (Oncorhynchus mykiss). Our long-term goal is to understand the genetic constraints on life-history evolution in the polyploid derived lineage to which these species belong. As a first step, we are constructing genetic linkage maps in collaboration with other groups in North America, Europe (SALMAP) and Japan. The maps are then used to locate QTL for upper thermal tolerance, body size, condition factor, spawning date and age at sexual maturation in various types of pedigrees (backcrosses between semi-inbred lines and outcrossed families). Although our initial efforts at map construction focused on simple sequence repeats (SSRs), the recent addition of amplified fragment length polymorphism (AFLP) markers has resulted in a significant increase in map density (approximately 300 in Arctic charr, 800 in rainbow trout, 600 in Atlantic salmon). The current maps are based on sex-specific analysis of linkage data to account for the marked differences in gene transmission between male and female salmonids. Analysis of SSR loci indicates that QTL for upper thermal tolerance and body size map to homologous chromosomal regions in Arctic charr and rainbow trout despite the genome reorganizations that have occurred between taxa. Thus, the genes underlying these fitness QTL may antedate the divergence of these species. Further, QTL for different traits sometimes co-occur on the same linkage groups in Arctic charr and rainbow trout suggesting the existence of single QTL with pleiotropic effects and/or close linkage of different QTL. The observed covariation among traits will be discussed within a life history framework. [FRI 13:20]

[FRI 13:20]

Fisher, J.A.1 and K.T. Frank 2

1 Department of Biology, Dalhousie University, Halifax, Nova Scotia. 2 Bedford Institute of Oceanography, Dartmouth, Nova Scotia

Changes In Finfish Community Structure Associated With The Implementation Of A Large

Offshore Fishery Closed Area On The Scotian Shelf

In 1987 a large area (~13700 km²) associated with two offshore banks of the Scotian Shelf was closed to fishing. Community level analyses of possible changes before and after the closure were undertaken. ♦ Species abundance data collected since 1970 during summer research vessel surveys provided the primary data for the analysis. Multivariate analyses such as non-metric multidimensional scaling and a randomization/permutation test revealed that the finfish community composition was significantly different after the implementation of the closure. Several species contributed to the post-closure difference including herring (*Clupea harengus harengus*), winter flounder (*Pseudopleuronectes americanus*) and redfish (*Sebastes* sp.), which showed dramatic increases in abundance. Haddock (*Melanogrammus aeglefinus*) was the dominant species throughout the entire period although increases in local density of juvenile life stages were noted. These findings suggest that several members of the finfish community benefited from the area closure. In order to determine whether or not the documented changes were unique to the closed area, comparisons were made to other offshore areas on the Scotian Shelf that have never been closed to fishing. In comparison to a downstream area, temporal changes in community structure were only slightly different and the species contributing to the differences were the same as the closed area. It appears that changes in the finfish community occurred at a scale larger than the closed area and fortuitously coincided with the imposition of the closure in 1987. On the other hand, the downstream area appears to be connected to the closed area through larval drift/juvenile migration suggesting the closed area is an important source area. [\[FRI 13:20\]](#)

♦ [Fitzsimons, J.](#)¹, B. Williston¹, G. Fodor¹, G. Bravener¹, L. Brown², and S. Brown² ¹ Department of Fisheries and Oceans, Burlington, Ontario. ²Environment Canada, Burlington, Ontario.

Sublethal Effects Of A Thiamine Deficiency On Larval Lake Trout - Moving Beyond Early Mortality Syndrome (EMS)

♦ A diet-related thiamine deficiency has been associated with acute mortality at the alevin stage of salmonids inhabiting the Laurentian Great Lakes, New York Finger Lakes and the Baltic Sea. A threshold for thiamine levels in eggs sufficient to avoid the acute effects of a thiamine deficiency at the alevin stage has been established. However, the concentration above which all sublethal effects in alevins are eliminated has yet to be established. Because of thiamine's involvement in carbohydrate metabolism and nerve function, a thiamine deficiency could potentially have significant effects on alevins. ♦ Alevins are almost totally dependent on the yolk sac for nutrition and utilization of the yolk sac is thiamine dependent. Moreover the emerging alevin faces a variety of challenges as it emerges from the substrate, developing buoyancy and initiating feeding but avoiding predation requiring the co-ordination of multiple senses that may be thiamine dependant. Using a combination of putative thiamine-replete self-sustaining lake trout stocks as controls, we evaluated the effects of thiamine levels at or just above the threshold for EMS for three critical parameters for alevins from a number of stocks. The three parameters were yolk sac utilization, avoidance of an interstitial predator and emergence and were separately assessed for responsiveness to thiamine using a combination of thiamine antagonists and thiamine supplementation. Despite the apparent responsiveness to thiamine for all three parameters, alevins from stocks with thiamine levels just above the EMS threshold were in general indistinguishable from alevins from stocks that were thiamine replete. ♦ Based on these results, management of thiamine levels to avoid EMS may be sufficient although there is still a need for more complex multifactorial tests of alevin performance. [\[POSTER\]](#)

Franzin W., G., and P. A. Nelson

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ETD (Erosion, Transport, Deposition), A Unifying Concept For Classification Of Fish Habitat And Predicting Productive Capacity

Fish use of habitat in relation to availability was examined in the Assiniboine River, MB over seasons and years at two distinct scales. Large-scale distribution data on CPUE, species richness-diversity, numbers per unit area and biomass per unit area were compared among macrohabitats (bank, channel, inside-outside bend, run), among major substrate categories, as determined by geomorphology, and among hydraulic conditions (ETD state - Froude number and substrate indicators). Randomization techniques were used to test the transferability of distribution data for use in smaller reaches typical of IFIM studies both within and outside the initial study area. These data are amalgamated into the ETD concept that has universal application in aquatic habitats. The status of each aquatic habitat is defined by hydraulics as being in an erosion, transport or deposition state. These basic principles explain meandering in streams and formation of beaches in lakes through sorting of sediments and clarify why some stream fish are found in lakes and some lake fish are found in streams. The productive capacity of aquatic habitat is a function of its energetic state, in much the same way as it is a function of the autocorrelated variables such as substrate, depth, velocity or other traditional categories that frequently are functionally correlated to fish occurrence. This concept takes into account both physical habitat, as we presently perceive it, as well as providing a mechanism for large-scale biotic factors (co-occurrences) and water quality (discharge, stage, chemistry) to be integrated into what determines why a fish might be found in any space at any time. These mechanisms hold true across all aquatic environments and may lead to insights regarding biogeographic patterns, effects on habitats of perturbations such as stream alterations or lakeshore development. Approaching habitat from a mechanistic perspective simplifies the analysis of potential effects of anthropogenic activities on the productive capacity of aquatic environments.

[SAT.14:20]

Fu, Caihong and Chris Wood, Fisheries and Oceans Canada, Conservation Biology Section, Pacific Biological Station, Nanaimo, B.C. V9R 5K6

A Generic Framework For Setting Conservation Limits In Fisheries Management

Setting conservation limits in fisheries management is an important part of the Precautionary Approach. Because of tremendous uncertainties involved in fisheries management, Monte Carlo simulation approaches are considered prospective for addressing conservation limits from a probabilistic perspective as opposed to analytical approaches. In this paper, a generic simulation framework was constructed to explore conservation limits in terms of exploitation rate and population size using Pacific herring (*Clupea harengus pallasii*) and sockeye salmon (*Oncorhynchus nerka*) in British Columbia as two examples. In this framework, species-specific conservation limits are examined using several performance indicators, including long-term average catch, risk of catch going below 0.5% of pristine exploitable abundance, time to quasiextinction, probability of quasiextinction within three-generation time, time to recovery, and probability of recovery within 10 years. Using the two example species, we demonstrate that the setting of conservation limits can be affected by factors such as discarding, predation, dispersal among populations within a metapopulation complex, change in survival rates, management threshold, and fishing effort allocation. We recommend that this generic framework should be used to incorporate more possibilities in natural processes and model structures to derive potential conservation limits and to carry out risk analysis for exploited populations.

[POSTER]

Galbraith, R.V.¹, E.A. MacIsaac¹, and A.P. Farrell² ¹Fisheries and Oceans Canada, Cooperative Resource Management Institute School of Resource and Environmental Management, Simon Fraser University Burnaby, British Columbia, CANADA V5A 1S6
²Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, CANADA V5A 1S6

The Effect Of Suspended Sediment On Sockeye Salmon (*Oncorhynchus nerka*) Fertilization Success

A high level of suspended sediment in streams is known to adversely affect Pacific salmon (*Oncorhynchus* spp.) at different life stages, yet conspicuously lacking is knowledge of the effect of suspended sediment on the fertilization process. We investigated the impact of suspended sediment on salmon egg fertilization

using sockeye salmon (**O.nerka**) from the Early Stuart stock in 1999 and 2000. ♦ Our primary objective was to test the effect of different concentrations of suspended sediment particles on the ability of salmon eggs and sperm to successfully combine. The fertilization process was simulated in a controlled flow flume using concentrations of suspended particles ranging from no suspended sediment to over 40,000 mg/l. ♦ Results suggest that concentrations greater than 2,000 mg/l reduce fertilization, but that large (>50%) reductions in fertilization success require suspended sediment levels in excess of 20,000 mg/l.

[\[POSTER\]](#)

Gaudreau, N. and D. Boisclair

Universit♦ de Montr♦al, D♦partement de sciences , biologiques, C.P.6128, Succursale Centre-ville, Montr♦al, QC. H3C 3J7.

Hydroacoustic Assessment Of Spatial Variability Of The Influence Of Moon Phase On Fish Abundance

Estimates of fish production require data on fish abundance and biomass. Sampling for, and interpretation of, fish abundance data are challenging. Indeed, fish abundance varies on a daily, lunar, and seasonal basis. Furthermore, fish abundance varies spatially, both vertically and horizontally. Even though, interpretation of data often assumes that sampling units, like transects, can be considered as an unbiased estimate of whole-lake fish abundance. Although this assumption is rarely tested, hydroacoustics in small lakes allow the study of abundance variations at short spatio-temporal scales. Our objective was to assess among-transect variation of the influence of moon phase on fish abundance. Sampling was performed in three small shallow lakes during the night because previous work suggested higher numbers of fish are acoustically detectable in these conditions. Sampling consisted of insonifying the complete contour of each lake with a single-beam echosounder using the horizontal scanning approach. Each circling of each lake was eventually divided in transects of 100 meters for statistical analysis. In each lake, a total of 9 circlings were performed: 3 during full moon, 3 during new moon and 3 during quarter moon. The 9 circlings were separated by a one-week pause; hence they covered a whole summer. Preliminary results suggest that moon phase influences fish abundance in each transect of a lake, but that the intensity of the moon phase influence varies among transects. [

[SAT. 15:40\]](#)

Giannico, Guillermo R. ♦ and Kathryn Staley Department of Fisheries and Wildlife, Oregon State University. Corvallis, Oregon. U.S.A.

Juvenile Coho Salmon In The Salmon River Watershed: Seasonal Distribution And Habitat Use

The objective of this study was to examine juvenile coho salmon distribution and habitat utilization in the Salmon River Watershed, Langley, British Columbia, during both summer and winter. ♦♦ Thirty-eight pools, glides and riffles, at 24 randomly selected locations throughout the watershed were sampled in August/September and in January/February. ♦ A three-pass removal method was used to estimate fish abundance in shallow units, whereas mark recapture with minnow traps was used in the deeper units and side channels of the river's floodplain. Channel morphology (i.e., pool abundance) alone did not entirely explain the distribution of juvenile coho salmon in the system. ♦ Multiple regression analysis identified water quality and cover (large wood, undercut banks and overhanging vegetation) as the most important variables in explaining variation in juvenile coho salmon densities among habitat units. During summer, lateral scour pools and backwater pools had the highest densities of coho. ♦ They were followed, in order of decreasing density, by trench pools and glides. ♦ Very few juvenile coho salmon occupied riffle habitat. The floodplain reaches of the Salmon River offered unsuitable water quality conditions for this species during August and September. The distribution of juvenile coho salmon in the watershed showed a seasonally changing pattern. Backwater and off-channel units with abundant in-channel wood and undercut banks attracted most fish during winter. ♦ Lateral scour pools followed in importance as coho salmon

winter habitat. ♦ In the floodplain area, while juvenile coho salmon were observed at very low densities in the main stem of the river, they were very abundant in drainage ditches and side ponds. Densities varied widely among sampling stations in the drainage ditches, but showed a tendency to increase with distance from the mainstem of the river. During a winter flood event, a few juvenile coho salmon were trapped in flooded fields. A proposal for a comparable study in the Willamette Valley is being developed.

[\[POSTER\]](#)

Gillis, D.M.[1], A.D. Rijnsdorp [2] and J.J. Poos [2,3]

[1] Department of Zoology, University of Manitoba, Winnipeg MB, R3T 2N2

[2] Netherlands Institute for Fisheries (RIVO), PO Box 68 1970 AB IJmuiden, The Netherlands

[3] Zoological Laboratory, University of Groningen, PO Box 14, 9750 AA Haren, The Netherlands.

Trawler Targeting In The North Sea

The identification of fishing strategies is becoming increasingly important to the management of our aquatic resources. ♦ This is particularly true in a multispecies fishery, such as that prosecuted by the North Sea beam trawl fleets. ♦ The distinction between "target" species and "by-catch" is critical for the use of commercial data in subsequent stock assessment. ♦ In the past, target species have often been identified by their abundance in the catch. In multispecies fisheries, some authors have advocated the use of multivariate statistics to identify target species assemblies. ♦ Here, we use the principles of fleet dynamics to interpret catch statistics from the North Sea beam trawl fleet. ♦ A preliminary spatial analysis of catch and effort suggests that a marketable species of average value that is also common in the catch is not being generally targeted. ♦ Further refinement of the analysis by vessel size class shows strategy (species) switching through the year by a component of the fleet. ♦ In general, fish harvester's behavior should be considered when examining temporal and spatial patterns in catch rate for the identification of target species.

[\[SAT. 13:40\]](#)

Gjerl♦v, C. and J.S. Richardson University of British Columbia, Vancouver, BC

Effects Of Leaf Litter And Forest Cover On Colonisation Patterns Of Stream Invertebrates

Harvested sites generally receive less leaf litter than forested sites. As well as being of nutritional value to shredders, leaf litter also provides refugia from flow and predation. Shredders may, therefore, colonise leaf packs preferentially for two reasons. Where leaf litter is scarcer (clearcut), organisms may be expected to colonise faster, reflecting a higher mobility associated with the search for food. We set out to test two hypotheses, therefore; that leaves would be colonised primarily for their value as food, and that colonisation would be faster where leaf litter was more scarce (clearcut). The study site was a small, fish-less stream, which had a section that was clear-cut in the winter of 1997 with no riparian buffer, and another section where the riparian vegetation consisted of dense second growth alder. The study was carried out near Williams Lake, British Columbia. The experiment was executed in two stages; in 1999 in the clearcut only, and in 2000 in both the clearcut and forested section. Replicate colonisation cages were filled with washed substratum, and were subjected to one of three treatments: no leaves, real leaves or artificial leaves. Cages were left in the stream for a week to allow colonisation, after which they were removed, the samples preserved and the experiment repeated. Background benthic assemblages were estimated at the end of the experiment from five Surber samples to enable an estimate of the relative speed of colonisation. Results show that the cages were colonised differentially by shredders and detritivores (ANOVA: $F_{2,36}=13.9$, $p < 0.001$): real > artificial = no leaves, in terms of both species richness and abundances. These results suggest leaves are being colonised for their value as food and not microhabitat. Colonisation rates also differed significantly between sites at a community level, where the forested site was colonised faster than the clearcut (ANOVA: $F_{1,36} = 44.2$, $p < 0.001$). This result was not expected, and possible explanations will be discussed.

[\[POSTER\]](#)

Gregory, R.S., D.C. Schneider and B.J. Laurel

Environmental Sciences, Fisheries and Oceans Canada, Environmental Sciences and Memorial Univ. of NF, Ocean Sciences Centre, St. John's, NF

Productive Capacity Of Eelgrass Habitat For Juvenile Atlantic Cod

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. In studies 1995-2001, we have been examining the functional relationships underlying the productive capacity of eelgrass nursery habitat in Newman Sound, Newfoundland. ♦ Spatial distribution of juvenile cod is poorly predicted on the basis of food supply. It is better predicted by the spatial complexity of eelgrass refugia and predator distribution. We have also shown that such relationships have implications for the distribution, habitat use, and possible survival rates of demersal juvenile cod in similar nursery habitats coastwide.

[SAT. 16:00]

Gregory, S.V. Department of Fisheries & Wildlife, Oregon State University, Corvallis, OR, ♦



Assessment of Restoration Potential for Fish and Riparian Plant Communities in the Willamette River in Oregon.

Historical analyses of river channels and riparian forests in the Willamette Valley reveal loss of physical complexity and riparian forests. ♦ We worked with stakeholders to identify three plausible scenarios for future landscape conditions. ♦ We sampled fish habitat and richness in the Willamette River and determined changes in channel structure, riparian vegetation, and fish assemblages in 1850, 1990, and 2050 under different scenarios. ♦ Fish assemblages in tributary junctions and multiple channel reaches contained greater fish richness than single channel reaches. Proportions of exotic species and fish with abnormalities increased downstream. Historical changes in habitat quality over the last 150 years were much greater than changes projected over the next 50 years for any scenario. ♦ In the future, local sites may experience large changes, but the landscape in general will face lower rates of degradation than observed in the past. Spatially explicit analyses of habitat conditions and human activity reveal locations where ecological restoration may be great and social obstacles are small. ♦ We developed an integrated analysis of ecological potential and anthropogenic constraints for restoration and spatially depicted patterns for future restoration and conservation. ♦ Some sites offer slight restoration potential but the social pressures are intense, making them unsuitable for restoration. ♦ Other locations with high ecological potential but high social obstacles offer opportunities to lower social limitations through policy changes. ♦ Areas with high human densities offer opportunities for public education through day-to-day experience and examples. ♦ Integration of biophysical and socioeconomic properties of rivers has major implications for long-term success in river restoration.

[SAT. 11:20]

Gross, M.

Department of Zoology, University of Toronto, 25 Harbord Street, Toronto, Ontario, Canada M5S 3G5

Superior Fitness For Precocial Males In Salmon

Many salmon species have males called ♦ jacks ♦ that become precociously mature at a size smaller than ♦ hooknose ♦ males and females. ♦ ♦ Why such jacks exist has long been a controversial question. ♦ Gross (1985) suggested that their higher probability of surviving to maturity combined with their use of sneaking to avoid hooknose males can result in approximately equal lifetime fitnesses for jack and hooknose males. ♦ In this presentation I show that the lifetime fitnesses of jack males is probably superior

to that of hooknose males. ♦ I use various data sets on frequencies and inheritances of jack males in coho and chinook salmon, and the conditional strategy model of Gross and Repka (1998), to calculate the relative fitnesses of jack and hooknose males. ♦ In both species, the calculations suggest that jacks have substantially higher fitnesses. ♦ Hooknose males are therefore the least fit individuals in the population. ♦ The conditional strategy model also predicts that jacks will be males with the highest genetic quality in the population. ♦ This suggests that the avoidance of jacks in hatchery programs over the past century may have contributed to a decline in the genetic quality of salmon populations, partially explaining the decline in body size and decreased production.

[\[FRI 13:40\]](#)

Haeseker, S.L. and M.L. Jones, Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, USA.

Quantifying Spatial And Temporal Uncertainties In The Abundance Of Larval Lampreys And Their Effect On Chemical Treatment Success In The St. Marys River

Effective chemical treatment of sea lamprey (*Petromyzon marinus*) larvae in the St. Marys River requires a reliable knowledge of their spatial distribution. ♦ However, surveys to adequately characterize the distribution cannot be conducted in the same year as the chemical treatment, thus raising questions about the accuracy of using historical survey data to delineate treatment areas. ♦ In this project we developed stochastic models that predict the abundance of larvae at a location in the next year based on data collected in the current year. ♦ Recursive application of this model can allow us to make stochastic forecasts for a location in space and time, and to simulate how population abundance may have changed from the time each location was originally mapped (1993-1996) until the time that the treatment took place (1999). ♦ Our approach to modeling was to develop two generalized linear models (GLMs). ♦ The first model estimates the probability that larvae would be present at a location, and the second model estimates parameters defining the probability distribution for larval abundance at that point, given that larvae were present. ♦ We applied these models to forecast a variety of possible abundance maps for the lampricide treatment that took place in 1999 in order to estimate the uncertainty in treatment effectiveness resulting from the spatial and temporal uncertainty in larval distribution. ♦ Our results suggest lower effectiveness than predicted when these uncertainties are ignored. ♦ These differences are most pronounced when less of the river is targeted for treatment. ♦ However, the large scale of the 1999 treatment may have compensated for the spatial and temporal uncertainty by targeting the majority of the high density areas in the river, leaving few areas with larval lamprey untreated.

[\[POSTER\]](#)

Haggarty, D. and M. Healey
Zoology Department, University of British Columbia, Vancouver, British Columbia.

Evaluating Juvenile Chum and Chinook Salmon Habitat in Burrard Inlet

Nearshore habitat loss and alteration is the main threat to the health of the marine environment in the Georgia Basin despite the no-net loss of productive fish habitat policy of the department of Fisheries and Oceans. One problem with maintaining productive fish habitat concerns the choice of the appropriate scale at which to assess habitat. We studied the habitat use of chum (*Oncorhynchus keta*) and chinook (*Oncorhynchus tshawytscha*) salmon in Burrard Inlet at three nested scales: the entire inlet; basins within the inlet; and sites within each basin. We sampled juvenile chum and chinook using different substrate types by beach seining, snorkeling and by observing chum from the shore. We also performed an analysis of the different nearshore substrate types found along Burrard Inlet's entire shoreline. Juvenile chum and chinook use nearshore habitats in Burrard Inlet from early spring to late summer. The abundance the two

species among the basins in the inlet corresponds to the strength of the runs of the nearby rivers and streams. More fish are therefore found at the western end of the inlet than the east. At the level of the site, juvenile chinook tended to use larger substrates such as bedrock, boulders and cobble than sand or mud. More juvenile chum were also found over cobble and gravel substrates than sand or mud. Juvenile salmon habitat can not, however, be solely assessed at the level of the site. Landscape-level metrics such as habitat connectivity, isolation, rarity, and abundance must be considered as juvenile salmonids must use a variety of nearshore habitats as they migrate to the sea. These habitat evaluation metrics are particularly important in urban situations such as Burrard Inlet that have already undergone considerable habitat alterations. Our analysis showed that 44.6% of Burrard Inlet's shoreline has already been altered. The Inner Harbour, at 79.7%, is the basin where most of the alteration has occurred.

[SAT. 9:50]

Healey, M.C., R. Lake and S.G. Hinch

Institute for Resources and Environment and Dept. of Forest Sciences, University of BC, Vancouver, Canada.

Energy Expenditures During Reproduction by Sockeye Salmon (*Oncorhynchus nerka*) of the Early Stuart River Stock complex, British Columbia, Canada.

From 1994 to 1996, behaviour and energy use by sockeye salmon spawning in Gluskie Creek, Stuart River drainage, British Columbia, was investigated using electromyogram (EMG) telemetry. ♦ The spawning life was 7.6 days for males and 10.6 days for females. ♦ Both sexes held in pools for a few days, with an average cost of 7.9 kcal/day, before starting to spawn. ♦ During spawning, dominant males performed 6 behavioural acts per 10 min, charging being the most frequent followed by quivering, chasing, digging, lateral and posture displays. ♦ Spawning females performed 4.4 behavioural acts per 10 min, digging being the most frequent followed by charges and chases. ♦ Following egg deposition, females entered a nest guarding phase and, in the latter stages of spawning, males adopted subordinate behaviour. ♦ Guarding females and subordinate males performed 1.1 and 1.6 behaviours per 10 min respectively. ♦ Lateral and posture displays by males lasted 6.3 s and 11 s respectively but all other behaviours lasted less than 2 seconds. ♦ Holding behaviour and posture displays required the most energy in males and holding and digging in females. ♦ Dominant males and spawning females expended 23.9 kcal/day whereas guarding females and subordinate males expended 11.0 kcal/day. ♦ Frequency of behaviours during active spawning was similar to other populations. ♦ Length of spawning life was shorter, however, and total energy expended was less than previous estimates based on body constituent analysis. ♦ Although EMG telemetry may underestimate total energy expenditure, recent data also indicate that energy available for reproduction was low in Stuart River sockeye due to declining average size and low energy reserves in fish arriving at the spawning grounds.

[FRI 10:40]

Heath, D.D., C.A. Bryden, J.W. Heath, E. Fillatre, L. Duke and J.M. Shrimpton

Great Lakes Institute for Environmental Research and Department of Biological Sciences, University of Windsor, Windsor, Ont.; Biology Program, University of Northern British Columbia, Prince George, B.C.; Yellow Island Aquaculture Ltd., Campbell River, B.C.

Inbreeding Depression In Pacific Salmon: The Myth And Reality

Inbreeding is a concern for managers assigned the task of conserving small, or at-risk, populations of animals. The basis for this concern is the possibility of inbreeding depression, or the reduction of fitness associated with loss of genetic variation due to mating between related individuals. Two key assumptions are implicit in these concerns for inbreeding effects: 1) reductions in population size lead to loss of genetic diversity, and 2) loss of genetic diversity is associated with reduced fitness. Although inbreeding

depression in small populations has been demonstrated in lab and field experiments involving various species, no direct evidence exists for Pacific salmon. We performed a series of experiments designed to detect and quantify the fitness consequences of inbreeding, or loss of genetic diversity, in chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*) and rainbow trout (*O. mykiss*). In a farmed population of chinook salmon, we found only limited support for relationships between genetic diversity and a wide array of fitness parameters. Using temporal data, we found only weak support for the expected relationship between population size and population genetic diversity. ♦ When we examined an isolated population of rainbow trout that exhibited extremely low levels of genetic variation at microsatellite loci, we found they had normal growth rates, liver condition index, and levels of fluctuating asymmetry. These data combined suggest that Pacific salmonids may have evolved resistance to inbreeding depression due to their propensity for frequent population bottlenecks.

[SAT. 16:20]

Heinzelmann, Frank University of British Columbia, Forest Resources Management, Forest Sciences Center, 2045 - 2424 Main Mall, Vancouver, B.C., Canada V6T 1Z4, Tel. 604.866.4383, Fax 604.224.5687, E-mail heinzelm@interchange.ubc.ca
President, ForestWerks Research & Consulting Inc. ,Tel. 604.866.4383, Fax 604.224.5687, E-mail Frank.Heinzelmann@ForestWerks.ca <http://www.ForestWerks.ca>

Predicting Relative Effects Of Forest Management On Coastal Fish Stream Habitat

Impacts of forest management options on small and intermediate stream habitat in coastal British Columbia are simulated in a semi-hypothetical landscape. The approximation of harvest-induced changes in runoff pattern, sediment input, and large woody debris (LWD) recruitment, and their impact on the stream channel network and hence aquatic habitat, are built into a pixel-based, stochastic model. This coastal watershed processes and forest management simulation is based on the assumption that major precipitation events and the ensuing storm runoff are 'driving' the system. These major events initiate debris torrents, mobilize sediments, and entrain LWD in stream channels, and result in changes in stream habitat characteristics. The model represents these processes and approximates the cumulative, downstream-propagating impacts on the stream system and coho salmon (*Oncorhynchus kisutch*) stream habitat. I contrast the following management options: 1) rate of harvest; 2) alternative spatial harvest patterns; 3) alternative temporal harvest patterns; and 4) road density of alternative harvesting systems. Results of sensitivity analysis for key parameters and Monte Carlo runs for management scenarios are presented and implications for forest management are discussed.

[POSTER]

Henderson, B.A., N.C. Collins¹, G. Morgan², and A. Vaillancourt³

¹Department of Zoology, University of Toronto; ²Co-operative Freshwater Fisheries Unit, Laurentian University, and; ³Ontario Ministry of the Environment

Sexual Size Dimorphism Of Walleye (*Stizostedion vitreum*)

Sexual size dimorphism (SSD) of walleye (*Stizostedion vitreum*) is achieved by females having higher growth rates before and after maturation, resulting in females with greater asymptotic sizes. ♦ Superior growth of females is not a function of greater consumption, but higher growth efficiency (GE). ♦ Growth efficiency of both sexes declines with age and size, but the GE of mature males is substantially lower than immature males and mature females. ♦ We propose that the inferior GE of males is a function of the greater activity of males, particularly during the spawning season. ♦ Bioenergetics inferred from Hg levels in axial muscle, assuming that Hg loadings are correlated with consumption. ♦ Hg loadings were determined from a maximum of 20 walleye from each lake (N= 31 lakes, 1998-99). ♦ Forklength (mm), age (otoliths), sex, and maturity were recorded for all walleye sampled from autumn gillnet surveys of these 31 lakes. ♦ Growth efficiency by sex, age, and maturity is estimated by a ratio of annual increments in weight ♦ (g) to annual increments of Hg (mg), using the pooled growth and Hg loadings of males and

females from the 31 lakes. ♦ Sexually dimorphic growth is described by a non-linear fit, using the size of the ten largest walleye (L4), to estimate k , and t_0 , corresponding to the von Bertalanffy growth equation Hg loadings were estimated by regressing Hg burdens by age and sex. ♦ Comparisons are made with other fish species for which growth and Hg loadings are available.

[SAT. 9:30]

Hengeveld, H.G. The Meteorological Service of Canada, Canadian Climate Centre, 4905 Dufferin Street, Downsview, Ontario, M3H 5T4

Global Climate Change: What ♦s Happening and What Can We Expect?

Observations indicate that the 20th century has been the warmest of the past millennium, and that recent decades have produced large changes in land ecosystems, in Arctic Ocean ♦ sea ice cover and in several other aspects of the global climate system. Indications are that the changes during at least the past 50 years are due to human interference with the climate system. Projections for a business as usual world suggest global temperatures may warm by an addition 1.4 to 5.8C by 2100, and that changes over much of Canada may be twice as large. Polar regions are expected to warm even more while, in contrast, changes in ocean circulation could cause some regions of the northern Pacific and Atlantic to experience little warming or even some regional cooling. These changes in temperatures, which will be unevenly distributed in space and time, will be accompanied by as yet poorly understood changes in atmospheric circulation, precipitation patterns and of weather in general. While efforts to mitigate the causes of such changes may help to reduce the rates and ultimate magnitude of change, large changes are already unavoidable. ♦ The presentation will provide latest results on the science behind these conclusions, and will briefly reflect on the need for better understanding of how the projected changes may affect the physical environment in order to develop adaptive strategies for optimizing ecological and human response to such changes.

[FRI 10:20]

Holmes, J.A.¹, S.S. Crawford², D.L.G. Noakes¹ and D.A. Wismer³

1 Axelrod Institute of Ichthyology, University of Guelph, Guelph, Ontario. ♦ 2. ♦ Chippewas of Nawash First Nation, Wiarton, Ontario. 3. Ontario Power Generation - Nuclear, Toronto, Ontario.

Sounding Out Fish: Distribution And Abundance Of Whitefish Near Douglas Point, Lake Huron

The Bruce Nuclear Power Development (BNPD) has operated on the eastern shoreline of Lake Huron for 30 years, but the impact(s) of this facility on lake whitefish (Coregonus clupeaformis) and round whitefish (Prosopium cylindraceum) in the main basin have never been investigated. We used a 710 kHz single-beam and 120 kHz split-beam hydroacoustic equipment to survey a 140 km² area around Douglas Point in November 2000 to determine if whitefish are present near the BNPD during the fall spawning period. ♦

Gillnets were set concurrently at 8 locations (12- and 28-m depths on 4 transects) for validation. ♦ During nighttime surveys acoustic estimates of fish biomass (SA) were about two times higher than estimates along the same transects during the day. ♦ Gillnet data are consistent with the hydroacoustic data in that daytime sets were largely ineffective, with CUE ranging from 0 (4 sets) to 60.4 fish/16 hrs (1 set). ♦ During nighttime sets fish abundance was higher with CUE ranging from 8.2 to 162.5 individuals/16 hrs fished. Acoustic estimates of pelagic and benthic fish biomass tended to increase from north to south and are consistent with overall fish abundance and lake whitefish relative abundance. ♦ The finding that the hydroacoustic and gillnet datasets exhibit similar north-south trends provides validation of the hydroacoustic sampling and supports the conclusion that the observed pattern of biomass distribution is real and may be related to lake whitefish behaviour. ♦ The high abundance of lake whitefish south of the BNPD on Transect 10 is near a rocky point with extensive shoals and adjacent beaches. ♦ These habitat conditions are important spawning sites elsewhere in Lake Huron. ♦ Thus, we hypothesize that spawning

may occur in this area and that the high relative abundance is consistent with the aggregation of pre- or post-spawning fish.

[\[POSTER\]](#)

Hoover, T.M., and N. Yonemitsu Department of Civil Engineering, University of British Columbia, Vancouver, British Columbia

A Rule-Based Model For The Evaluation Of Invertebrate Transport Processes In Streams

Invertebrate drift is the downstream transport of benthic invertebrates by stream current. ♦ Invertebrate drift in streams has received considerable attention from ecologists because of its importance in invertebrate dispersal, population dynamics, and trophic interactions. Current models of invertebrate drift make two primary assumptions: 1) invertebrates behave like passive particles when drifting, and 2) streams are simple, longitudinally homogeneous channels. ♦ However, invertebrates may alter their sinking rates by swimming or modifying their body posture, and streams are generally composed of subunits with distinct physical properties (e.g., riffles and pools). In order to examine the potential importance of these factors for invertebrate dispersal, a simple rule-based walk model was developed. Each iteration of the model consists of the path generated by the movement of a ♦ particle ♦ (i.e., an invertebrate) through a simulated 2-D stream landscape. Particle step length is modelled as a function of water velocity, turbulence intensity, particle settling velocity, and directional settling bias (to simulate swimming or other behavioural modifications of settling velocity). Two sets of trials were conducted; the first in a homogeneous landscape (with no longitudinal variation in depth or velocity), and the second in a structured landscape (velocity and depth vary in simulated riffle-pool sequences). ♦ The results of the model suggest that stream invertebrates, by modifying their sinking rates, may control their transport distances, and avoid aggregating in depositional areas of the streambed. This suggests that in natural systems, stream invertebrates may exert control over settling location, allowing individuals to locate suitable patches of benthic habitat and avoid drift-feeding predators while drifting.

[\[POSTER\]](#)

Howland*, K.L., Tallman, R.F.

Life History Variation In Lake Trout, Salvelinus namaycush, In Great Bear Lake, NWT: Implications For Future Research And Management

Great Bear Lake represents one of the only remaining large lake trout populations in North America, thus providing a unique opportunity to study natural variability of this species in a large lake system with few competing predators. ♦ Great Bear lake supports a trophy lake trout fishery as well as a small subsistence fishery in Keith Arm (near the community of Deline). ♦ It is currently managed by geographic area under the premise that trout exhibit minimal movement between different arms of the lake. ♦ As part of our research, we have been collecting baseline biological data on lake trout in the Keith Arm area to determine productivity of the stock and safe harvest levels. Our findings have shown that lake trout in the Keith Arm area of Great Bear Lake exhibit considerable life history variation and may be comprised of more than one form, a situation that has also been observed in other large lakes such as Great Slave Lake and the Southern Great Lakes. ♦ This variation has been extinguished in these more southerly populations due to overexploitation. ♦ We discuss the implications of our findings to future research and management of lake trout in Great Bear Lake. Past surveys have found removals of up to 18,000 trout/year by sport fishing alone with associated changes in population parameters indicative of exploitation. ♦ Recently proposed community initiatives are expected to increase tourism and associated sport fishing activity. Given our results and the example of other large lakes we believe it is important to direct research towards understanding the underlying source of life history variation in lake trout stocks. ♦ For instance, if different forms exist, are they reproductively and/or ecologically separated? ♦ If so, what is the relative abundance,

productivity and vulnerability of each form?

[\[POSTER\]](#)

Howland, K.L., J.D. Reist, W.M. Tonn and R.F. Tallman

Postglacial Dispersal Patterns And Genetic Relationships Among Inconnu Populations In The Western Arctic

Inconnu (*Stenodus leucichthys*) in the Mackenzie River system, NWT, are represented by two life history forms, which differ in migratory behavior, habitat use, and various life history traits. Populations in the lower Mackenzie River region are anadromous, whereas those in the Great Slave Lake area are year-round residents of freshwater. ♦ The origin and evolution of these life history forms is presently unknown. ♦ Inconnu most likely survived past glaciations in the Yukon R. (southern) as well as north draining watersheds of Beringia, and/or arctic Siberia (both of which contain freshwater and anadromous populations). Thus, they may have gained access to the now separated Mackenzie River watershed by one of several routes. ♦ In this study we examine the genetic relationships of inconnu populations within and outside the Mackenzie River system to gain insights about how this species initially colonized the Mackenzie River basin. We surveyed 11 western Arctic, and 1 Siberian population for sequence variation in the d-loop region of mitochondrial DNA. ♦ Preliminary results suggest that inconnu in the Mackenzie watershed originated from Beringia, although it is unclear whether they gained access to these areas via a northern coastal route or through inland post-glacial connections with the Yukon River system. Higher genetic diversity in the Alaskan populations is consistent with the idea that these are source populations which survived past glaciations in the Beringian refugium and therefore have a longer evolutionary history than populations in the Mackenzie Basin.

[\[POSTER\]](#)

Huato, L.

Department of Zoology, University of British Columbia, Vancouver, British Columbia

A Spatially Explicit Fitness Based Model For Predicting The Migratory Behavior In Fishes With Ontogenic Migrations. A Case Study Of The Marine Migration Of Sockeye Salmon From The Fraser River

Fish species with ontogenic migration have time-and-space constrained reproduction, they spawn at a specific time of the year at a specific geographic location, and their migratory behavior is considered a fitness maximizing strategy. Under these considerations I developed a spatially explicit optimality model based on the assumption that the oriented swimming behavior required during active migration interferes with the search process required for foraging, and leads to a trade-off between migration time and foraging time. Therefore, the migration pattern observed in a population is an optimal response to constraints imposed by environmental conditions in the area where migration occurs and the time available until reproduction. The application of this model to the sockeye salmon from the Fraser River successfully predicted the following characteristics of their marine migration in the NE Pacific: 1) Juveniles migrate along the coast and then move into the Alaska Gyre where they stay the rest of their oceanic residence. Model predictions do not support the commonly held hypothesis of an annual circuit around the Alaska Gyre. 2) The juvenile migration arises as a response to high zooplankton density in the coast at the time of the migration, although the high risk of mortality there creates a bottleneck in their life cycle. 3) Sockeye salmon has a seasonal growth pattern as a response to the seasonality of zooplankton density in the NE Pacific. 4) Juvenile fish display higher swimming migration activity than adults. 5) Individuals behaving optimally distribute below the observed thermal limits, however their distribution follows that of prey density. 6) The size-dependency of mortality observed during the smolt-to-adult phase likely arises from smaller individuals taking longer to swim through the coast.

[\[SAT. 11:00\]](#)

Hunter, K.L. ¹ and M.G. Fox ²

¹Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario.

²Department of Environmental and Resources Studies and Department of Biology, Trent University.

Reproductive Allocation And Growth Of The Mummichog (Fundulus heteroclitus) In Salt Marsh Habitats Of New Jersey, USA.

Spatial variation in the allocation of energy to reproduction and growth of the mummichog (Fundulus heteroclitus) was studied in the Jacques Cousteau National Estuarine Research Reserve, New Jersey, USA. Four subtidal creeks and four marsh pools were selected in the Reserve for reproductive condition and growth analysis. In phase with the lunar spawning cycle of mummichog, females were collected bimonthly from May to August 2001 using standard minnow traps. During peak spawning, 13% of individuals had a GSI higher than 20%. Fish from both habitats began entering a reproductively quiescent phase in mid-July which is characteristic of the annual reproductive cycle of this species at this latitude. Preliminary analysis of GSI data suggests that fish inhabiting pools enter this phase at least one spawning cycle prior to creek fish. It also appears that the pattern of energy allocation to spawning differs between habitat types, where the reduction in allocation over time is more conspicuous in pool fish. We are analysing growth trajectories and various biophysical factors which may be attributable to these findings. There has been little emphasis on variation of life history traits between creek and pool fish populations that inhabit salt marshes. Comparing reproductive and growth potentials could highlight the importance of habitat diversity in these systems.

[FRI 13:40]

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

Growth And Production Of Young-Of-The-Year Arctic Grayling In Natural And Artificial Tundra Streams

To effectively assess or predict the effects of changes to habitats on which fish populations depend, fisheries biologists need to understand species habitat requirements and how habitat characteristics relate to productivity. This is not the case for many aquatic systems in arctic North America, where industrial activity is increasing rapidly, particularly for streams that are home to Arctic grayling (Thymallus arcticus). We examined the growth of young-of-the-year grayling in relation to fish density and habitat quality, including food quantity and quality, stream water temperature, and habitat structure in several natural and one 3.4-km artificial tundra stream in a remote region of the Barrenlands, Northwest Territories, from 1998-2000. Growth was approximately 65% lower in the artificial stream than in natural streams where habitat complexity was higher. Chironomidae and Simuliidae dominated the diet of young-of-the-year grayling in both the artificial and natural streams. Invertebrate drift, particularly large organisms, (e.g., Chironomidae and Simuliidae) were less abundant in the artificial than in natural streams. Benthic invertebrate densities and biomass were marginally and significantly greater in natural streams, respectively. Stream water temperatures in natural streams were also consistently warmer than in the artificial stream by 1 °C. A bioenergetics model indicated that approximately 70% of the differences in growth among natural and artificial streams may be due to food availability, with temperature explaining the remainder.

[SAT. 16:40]

Jordaan, A. and L.J. Kling School of Marine Sciences, University of Maine, 214 Libby Hall, University of Maine, Orono, Maine ♦ 04469 USA

To What Degree Can Cod (Gadus morhua) Larvae Buffer Against A Change In Temperature During Development

Changes in the average temperature of ocean environments will likely influence the range limits of marine species. However, increased variation in oceanographic conditions which overlap temporally and spatially with developing eggs and larvae could have more significant short term effects on survival. Since maternal thermal history has an effect on the temperature tolerance limits of developing eggs and larvae, it becomes important to relate larval performance to parental temperature conditions. This will hopefully lead to a better understanding of how larval stages are affected by changes in temperature during development and what magnitude of change might significantly influence survival. In the present study, three batches of cod (Gadus morhua) eggs were acquired from an adult broodstock held at 4.5-5.5 degrees Celsius. The eggs were divided and acclimated to 4 constant temperature regimes maintained between 1 and 12 degrees.

Observations on development, growth and survival were made approximately every 4 degree days (mean temperature X number of days). Size and stage at hatch, development, yolk-sac absorption, growth after the yolk sac period and survival will be compared at the different temperatures and discussed in relation to the temperature of the parental stock. Conclusions will be presented in an attempt to integrate ideas from fish physiology, fisheries biology and some basic oceanography.

[\[POSTER\]](#)

Josh L. Taylor

Aquatic Resources Limited, Vancouver, British Columbia and Steven K. A. Arndt, Columbia Basin Fish and Wildlife Compensation Program, Nelson, British Columbia

Inter-Annual Variation In Burbot Cohort Abundance In Columbia Lake, British Columbia

Declines in some burbot populations and increased interest in the conservation of biodiversity have stimulated greater interest in the biology and management of burbot. This study examines the growth pattern and inter-annual variation in cohort abundance of burbot in Columbia Lake, British Columbia. Growth was examined using otoliths from burbot sampled in shoreline habitats, a recreational fishery, and a spawning tributary between 1995 and 2001. Estimated lengths of Columbia Lake burbot after one, five, and ten years were 16.4, 49.0 and 60.2 cm, respectively. Thirty-nine cm appears to be a threshold above which they begin to recruit to the ice fishery and no longer inhabit shoreline habitats. Variation in cohort abundances was determined using changes in juvenile abundance from 1997 to 1999, changes in spawner abundance and length frequency distribution in a tributary from 1996 to 2001, and the adult size at age data described above. Spawner numbers declined from about 1400 in 1996 and 1997 to 86 in 1999. By 2001, however, spawner abundance had rebounded sharply to 1000. A five year period of relatively low cohort abundance, 1994 to 1998, between two years of relatively high cohort abundance, 1993 and 1999, underlies this fluctuation in spawner abundance. The 1999 cohort, in being more abundant than the 1997 and 1998 cohorts at the adult stage but not at the early juvenile stage, demonstrated the potential for processes operating during the juvenile stage to have a substantial influence on recruitment success. Possible explanations for the exceptional juvenile survival of the 1999 cohort include density dependent intra-specific competition, delayed density dependent cannibalism, and/or increased juvenile habitat availability due to unusually high water levels. Although the density independent effect of environmental stochasticity on early mortality is probably the primary cause of variation in burbot cohort strength, delayed density dependent processes such as cannibalism could have a role in propagating the recruitment variation initiated by environmental stochasticity.

[\[SAT. 11:40\]](#)

Juanes, F.

Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA, USA, 01003

The Allometry Of Cannibalism In Piscivorous Fishes

Cannibalism is a widespread phenomenon which can have strong population and community effects. ♦ In most fish species cannibalism is an occasional part of the diet, but in a few species cannibalized prey represent a major part of the diet. For example, conspecifics can represent up to 40% of the diet in silver hake (*Merluccius bilinearis*), 49% in walleye pollock (*Theragra chalcogramma*), and >70% in Cape hake (*Merluccius capensis*). In this study I compare the prey-size predator-size relationships of diets with and without cannibalized prey for four piscivorous species that are commonly cannibalistic and where large databases exist (Atlantic cod, *Gadus morhua*; silver hake; walleye pollock; and Cape hake). ♦ I then examine the resultant trophic niche breadths (range of relative prey size consumed) to quantify whether inclusion of cannibalized prey in the diet slows down the decline in trophic niche breadth that many large predators exhibit as they grow. When comparing diets including cannibalized prey to those without, consistent differences were found among all predator species. ♦ In all cases the slope of the upper bound was larger for cannibal predators compared to non-cannibals suggesting selectivity for larger cannibal prey which may be driven by higher rates of size-dependent capture success with familiar prey. ♦ The slopes of the upper bounds of the cannibal relative prey size vs predator size scatter also tended to be larger than the

non-cannibal slopes. ♦ Finally, for all species, mean trophic breadth of diets including cannibalized prey were larger than those not including cannibal prey suggesting that relatively large prey sizes may always be available for cannibals. ♦ Such a result implies a benefit for large cannibal predators but a potentially self-regulating process for younger (but large) conspecifics.

[SAT.16:20]

Keeley, E.R., E.A. Parkinson and E. B. Taylor

Dept. of Biological Sciences, Idaho State Univ., B.C. Fisheries Branch, UBC; Dept. of Zoology, UBC.

Ecotypic Variation In Rainbow Trout Morphology

Rainbow trout populations in British Columbia differ dramatically in life-history characteristics that may vary according to the ecological conditions 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 environmental features or 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 a population occupies a stream or lake environment. However, the presence of competitor fish species and the trophic level occupied by rainbow trout also seem to influence morphological variation.

[SAT. 15:20]

Kidd, K.(1), Palace, V.(1), Park, B.(1), Werner, J.(1), Evans, B.(1), Mills, K.(1), Podemski, C.(1), Salki, A.(1), Paterson, M.(1), Findlay, D.(1), Blanchfield, P.(1), McMaster, M.(2), Brown, S.(2), Van Der Kraak, G.(3), Lattier, D.(4), Toth, G. (4), Lazorchak, J. (4), Liber, K.(5), Londry, K.(6) and Graham, D.(7)

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(7) (7) University of Kansas, Lawrence, KS, 66045

A Whole-Lake Synthetic Estrogen Addition Experiment To Assess Effects Of A Hormone Mimic On Aquatic Populations.

There is increasing evidence that natural and synthetic estrogens in sewage effluents are impacting wild fish. ♦ It is not known whether the effects observed in individuals, such as egg protein production in males, are indicative of problems at the population level. ♦ A whole-lake addition experiment is being conducted at the Experimental Lakes Area, northwestern Ontario to assess the effects of a potent hormone mimic, the synthetic estrogen ethynylestradiol (EE2), on well-defined aquatic populations. For lake trout, white sucker, fathead minnow and pearl dace, we are examining effects at the biochemical (e.g. egg protein), tissue (e.g. gonadal development), organism (e.g. condition) and population (e.g. abundance) level. ♦ Impacts on community composition and species abundance are being examined for benthic and pelagic invertebrates, algae and bacteria. ♦ Effects on mink and green frog tadpole development are also being examined. ♦ Baseline data on these organisms were collected from the intended manipulation lake as well as reference lakes in 1999 and 2000, and these results are being compared to data collected during the whole-lake addition of EE2 in 2001. ♦ Mean water concentrations of EE2 during the whole-lake additions were 6 +/- 1 ng/L. ♦ To date, elevated concentrations of the egg protein vitellogenin and its mRNA have been observed in male fish in the treated lake. ♦ Initial responses in the fish populations as well as preliminary impacts upon the lower-trophic-level organisms will be discussed. ♦ Results will be critical in understanding the magnitude and timing of effects of hormone mimics on aquatic populations, and the risks these substances pose to wildlife.

[SAT. 9:30]

Kolodziejczyk, R.I. and J.S. Richardson Department of Forest Sciences, University of British Columbia, Vancouver, BC [renatai@interchange.ubc.ca]

Linking Riparian Tree Species Composition To Stream Community Dynamics: Effects On Fungal Biomass And Invertebrate Diversity, Density And Productivity

An important link in the relationship between terrestrial and aquatic systems involves the transfer of nutrients. Management of riparian vegetation can affect the ecology of a stream system through the alteration of tree species composition, which affects allochthonous litter inputs. Litter from different tree species varies in nutrient content, physical features, and susceptibility to aquatic fungal colonization. On this basis, we hypothesized that a change in species of leaf litter inputs to streams would result in changes within the benthic foodweb. To test this, litter from three tree species ♦ red alder (*Alnus rubra*), western redcedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) - were placed in streamside experimental channels individually and in combinations at the same input rate. The experiment was conducted over an 87-day period from August to October. Evaluation of the fungal biomass index (ergosterol) showed increases in hemlock up to twice that of alder or cedar treatments. Ergosterol increased in all treatments up to Day 69 then decreased, except for hemlock treatments, which remained high at 0.6 mg/g leaf. Hemlock treatments also showed increased genus level invertebrate taxon richness. Invertebrate data at Day 42 suggest a higher abundance of shredders in the alder treatment associated with a significant increase in the chironomid *Brillia* spp. The stonefly *Zapada* spp. and the caddisfly *Wormaldia* spp. also increased in abundance in the alder treatments. By Day 42, invertebrate abundance was not positively correlated to fungal biomass.

[POSTER]

Leavitt, P.R.(1), G. Chen (2,3), J.A. Rusak (1), O.G. Olson (1), S. Wunsam (1), B.F. Cumming (4), and K. Laird (4)

(1) Department of Biology, University of Regina, Regina, Saskatchewan, S4S 0A2

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(3) Department of Mathematics and Statistics, University of Calgary, Calgary, Alberta, T2N 1N4

(4) PEARL, Department of Biology, Queen's University, Kingston, Ontario, ♦ K7L 3N6

The Past, Present And Future Of Prairie Droughts

Severe droughts displaced up to 20% of humans in central North America during the 1930s and caused agricultural losses of \$35 billion USD in 1988-89. ♦ Similarly, water shortage is the largest source of crop insurance losses, yet drought risk assessments are based on fewer than 45 years of data. ♦ Here, we use 2000-year paleoclimatic records from saline lakes to estimate the risks of future catastrophic droughts for the northern Great Plains. ♦ Conditional probability analyses estimated up to a 45% likelihood of severe drought by 2030 AD, with 95% confidence limits of 33-67%. ♦ Based on past events, expected drought duration is 5-12 years, with declines in water quality due to blooms of potentially-toxic cyanobacteria. ♦ Strong correlations between fossil records, crop production and climate ($r^2 = 0.28-0.65$) during the 20th century show that risk assessments are relevant to agricultural economies and suggest that future losses may be in excess of \$450 billion USD. ♦ Scenario analyses show that while global-warming may increase drought occurrence, its impacts will be indistinguishable from those of natural variance for at least 30 years. ♦ Rather, we recommend development of flexible economic and social strategies that adapt to the inherent variance of drought occurrence. .

[FRI. 16:00]

♦ Lee, Chris G.¹, Anthony P. Farrell¹, Scott G. Hinch² and Michael Healey³

¹Department of Biological Sciences, Simon Fraser University, Burnaby B.C. Canada, V5A-1Y6

²Department of Forest Sciences, University of British Columbia, Vancouver, BC, Canada, V6T 1Z4

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Field Measurements Of Swimming Performance And Metabolic Expenditure With Hatchery-Reared And Transgenic Coho Salmon (*Oncorhynchus kisutch*) In Comparison With Wild Sockeye Salmon (*O. nerka*)

Metabolic rates (M_{O_2}), critical swimming speed (U_{crit}), and metabolic recovery were examined using a 471.2 L portable swim tunnel. We have established that high caliber respirometry field studies can be conducted in the field with adult salmon as our field measurements were comparable to laboratory measurements, except when fish were very close to spawning out. It was also established that metabolic differences exist among stocks and species and that depending on maturation state, a sexual dichotomy in U_{crit} exists. U_{crit} values and corresponding metabolic rates were 2.1 bl/s (15.1 mg O_2 /kg/L/min) at 18.0 °C for Seton sockeye, 1.6 bl/s (10.8 mg O_2 /kg/L/min) at 13.8 °C for wild Harrison sockeye, 1.7 bl/s (9.1 mg O_2 /kg/L/min) at 7.9 °C for Harrison hatchery-reared coho, and 1.3 bl/s (8.4 mg O_2 /kg/L/min) at 8.7 °C for transgenic coho. Transgenic coho were poorer and less efficient swimmers compared to hatchery-reared coho at the same temperature. The slower time-to-50% recovery in sockeye compared to coho may reflect a higher absolute performance. The sockeye stock that migrated further inland to spawn attained a greater U_{crit} speed and maximum aerobic capacity relative to coastal sockeye. Further research is being conducted on temperature effects among stocks.

[\[POSTER\]](#)

Levings, C L. and G. Jamieson ²

Fisheries and Oceans, Science Branch

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Marine And Estuarine Riparian Habitats And Their Role In Coastal Ecosystems, Pacific Region

We provide an assessment of the fish habitat significance of a particular ecotone of the marine and estuarine shoreline in British Columbia locations where aquatic habitat at higher tides merges into terrestrial habitat. Scientific data on these supralittoral areas, frequently called the "marine riparian" by managers, are scarce. There is evidence showing that unvegetated beach substrate in the marine riparian is used as spawning and incubation habitat for sandlance and surf smelt. Marine riparian is also recognized as rearing and migratory habitat for juvenile salmonids. Preliminary studies conducted at two locations in the Strait of Georgia in February and March 2001 showed that a variety of arthropods are potentially available as fish food from intact marine riparian habitats. The functional importance of marine riparian is likely to be related to food production, temperature regulation, wave energy absorption, and provision of structure as well as indirect ecological value. As an interim measure, based on the sparse available literature, we recommend that a site specific approach be taken to buffer zone widths to manage the marine riparian. Gravel, sand, or cobble beaches may be most susceptible to erosion and sediment sloughing from land, depending on backshore conditions.

[\[FRI 14:20\]](#)

Macgregor, B.W., R. M. Peterman, B. J. Pyper and M.J. Bradford²

School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, CANADA, V5A 1S6

Canada Department of Fisheries and Oceans, Cooperative Resource Management Institute c/o School of

²Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, CANADA, V5A 1S6

A Decision Analysis Framework For Comparing Experimental Designs Of Projects To Enhance Pacific Salmon

Fisheries management agencies are involved in many activities to enhance Pacific salmon (*Oncorhynchus*

spp.). ♦ Monitoring the performance of pilot projects prior to making a decision whether to apply a particular method of enhancement on a wide scale will result in better investment decisions. ♦ However, the costs of monitoring can be substantial. ♦ We developed a quantitative framework based on decision analysis to determine whether the expected value of information obtained through monitoring exceeds the costs of obtaining that information. ♦ We applied this framework to a hypothetical decision problem in which managers have a fixed budget to construct groundwater-fed side channels for chum salmon (*O. keta*) and must choose how much, if any, of their budget to allocate to monitoring. ♦ We used this example to identify the conditions under which monitoring can generate positive net economic returns and the characteristics of experimental designs for monitoring that yield the greatest economic benefits. ♦ The choice between monitoring or not monitoring prior to making a decision to apply enhancement on a wide scale depended critically on the probabilities placed on alternative hypothesized effects of enhancement. ♦ In addition, economically optimal experimental designs for monitoring programs generally had low statistical power. ♦ Thus, in cases such as ours, improvements in management performance from adopting statistically powerful experimental designs may not outweigh the potentially high costs of measuring the effects of enhancement on Pacific salmon.

[\[SAT. 9:50\]](#)

Mackenzie-Grieve, Jody and ♦ J.R. Post ♦ Department of Biological Sciences,
The University of Calgary, Calgary, Alberta.

Behavioral Thermoregulation In Lake Trout (*Salvelinus namaycush*) With Applications To Predicted Impacts Of Global Warming

Movements of lake trout in two lakes in the southwest Yukon Territory were studied over the summer and fall of 2001. ♦ Twenty lake trout in Dezadeash Lake were fitted with externally attached radio transmitters, and nineteen lake trout in Kathleen Lake were fitted with externally attached sonar tags. ♦ In general, lake trout in Dezadeash Lake appeared to move around more than those in Kathleen Lake. ♦ Lake trout in Dezadeash Lake, however, appeared to rely heavily on coldwater creek inlet areas for most of the summer. ♦ In many cases lake trout moved between inlet areas along one side of the lake until water temperatures dropped off in the main lake in the fall. ♦ Flow and temperature of the coldwater creeks flowing into Dezadeash Lake were measured over the summer. ♦ We expected lake trout would aggregate at inlet areas with the greatest flow and the least seasonal variation in flow. ♦ The data appear to support this prediction. ♦ The streams that appear to provide the most critical cold water habitat for lake trout are the result of

runoff from snowbeds in the Front Ranges of Kluane National Park. ♦ It appears, therefore, that in the short term summer thermal habitat for lake trout in Dezadeash Lake should increase as these snowbeds melt off. In the long term, however, the increased variability in precipitation, and reduced availability of cold water run-off (other than spring runoff) should decrease the availability of thermal habitat for lake trout in Dezadeash Lake.

[\[POSTER\]](#)

Mackereth, R.W., D.J. McCormick and K.D. ♦ Strilchuk
Centre for Northern Forest Ecosystem Research, OMNR, Lakehead University, Thunder Bay ON.

Spatial Scale Considerations For Assessing And Managing Risk Of Hydrologic Impacts To Stream Fish Habitat In Ontario ♦s Boreal Forest

Stream systems are functionally linked to the surrounding landscape and as such are particularly sensitive to land-use impacts. ♦ Management of stream habitat typically focuses on site specific protection and mediation without explicit consideration of catchment scale impacts. ♦ Addressing this problem may be complicated by the fact that management objectives at different spatial scales are often not compatible. ♦ Policies designed to protect fish habitat from forest management impacts in Ontario ♦s boreal forest illustrate the mismatch between spatial scales and management objectives. ♦ Ontario has site specific forest management guidelines to protect stream fish habitat that appear to be effective at preventing site level impacts such as sedimentation and shade loss. ♦ However, a number of studies in other regions have demonstrated that harvesting timber from more than 50% of a small stream catchment (less than 10 sq km) can cause increases in water yield and peak flows. These hydrologic changes may have detrimental impacts on stream fish habitat. ♦ To evaluate the risk of hydrologic impacts, Ontario requires forest companies to report the average percent area harvested over a 10 year period within 2nd order catchments. ♦ Our analysis of 2nd order catchment disturbance within the Black Sturgeon Forest Management Unit indicated two general problems. ♦ First, although average harvest was 12% (n=140), catchment size ranged from 0.1 to 51.5 sq km and streams across this range differ physically and biologically. ♦ Limiting the analysis to catchments of 1 sq km and less, considered to be most vulnerable, resulted in an average harvest disturbance of 24%. Second, catchment disturbance pattern differed between harvested and burned catchments (burned averaged over 70% disturbance, n=53). ♦ This shows that limiting harvest within small catchments is not compatible with the provincial objective of emulating natural disturbance patterns. ♦ Our results demonstrate that the management of stream fish habitat requires consideration of both the biologically appropriate spatial scale and socially acceptable management goals.

[SAT. 11:40]

MacNutt, Meaghan ♦ Scott Hinch and Tony Farrell

Swimming Performance And Energetics Of Sockeye (*Oncorhynchus nerka*) And Pink Salmon (*O. gorbuscha*)

Pacific salmon do not feed during spawning migration and rely on body reserves for all their energy requirements. Inappropriate allocation of energy due to inefficient migration limits the amount available for gamete production and could significantly reduce reproductive fitness. To assess the physiological limitations of migrating Fraser River salmon, the swimming performance and energetics of pink (*Oncorhynchus gorbuscha*) and sockeye salmon (*O. nerka*) were examined. These species are believed to be the weakest and strongest swimmers, respectively, of the Pacific salmon species. Two large mobile Brett-type respirometers were used to evaluate Ucrit, MO₂, TBF and recovery ability of 9 early Stuart sockeye and 32 upper Fraser River pink salmon. Sockeye were collected from the Hell's Gate Fishway in July 2001 and pinks were collected from Hell's Gate and the Seton Dam in September/October 2001. Fish performed modified ramp, repeat Ucrit tests at temperatures ranging from 9-22C. Preliminary analyses showed little difference between the critical swimming speed for sockeye and pinks, however pinks tended to consume more oxygen at a given swimming speed. For both species Ucrits were maximum between 15-16C. Contrary to our expectations, sockeye did not perform better than pinks, although our low sample size may have obscured differences.

[POSTER]

Magnan P., R. Proulx, F. ♦ Marched and J. Adams

Groupe de recherche sur les ♦cosyst♦mes aquatiques, Universit♦ du Qu♦bec ♦ Trois-Rivi♦res, C.P. 500 Trois-Rivi♦res (Qu♦bec) G9A 5H7.

Potential Mechanisms For Reproductive Isolation In Littoral And Pelagic Brook Trout, *Salvelinus*

***fontinalis*: A Hot Story!**

Brook trout, *Salvelinus fontinalis*, inhabiting oligotrophic lakes of the Canadian Shield often exhibit trophic polymorphism, where some individuals are better adapted to feeding in the littoral zone (◆littoral individuals◆) and others are specialists at feeding in the pelagic zone (◆pelagic individuals◆). The results of the present study show that (i) littoral individuals exhibited higher thermal preferences than pelagic ones when maintained in thermally stratified pelagic enclosures in the field, (ii) differences in thermal preferences between littoral and pelagic individuals were maintained after a short acclimation period to laboratory conditions but not after a long acclimation period, suggesting an effect of ambient temperature (acclimation) on individuals in the field, and (iii) littoral individuals spawned in the first two weeks of the spawning period while pelagic ones spawned in the last two weeks; the spawning period lasted 5-6 weeks. We present a conceptual model suggesting the potential role of temperature in reproductive isolation between the littoral and pelagic brook trout. [

[FRI 14:40\]](#)

Mazumder, A.

NSERC-Industry Research Chair program, Environmental Management of Drinking Water, Department of Biology, University of Victoria, Victoria, BC V8W 3N5, Email mazumder@uvic.ca

Integrated Ecosystem- And Watershed Management For Sustainable Clean And Healthy Drinking Water At The Source.

Quality of water is a top priority for Canadians, who consider clean water as fundamental for sound human and environmental health. During the last two years, Canada has been faced with several serious incidents of contaminated drinking water. These much-publicized incidents are only a small fraction of the actual problems faced by small to medium-sized communities across Canada. Most water quality problems originate at the source water ecosystems and watersheds. The management and protection of source water are critical because 75 to 80% of Canadian communities use surface water of lakes, reservoirs, streams and rivers as primary sources of water for drinking, agriculture, industry and recreation. Yet, relatively little effort is given to the management and protection source water ecosystems and watersheds. The majority of surface water ecosystems and watersheds in Canada are facing multiple land- and water-use activities in an unsustainable manner because the science, policy and regulations needed for best land and water resource practices are not available. It is becoming more and more difficult to sustain clean water at the source as a result of wide spread environmental stresses. These include pollutants, changes in hydrology, changes in land-use practices and unsustainable exploitation of natural resources. Currently, a major emphasis is on the filtration and disinfection of water. There is no doubt that the removal of pathogens from source water by the best treatment technology must be a top priority, but we cannot continue to apply more intense treatment processes in the face of source water degradation. We must realize that more intensive treatments produce higher concentrations of treatment byproducts, some of which are known to be carcinogenic to humans. Furthermore, it is often less costly and less risky to sustain good water quality at the source rather than to install larger and more complex treatment facilities. Successful science and policy development for sustainable clean water is inter- disciplinary and falls under vastly different disciplines, funding systems and government jurisdictions. Ecosystem and watershed management and protection integrating environmental, health, economic and policy issues of sustainable clean water are yet to be fully developed in Canada. I will discuss the integration of science, policy and regulations needed to minimize the contamination and deterioration of water quality at the source so that the water quality degradation at the tap and associated risks can be minimized, and that the society benefits from added protection at modest additional cost.

[\[SAT. 9:10\]](#)

McCormick, D.J., R.W. Mackereth and K.D. Strilchuk. Centre for Northern Forest Ecosystem Research, OMNR, Lakehead University, Thunder Bay ON.

Assessing Risk Of Hydrologic Impact To Stream Fish Habitat In Ontario◆s Boreal Forest: A Comparison Of Catchment Scales And Disturbance Types

Forest management practices, such as clearcutting, temporarily removes vegetation from large areas which may have an impact on the hydrologic cycle. ♦ A number of studies have demonstrated that harvesting timber from more than 50% of a small stream catchment (less than 10 sq km) can cause increases in water yield and peak flows. These hydrologic changes may have detrimental impacts on stream fish habitat. To evaluate the risk of hydrologic impacts, Ontario requires forest companies to report the average percent area harvested over a 10 year period within 2nd order catchments (as delineated at a 1:20 000 map scale). ♦ We analyzed disturbance within the Black Sturgeon Forest Management Unit in order to: 1) evaluate how harvest ♦ area was distributed among all 2nd order catchments, 2) compare the extent of disturbance within harvested and burned catchments, and 3) compare the distribution of areas disturbed by harvest and fire using area-based catchment delineation. Of the 822 2nd order catchments delineated in the unit, most (n=592) were not disturbed during the 10 year period. ♦ Harvested catchments (n=140) averaged 12% disturbance and fewer than 10 had greater than 50% disturbance. ♦ Burned catchments (n=53) averaged 70% disturbance with only a few catchments disturbed less than 50%. ♦ Second order watersheds account for 60% of the total forest area and range in size from 0.1 to 51.5 sq km. ♦ However, streams draining catchments across this size range differ significantly in their fish and invertebrate communities and in the risk of habitat impacts resulting from hydrologic changes. ♦ Area-based analysis on catchments of 1 sq km and less, considered to be most vulnerable, resulted in an average harvest disturbance of 24%, with 45 catchments having greater than 50% disturbance. ♦ Our results indicate that the interpretation of catchment disturbance is influenced by the spatial scale considered and that the management of fish habitat requires a more explicit consideration of scale. [

[POSTER\]](#)

McDermid, J.L., J.D. Reist and R.A. Bodaly | University of Winnipeg, Department of Biology, Winnipeg, Manitoba, 2 Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba

Phylogeography And Postglacial Dispersal Of Whitefish (Coregonus clupeaformis Complex) In North America

Three nominate forms comprise the Coregonus clupeaformis complex in North America, C. clupeaformis, C. nelsonii, and C. pidschian. ♦ These forms are closely related to their European and Russian relatives, C. lavaretus and C. lavaretus pidschian. ♦ Samples of whitefish from Quebec to Alaska were analyzed using direct sequencing of the mitochondrial DNA control region. Haplotype distributions determined probable glacial refugia and subsequent dispersal following Pleistocene glaciation. ♦ Three distinct taxa were identified. ♦ 1) One haplotype representing Mississippian C. clupeaformis was present across Canada from Quebec to the eastern side of the Mackenzie River, Northwest Territories, with approximately 96% of all populations sampled being characterized by this haplotype. 2) Two additional haplotypes believed to represent C. nelsonii or C. clupeaformis characterized fish from southern Yukon and Alaska and sites in the Yukon River and its tributaries in central Alaska. ♦ These fish are suspected as being of Nahanni refugial origin. ♦ 3) Northern and western coastal populations from Alaska are characterized predominantly by an additional haplotype believed to represent C. pidschian. ♦ The lower Mackenzie River appears to be a mixture of Mississippian C. clupeaformis, Nahannian C. clupeaformis/C. nelsonii, and C. pidschian. Relationships among the taxa indicate North American nominate C. pidschian is closely related to Eurasian C. lavaretus and C. lavaretus pidschian; whereas Mississippian C. clupeaformis and Nahannian C. clupeaformis/C. nelsonii, share similarities with the Reeska form of C. lavaretus from Finland.

[\[POSTER\]](#)

Mclaughlin, R. L. Department of Zoology, University of Guelph, Guelph, Ontario

Impacts Of Low-Head Barriers On Stream Fishes: Selection For More Headwater-Type

Assemblages

This study examines the nature of the impact that small, low-head barrier dams used in the biological control of parasitic sea lamprey (*Petromyzon marinus*) in the Laurentian Great Lakes have on fish assemblages in tributary streams. ♦ Four scenarios were developed to predict the nature of impact in terms of more downstream- vs. more upstream-type assemblages. The scenarios were tested using fish assemblage data from 24 matched pairs of barrier (with barrier) and reference (without barrier) streams. ♦ At the assemblage level, canonical correspondence analysis indicated that low-head barriers favour more headwater-type assemblages above a barrier. ♦ At the species level, lentic-lotic generalists were under-represented above real barrier locations in barrier streams, relative to above hypothetical barrier locations in reference streams, while lotic specialists were not. A seasonal mark-recapture study demonstrated that the barriers restrict the movements of some fishes. ♦ These analyses support the hypothesis that low-head barriers favour more headwater-type fish assemblages above the barrier through declines in the abundances of lentic-lotic generalists and prevention of colonization from downstream. .

[\[FRI. 15:20\]](#)

McLean, Jennifer E., Paul Bentzen and Thomas P. Quinn
School of Aquatic and Fishery Sciences University of Washington Seattle WA

Differential Reproductive Success of Sympatric Naturally Spawning Hatchery and Wild Steelhead, *Oncorhynchus mykiss*

Hatchery propagation of salmonids has had a long history in North America and Europe. ♦ Decreases in the abundance of wild salmon and efforts to mitigate these declines through hatchery production have greatly increased the relative abundance of hatchery fish. ♦ Although issues such as overharvest of wild populations by fishing mixed hatchery and wild stocks have been of concern for a number of years, genetic interactions such as hybridization, introgression and outbreeding depression are a more recent focus of investigations. ♦ Our goals were to examine whether a newly-established hatchery population of steelhead successfully reproduce in the wild, and to compare their rate of reproductive success to that of sympatrically spawning native steelhead. ♦ We used 9 microsatellite loci to create allele frequency profiles for baseline hatchery and wild populations and assigned the offspring of this parental generation to a population of origin. ♦ The hatchery fish (originating from a different river system location and artificially selected for early return and spawn timing) did reproduce in the wild; however, the reproductive success of hatchery fish spawning in the wild was much less than that of the wild fish. ♦ This is the beginning of a long term study at Forks Creek in southwest Washington designed to examine factors important for reproductive success in salmonids, including body size, spawn timing and population of origin.

[\[FRI 11:20\]](#)

McPhail, J.D.
Department of Zoology, University of British Columbia, Vancouver, V6T 1Z4.

Molecular Identification Of Sculpins (*Cottus*) In The Canadian Portion Of The Columbia Basin

Five species of sculpins occur in the Canadian portion of the Columbia Basin. The taxonomy of three of the species (*C. asper*, *C. cognatus*, and *C. rhotheus*) is stable; however, the taxonomic status of two of the species (Columbia mottled sculpin, *C. bairdi*? and shorthead sculpin, *C. confusus*) are contentious. It is not clear that the Columbia mottled sculpin is the same species as the mottled sculpin in eastern North America and, west of the Continental Divide, there is argument about what species of sculpin occurs in the Flathead River (*C. bairdi* or *C. confusus*). Additionally, it is unclear what species of sculpin occurs in southwestern Alberta (*C. bairdi* or *C. confusus*). The cytochrome b gene and control region were sequenced in all five Columbia species as well as sculpins from the St. Mary River, southwestern Alberta, and an upper Missouri tributary in Montana. The data from both mitochondrial regions clearly demonstrate that the Flathead River sculpin is *C. confusus* and that the southwestern Alberta and upper Missouri sculpins are not *C. confusus*. The data also indicate that the Columbia mottled sculpin is closely related to the sculpins in southwestern

Alberta and the upper Missouri system; however, the relationship of these western members of the C. bairdi species complex to eastern North American mottled sculpins is still unclear

◆[FRI. 16:40]

McPherson, A.1,2, P.T. O'Reilly 2,3, M. Jones 2, and C.T. Taggart 1,2

1 Department of Oceanography, Dalhousie University, Halifax NS

2 Marine Gene Probe Laboratory, Dalhousie University, Halifax, NS

3 Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS

Spatial And Temporal Patterns Of Population Structure In Atlantic Herring

The marine fish genetics literature report limited evidence of population structuring in Atlantic herring. However, recently developed tetranucleotide microsatellite loci and greater than 1700 samples of spawning adults collected over a range of temporal and spatial scales provide increased resolution for examining population structure in this species. Further, by employing 2000 recently hatched larval samples collected at relatively small spatial scales on the Scotian Shelf, it becomes possible to address models related to the life history and the proposed population structuring mechanisms of herring.

[SAT. 15:40]

Mehranvar, L. and M. Healey

Department of Zoology, University of British Columbia, Vancouver, British Columbia

A Genetic Evaluation Of The Factors Affecting The Breeding Success Of Sockeye Salmon, *Oncorhynchus nerka*

Factors associated with the evolution of stable life history strategies in sockeye salmon were examined by relating the energy reserves, secondary sexual characteristics, and aggression to genetic reproductive success. ◆ Adult salmon were captured, a tissue sample taken for energy density, measured for secondary sexual characters, tagged, and released into four enclosures within a spawning channel. ◆ Six females and seven males were placed into each 3X10 m enclosure and their spawning behaviour recorded throughout spawning life. ◆ Additional tissue samples were taken from dead, spawned out fish for energy density and paternity analysis. ◆ Embryos were sampled from 3-6 pockets of eggs deposited by each female and reproductive success was inferred from microsatellites by applying a maximum likelihood method. ◆ In this paper we focus on the patterns of paternity in the four enclosures and among pockets within a redd. ◆ Within an egg pocket we found that usually one male fertilized most of the eggs but the most common father frequently differed among pockets. ◆ In one enclosure one male dominated paternity and two males fathered no offspring whereas in other enclosures paternity was more evenly distributed among potential fathers. ◆ In one enclosure males dominated individual females and usually fertilized all the eggs from that female whereas in another enclosure males moved from female to female and fertilized eggs from up to four females. These paternity results will be compared with aspects of male quality such as size, secondary sexual characteristics and energy reserves.

◆[SAT. 9:10]

Michelle Roberge*1, Scott G. Hinch², E.B. Taylor², Tim Slaney¹, Stoolo First Nations. ¹Aquatic Resources Limited, ²Department of Zoology, University of British Columbia, Vancouver, BC.

Movement And Genetic Relatedness Of Coastal Cutthroat Trout In Small, Coastal British Columbia Streams

Population size and genetic relatedness of coastal cutthroat trout populations in British Columbia are not well understood. ◆ An intensive study conducted in three coastal streams in 1998/99, revealed that coastal cutthroat trout moved between mainstem and tributary streams during the winter during high water

events. ♦ To assess the connectivity and genetic relatedness of coastal cutthroat trout populations within and between different streams and watersheds in the Lower Fraser River Valley, we have selected 10 streams in five different watersheds for intensive examination. ♦ We are using monthly recapturing of PIT tagged fish from set trap locations to examine individual growth and movement among and between streams over the fall, winter and spring of 2001/02. ♦ Tissue samples are being taken from each fish and will be used to determine the genetic make-up of cutthroat trout in each watershed. ♦ Preliminary results will be available at the time of the conference.

♦ [POSTER]

Minns, C.K.

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The Roles Of Uncertainty And Complexity In Assessing Net Change Of Productivity Capacity Of Fish Habitats

The Fisheries Act and the Policy for the Management of Fish Habitat are the guideposts for fish habitat science and management in Canada. The perspectives of science and management groups on needs and priorities are often mismatched. Scientists tend to take a systems view, expecting that management decision-making will be based on scientific methods, knowledge and data while granting that current resources are sparse. Managers usually have limited access to knowledge and data when processing specific proposals and generally adopt more pragmatic, non-scientific approaches to decision-making. Here, taking lake habitats as a case study, these varying perspectives are explored. While scientists see the linkages between fish and habitat as complex and uncertain, managers are pressing for science-based tools that are simple and certain. Reconciling these views is challenging. In lakes, at least, the patterns of empirical evidence suggest that uncertainty and complexity are here to stay. Nonetheless, there may still be ways to develop simple tools that are robust for practical decision-making by management. A simple pilot approach to assessing net change of productive capacity in lakes is proposed along with a means of assessing the impact of uncertainty on decisions.

[SAT. 13:40]

Mochnac^{*}, Neil J¹., James D. Reist², and G. Low.³ ¹University of Manitoba, Natural Resources Institute, Winnipeg, MB R3T 2N2 Canada (N.M.), ²Department of Fisheries and Oceans, Freshwater Institute, Winnipeg, MB R3T 2N6 (J.R.), ³Department of Fisheries and Oceans, Hay River, NT X0E 0R9 (G.L.).

Distribution And Biology Of Bull Trout Populations In Mountain Streams Of The Central And Southwestern Northwest Territories

During the summer and fall of 2000 ♦ 2001 fisheries surveys were completed in the Deh Cho and Sahtu regions of the Northwest Territories (NWT). Bull trout (*Salvelinus confluentus*) populations were found in the Liard (60 ♦ 36.092 ♦ N, 124 ♦ 02.071 ♦ W), South Nahanni (61 ♦ 36 ♦ 22.9 ♦ N, 124 ♦

48 ♦ 28.8 ♦ W), and Keele River (64 ♦ 14.99 ♦ N, 125 ♦ 59.74 ♦ W) watersheds. A linear discriminant function proven to be 100% effective in distinguishing bull trout from Dolly Varden (*S. malma*) (Haas and McPhail, 1991, Can J. Fish. Aquat. Sci. Vol. 48 pp. 2191-2211) was used to confirm the identity of the char captured. Repeated capture of bull trout over consecutive years at these sites indicate that self-sustaining populations occur in these areas. Growth, age, sexual maturity, and feeding habitats are summarized for populations from various streams throughout the region. Ages for all individuals were determined using thin sections from otoliths and pelvic fin rays. Preliminary data show that stream resident, fluvial and adfluvial life history types occur in the region. Results from the study suggest that populations found throughout these watersheds are relatively small, widely dispersed, and exhibit meta-population structure. The demonstrated sensitivity to perturbation displayed by bull trout populations in other areas, the presence of what appear to be small widely dispersed populations, and the existing and anticipated level of industrial development in the NWT present significant conservation and management challenges in the area.

[FRI. 16:20]

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

Habitat Preferences, Movement Patterns, And Home Ranges Of Coaster Brook Trout In Lake Superior

Named for their affinity to the nearshore waters of Lake Superior, coaster brook trout were abundant a century ago, but have since 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 ranges. Individual fish were also tracked at 4 hour intervals for a 24 hour period to determine diurnal movements and habitat use. Locations within Lake Superior were predominantly in areas less than 4 m deep and within 150 m of shore. Coaster brook trout were found to inhabit differing depths with respect to month, being located in significantly deeper areas in the months of July and August when surface water temperatures were higher than the tolerable range for brook trout. Twenty-four hour tracking revealed coaster brook trout residing in significantly deeper waters during daylight hours in comparison to nighttime. Home range estimates were calculated using a fixed kernel produced 95% and 50% probability contours for individual brook trout. Home range sizes of coaster brook trout varied from <1 km² to over 100 km² but was not correlated with the number of locations made per fish or fork length. Tagged coaster brook trout began ascending streams in late summer in both 1999 and 2000. Spawning occurred in early October in both years with brook trout reentering Lake Superior by mid-October. A total of 4 streams were utilized by coaster brook trout with fish exhibiting spawning site fidelity during the two year period. Stream reaches utilized by coaster brook trout were characteristic of moderate gradient, riffle-pool complexes, well-sorted gravels, cover, and groundwater input. These results suggest that coaster brook trout have specific habitat preferences in both the lake and stream. Identification and protection of these areas is critical to maintain these remnant stocks.

[POSTER]

Muchow *, Christine L. and John S. Richardson. Department of Forest Sciences, University of British Columbia, Vancouver, BC.

Aquatic Insect Diversity And Productivity In Intermittent And Continuously-Flowing Streams

First-order headwater streams with intermittent flow may constitute over 50% of cumulative stream length in watersheds, however, their value as habitat for aquatic faunas remains largely unexplored, and they are afforded little protection under current legislation. Despite the importance of coastal rainforest riparian habitats to ecosystem function, only one other Pacific Northwest study (Oregon) has attempted to explore the benthic macroinvertebrate fauna in these unique stream habitats. At UBC's Malcolm Knapp Research Forest, we studied the aquatic macroinvertebrate assemblage as part of a larger riparian buffer strip study. Seven small streams with a range of permanence of flow were chosen, of which three have no detectable surface flow in summer periods. We hypothesised that invertebrate assemblages in these first-order streams do not completely overlap, or are distinct from, that of larger streams, and that invertebrate assemblages will differ between intermittent and continuous flow regime sites. Stream sites were sampled by emergence traps throughout the year and by spring and fall Surber samples. In even the smallest streams with intermittent flow (<0.5 m bankfull width), true aquatic insects with one-year or longer life cycles were found, even in periods of no perceptible flow. Rather than being biologically barren, intermittent channels had approximately the same species richness and higher densities, as continuous flow streams. *Despaxia augusta* (Leuctridae) with a two-year life cycle, produced its highest densities in the intermittent channels, suggesting that suitable refugia exist within these habitat's wetted sediments. *Ostracerca diminiki* (Nemouridae) showed a preference for intermittent flow channel sites.

Species found in the intermittent channels were located in the continuous -flow channels, but not vice versa, indicating that fauna of these headwaters is mostly a subset of the downstream fauna for the Plecopteran and Ephemeropteran orders explored.

[\[POSTER\]](#)

Mueter, F.J., B.J. Pyper and [R.M. Peterman](#)

School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6

Opposite Effects Of ♦ Sea-Surface Temperature On Survival Rates Of Salmon From Northern And Southern Areas

Environmental conditions cause large variations in productivity of Northeast Pacific salmon

(*Oncorhynchus* spp.). ♦ Although aggregate catches of salmon have previously been related to large-scale climatic variability, recent analyses show that survival rates among stocks are positively correlated across local or regional spatial scales of several hundred kilometers, but not at larger scales. ♦ Coastal sea-surface temperatures (SST) have similar spatial correlation scales, suggesting that covariation in survival rates among salmon stocks is driven by regional-scale processes in the coastal ocean. ♦ To improve our understanding of linkages between regional temperatures and salmon productivity, we modeled stock-specific survival rates (log (recruits-per-spawner)) as a function of spawner abundance (to account for density-dependent effects) and regional measures of SST. ♦ We used 120 stocks of pink (*O. gorbuscha*), chum (*O. keta*), and sockeye (*O. nerka*) salmon, ranging from Washington to western Alaska, as "replicates" to help identify the effects of SST more clearly than is possible with single-stock analyses. ♦ We averaged SST anomalies across those coastal areas occupied by a given stock during the first four months of ocean life. ♦ We found strong geographical differences in estimated effects of SST on survival rates for all three species. ♦ Warm anomalies in coastal temperatures were associated with increased survival rates of all salmon stocks in Alaska and with decreased survival rates of pink and sockeye salmon stocks in Washington and British Columbia. ♦ To determine the relative importance of regional and large-scale measures of ocean temperature for explaining variability in survival rates, we used the Pacific Decadal Oscillation (PDO), a large-scale index of SST anomalies across the Northeast Pacific, as an alternative to regional SST in modeling survival rates. ♦ Generally, regional-scale SST was a much better predictor of survival rates than the PDO. ♦ To quantify the effects of SST on survival rates, we used multi-stock, mixed-effects models to estimate separate mean effects within the northern and southern areas, as well as the variability of SST effects across different stocks. Our results suggest that temperature effects are much more consistent across adjacent stocks than indicated by single-stock analyses, and provide precise estimates of mean SST effects within each area. .

[\[FRI. 15:40\]](#)

[Murray*1, L.](#) and [J. D. Reist2.](#) ♦

1Department of Zoology, University of Manitoba, Winnipeg, Manitoba. ♦

2Department of Fisheries and Oceans, Winnipeg, Manitoba.

Shortjaw Cisco (*Coregonus zenithicus*) in Manitoba Waters

The shortjaw cisco, *Coregonus zenithicus*, was listed as a threatened species by COSEWIC (1987). ♦

However, this designation was based on their distribution in the Great Lakes, which has been reduced through over-fishing, competition with non-native species, and habitat change. ♦ Reports exist of shortjaw ciscoes in boreal lakes across Canada however little is known about their distribution, abundance or status beyond the Great Lakes. ♦ Previous research in Manitoba has reported their presence in Lake Winnipeg,

Reindeer Lake, George Lake, Clearwater Lake, and Lake Athapuskow. ♦ The identification of shortjaw ciscoes beyond the Great Lakes region is uncertain because of the difficulty in distinguishing sympatric shortjaw cisco from *C. artedii* (lake cisco). ♦ As with most Coregonines the primary means of determining taxa has been based on gill raker counts, which may be unreliable especially for very plastic fish such as cisco. ♦ This project examines meristic and morphometric variation to determine: (1) if the variation present in Manitoba lakes indicates the presence of multiple cisco taxa; and, (2) if so are these forms of lake cisco or shortjaw cisco. ♦ For (1), univariate and multivariate statistical analysis will be used to distinguish sympatric forms in each lake. ♦ For (2), samples will be compared to each other and to known specimens of shortjaw cisco from Lake Superior and Lake Nipigon. ♦ Confirmation of the presence of shortjaw cisco in Manitoba will then allow for proper assessment of their status.

[POSTER]

Nelson, T.C., ♦ J. Risling, C. Mussell, M.L. Rosenau and P. A. Caverhill LGL Limited, 9768 Second Street, Sidney, B.C.

The Comparative Behavior Of Wild And Hatchery Adult Steelhead In The Chilliwack River, BC: An Analysis Of Run Timing, Recapture Rates, Survival To Spawning, Spawning Behavior, And Survival To Kelt Using Radio Telemetry Techniques

The Vedder/Chilliwack River, a tributary to the Fraser River, has the most important steelhead return in the Lower Mainland Region of BC, and is the most heavily fished steelhead river in the province. ♦ The objectives of the 1999-2000 telemetry project were to radio tag and subsequently track returning adult steelhead in the Vedder/Chilliwack River watershed from January 1999 through June 2000 to determine the migration characteristics and spawning behavior/locations of wild and hatchery steelhead, and identify overlaps in these characteristics and behaviors, both spatially and temporally. Coded radio tags and advanced biotelemetry techniques were used to monitor the movements and locations of 101 hatchery (adipose fin missing) steelhead and 125 wild steelhead for up to 7 months each year within the watershed. ♦ All steelhead were captured by conventional angling methods. ♦ Technicians applied radio tags to fairly equal numbers of hatchery and wild steelhead, proportionally across the run (river entrance timing) from December-May, by sex. ♦ Radio-tagged steelhead were subsequently located using four fixed-station receivers and a mobile receiver unit (operated by technicians conducting foot, truck, boat, and helicopter surveys). Important results of the 2-year telemetry study include: * A very high (over 98%) survival to spawning following release of all radio-tagged steelhead (hatchery and wild, all captured by conventional angling methods); * For all steelhead that spawned, approximately 75% of both hatchery and wild fish survived spawning and returned to the Fraser River (kelt); * Radio-tagged hatchery steelhead spawned in the same specific locations as radio-tagged wild steelhead, although there is a tendency for spatial separation between groups. The study provides key information regarding the location of major holding areas (prior to spawning), the locations and timing of spawning events (for various run timing groups), and the comparative survival rates of various groups (run timing, hatchery/wild, sex). ♦ Multiple captures of individual steelhead by anglers can be high in the Vedder/Chilliwack. ♦ In 1999, voluntary reporting of recaptured tagged steelhead (both hatchery and wild) suggested that a minimum of 43% of the fish are captured a second time, with some individual steelhead (mostly males) being captured up to 4 times.

[FRI 11:40]

♦ Boyle, R.¹, G. Jamieson², J. Arbour, D. Cobb, S. Courtenay, R. Gregory, C. Levings, J. Munro, I. Perry and H. Vandermeulen

¹Bedford Institute of Oceanography P.O. Box 1006, Dartmouth, Nova Scotia
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Ecosystem-Based Management Of Canada's Oceans: Objectives, Indicators And Reference Points

During 27 February - 2 March 2001, a workshop was sponsored by Fisheries and Oceans Canada (DFO) in Sidney, B.C. to identify ecosystem-level objectives, with associated indicators and reference points, that could be used in managing ocean activities. Participants included DFO scientists, fisheries managers, ocean managers, and habitat managers, as well as experts from other federal government departments, academia and other nations. Under the overarching objective of conservation of species and habitat, the workshop defined objectives related to biodiversity, productivity and the physical and chemical properties of the ecosystem. Under each of these, further nested components were defined, along with an **unpacking** process to link these conceptual objectives to those suitable for operational management. For each nested component, a suite of biological properties or characteristics was developed that further described the objective. Example indicators and reference points were also developed by operational objective, although further work on these at both a national and regional level is required. Assessment frameworks that evaluated progress against all objectives simultaneously were discussed and their potential uses investigated. A major achievement of the workshop was development at a national level of the concepts and terms related to ecosystem-based management. Finally, the workshop developed a list of issues and proposed next steps, including recommendations for further research, that DFO would need to address to further the implementation of ecosystem-based management in Canada.

[\[POSTER\]](#)

Parkinson, E. A., J.R. Post, P. Biro and N.T. Johnston
B.C. Fisheries Branch, UBC; U.Cal., Dept. of Biological Sciences.

Mechanisms For The Regulation Of Population Abundance Of Rainbow Trout In Lakes

Lacustrine populations of rainbow trout spawn in streams but migrate to the lake as juveniles that range in age from a few days to a few years. When rainbow trout are the only fish species, the population dynamics in the lake forms a relatively simple system driven by interactions within and between size classes. We performed a series of whole lake experiments in which we manipulated density and size structure in lakes with no natural recruitment. We used these experiments to define the empirical relationships of growth, survival and fecundity as functions of density and size structure of conspecifics. Concurrent studies examined the mechanisms of competition for food, risk taking behavior and energy allocation in young trout. These relationships and mechanisms were integrated into a model, which incorporates most of the important population regulation processes that take place in the lake. This model can be validated used data from stocked lakes that have no natural recruitment but vary in the harvest rate and size structure of the harvested fish. We then link the lake model to a stream recruitment model in order to predict the effect of habitat and harvest perturbations on populations driven by natural recruitment.

[\[SAT. 8:50\]](#)

Parkinson, E.A., E. Taylor and E. Keeley
B.C. Fisheries Branch, UBC; Dept. of Zoology, UBC;
Dept. Biological Sciences, Idaho State Univ.

Using Geographic Models To Apply Limited Genetic Information To Species Conservation

Molecular genetics can be used to define the genetic structure of a species in terms of a series of genetically independent populations and then to group these populations into cohesive phylogenetic groups. Observations of phenotypic variation, supplemented by heritability estimates, provide some information on quantitative genetic variation. In most cases however, data is available from only a small proportion of

populations and utilizes only a small proportion of the total genetic variability in the species. ♦♦ Conservation of genetic diversity depends on an assessment of the entire species in order to identify rare population types and populations with critically low population levels. We have produced a species level assessment for rainbow trout by collecting all three types of information for selected populations then developing rules that define population structure, phylogenetic groups and phenotypic variation based on geographic features. ♦ We linked these rules to an electronic watershed atlas and used them to make inferences about the genetic profile for all populations of the species within BC. ♦ Populations that share common genetic attributes can be located and enumerated. ♦ Maximum population sizes can be derived from simple habitat capability models based on mapped features such as lake size and habitat features, such as temperature and water chemistry, that are derived from geographic isopleth models. ♦ This process is illustrated using anadromous rainbow trout (steelhead) which can be broken into 3 phylogenetic groups, ~600 populations and several ecotypes.

[SAT.16:00]

Paszkowski*, C., B. Eaton, W. Tonn, and A. Danylchuk, Department of Biological Sciences, University of Alberta, Edmonton

Fish Winterkills Shape Amphibian Recruitment In Western Boreal Lakes

Interactions with fish have played key roles in shaping the reproductive strategies, metapopulation dynamics, and distribution of amphibians, and recent declines or local extinctions of amphibian populations are often linked to introductions of non-native fish. ♦ Most information on interactions between fish and amphibians has been generated by short-term laboratory or enclosure studies, or surveys documenting patterns of co-occurrence at the landscape level. ♦ To examine dynamic interactions in natural water bodies, we monitored native fish and amphibian populations at 12 north-central Alberta lakes (14 - 157 ha) over 5 years. ♦ Five lakes were dominated by large bodied fish species, most notably piscivorous northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*). ♦ Six lakes contained only small-bodied species, such as brook stickleback (*Culaea inconstans*) and fathead minnow (*Pimephales promelas*), and one lake was fishless. ♦ Amphibian abundance responded strongly to large changes in populations of both large- and small-bodied fish. ♦ Toads (boreal toad [*Bufo boreas*] and Canadian toad [*B. hemiophrys*]) responded to changes in abundance of large-bodied piscivores, whereas wood frog (*Rana sylvatica*) reacted more strongly to changes in populations of small-bodied fish. ♦ The most marked responses were to declines in fish densities due to winterkills that resulted in dramatic increases in larval amphibian recruitment to metamorphosis the following summer. ♦ Within the boreal-forest landscape, periodic high recruitment events from lakes may be an important source of dispersing juvenile amphibians for founding new populations or rescuing declining populations.

[POSTER]

Patterson, D.A.*1, J.S. Macdonald1, H.E. Herunter1 and A.P. Farrell2

1 Fisheries and Oceans Canada, Cooperative Resource Management Institute, School of Resource and Environmental Management, Simon Fraser University, Burnaby B.C. V5A 1S6

2 Department of Biological Sciences, Simon Fraser University, Burnaby B.C. V5A 1S6

Individual and Population Variation in Gamete Viability in Fraser River Sockeye Salmon Populations

♦ The life history of sockeye salmon (*Oncorhynchus nerka*) culminates in a one-time opportunity to manage allocation of a finite supply of energy into the contrasting demands of migration and reproduction. ♦ Our prediction, which has not been tested for wild Pacific salmon, is that environmental

stresses during migration will reduce gamete quality. ♦ The primary objective of the present research was to quantify individual and population variation in gamete viability and relate different strategies to the long-term goal contrasting the demands of environmental stress and reproductive success. ♦ Individual brood stocks were collected from four reproductively isolated Fraser River sockeye populations from 1997 to 2001. ♦ Full-sib broodlines were created, whereby each female was crossed with a minimum of three males and each male was crossed with minimum of five females from each time and location. ♦ The effect of population and parental origin of gametes on offspring survival was assessed at the eyed-egg stage. ♦ There were no interaction effects among the combinations of gametes. ♦ However, major differences existed in the individual male and female viability of gametes among different populations. Three long distance migrating populations exhibited a lower mean survival rate and greater variation in survival compared with a short distance migrating stock. ♦ ♦ None of a suite of parental physiological and morphology characteristics was a good predictor of gamete viability. ♦ ♦ This research has revealed fundamental differences in gamete viability between different individuals, suggesting individual phenotypic plasticity in the strategies used for dealing with migration stress. ♦ The potential intergenerational consequences of this variation on the population level, as it relates to changing environmental conditions, are discussed.

[\[POSTER\]](#)

Pearson, Mike and M.C. Healey, Institute for Resources and Environment, UBC

The Distribution and Abundance of the Salish sucker (*Catostomus sp.*) and Nooksack Dace (*Rhinichthys sp.*)

Salish sucker and Nooksack dace are red listed in B.C. and listed as endangered by COSEWIC. Their Canadian distribution is limited to a handful of streams in the lower Fraser Valley. We have estimated sizes of some key populations, located some previously unknown ones and learned some basic life history about both species. Work on habitat requirements over a range of spatial scales and an assessment of the long term prospects for both species is underway.

[\[POSTER\]](#)

Pepin, Pierre Northwest Atlantic Fisheries Centre, DFO-Newfoundland

Early Life Stages in Fisheries Research: A Perspective From the Larva ♦s Point of View

Despite laboratory evidence that the growth and survival of larval fish are strongly affected by variations in prey and predators, there is limited field evidence which concurs with those observations. ♦ This discrepancy may be due partly to the mismatch in the scales at which manipulative and observational studies are conducted. ♦ However, our fundamental approach to describing the environmental variability faced by larvae as well as the larva ♦s potential to respond to it may also contribute to difficulties in matching lab-derived predictions with field data. Information from several field studies dealing with the growth and mortality of radiated shanny (*Ulvaria subbifurcata*) larvae will be used to illustrate some limitations of past approaches used to study the dynamics of the early life history stages of fish. ♦ Patterns in growth histories show how differences among individuals may lead to varying responses to fluctuations in prey availability. I will also discuss issues concerning the level of variability in environmental conditions that may be described by standard surveys methods used in the study of larval fish. ♦ The examples will serve to illustrate the need to better describe the stochastic (i.e. probabilistic) structure of environmental conditions in order to understand early life dynamics.

[\[FRI. AM STEVENSON LECTURE\]](#)

Perry, Russell W., ♦ Michael J. Bradford and Jeffrey Grout ♦ School of Resources and Environmental

Management, and Cooperative Resource Management Institute Fisheries and Oceans Canada, Simon Fraser University, Burnaby, British Columbia

Variation In Contribution Of Energy Sources To Growth Of Juvenile Chinook Salmon In Small Boreal Streams: A Dynamic Approach Using Stable Isotopes

We used stable isotopes of carbon and nitrogen to quantify the relative contribution of terrestrial and autochthonous energy sources to the growth of juvenile chinook salmon in five small boreal streams. Because juvenile salmon were not in isotopic equilibrium with their diet, we tracked changes in their isotope ratios over the summer and used a growth-based tissue turnover model to quantify contribution of energy sources to fish tissues. We also collected information on the abiotic and biotic structure of the study streams to identify mechanisms causing variation in autochthonous contribution to juvenile salmon. Autochthonous contribution to fish varied among streams, ranging between -10 and 42%, and appeared to be related to the effects of disturbance on the stream ecosystem. Measures of suspended material varied by 3-4 orders of magnitude among streams because of the combined effects of higher than average precipitation and discharge in 2000, and forest fires that impacted 2 of the study streams in 1999. Autochthonous contribution to fish tissues and the relative abundance of macroinvertebrates that consume mostly algal organic matter (collectors and grazers) were negatively correlated to measures of suspended material. However, the relative abundance of invertebrates that consume terrestrial organic matter (shredders) was positively related to suspended material. Our findings suggest that disturbance is an important mechanism regulating transfer of energy sources to higher trophic levels. In addition, our results illustrate the use of a growth dependent turnover model for estimating contribution of energy sources when an organism is not in isotopic equilibrium with its diet.

[\[POSTER\]](#)

Peterman, R.M., and B.J. Pyper

School of Resource and Environmental Management, Simon Fraser University, Burnaby, B.C., CANADA V5A 1S6

Reconstruction Of Time-Varying Productivity Of Sockeye Salmon Stocks In Bristol Bay, Alaska, Using Smoothed Kalman Filter Estimates

Most analyses of population dynamics of Pacific salmon (*Oncorhynchus* spp.) assume that parameters of stock-recruitment models are constant over time. This assumption is pragmatic because relatively short data sets, combined with large natural variability and measurement errors, make it difficult to detect changes in parameters of stock-recruitment curves. However, there is growing evidence of non-stationarity in such parameters. As well, past work has demonstrated that a Kalman filter is more effective at tracking changes in simulated time series of productivity parameters than the standard approach of annually updating parameter estimates from stock-recruitment models that assume stationary parameters. We therefore used smoothed Kalman filter estimates of the 'a' parameters of the Ricker stock-recruitment model to reconstruct historical productivities for 8 Bristol Bay sockeye salmon (*O. nerka*) stocks, based on past abundances of spawners and recruits. The resulting time series of Ricker 'a' values indicate that the productivity of Bristol Bay sockeye stocks has varied considerably over 35 years. Particularly noteworthy is the dramatic increase in productivity of the Kvichak, Igushik, and Ugashik stocks starting with the early 1970s brood classes, which produced many more adult recruits per spawner than expected from a stationary model. Such evidence of time-varying productivity has important management implications. Because the Kalman filter method assumes non-stationarity, it will provide a more timely indication of changes in productivity (e.g. from climatic change) than current approaches that assume constant parameters over time. Thus, escapement goals can be revised more rapidly to reflect the latest information, thereby reducing the chance of over harvesting or under utilizing a stock. Also, interpretation of past trends in productivity could be improved by a Kalman filter approach, which attributes some of the observed variation in recruits

per spawner to measurement error. Finally, a Kalman filter approach creates a "cleaner" data set for use in analyses of relationships with oceanographic or other environmental variables.

[SAT. 16:20]

Pienitz, R.(1), M.- A. Fallu (1), T.E. Laing (1), E. Saulnier-Talbot (1), K. Ponader (1,2), K. Swadling (1,3), and I.R. Walker (4)

(1)Paleolimnology-Paleoecology Laboratory, Centre d'Études Nordiques, Department of Geography, Université Laval, Québec, Québec, G1K 7P4

(2) The Academy of Natural Sciences, Philadelphia, PA 19103

(3) School of Zoology, University of Tasmania, Hobart 7001, Australia

(4) Department of Biology, Okanagan University College, Kelowna, British Columbia, V1V 1V7

Paleoclimatic Trends In Northern Quebec And Labrador, As Inferred From Paleolimnological Data

The predicted amplification of the effects of global warming at high latitudes makes it important to understand the potential response of this region and its abundant freshwater ecosystems to global climate change. To explore the potential responses of northern lakes to climate change and to place instrumental temperature records into a longer-term perspective, we studied the fossil diatom, chironomid, pollen and macrofossil records preserved in the sediments of 11 lakes distributed throughout the northern part of the Québec-Labrador Peninsula. Diatom stratigraphic sequences and diatom-inferred patterns of limnological change since basin formation following the retreat of post-glacial marine or fresh waters revealed Holocene lake trajectories that are closely associated with successional shifts in lake catchment vegetation and soils. The main trends observed in all reconstructed lake histories are: (1) a progressive loss of alkalinity over time; (2) abrupt increases in dissolved organic matter (DOC) and water colour that coincide with the arrival of conifer trees; and (3) subsequent shifts that are closely correlated with the export of organic matter to recipient lakes. In terms of paleoclimate, our chironomid-based reconstructions of surface water temperatures together with the diatom records provide evidence for relatively stable climatic conditions or slight cooling over recent centuries in eastern subarctic Canada. This climatic scenario is in sharp contrast with records of climate warming as inferred from paleolimnological studies conducted in northwestern Canada and Alaska, yet it is consistent with decadal observational data that reveal pronounced climatic cooling over the western subpolar North Atlantic and adjoining land areas of eastern Canada. .

[FRI.15:20]

Pienitz, R., W.F. Vincent, E. Saulnier-Talbot

Centre d'Études Nordiques, Université Laval, Québec, Québec, G1K 7P4

Paleo-Optics: A Window Into The Ancient Light Fields Of Lakes

Variations in DOC and water colour are of great importance to aquatic biota in high latitude freshwater ecosystems as they generally contain low concentrations of UV-screening CDOM (coloured dissolved organic material = a correlate of DOC). To address the potential impact of climate change relative to ozone depletion on northern lakes, bio-optical models based on the present-day conditions were applied to the diatom-inferred DOC concentrations to estimate the magnitude of past variations in the underwater light regime of boreal treeline lakes. This paleo-optical approach revealed large-scale shifts in underwater UVB, UVA and photosynthetically available radiation (PAR) associated with changes in CDOM input to subarctic lakes during the Holocene. In Queen's Lake (central NWT), the inferred changes in biological exposure to UVR were at least two orders of magnitude greater than those associated with moderate (30%) ozone depletion. In Lake Kachishayoot (northern Québec), abrupt increases in DOC concentrations and water colour coincided with the arrival of trees following the retreat of postglacial marine waters, but remained relatively stable thereafter due to more subtle vegetational changes in the

lake's catchment basin. Our study shows that aquatic biota of lakes in the boreal treeline zone may have experienced their greatest UV exposure immediately following Holocene deglaciation and retreat of postglacial seas (prior to the development of CDOM sources in the catchment) and during subsequent episodes of reduced CDOM inputs when climatic cooling reduced forest canopy and treeline shifted south, ultimately causing the transition from forest to shrub tundra in the catchment basin. Freshwater ecosystems presently located in ecotonal regions will likely experience major shifts in underwater spectral irradiance through the effects of climate change on catchment vegetation and CDOM loading. Our results also show that the corresponding drastic shifts in the physical and chemical conditions are likely to be accompanied by profound changes in the composition of aquatic food webs which may alter the overall structure and dynamics of these ecosystems. Our related work on modelling underwater light conditions in the Arctic Ocean similarly shows the greater effects of CDOM relative to changes in stratospheric ozone in controlling the biological exposure to UV radiation.

[\[FRI 13:40\]](#)

Plate, E.M., C.C. Wood and C.W. Hawryshn

University of Victoria, PO Box 3020 STN CSC, Victoria, BC V8W 3N5

No Place Smells Like Home When You Are In The Mood: Roles Of Thyroid And Gonadotropin-Releasing Hormones In Olfactory Imprinting In Sockeye Salmon (*Oncorhynchus nerka*)

Two behavioural assays (rheotaxis towards an odour plume and an odourant-treated waterfall) were performed to assess the influence of thyroid hormones (T3 or its precursor T4) and gonadotropin releasing hormone (GnRH) on the ability of three-year-old sockeye salmon to recognize odourants they were exposed to during juvenile stages. Juvenile fish exposed to the odourants L-glutamine, L-alanine, cholic acid, MnCl₂, BaCl₂ or CuCl₂ in the absence of hormone treatment did not recognize the imprinting odourant when tested at age three either as immature or mature fish. In contrast, sexually mature fish exposed to MnCl₂ in combination with T3 and T4, or T3 alone, recognized the odourant when tested at age three, but only if sexually mature. Immature fish from this group did recognize the imprinting odourant after treatment with the maturation hormone GnRH. Furthermore, GnRH treatment also increased motivation to jump a waterfall. Prior to sexual maturation or GnRH treatment, imprinted fish actively avoided the odourant they experienced as juveniles. Electrophysiological recordings from the olfactory epithelium (EOGs) further supported the aforementioned behavioural findings by demonstrating that the state of maturity or GnRH treatment can affect peripheral olfactory sensitivity to different odourants in different ways. These results suggest that: (1) A combination of T3 and T4 or T3 alone is essential to the imprinting process in sockeye salmon, and (2) that maturity and GnRH are involved in the behavioural expression of motivational processes underlying homing behaviour and the recognition of imprinted odourants.

[\[FRI 10:20\]](#)

Post, J.R. 1, L.G. Rudstam 2 and J.R. Forney 2

1Biological Sciences, University of Calgary, Calgary, Alberta. jrpost@ucalgary.ca and 2Cornell Biological Field Station, Bridgeport, NY. lgr1@cornell.edu.

Recruitment Dynamics In Yellow Perch: Phenomenological Description And Mechanistic Understanding

Oneida Lake, NY contains a diverse fish fauna including yellow perch and walleye as dominants. A long-term data set of 40+ years exists for abundance of larval, juvenile and adult yellow perch allowing examination of stock and recruitment relationships among various life stages and adult stocks. The data suggests that survival of pre-recruit yellow perch is highly variable, rendering single species phenomenological descriptions of stock and recruitment a poor predictor of recruitment levels in yellow perch. We hypothesize that size dependent predator-prey interactions between yellow perch and walleye may explain variable survival of pre-recruits and therefore variability in yellow perch recruitment. We develop from field data: (1) a mechanistic functional response model including walleye consumption allometry and prey size-dependent digestion and (2) a description of juvenile perch vulnerability as a

function of prey:predator length ratio. ♦ Sequential estimates of abundance of age-0 yellow perch in Oneida Lake from larval to demersal stages are contrasted to predictions from a mortality model created from the functional response and size-vulnerability models. ♦ In general, the walleye-perch predator-prey model explained declines in age-0 yellow perch from spring to fall over ranges of density of 2-3 orders of magnitude in the perch.

[SAT. 9:10]

Pratt, T.C. and K.S. Smokorowski

Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Sault Ste. Marie, ON.

Habitat Utilization Patterns Of A Nearshore Fish Community; Implications For Habitat Management

Compensation measures in response to the Fisheries and Oceans Canada (DFO) Policy for the Management of Fish Habitat include provisions for habitat creation and enhancement. ♦ Thus, an assessment of nearshore habitat utilization patterns by fishes is needed to put DFO compensation measures in context of the 'no net loss of the productive capacity of fish habitat' directive. ♦ A variety of littoral habitat types, separated by substrate, depth, and macrophyte density and type, were available to the fishes of a mesotrophic eastern Ontario lake. ♦ The relative abundance, richness, evenness, and diversity of species and species life stages were compared across nine habitat types using rapid visual underwater assessment. ♦ Correspondence analysis separated habitats into three groups - shallow (0 - 2m) rock, shallow mud, and a cluster of all vegetated habitats - and identified two distinct species assemblages. ♦ The majority of species and life stages were associated with the vegetated habitat cluster, but a few species and life stages (smallmouth bass, logperch, and rock bass) were associated with shallow rock habitats. ♦ Analysis of variance indicated that shallow mud habitats contained significantly fewer species, and had lower relative abundance and diversity, than all other habitat types. ♦ Shallow rock habitats had greater diversity and higher relative abundance than shallow mud habitats, but lower relative abundance and diversity than most vegetated habitat types. ♦ Very few differences in richness, diversity, and relative abundance were discerned across vegetated habitats. ♦ Several species (pumpkinseed, bluegill, largemouth bass, yellow perch, and bluntnose minnow) were ubiquitous and relatively abundant among habitat types. ♦ Our results suggest that habitat heterogeneity is critical in maintaining diverse communities, and that mitigation and compensation measures should account for differences in relative abundance and diversity among open, rock substrate, and vegetated habitats.

[SAT. 14:00]

Proulx, R. and P. Magnan

Groupe de recherche sur les écosystèmes aquatiques, Université du Québec Trois-Rivières, C.P. 500, Trois-Rivières (Québec) G9A 5H7.

Mechanisms Involved In Trophic Polymorphism Of Brook Trout, *Salvelinus fontinalis*

To determine if trophic polymorphism is adaptive one must demonstrate that each given ecotype has a higher fitness in its own niche. Brook trout, *Salvelinus fontinalis*, inhabiting oligotrophic lakes of the Canadian Shield exhibit trophic polymorphism, where some individuals are better adapted to feeding in the littoral zone and others are specialists at feeding in the pelagic zone. The first objective of our study was to determine the genetic and environmental components (and their interaction) of trophic polymorphism in brook trout. Our second objective was to relate feeding performances of both forms in pelagic and littoral environments to their morphology. Common garden laboratory experiments were conducted over 16 months, where fish of both forms were fed in artificial pelagic (prey captured in the water column) and

littoral (prey captured on the substrate) environments. Morphological differences between the pelagic and the littoral forms appeared early in their development and were maintained until the end of experiments. Littoral individuals had longer dorsal and pectoral fins, shorter heads and mandibles, and a greater body width than pelagic individuals. Our results indicate that there are genetic and environmental components in the trophic polymorphism of brook trout, which together explained 16% of the variations in morphology (based on a PCA on morphological variables). Finally, our results showed that the feeding efficiency (size-adjusted daily ration, g \diamond g fish wet weight \diamond^1) of a given form was significantly higher in its own environment (littoral or pelagic).

[SAT. 16:40]

Purchase, C.F.¹, N.C. Collins¹, B.A. \diamond Henderson², and G.E. Morgan³

¹Department of Zoology, University of Toronto at Mississauga; ²Lake Huron Management Unit, Ontario Ministry of Natural Resources; ³Co-operative Freshwater Ecology Unit, Laurentian University.

Annual Repeatability In Determining Life History Traits: \diamond Implications For Predicting Population Parameters From Lake Characteristics

Life history traits can be predicted from environmental characteristics of lakes, which can be used to manage lakes based on a categorical system (e.g., lake trout, Shuter et al. 1998). \diamond Such work uses data collected from many populations over several years, and thus assumes that annual variation is unimportant. \diamond Here, we test this assumption in yellow perch by determining the relative amount of life history variation present among years within the same population, compared to that present among populations. \diamond Life history traits such as growth rates, maturity schedules, fecundity, and life span were compared from 1989-1996 from three locations within Lake Huron, along with those from five inland Ontario lakes in 1999 and 2000. \diamond The relative amount of among year versus among population variation is discussed as to its influence on the ability to predict population characteristics.

[SAT. 14:40]

Puvanendran, V.* and J.A.Brown. Ocean Sciences Centre, Memorial University of Newfoundland, St.John's, Newfoundland A1C 5S7.

Growth And Survival Of Atlantic Cod Larvae From Two Latitudinally Separated Populations In A Common Garden Experiment - Preliminary Results

Studies have shown that growth performance varies among latitudinally separated fish populations. The counter-gradient variation hypothesis predicts that within a species northern fish would outperform southern fish in growth at all temperatures. To test this hypothesis, we carried out common garden experiments on larval cod originated from two regions in the North Atlantic, 3PS (Placentia Bay, NF. 48 N; 54 W) and 4T (Northumberland Strait, P.E.I. 46 N; 64 W). Adult fish were caught from wild 1-2 months before spawning and brought to the lab. Eggs were obtained through spontaneous spawning. Experiments were carried out at two temperatures (7 and 11 C) and two prey concentrations (1500 and 4500 prey/L). Larvae were sampled weekly from 1 to 43 days post-hatch for growth. Larval survival in all tanks were recorded at the end of the experiment. Comparison of results between the two populations showed that neither prey concentration nor temperature affected the growth and survival. However, both temperature and prey concentration significantly affected growth within a population. Within a population, temperature had no effect on survival while prey concentration had a significant effect. The results did not support the counter-gradient hypothesis and we discuss them based on our knowledge of cod larval ecology.

[POSTER]

Quinn, T.P.

School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington

Migration Timing And Conservation Of Atlantic Salmon In Ireland

Anadromous salmonids achieve most of their growth at sea and return to fresh water to complete maturation

and spawn. ♦ However, in many species (notably chinook and sockeye salmon, steelhead trout, and Atlantic salmon) there are populations that return early in the year, many months before they spawn. ♦ In some adult Atlantic salmon populations, adults return at least six months prior to spawning, and these fish are often larger or older than the salmon returning later. ♦ Neither the migration timing, nor the connection between age/size and migration timing has an obvious explanation. ♦ This phenomenon is not only an intriguing life history puzzle but also a pressing issue for salmon conservation because there are indications that large/early salmon are in particular jeopardy in some areas. ♦ I investigated the size composition and migration timing in salmon from Ireland, especially the population in the Blackwater River. Records since 1926 from a privately owned fishery at Careysville revealed 1) broad timing of angler catches, from February through September, 2) co-variation between timing and size, 3) decline in catches of large, spring salmon and increased catches of smaller, summer salmon, and 4) an apparent decline in size at age as well as age at maturity. ♦ Records from an electronic counter upstream from Careysville corroborated the general pattern of timing and correlated with angler catches. ♦ Records from commercial fisheries at the river's mouth also indicated declines in the size of salmon over the past two decades, despite management regulations to protect spring migrants. ♦ These results, and those from other Irish rivers, are discussed in the light of the need to conserve Atlantic salmon populations.

[\[FRI 14:00\]](#)

Reinhardt, U.G. and T. Yamamoto

Eastern Michigan University, Ypsilanti, Michigan and Hokkaido University, Sapporo, Japan.

Selection For Elevated Metabolic Rates In Salmonid Hatcheries: Indirect Evidence From Otolith Microstructure

A conceptual model predicts the evolution of elevated metabolic rates in the hatchery environment. Individual juvenile fish with an inherited tendency for a high metabolic rate (MR) are predicted to develop to the exogenous feeding stage faster than individuals with a low MR. Through greater feeding motivation and aggression, high MR fish are predicted to grow faster and attain greater fitness. Successive generations of hatchery raising thus result in a shift to higher population mean MR. Based on a previously shown correlation between MR and otolith growth, we performed two experiments to find indirect evidence for crucial steps of the model. In a controlled breeding study with masu salmon (*Oncorhynchus masou*), otolith size of swim-up fry varied significantly with their sires, showing heritability of otolith size and suggesting the same for MR at early life stages. In a comparison of otolith dimensions of farmed, sea-ranched and wild swim-up fry of masu salmon, the populations differed in accordance with model predictions: the wild fry had on average smaller otolith diameters and daily increment widths.

[\[FRI 11:00\]](#)

♦ Rejwan*, C., J.R. Post, and E. Parkinson. ♦ Department of Biological Sciences, University of Calgary, and Fisheries Centre, University of British Columbia. ♦ ♦

Are Densities And Recruitment Rates Of Wild Rainbow Trout Different Among Populations, And If So, Which Mechanisms Could Be Responsible?

Wild rainbow trout populations are typically highly varied in densities and in recruitment rates to adulthood, for reasons which are unclear. ♦ This creates difficulties in accurately predicting sustainable sport fishing intensities on wild populations. ♦ To provide a means for more accurate predictions, densities of rainbow trout at age-2 (approx. age at maturity) and age-2 & up, survival rates from eggs to age-2, and environmental habitat conditions of expected importance were measured from 37 remote wild rainbow trout populations. ♦ The extent of among-population differences in densities and recruitment rates were quantified, the life history period at which population regulation may be consistently intense was evaluated,

and predictions were made of observed among-population differences using environmental measures. ♦ Large among-population differences ♦ (1 to 3 orders of magnitude) exist in densities at age-2, age-2 & up, and survival rates between eggs and age-2. ♦ Coefficients of variation in densities of each age-group suggest that at some time before age-1, the main constraints on cohort densities are imposed. ♦ ♦ Among-population differences in densities at age-2 and age-2 & up could not be predicted by any of the ecological measurements using linear mixed effects (lme) regression analyses, and part of the unexplained variance in the dataset was associated with one or more unidentified variables (not sampled in this study) that have inter-population and/or inter-annual differences. ♦ Therefore, it seems that the variables which most fisheries scientists and managers who work on rainbow trout would likely expect to be important predictors of adult population density (useable stream area (m²), lake area/stream area, % epilittoral-refuge area, lake conductivity (uMHOS/cm), non-rainbow trout fish density) are not important predictors. Lme regression ($r^2 = 0.33$) of recruitment rates to age-2 were related positively with non-rainbow trout fish density ($p < 0.0001$, $df = 127$), and negatively with lake conductivity ($p < 0.006$). ♦ There were no obvious explanations for the importance of lake conductivity, and preliminary plots suggest that this may be an imprecise association. ♦ Possible mechanisms responsible for the increased recruitment rates among populations with high densities of non-rainbow trout will be discussed. ♦ Non-rainbow trout fish density may be useful in a management context, in predicting recruitment rates to age-2.

[POSTER]

Rempel, L. and M. Church

Department of Geography, University of British Columbia, Vancouver, British Columbia

Eco-Physical Habitat Classification For Large, Gravel-Bed Rivers: A Tool For Research And Management

In contrast to small streams, aquatic habitats in large, gravel-bed rivers, as well as their extent and distribution have been inadequately described. The fish assemblages they support have remained equally uncertain but often include commercially valuable species. We present a hierarchical classification of riverine habitats for the gravel reach of Fraser River, British Columbia, between Hope and Mission. The classification links physical characteristics of distinct habitat types, as determined from air photos and ground surveys, with ecological attributes of the habitats as determined by field sampling for fish and benthic invertebrates. Emphasis has been placed on delineating habitat types for all species of juvenile fish known to use the gravel reach for rearing (>24 species including 10 salmonid species and 5 species of special concern). The classification consists of three levels. At the highest level, we divide the river into 5 sub-reaches, each of which presents a distinct array of aquatic environments. Taking note of these distinctions is believed to be important in strategic planning for fish and fisheries management. At the intermediate level, we identify major pool-bar-riffle units along the river. This level is intended to guide field studies and operational management of fisheries along the river. At the finest level, we identify habitat types around individual gravel bars. Twelve habitat types are recognized based on morphologic and hydraulic properties and a typical pool-bar-riffle consists of 30-50 units. Units associated with large morphological features may exceed 5,000 m² whereas smaller units occupy 100 m². More than 55,000 fish have been collected from 340,000 m² of channel area over 3 years of sampling to provide an extensive database of fish habitat use in a large, gravel-bed river. Habitat types are found to differ in terms of the species assemblage and fish density they support, and hence differ in productive capacity. The finest classification level has application for assessing the productive capacity of the river as pressure to modify fish habitat increases due to flood risk and bank erosion.

[SAT. 14:40]

Richardson, J. S. and P. M. Kiffney

Department of Forest Sciences, University of British Columbia, Vancouver, BC, Canada, V6T 1Z4

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Experimental Studies Of The Effects Of Riparian Management On Communities Of Small Streams: Establishing Causal Mechanisms.

Headwater systems can be defined as channels with direct coupling to adjacent hillslope processes and by high variance in discharge and other processes, relative to downstream reaches. ♦ In the Pacific Northwest these channels may be steep and intermittent, and may also lack fish, nevertheless these streams support a diverse assemblage of invertebrates and other organisms, and contribute in a large way to downstream processes through storage and export of organic matter and other materials. ♦ Riparian buffers are the usual prescription to mitigate some of the effects of forest practices. ♦ However, there have been few experimental tests of the effectiveness of riparian protection, and tests of the mechanisms responsible for changes in foodwebs of small streams are scarce. ♦ At one scale, we have established a BACI experiment to evaluate riparian reserves using 13 small streams assigned to controls (unharvested) or one of three treatments: 30 m reserves, 10 m reserves, and clearcuts. ♦ As part of the larger experiment we measured changes in invertebrate assemblages, periphyton production, and organic matter dynamics. ♦ Even with 30 m reserves there were five-fold increases in the amount of algal biomass, and shifts to filamentous forms as riparian protection was reduced. Invertebrate communities exhibit shifts to more generalist taxa, such as Baetis and Ameletus as the degree of riparian reserve decreases. ♦ Other shifts in the community are associated with changes in organic matter dynamics, with reduced litter inputs, and a greater fraction of inputs exported. ♦ At finer scales we have experimentally tested the effects of changes associated with forestry to elucidate the causal mechanisms. Manipulation of shading, litter inputs, suspended sediments, nutrients, and their interactions have all shown direct effects on benthic organisms, but not always as predicted from simple models of the pathways by which forestry impacts are thought to act. ♦ These studies are leading towards refinements in the understanding of forest-stream interactions and the measures needed for conservation efforts. ♦ One of the challenges remains to determine the cumulative effects downstream of modifications along headwaters, since the dynamics of headwaters are still not well described. .

[\[FRI. 16:00\]](#)

Rubidge, Emily M.¹, Peter Corbett² and Eric B. Taylor¹

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Genetic Analysis Of Hybridization Between Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) And Introduced Rainbow Trout (*O. mykiss*) In The East Kootenays Of British Columbia

The Upper Columbia/Kootenay and upper Missouri river systems in northwestern North America represent the heart of the geographic range of the westslope cutthroat trout (*Oncorhynchus clarkii lewisi*). Throughout most of the southern parts of this range, extensive hybridization with introduced rainbow trout has eliminated genetically pure westslope cutthroat. The upper Kootenay River in British Columbia is thought to be the last stronghold of pure westslope cutthroat populations. We used restriction site variation in nuclear gene introns to assess the incidence of westslope cutthroat trout, rainbow trout, and interspecific hybrids between these species at 20 locations in the Upper Kootenay River drainage. A total of 672 fish were assayed and hybrids were found at 15 of the 20 locations across 14 different streams where they comprised 3-43% of all fish assayed, and rainbow trout were found at four of the sites. Most of the hybrids represented backcrosses to both westslope cutthroat and rainbow trout or post F1 hybrids. Mitochondrial DNA analysis indicated that hybrid matings occur between male rainbow trout and female westslope cutthroat trout and vice versa. More detailed analyses within specific sites suggested that hybrid survival remains relatively constant with age, and that specific ecological conditions (e.g., presence of lakes) may constrain hybridization. Determining why certain sites appeared to be "immune" from hybridization with rainbow trout will be crucial to conservation of native westslope cutthroat trout at the edge of their range

[\[POSTER\]](#).

Sander*, B.C., and R. Lewis. *Golder Associates Ltd., Burnaby, BC and Squamish Nation, Squamish, BC. Funded by Fisheries and Oceans Canada (DFO) and conducted by the Squamish Nation and Golder Associates Ltd.,

Chinook And Coho Spawner Enumeration In The Squamish Watershed

Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) spawner enumeration programs have been conducted in the Squamish River watershed for the last 6 years. This enumeration data collected will assist in the development of a long-term fisheries management plan for the Squamish area. Adult chinook and coho spawners were enumerated by visual observation in 11 streams and side-channels. The number of chinook spawners was highest in 1997 (910 chinook) and in 2000 (887) as compared to 1998 and 1999. The number of coho spawners was highest in 1999/00 and 2000/01 (5704 and 5401, respectively). Chinook preferred to spawn in mainstem rivers with larger substrate, while coho preferred smaller side-channels. A literature review of fisheries work previously conducted in the Squamish Watershed revealed that future studies in the watershed should focus on determining potential salmonid carrying capacities within the sections of the watershed that are accessible to anadromous salmon. Consequently, preliminary quantitative habitat assessments focused on determining coho spawning capacity in the systems surveyed as part of the enumeration program were also conducted. The area of potential coho spawning habitat was compared to published biostandards for recommended area of redds per spawning pairs. The number of coho calculated by this method was compared to the actual number of coho observed in that system to estimate whether carrying capacity had been met. Based on this analysis, only 3 streams were categorized as meeting carrying capacity for coho spawners. Seven systems were categorized as being below carrying capacity, while one stream was above carrying capacity. This information will be used to prioritize future fisheries work in the Squamish watershed.

[\[POSTER\]](#)

Schindler, D.E.(1), P.R. Leavitt(2), W. Lew (3), R. Hilborn,(3) T.P. Quinn(3) and D.E. Rogers(3)
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(2)Departments of Biology, University of Regina, Regina, Saskatchewan, K S4S 0A2 (3)School of Fisheries and Aquatic Sciences, University of Washington, Seattle, WA 98195, U. S. A.

Do Climate Change and Fisheries Cause Depensation in Sockeye Salmon Populations?

Traditional approaches to management of Pacific salmon have use models that generally ignore negative feedbacks to population dynamics when stocks are at low densities (i.e. depensatory effects). However, several ecological mechanisms may lead to depensation in sockeye population dynamics. In Iliamna Lake, Alaska, juvenile sockeye growth is density-dependent such that juveniles grow relatively fast and tend to migrate to the ocean as 1-year old smolts following years with low densities of spawners. Following large spawning events, juveniles grow slowly and delay migration to the ocean until they are two years old. Marine survival rates of the fast-growing 1-year old smolts are substantially lower than for the slow-growing 2-year old smolts. In addition, because post-spawning mortality of salmon represents a major nutrient subsidy to nursery lakes and streams, decreases in salmon densities in response to fishing and climate may reduce the productivity of freshwater nursery ecosystems, and thus, the productivity of sockeye populations. Despite these two depensatory mechanisms that may reduce salmon productivity at low population sizes, data from paleolimnological studies, and from long-term monitoring of Alaskan salmon fisheries and nursery lakes, suggest that sockeye populations are very resilient to environmental change and to exploitation. Evidence from paleolimnological studies in southwest Alaska demonstrate that spawning runs of sockeye salmon have shown marked variation in response to both climatic forcing over the last 300 years and to the advent of commercial fishing at the beginning of the 20th century. Sedimentary chronologies of algal fossils show that the productivity of nursery lakes has paralleled changes in historical salmon populations. We estimate the algal production is currently about 60% lower in nursery lakes than it was when commercial fishing started. ♦ However, contrary to conventional wisdom, there is no evidence that this decline in lake productivity has translated into reduced productivity of sockeye populations. We suggest that life-history diversity may reinforce the resiliency of this species.

[\[FRI 11:40\]](#)

Scott, R. J. (1), D. L.G. Noakes * (1), F. W. H. Beamish (1) and Leon M. Carl (2)
(1) Department of Zoology and Axelrod Institute of Ichthyology, University of Guelph
Guelph, Ontario N1G 2W1 (2) Aquatic Ecosystems Science Section, Ontario Ministry of Natural
Resources, Trent University, Science Complex , 1600 West Bank Drive, Peterborough, Ontario ♦ K9J 8N8

Exotics Impede Atlantic Salmon Restoration

The presence of non-native species can have a substantial impact on the behaviour of native species. We found that Atlantic salmon (*Salmo salar*) suffered negative impacts from chinook salmon (*Oncorhynchus tshawytscha*), an exotic species introduced to Lake Ontario, during spawning. We isolated 10 replicate sections of Orono Creek, a small tributary to Wilmot Creek, which flows directly into Lake Ontario approximately 85km east of Toronto, Ontario. ♦ This stream system had abundant spawning populations of Atlantic salmon historically, and presently has a large fall spawning population of chinook salmon. ♦ Eight individually marked hatchery-reared adult Atlantic salmon (four males and four females) were released into each of the 10 sections. Four wild - caught adult chinook salmon (two males and two females) were released into five randomly chosen sections. The combined frequency of all Atlantic salmon behaviours was higher when chinook salmon were present than when they were absent. This pattern was also seen in the frequency of general and agonistic Atlantic salmon behaviours, but not in the aggressive behaviours. Furthermore, Atlantic salmon initiated nesting earlier, and survived longer when chinook were absent compared to when they were present. Our results have implications both for efforts to reintroduce Atlantic salmon in the presence of chinook salmon, and for spawning by Atlantic salmon introduced within the native range of chinook salmon.

[[POSTER](#)]

Scott, R. J., D. L .G. Noakes * and F. W. H. Beamish
Department of Zoology and Axelrod Institute of Ichthyology, University of Guelph, Guelph, Ontario

Nest Site Selection In The Wild By Cultured Atlantic Salmon

Atlantic salmon, *Salmo salar*, was extirpated from Lake Ontario by the end of the 19th century. Efforts to restore this species to this part of its native range depend upon stocking fish from hatchery stocks. There is concern that the spawning behaviour of these fish may not be successful as a result of the hatchery origin, and experience, of the stocked fish. We surveyed 1.5 km of Wilmot Creek, a known historical stream for this species, and the site of the current restoration program of the Ontario Ministry of Natural Resources, for spawning activity of stocked Atlantic salmon. We observed behaviour directly, and recorded a number of characteristics of spawning fish. We measured a number of physical characteristics for each nest, after spawning was completed. We took comparable measurements from 100 randomly chosen sites within the study sections, and for sites immediately adjacent to spawning sites selected by the fish. We found that sites selected for spawning by the fish were consistently different from either the random sites, or the sites adjacent to actual spawning sites. These results suggest that hatchery fish are still competent in terms of spawning site selection and spawning behaviour. Analyses in progress are relating this spawning site selection to successful incubation and emergence of young salmon.

[[POSTER](#)]

Scruton, D., A. and K., D. Clarke
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Habitat Productive Capacity Research In Freshwaters Of Newfoundland: Progress Towards Refining Fluvial And Lacustrine Habitat Relationships In A Depauperate Fish Assemblage

Over the last 15 years, a considerable effort has been undertaken in Newfoundland to research fluvial and lacustrine habitat relationships for freshwater fish in order to understand factors affecting habitat productive

capacity and to develop scientifically defensible tools for habitat management and conservation. ♦ The island of Newfoundland is relatively unique containing a depauperate freshwater fish community, with low productivity, allowing fish species to utilize a broader range of habitats than in other areas. Research has evolved from a lotic macro-habitat classification system that became the standard for environmental assessment and habitat quantification in the Region. ♦ This system has since been modified and ♦ tiered ♦ to allow for application at macro-, meso-, and micro-habitat scales. ♦ Studies have addressed simple methods of field measurement of habitat productive capacity, development of temporally and spatially explicit habitat criteria (indices), and investigating habitat production linkages. ♦ Studies have also focussed on potential habitat limiting periods or ♦ bottlenecks ♦ (e.g. winter). ♦ Recently, a method has been developed for the quantification of lacustrine habitats based on a modification of the ♦ defensible methods ♦ approach, pioneered by Minns (1997). ♦ The fish habitat requirements database for this methodology was developed from available literature with subsequent research being undertaken to develop region-specific data for fish habitat utilization (depth, substrate, temperature, etc.) in lentic habitats. ♦ Finally, ecosystem based research has been initiated to inter-link the importance of fluvial, lacustrine, and estuarine habitats, and the movements between habitats, at various life stages of our freshwater species and to develop habitat production linkages within meso-habitats. ♦ This paper provides an overview of the various research studies undertaken in Newfoundland to address freshwater habitat productive capacity.

[SAT. 13:20]

Shuter, B.J.¹ and C.K. Minns²

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²Department of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences, 867 Lakeshore Road, P.O. Box 5050, Burlington, Ontario, L7R 4A6

Impacts Of Climate Change On Freshwater Fish And Fisheries

Climate change is expected to have significant impacts on freshwater fisheries in Canada. ♦ Fisheries and fishers will have to adapt to major changes. ♦ In this paper, we present case studies illustrating the sensitivity of both smallmouth bass and walleye populations to temporal and spatial variations in climate. ♦ We show how these assessments of sensitivity can be used to develop regional forecasts of the potential impacts of climate change on these species in Ontario. ♦ We suggest that such regional predictions of ecological impacts are needed in order to properly assess tradeoffs between the costs associated with protection ♦ from change, and those associated with adaptation to change.

[FRI 14:00]

Sirois, P. (1), M. Ringuette (2), L. Fortier (2), V. Perron (2), M. Fortier (3) and J. Gagne (4)

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The Role Of Temperature In The Survival Of Arctic Cod Larvae (*Boreogadus saida*) In The Northwest Water And The North Water Polynyas

Arctic cod is a key species in the Arctic food web. According to the growth-mortality hypothesis, inter-annual and regional differences in larval and juvenile growth determine the strength of Arctic cod year classes and, therefore, the amount of food available to several mammal and avian predators. The deposition

of daily increments in the otolith of young fish allows to back-calculate individual growth trajectories. The daily nature of increments in Arctic cod larvae and juveniles was confirmed by marking the otoliths of fish reared on board with alizarin and tetracyclin. Hatch dates were determined in 215 fish captured from May to July 1993 in the Northeast Water and in 140 fish collected from May to July 1998 in the North Water. The survival of Arctic cod hatched in different months is compared between the two polynyas. In particular, we investigate the relative role of temperature, ice concentration and food availability in determining survival, to test the general hypothesis that the spawning strategy of Arctic cod is adapted to disperse the larvae in areas where higher temperatures are likely to prevail in summer. .

[\[FRI. 16:40\]](#)

Sleeman*, J.D. Department of Forest Sciences, University of British Columbia, Vancouver, British Columbia

Influence Of Riparian Vegetation And Soils On Stream Macroinvertebrate Communities In Coastal Headwaters Of British Columbia: Providing Perspectives For Riparian Management

Relatively few empirical tests investigating the relationships between riparian vegetation and soils, and aquatic invertebrates have been performed in the coastal headwaters of British Columbia. Consequently, we simply do not have the insight needed to properly manage coastal riparian areas with the maintenance of invertebrate communities as an objective. Therefore, I propose that comparisons of current management (buffers/no buffers) and alternative tree-patch retention designs are required to gain the insight needed to improve upon management guidelines. I hypothesize that retention of tree-patches, which takes into account and balances the competing demands of ecology and economy- i.e., a patch of sufficient size that meets ecological management objectives, yet which remains financially rewarding to the forestry sector; will have the potential to mitigate changes associated with harvesting, which are potentially deleterious to invertebrate communities. ♦ In partnership with Weyerhaeuser BC Coastal Group, innovative riparian management areas- i.e., aggregate (group) retention as prescribed under their Variable Retention program; are being implemented in headwater basins on Vancouver Island to test their effectiveness for mitigating the effects on the streams which run through them. This will be a multi-year experiment comparing the effects of clear-cut, buffer strip retention, and aggregate (group) retention along non-fish bearing reaches of coastal headwater stream channels. Studies will be conducted before and after implementation to monitor changes in riparian vegetation and aquatic invertebrate communities. I will also perform manipulative experiments, including leaf litter additions to streams within clear-cuts, to investigate the relationships between organic matter inputs and aquatic invertebrate communities. Additionally, I will examine the influence of riparian soils via groundwater transfer of dissolved organic carbon to more fully understand the links that bind the stream communities to their adjacent riparian areas. The objectives of this study are to determine: i) the extent to which clear-cut harvesting and buffer strip retention alters the biological attributes of these systems, ii) the extent to which changes associated with clear-cut harvesting and buffer strips are mitigated by aggregate (group) retention designs, and iii) to develop predictive models for assessing the cumulative effects of timber harvest along small streams under these different management plans.

[\[POSTER\]](#)

Smith, C.T., R.J. Nelson, C.C. Wood and B.F. Koop
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Glacial Biogeography Of North American Coho Salmon

To study the glacial biogeography of coho we examined 20 microsatellite loci and mitochondrial DNA d-loop sequence in samples from Alaska to California. ♦ Microsatellite data divided our samples among 5 geographic regions; 1) Alaska and northern coastal British Columbia, 2) the Queen Charlotte Islands, 3) the mainland coast of British Columbia and northern Washington State, 4) the Thompson River, and 5) Oregon and California. ♦ D-loop sequence data suggested 3 geographic regions; 1) Oregon and California, 2) the Thompson River, and 3) all other sites north of the southern ice margin. ♦ Microsatellite data revealed no difference in the number of alleles in different regions, but mtDNA data revealed a cline of decreasing

diversity from south to north. ♦ We suggest that the two signals presented by these different marker types illuminate two time frames in the history of this species. ♦ Endemic microsatellite diversity in Alaska and on the Queen Charlotte Islands provides evidence of Fraser Glaciation refugia in these regions. ♦ The loss of mitochondrial variation from south to north suggests that one of the earlier, more extensive, Pleistocene glaciations eliminated coho from its northern range. .

[\[FRI. 16:20\]](#)

Smokorowski*, K. E., Pratt, T., Muirhead, J., Jones, L., Gardner, W., and Kelso, J.R.M. ♦ Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Sault Ste. Marie, ON, P6A 6W4.

Assessing Nearshore Fish Community Associations With Differing Habitat By Using An Underwater Video Camera

In support of DFO's Policy for the Management of Fish Habitat, research defining linkages between physical habitat and fish abundance was conducted in inland lakes. ♦ We developed methods, using an underwater camera, to assess the association of fish relative abundance with various nearshore habitat types, and to test if this association holds for equivalent habitat types across two Ontario Lakes. ♦ Over the four periods of July 1999, June and July 2000, and June 2001, we observed fish in five habitat classes including open, natural and artificial vegetation, and coarse woody debris (CWD) designed to provide 'standard' habitat measurements and to mimic natural habitat. ♦ In addition, in the fall of 1999, we removed all CWD from 50% of the nearshore area in each lake and created perturbed areas where approximately half the sites no longer contained CWD. ♦ Using an underwater video camera in combination with baited minnow traps, we developed methods and analyses to 1) assess if fish abundance is similar among habitats among seasons/years/lakes, and 2) examine how assessment of fish abundance from the video footage relates to baited minnow trap catches at the same locations. ♦ There were no clear, consistent patterns in fish habitat association as fish relative abundance depended both on the habitat type and the season/year in which the lakes were sampled. ♦ Also fish association patterns were different between lakes. ♦ Minnow trap catches were not significantly correlated with fish relative abundance from video counts.

[\[POSTER\]](#)

Smokorowski, K.E., M. Ridgeway and J. Hume
Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Sault Ste. Marie, ON, P6A 6W4



The Effectiveness Of Different Sampling Techniques In Identifying Associations Of Fish With Differing Habitats In Inland Lake Littoral Zones

Research on defining linkages between physical habitat and fish abundance was conducted in inland lakes, Great Lakes, and rivers in Canada, as part of a large-scale, DFO sponsored, study on the productive capacity of fish habitat. ♦ A variety of methods were used to determine fish diversity, abundance and/or biomass in different, previously defined, habitat types in inland lakes. The methods differed in their approach (underwater camera, visual line transect, and traditional netting gear), habitat specificity, precision, and result output. ♦ The purpose of this comparison is to assess the techniques in terms of their consistency and applicability in various habitat types, transferability across habitat types and systems, and comparability of results. ♦ As well, we were interested in assessing the effectiveness of each technique in terms of quantification of fish in their habitat, quantification of productive capacity of habitats, and potential for extrapolation to a whole-system level to assess the relative contribution of habitat types to productive capacity of a system. All techniques have inherent inconsistency affected by fish behaviour and aggregation. Overall, the visual line transect method was the most effective in quantifying fish in a variety

of habitat types, over a precise habitat area, in a range of systems. ♦ Defensible mathematical tools exist to convert the visual counts into a unit of production, and with appropriate habitat availability data, production by area can be extrapolated to the whole-lake level. ♦ The camera method demonstrated potential, but as currently deployed could not be used to assess productive capacity of habitat, or be extrapolated to the whole system. ♦ Traditional netting was the least precise method of quantifying fish in their habitat, but was the only method not dependent on water clarity to be effective.

[SAT. 15:20]

Stamford, M. D. and E.B. Taylor

Department of Zoology, University of British Columbia, Vancouver, British Columbia

Phylogeography, Local Population Structure And Conservation Genetics Of Arctic Grayling ♦ (Thymallus arcticus) In North America

The distributions of most Holarctic freshwater fish species were severely altered and restricted during the many glaciation events that have occurred throughout the Pleistocene. ♦ Isolation of groups of fish into distinct glacial refugia provided the opportunity for genetic divergence during these periods of allopatry through genetic drift and novel selection pressures. ♦ In this thesis, I examined the signature of such isolation and postglacial range expansion in the Arctic grayling (*Thymallus arcticus*) by assaying mitochondrial and microsatellite (nuclear) DNA variation throughout the species Peace River, British Columbia, because local demographics are integral to a species phylogeographic structure. ♦ I found a dramatic decline in genetic diversity from Alaska to the southeast, which suggests Arctic grayling survived the last ice age in Beringia then bottlenecks and founder events reduced diversity during southward postglacial range expansion. ♦ Genetic similarities among regions suggest that Arctic grayling survived glaciation in three refugia north of the ice sheets and in one region south of the ice sheets. ♦ A north Beringian lineage dispersed south during the Wisconsinan glaciation and founded populations in an upper Missouri River glacial refuge. ♦ These upper Missouri grayling dispersed north postglacially, and founded populations in Saskatchewan and eastern British Columbia. ♦ A south Beringian lineage dispersed south from the Yukon River Valley as far as the Peace and Stikine rivers in British Columbia. ♦ A third lineage from the Nahanni Valley in the Northwest Territories was more locally distributed in the Mackenzie drainage between Great Slave Lake and the lower Liard River. ♦ Population subdivision in the Peace River strongly suggests that Arctic grayling home to their natal stream to spawn. ♦ Such local population subdivision and low genetic diversity throughout the species range suggest that Arctic grayling habitat is partitioned among small isolated effective population sizes. ♦ Genetic diversity is distributed among lineages on a large geographic scale, and among populations on a local geographic scale. ♦ Consequently, to preserve the evolutionary potential of Arctic grayling, several populations within a watershed, several watersheds within a lineage, and several lineages within their geographic range must be prioritized for conservation.

[SAT. 15:20]

Standen, E. M. and S. Hinch

Department of Forest Sciences, University of British Columbia, Vancouver, British Columbia

Is Scale An Issue? Using Underwater Stereo Videography To Study The Effects Of Hydraulic Condition On Energy Use In Up-River Migrating Salmon

Anadromous salmon have limited somatic reserves with which they complete their upstream migration, gamete maturation and spawning behaviours. The amount of energy used by salmon during the up-river portion of their migration may determine their spawning success. To better understand energy use in up-

river salmon migration we studied the natural river swimming behaviours of Seton River sockeye salmon (*Oncorhynchus nerka*). We used underwater stereo videography to determine relationships between fish energy consumption and small-scale river hydraulics. Individual fish pathways were digitally superimposed onto measured 3-D flow fields. Relationships between ground speed, water velocity and energy use (as determined by tailbeats and bioenergetics modeling) were compared assessing both the relationship between fish activity and hydraulic condition and the effectiveness of different energy prediction models. It appears sockeye utilize very small scale (<0.25m²) flow fields to minimize energy use during up-river migration. Salmon are highly efficient at migration through low velocity currents (i.e. ground speeds equaled or exceeded swimming speeds). ♦ Conversely, fish tended to display faster, less efficient, swim speeds through sites with higher velocities. Fast swimming speeds in these areas could minimize travel time, despite high costs. ♦ Migrants may be balancing energetic costs of migration against the fitness costs of spawning delays.

[SAT. 11:20]

Stanfield, Les W.¹, Bruce Kilgour², ♦ Jacques Whitford² and ♦ Jack Imhof³

¹Ministry of Natural Resources, R.R. # 9, Picton, ON K0K 2T0; 613/476-3255; Fax 613/476-7131; Les.Stanfield@mnr.gov.on.ca) ²Environment Limited, 2781 Lancaster Road, Ottawa, ON, K1B 1A7; 613/738-0708; Fax: 613/738-0721; bkilgour@jacqueswhitford.com ♦ ³Ministry of Natural Resources, 1 Stone Road, Guelph, ON, N1G 4Y2; 519/ 826-4938; ♦ Fax 519/826-4929; Jack.Imhof@mnr.gov.on.ca

Linking Values, Risk, Precision, Scale And Level Of Effort Into A Framework For Managing Streams For A Net Gain In Productive Capacity For Streams

Ecosystems are organized hierarchically with large-scale features such as geology, topography, and climate limiting or determining finer-scale features such as channel form, structure, riparian conditions, and biological composition. ♦ Management of these systems can and should reflect that hierarchical reality. ♦ But managers face decisions that vary in the extent and intensity of an application (land use change or management action), the temporal nature of the event and their understanding of the relationship between the application and the valued attributes of the aquatic ecosystem. ♦ In addition managers must determine the likelihood that a proposed development will cause an adverse effect. ♦ The assessment of risk is performed using site information that is often collected without a priori understanding of the level of detail that is required for the assessment. ♦ Therefore, managers often assess risk on an ad-hoc basis, and often seeking more information (data) than is needed. The Ontario Ministry of Natural Resources (OMNR) has recently developed a number of protocols for characterizing general biophysical attributes of streams with varying levels of effort, and with known efficiency, repeatability (precision) and accuracy. Because effort varies, the resulting data offer varying levels of certainty in assessments of risk. ♦ Therefore, specific methodologies should be matched to the desired level of certainty. Coupled with these methodological developments, the OMNR has recently standardized the characterization of landscape attributes considered important to stream fish populations and habitat. ♦ Standardized characterization of landscape features is important for the development of models that predict large-scale distributions of fish species in the province. ♦ In this presentation we will present an overall framework that will demonstrate how the level of sampling intensity and landscape information can be used in assessing the risk of adverse effects resulting from a development.

[POSTER]

Steedman, R.

Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources, Thunder Bay, Ontario.

Aquatic Science For Managed Landscapes: Where Is Our Habitat Habit At?

We face a design and benchmark shortfall in Canadian aquatic habitat management. ♦ For example, early results from a number of Canadian studies suggest that even-aged (clearcut) forest management systems do not harmfully alter water quality, habitat, or biota of boreal forest waters, contrary to long-standing institutionalized assumptions that a serious habitat threat existed. ♦ Such findings contrast dramatically with impacts of permanent deforestation and development in urban and agricultural settings, where habitat simplification and loss of aquatic biodiversity are the norm in spite of clear understanding of the causes and solutions. ♦ These examples highlight some of the shifting dogma and chronic regulatory challenges facing Canadian aquatic habitat managers. ♦ A limited empirical foundation and large-scale environmental complexity contribute to the poor performance of productive capacity models based on physical descriptions of substrate and hydraulics. ♦ Skeptics could suggest that quantitative models of aquatic habitat have served primarily to provide an "illusion of technique" where legislation or policy requires numerical thresholds to regulate local resource degradation. ♦ Optimists could argue that habitat science should be more than an enabler of incremental habitat loss. ♦ Some of these shortcomings could be addressed by considering human activity and aquatic habitat in a bioregional design context, as well as in the site-scale mitigative context commonly used at present. ♦ Practical methods will come initially from the "design with nature" traditions of stream and wetland restoration, landscape architecture and modern urban runoff engineering. Regional planning and design benchmarks for habitat and biotic complexity and dynamics may be patterned on attempts to emulate natural disturbance regimes in sustainable forest management, and Karr's IBI.

[SAT. 14:00]

St-Laurent, M.H.¹, P. Magnan¹ and M. Legault²

1: Groupe de recherche sur les écosystèmes aquatiques, Université du Québec Trois-Rivières, C.P. 500, Trois-Rivières (Québec) G9A 5H7; 2 : Direction de la recherche sur la faune, Société de la faune et des parcs du Québec, 675 boul. René-Lévesque est, Québec (Québec) G1R 5V7.

Impact Of Six Years Of White Sucker Biomanipulation On Fish Communities Of Five Canadian Shield Lakes

The goal of this study was to evaluate the response of fish communities to six years of white sucker (*Catostomus commersoni*) mass removal in five Canadian Shield lakes (Québec). This experiment took place during a program to control populations of white sucker, a competitor of brook trout (*Salvelinus fontinalis*) in several Québec lakes. After six years of biomanipulation, the white sucker biomass decreased to between 48 and 96% of the biomass removed the first year, which had ranged from 24.7 to 51.7 kg/ha. This reduction of intra- or interspecific competition caused an increase in surplus energy that was invested in growth and/or in reproduction. Annual growth increases in brook trout and white sucker populations were related to the magnitude of the mass removal. Biomass and catch per unit of effort of 1+ to 4+ white sucker and brook trout increased in four of the study lakes. Growth compensation led to an increase in the length at maturity in white sucker females in all lakes and in brook trout females in the three lakes where the intensity of the mass removal was the highest. A general decrease in the age at maturity was observed in white sucker and brook trout of both sexes. The mean adjusted fecundity increased significantly in brook trout in three of the five study lakes while white sucker fecundity increased in all the lakes. Our results indicate that brook trout and white sucker exhibited compensatory responses to white

sucker biomanipulation and that these responses were related to the magnitude of the mass removal.

[SAT. 14:20]

Suthers, Iain.

School of Biological Sciences, The University of New South Wales, Sydney NSW 2052. ♦ Australia.

A Nutrient Limited Ecosystem Off Eastern Australia: Upwelling And Sewage Effects On Ichthyoplankton And Stable Isotope Composition

Upwelling events driven by topography and wind are spatially massive but temporally rare in the oligotrophic waters off eastern Australia. ♦ In stark contrast is the comparatively minute yet continuous discharge of 1200 ML sewage per day off Sydney, which produces a distinctive stable isotope signature (^{13}C and ^{15}N) in planktivorous fishes associated with Sydney's rocky reefs. ♦ Therefore we examined the ichthyoplankton community, SIA and condition during two cruises in the upwelling zone off northern NSW coast in November 1998 and January/February 1999 and compared these with samples off Sydney. ♦ Neuston net and EZ-net (at 10-30 m depth) samples at 50 m (inshore) and 100 m contour stations (offshore) were collected at four latitudinal/oceanographic regions: Urunga, Smoky Cape (both in the free stream of the East Australian Current), Point Plomer, Diamond Head (being downstream of the upwelling), and off Sydney. A total of 120 taxa (119 families and 1 order) were found within the ichthyoplankton samples. ♦ The community shows separation between the 50 and 100 m contour stations and a significantly distinct community among regions in January. ♦ A separate comparison of the November neuston and EZ-net data between Diamond Head and nutrient enriched waters off Sydney revealed a further evolution of the ichthyoplankton community, showing distinctive gradients in stable isotope composition, and the effects of each nutrient source.

[FRI 14:00]

Swansburg, E.¹, G. Chaput², ♦ D. Moore², D. Caisse,² ♦ ♦ and N. El-Jabi²,

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Size Variability of Juvenile Atlantic Salmon (*Salmo salar* L.): Links to Environmental Conditions

Climate change models predict a 2 to 6 ♦ C increase in air temperature within the next 100 years in the Maritime Provinces of eastern Canada. ♦ Higher air temperatures are expected to contribute to increased water temperatures, alterations in stream flow conditions, and ultimately reductions in fish growth. ♦ Changes in timing of the peak spring discharge and in the minimum annual flows consistent with climate change predictions have been noted in the Miramichi River over the last 40 years. For juvenile Atlantic salmon (*Salmo salar*), mean annual size-at-age has decreased in the Northwest Miramichi and Southwest Miramichi rivers over the last 30 years. Lengths-at-age of juveniles were significantly correlated between the two rivers. ♦ For salmon parr, stronger associations between inter-cohort fork length than intra-cohort fork length were observed, suggesting that environmental conditions in the current year of growth have the more significant effects on size of age-2 parr than conditions encountered the previous year by age-1 parr of the same cohort. ♦ Fork lengths of juvenile parr were significantly and negatively associated with spring air and water temperatures. ♦ Growth potential, based on a maximum functional growth model, did not change significantly over the last three decades, despite significant increases in air and water temperatures. ♦ In the Miramichi River, increases in air and water temperature as predicted from climate change models will have adverse affects on growth of juvenile Atlantic salmon parr resulting in reduced productivity of the Atlantic salmon populations in this region.

[FRI 13:20]

Tallman, R. F.

Department of Fisheries and Oceans, Central and Arctic Region, 501 University Crescent Winnipeg, MB R3T 2N6

Conservation And The Evolutionary Genetics Of Seasonal Migrations In Fishes

Seasonality and migration between different key habitats is a characteristic of many temperate and Arctic fishes. ♦ I provide examples of the occurrence of seasonal migrations to spawning, rearing and overwintering habitats. ♦ I review the information on the relative contribution of genetics and environment to diversity in seasonal migrations using examples from temperate and Arctic salmonoids. ♦ Evidence is presented to demonstrate the consequences to abundance of perturbations to the natural timing of migration. ♦ Failure to conserve the timing of fish migrations can result in a cascade of effects on the fitness and may therefore result in reduction in abundance.

[FRI 14:20]

Tamke, P.1, E. A. Parkinson 2 and E.B. Taylor 1

1. Department of Zoology and Native Fish Research Group University of British Columbia, Vancouver, BC V6T 1Z4

2. Ministry of Water, Land and Air Protection University of British Columbia, Vancouver, BC V6T 1Z4

The Impact Of Geographic And Habitat Complexity In Organizing Genetic Variation And Differentiation In Rainbow Trout, Oncorhynchus mykiss

Understanding the processes that influence the extent and patterns of genetic variation within species is a fundamental goal of evolutionary biology. Considerable work has been conducted on the role of large scale geographic processes (e.g. glaciation) in structuring intraspecific genetic variation, but few studies have looked at the impact of habitat and geography on genetic diversity within and among natural populations at smaller spatial scales. We studied microsatellite DNA variation at ten loci among 27 populations of rainbow trout (*Oncorhynchus mykiss*) to assess the relative importance of habitat size (e.g. lake size) and geographic complexity (e.g. interconnectedness among lakes, presence of migration barriers) as factors determining genetic variation within populations (numbers of alleles, expected heterozygosity) and differentiation among populations in rainbow trout sampled from throughout British Columbia. Our samples included three chains of lakes and 11 non-contiguous populations, and each lake-chain varied in the number of populations (N= four to seven), as well as elevation, lake size, stream size, presence or absence of barriers, degree of connectivity among lakes, and degree of isolation. Across all samples, expected heterozygosity and numbers of alleles averaged 0.6471 and 3.43, respectively, and the degree of population subdivision (F_{st}) was 0.4360. Our data indicate that there is a negative correlation between latitude and heterozygosity, and between latitude and number of alleles per locus, and that riverine populations tend to have a higher average heterozygosity and number of alleles per locus than lacustrine populations. Our results suggest that local hydrographic features can be important determinants of intraspecific genetic structure, and that physical features of waterbodies may serve as useful indicators of molecular variation in rainbow trout.

[SAT. 9:30]

Taub*, Frieda B., John E. Petersen, W. Michael Kemp, and Debbie Hinkle. (Taub University of Washington, School Of Aquatic and Fishery Sciences, Seattle, WA, 95105, USA taub@u.washington.edu, others, University of Maryland, Horn Point Environmental Laboratory, Center for Estuarine and Environmental Studies, Cambridge, Maryland 21613, USA)

Community Metabolism: Properties Of Scale (Size/Shape And Data Analyses)

Most analyses of (net, daytime) Photosynthesis and (nighttime) Respiration focus on a daily ♦ scale, and most often, the P/R ratio over 24 hours is approximately one. ♦♦ The tight coupling of P and R have been documented in many experiments. ♦ When the Dissolved Oxygen concentrations are analyzed over a

multi-day scale, additional attributes become apparent. Superimposed on the daily P/R relationship, a sine wave can be observed, such that there are a series of days for which P slightly exceeds R, alternating with a series of days in which P is slightly less than R, and the cycle is repeated. ♦ This pattern was observed in a series of MEERC ♦cosms of different sizes (from 0.1 to 10 m³ and different light receiving areas). ♦ The multi-day scale shows why replication is such a problem in ♦cosm experiments; often the cycles are out of phase among replicates. ♦ Data on chlorophyll and copepod abundance for some of the ♦cosms suggest that trophic interactions contribute to these patterns. In smaller, freshwater microcosms (Standardized Aquatic Microcosms), similar multi-day cycles can be observed, and these relate to algal and grazer (particularly Daphnia) abundance. ♦ When we focused on daily P/R ratios, the addition of toxic substances did not appear to modify P/R ratios. ♦ Analyzed in a multi-day scale, new information can be observed. These longer-term relationships do not negate the daily coupling of P and R, but demonstrate a longer scale pattern that is missed by the more usual, daily analysis. ♦ Thus, the scale of analysis can alter the perception of results.

[\[POSTER\]](#)

Temple*, S.E., Hawryshyn, C.W. and Haimberger T. Department of Biology, University of Victoria, British Columbia.

Visual Pigments As A Quantitative Measure Of Preparedness For Smoltification In Coho Salmon

Anadromous salmon are known to change their visual pigment composition when they migrate from freshwater to the marine habitat. ♦ While in freshwater most salmonids predominantly use porphyropsin (3,4-dehydroretinal), which is the common visual pigment in freshwater fishes. ♦ However, in the marine habitat, salmon use the visual pigment rhodopsin (retinal), which is the pigment used by most marine fishes and terrestrial vertebrates. ♦ The replacement of rhodopsin with porphyropsin causes an approximately 30 nm red-shift in maximal absorbance of the rod photoreceptors, thus the shift in visual pigments may be adaptive to the different photic environments of the freshwater and marine habitats. The transition in visual pigments may be a useful indicator of smolt status, as it is preemptive and coincides with other physiological transitions that occur at smoltification (silvering, increased hypoosmoregulatory abilities and decreased condition factor). ♦ Using charged coupled device microspectrophotometry we are able to quantify the shift in visual pigments in coho salmon, the timing of which we compare to osmoregulatory abilities (24 hour saltwater blood sodium content measured using a sodium microelectrode), and silvering (quantified using the spectral reflectance of broad spectrum white light). ♦ The discussion will focus on our preliminary results and their implications.

[\[POSTER\]](#)

Tonn*1 W., N. Jones1, and G. Scrimgeour2. ♦ 1University of Alberta and ♦ 2Alberta Research Council, Edmonton, AB ♦

Physical, Chemical, And Biological Characteristics Of ♦ Barrenland Tundra Streams Of The Northwest Territories

During 1998-2000, we quantified characteristics of 20 streams in a 4000 km² area of east-central NWT, where diamond mining and mine development are occurring. ♦ General hydrothermal characteristics are ♦ similar to tundra streams in arctic Alaska, driven largely by similar climatic regimes. Barrenland streams, however, are shorter, connecting chains of lakes, and flow through boulder-filled channels of variable degrees of confinement and braiding. ♦ The underlying Canadian Shield keeps alkalinity and nutrient concentrations low while the lakes provide abundant microcrustaceans to the drift. ♦ Lakes also funnel

migrating caribou through streams, causing seasonal catastrophic drift of benthic macroinvertebrates and adding fine woody debris and particulate organic matter from the surrounding tundra. ♦ Most fish assemblages are impoverished, but streams serve as spawning and nursery habitat for lake-dwelling Arctic grayling; growth rates of YOY grayling compare favorably with other northern streams, corrected for latitude. ♦ Annual variation in temperature, rainfall, and discharge influence the abundance of invertebrates, epilithon, and the growth of YOY grayling. These surveys will provide a benchmark for restorative and enhancement measures for fish habitat affected by mining and other development.

[POSTER]

Tremblay, G.I., P. Sirois 1 and M. Legault 2

1Département des sciences fondamentales, Université du Québec Chicoutimi, 555 boulevard de l'Université, Chicoutimi, QC G7H 2B1. 2Direction de la recherche sur la faune, Société de la faune et des parcs du Québec, 675 boulevard René-Lévesque Est, Québec, QC G1R 5V7

Inter-Annual Comparison Of Size-Selective Mortality Of Rainbow Smelt (*Osmerus mordax*) Due To Predation By Landlocked Atlantic Salmon (*Salmo salar*) In Lac Saint-Jean

Early life stages in fishes are characterised by high mortality. Therefore a particular individual has very few probability to survive until first reproduction. Many investigators have tried to determine which members of a cohort or year class survive and why. It is generally thought that larger and faster growing individuals are more likely to survive because smaller fish are more susceptible to starvation and predation. Rainbow smelt is the most important prey of landlocked Atlantic salmon in Lac Saint-Jean (Quebec, Canada). Inter-annual variations in the year-class strength of rainbow smelt have been identified to be a key factor affecting the production of landlocked Atlantic salmon. Our objective was to investigate the size-selective mortality of rainbow smelt due to predation by landlocked Atlantic salmon during three consecutive years in Lac Saint-Jean. Annual surveys were conducted in early August in Lac Saint-Jean, from 1997 to 1999. Young rainbow smelts were measured from the field surveys and from the stomachs of landlocked Atlantic salmon. Length frequency distributions suggested that landlocked Atlantic salmon feed on small age-1 smelt in 1997 and 1999. However, larger YOY were the preferred prey in 1998. Understanding factors affecting survival of young smelts may provide a promising tool to predict year-class strength fluctuations in Lac Saint-Jean.

[SAT. 13:20]

Trudel, M.¹, S. Tucker² and D.W. Welch¹

¹Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, British Columbia

²Department of Biology, Dalhousie University, Halifax, Nova Scotia

Are Pacific Salmon Starving In The Ocean?

There is a concern that the carrying capacity of the ocean has been exceeded by the massive release of hatchery-reared salmon, as ocean survival of salmon decreases with the number of salmon in years of poor ocean productivity. In order to determine the carrying capacity, we need to accurately estimate prey supply and predator demand. Yet, food requirements of wild and hatchery fish have never been compared in the ocean. Here, we present food consumption rates of juvenile coho salmon off the west coast of British Columbia that were obtained using a chemical tracer approach. Food consumption rates of juvenile salmon averaged approximately 10 % bw d⁻¹ during summer and represented 75% of their maximum consumption rates. These values were sufficient to allow juvenile salmon to grow at 2-3 % bw d⁻¹. In addition, food consumption rates of juvenile salmon did not differ between years of poor and good ocean conditions. Overwinter feeding rates of these fish averaged 3 % bw d⁻¹, and were sufficient to generate positive growth, albeit at a much lower rate than during the summer. Thus, we found no evidence that salmon are starving in coastal waters.

[FRI 14:40]

van Poorten*, B. T. and J. R. Post. ♦ Department of Biological Sciences, University of Calgary, Calgary,

Alberta

Angler-Induced Changes In Size- And Age-At-Maturity In Size-Structured Populations: Individual And Population Level Impacts

Density-dependent processes resulting from natural mortality are well known. While natural mortality typically involves the highest mortality of the smallest individuals, angling mortality works in the opposite direction: vulnerability increases with size. This study is intended to create a better understanding of the individual and long-term effects of angling mortality on population structure and abundance. There are two components: 1) effects of angling on individual maturity schedules and 2) how this affects long-term stability of the population. In answering the first component, we use an i-state distribution model to ask what the resultant changes in size- and age-at-maturity will be after a shift in angler effort. Here we incorporate size-selective vulnerability to angling and flexible growth rates, which we relate to density. We fix either age- or size-at-maturity and ask what will be the resultant changes in size- or age-at-maturity, respectively. To answer the second component, we then create an intergenerational model incorporating annual recruitment. This allows us to examine equilibrium density and population abundance over time. General trends and equilibria will be presented, and the role of this research to aid in management will be discussed.

[\[POSTER\]](#)

Vascotto, K., B. Shuter and D. Jackson

Department of Zoology, University of Toronto, Toronto, ON

An Examination Of The Varying Life History Characteristics Of Three Ontario Lake Herring (*Coregonus artedii*) Populations

Lake herring (*Coregonus artedii*) are widely considered to be the dominant prey item of many commercially important, piscivorous lake trout (*Salvelinus namaycush*) populations. Although a large degree of variation has been observed in growth, maturity, behavior and abundance of cisco, little is known about the factors generating this diversity. Two Ontario lakes (Lake Opeongo and Smoke Lake) with introduced herring populations and indigenous lake trout populations are examined. Since introduction 65 years ago, both herring populations have undergone dramatically different trajectories. Preliminary examination of results from both acoustic and netting projects indicate higher density herring populations in Lake Opeongo, accompanied by smaller asymptotic body sizes and smaller sizes of sexual maturity relative to the Smoke Lake population. Estimates of mortality and reproductive investment will also be compared. Life histories of the lake trout populations in these two lakes were also compared. A third cisco population, resident in a lake void of piscivorous predators, was then examined to provide a contrast of non-predator structured herring populations. This population was characterized by an older population structure with faster growth rates, different patterns of gonadal allocation and different schooling patterns.

[\[SAT. 11:20\]](#)

Venturelli*, P. and W. Tonn. Department of Biological Sciences, University of Alberta, Edmonton, Alberta

The Introduction Of Northern Pike Into A Fishless Boreal Lake: Does A Diet Of Leeches Affect Predators Or Prey?

Lakes containing only northern pike (*Esox lucius*) are common in boreal Alberta. Populations persist partly because pike can survive on a macroinvertebrate diet. Population variability, however, is high, often associated with winterkill (and recovery). An earlier study suggested that populations of certain

macroinvertebrates respond to these fluctuations in pike populations. ♦ The objectives of this study, therefore, were to determine the effect of (a) an introduction of pike into a small, fishless, boreal lake on the abundance and size of littoral macroinvertebrate prey; and (b) a macroinvertebrate diet on the growth of pike. ♦ In May 2001 we stocked individually tagged pike at a density of ~31 kg/ha. ♦ Stomach contents of pike recaptured during the summer were compared to monthly samples of macroinvertebrates. ♦ The growth of pike was determined from individuals recaptured in the fall. ♦ Pike consumed almost exclusively two species of erpobdellid leeches, *Nepheleopsis obscura* and *Erpobdella punctata*. ♦ ♦ On average, leeches consumed by pike were larger than those sampled in the lake and occurred frequently in pike stomachs despite limited abundance in littoral samples. ♦ Growth in length of pike was less than predicted from the literature while the relationship between length and weight was not affected. ♦ Thus, there may be a cost associated with a macroinvertebrate diet irrespective of feeding strategy or prey availability. ♦

Understanding how fluctuations in populations of pike affect the diet and growth of pike, as well as the structure of food webs, is important to understanding natural disturbance dynamics of Boreal Plains lakes. [POSTER]

Wagner*, G.N.1, R.S. McKinley1, P.A. Bjørn 2, B. Finstad 3. 1Faculty of Agricultural Science, The University of British Columbia, Vancouver, B.C. 2Norwegian College of Fishery Science, Breivika, Troms ♦, Norway. 3Norwegian Institute for Nature Research, Tungasletta, Trondheim, Norway

Physiological Impact Of Different Levels Of Salmon Lice (*Lepeophtheirus salmonis*) Infestation On The Cardiac Output And Swimming Performance Of Atlantic Salmon (*Salmo salar*)

The salmon louse, *Lepeophtheirus salmonis*, is known to contribute to salmonid mortality by causing immunosuppression and osmoregulatory disturbances. However, the effect of increased lice numbers on host cardiovascular parameters and swimming ability has yet to be examined. The purpose of this study was to determine if the cardiac or swimming performance of Atlantic salmon is affected by increased lice infestation. Fish were infected with moderate (0.127 ♦ 0.018 lice g⁻¹), and low (0.019 ♦ 0.002 lice g⁻¹) levels of lice over a period of 2 hours. Once lice reached adult stages, the ventral aorta of each fish was fitted with a Doppler cuff in order to measure cardiac output, stroke volume and heart rate during swim testing. Critical swimming speeds of moderately infected fish (2.10 " 0.12 bl s⁻¹) declined significantly (P < 0.05) compared to low (2.43 " 0.12 bl s⁻¹) and control (2.64 " 0.10 bl s⁻¹) treatments. Heart rates of moderately infected fish (62.7 " 1.8 beats min⁻¹) decreased significantly compared to low (68.6 ♦ " 1.4 beats min⁻¹) and control (68.6 " 1.8 beats min⁻¹) fish at the final stages of the swim trials, but overall cardiac output did not change. Chloride levels of moderately infected fish (184.4 " 11.3 mg ml⁻¹) were significantly higher than low (142.0 " 3.7 mg ml⁻¹) or control (159.5 " 3.5 mg ml⁻¹) fish after swim testing; levels increased significantly from resting values only in the moderate treatment. These results indicate osmoregulatory stress occurs in moderately infected fish during exercise. This stress likely is the cause of the decreased heart rate and a decrease in swimming performance. These changes show the overall fitness of salmon is compromised by infection with moderate levels of lice.

[POSTER]

Ward, B.R. (1), D.J.F. McCubbing (2), D.W. Welch (3)

(1) B. C. Fisheries Research and Development Section, University of British Columbia,

(2) In-Stream Fisheries Consultants, Vancouver, B.C.,

(3) Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C.

Flip, Flop and Fry: Climate-Induced Variation In Keogh River Salmonid Carrying Capacity And Survival In The Ocean

Monitoring of smolt yield and adult returns of steelhead trout (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) at the Keogh River on northeastern Vancouver Island has shown large variation in survival during

both the freshwater and ocean phases of the life history. ♦ In the early 1990s, both species experienced a large and persistent drop in survival. ♦ The estimated carrying capacity for steelhead trout in freshwater declined by more than a factor of 3 (mean 7,000 smolt recruits, 1977 to 1990; <2,000, 1991 to 1997) and was coincident with numerical declines to record low levels in yield of all other spring migrants (coho, Dolly Varden *Salvelinus malma*, Cutthroat trout *O. clarkii*, cottids *Cottus asper* and *C. aleuticus*). ♦ Meanwhile, the survival of both steelhead and coho smolts at sea dropped by a factor of 5 (from 15% to 3% marine survival) when compared to the previous decade. ♦ Recruitment dropped below replacement levels. ♦ Variation in smolt-to-adult survival within the decades of the 1980s and 1990s seems to be related to El Nino events of successively increasing intensity and frequency, followed by an equally intense La Nina that is now dissipating. ♦ An increase in marine survival during the smolt-to-adult stage for the 1997 and 1998 out-migrating steelhead and coho smolts may have been short-lived, based on our results from electronic escapement counts over the past two years (1999 and 2000 smolts). ♦ We suggest that it is too early to judge whether a new trend towards higher marine survival is emerging, and caution that our observations may indicate a continuation of poor survivals and reduced productivity. ♦ Our findings may be an indication of the magnitude of future climate changes on important salmon stocks. .

[FRI. 16:20]

Welch, D.W.

Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, British Columbia, V9R 5K6

A Comparison Of Projected Climate Change Scenarios On Ocean Distributions Of Pacific Salmon

Ocean surveys show that extremely sharp thermal boundaries have limited the distribution of all species of Pacific salmon in the Pacific ocean and adjacent seas over the past 40 years. ♦ These limits are generally expressed as a step-function, with the temperature defining the upper thermal limit varying between months in an annual cycle, and with the temperature limiting the distribution differing between species. ♦ The sharpness of the edge, the different temperatures that define the position of the edge in different months of the year, and the subtle variations in temperature with area or decade for a given month probably all occur because temperature-dependent metabolic rates exceed energy intake from feeding over large regions of otherwise acceptable habitat in the north Pacific. We compared the projected distribution of surface isotherms defining the southern limit to the distribution of salmon (*Oncorhynchus spp*) for a variety of climate models, under current (1xCO₂) and future (2xCO₂) greenhouse gas concentrations. ♦ The results indicate that the major GCMs all provide a reasonable picture of the average sea temperatures for the North Pacific (mean monthly model SSTs less than 1SD different from the observed climatological means). ♦ Projections of these fields of monthly SST into the future suggest that the temperatures defining the current ocean distribution of sockeye salmon would move out of the North Pacific and into the Bering Sea in 3-4 decades assuming ♦business as usual♦ projections of CO₂ increase. ♦ By the 2090s, these isotherms are projected to have moved out of the Bering Sea as well into the Chukchi Sea. ♦ Results for the other species of salmon are qualitatively similar, although the projected time until the bounding isotherms move out of the Pacific Ocean is longer for those salmon species with higher thermal limits. These results raise troubling questions concerning the fate of Canadian salmon. ♦ Assuming that salmon do migrate into the Bering Sea to forage within energetically acceptable regions, it is unclear whether they will be able to successfully migrate back to Canadian waters, as much of Alaska will block their straight line path back. ♦ This places a premium on determining the biological basis of many aspects of their ocean biology, such as migration strategy, which at present are very poorly understood. ♦ There is a great need to better understand the biological basis for these thermal limits, and to understand how global warming impacts may also directly impact the ocean at lower trophic levels.

[FRI 14:40]

Wells*, J.I., ♦ D. Scruton² and Joseph Brown¹. ♦

¹Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland, A1B 5X9.

²Fisheries and Oceans, Canada, Science, Oceans, and Environment Branch, P.O. Box 5667, St. John's, NF, A1C 5X1.

Effects Of Managed Buffer Zones On Aquatic Fauna And Habitat Associated With A Headwater Stream In Newfoundland

Impacts of buffer zones on stream ecology are well documented on the west coast of North America, however, the applicability of this research for the Atlantic region is limited due to differences in fauna, topography, soil and forest conditions, and climate. ♦ Therefore, the possible effects of managed buffer zones on aspects of a headwater stream's ecosystem in Newfoundland were studied so that forest management practices could be based on region specific data. Three experimental buffer zones were established using a mechanical harvester: 20 m width (current provincial regulation); 20 m width (with selective harvesting within the buffer); and 30-50 m width (with selective harvesting within a serrated edged buffer). ♦ The following parameters were studied pre- and post-harvest: sediment deposition; water temperature; population estimate/biomass of salmonids; brook trout (*Salvelinus fontinalis*) migration (through floy tagging; hydrology, heat shock protein in brook trout; and density and diversity of aquatic invertebrates. ♦ Data collected post-harvest was used to determine the effects of the experimental zones on these parameters. ♦ This study is attempting to assess whether managed buffers are a superior method of riparian zone management, allowing maintenance of the ecological integrity of an area, while maintaining the total wood production for the forestry industry.

[\[POSTER\]](#)

Wicks*, B.J., P.A. Ackerman**, G.K. Iwama***, and D.J. Randall****.

*Department of Zoology, University of British Columbia, Vancouver, BC, V6T 1Z4 **Faculty of Agricultural Sciences, University of British Columbia, Vancouver, BC, V6T 1Z4 ***Institute for Marine Biosciences, National Research Council, Halifax, N.S., B3L 3V2

****Department of Biology and Chemistry, City University of Hong Kong, Kowloon, H.K.

The Effect Of Ammonia Exposure On Ammonia Metabolism And Immune System Response Of Chinook Salmon Smolts

Limited research has been conducted on ammonia toxicity in fish in the marine environment and such research rarely takes life history into consideration. The nature of the salmonid life cycle can place juvenile fish in areas of potentially high ammonia concentrations at the end of the smoltification process and downstream migration. There have been several studies indicating that smolts are more susceptible to anthropogenic toxicants than other life-stages. This study was designed to consider the effects of a sub-lethal ammonia exposure on ammonia regulation and the immune system of recently smolted Chinook salmon. The second purpose of the study was to determine if a low-grade ammonia exposure affected disease susceptibility in fish exposed to a subsequent disease challenge. To investigate the effects of sub-lethal levels of ammonia in coastal waters on physiological and immunological systems of fish, juvenile Chinook salmon were maintained in seawater (10 ♦C, pH 7.8) and exposed to two concentrations of ammonia, 2.5 and 10 mg/L nitrogen. ♦ Both test levels are below the acute standard (2.5 mg/L is also below the chronic standard) and resulted in increased internal levels of ammonia in the fish. Neither treatment level affected feeding rates. Over a time course of 10 days, significant changes were noted in tissue enzymes and metabolites (glutamate and glutamine) associated with ammonia regulation between treatment and control fish. Blood cell counts changed significantly as did respiratory burst activity. Plasma lysozyme activity and plasma glucose concentration changed significantly over time in both treatments compared to controls. Levels of stress protein 70 (SP70) in liver tissue and head kidney tissues were measured and differences were observed between treatment groups and controls. ♦ In an experimental infection with *Vibrio anguillarum*, fish previously exposed to sub-acute levels of ammonia were more

susceptible to pathogenic challenge. The findings of this study indicate that a more thorough investigation into the effects of environmental ammonia on fish populations in coastal waters should be undertaken and the current environmental standards reassessed.

[\[POSTER\]](#)

Wilson, C.

Ontario Ministry of Natural Resources

Genetic Stock Structure Of Walleye (*Stizostedion vitreum*) In The Lower Great Lakes: Comparison Of Population-And Individual-Based Analyses

Declines in walleye (*Stizostedion vitreum*) populations in the lower Great Lakes in recent years have prompted investigation of their genetic stock structure, to ensure the sustainable management of distinct breeding populations. ♦ Analyses of stock structure and contribution of walleye stocks to mixed-stock commercial and recreational fisheries have been carried out in Lake Erie and Lake Ontario using mitochondrial DNA (mtDNA) and microsatellite DNA markers. Analysis of the genetic data using population- and individual-based tools yielded complementary findings: whereas traditional (population-based) analyses provided information on stock structure, relatedness among populations and gene flow, newer individual-based approaches gave insights into dispersal, metapopulation dynamics and genetic neighbourhoods. ♦ This combined approach to analysis of genetic stock structure has great potential for describing both historical and contemporary structure and gene flow, as well as the contribution of populations and metapopulations to mixed-stock fisheries.

[\[SAT. 16:00\]](#)

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

Mitochondrial Phylogeography Among Great Lakes Populations Of The Deepwater Sculpin, *Myoxocephalus thompsoni*.

The deepwater sculpin, *Myoxocephalus thompsoni*, is considered a 'glaciomarine relict' from the Pleistocene, although its phylogeographic history is uncertain. ♦ Although deepwater sculpin disappeared from Lake Ontario several decades ago, the capture of several specimens in recent years may indicate their recovery or re-establishment. ♦ To resolve the genetic origins of the recent Lake Ontario specimens, several regions of the mitochondrial genome were sequenced, comparing specimens of *M. thompsoni* from Lake Ontario, Lake Huron and Lake Michigan. ♦ The marine fourhorn sculpin, *M. quadricornis*, was used as an outgroup for comparison. ♦ The low level of sequence variation and phylogeographic divergence among lakes suggests a single postglacial origin for Great Lakes populations of *M. thompsoni*, and highlights the need for higher-resolution genetic markers to track the genetic structure and dynamics of this re-emerging deepwater species.

[\[POSTER\]](#)

Winans, G.A., ♦ E. Iwamoto and R.G. Gustafson

National Marine Fisheries Service, Northwest Fisheries Science Center, Conservation Biology Division, 2725 Montlake Boulevard East, Seattle, WA ♦ 98112-2097

New Genetic Data For River-Sea-Type Sockeye Salmon In Western North America

In contrast to the well-known ♦ lake-type ♦ sockeye salmon, two additional anadromous life-history types have been recognized within the species: ♦ river-type ♦ sockeye salmon whose juveniles spend 1 or 2 years in off-channel river habitats prior to migrating to sea, and ♦ sea-type ♦ sockeye salmon that initially rear in similar river habitats yet migrate to sea as underyearlings. ♦ Persistent populations of river-/sea-type

sockeye salmon occur in small numbers throughout the species' range in North America but are usually associated with glacier-fed rivers. We found published and unpublished records showing that riverine-spawning sockeye salmon occur in 11 rivers in western Washington, USA, that don't have access to juvenile lake-rearing habitat. Evidence of persistent spawning was strongest for the Nooksack and Skagit rivers in northern Puget Sound. Here, we add new allozyme data for several Canadian populations and view genetic differentiation in 27 lake-type and 15 river-/sea-type populations in North America, ranging from northern Puget Sound, Washington to northern Southeast Alaska. Across this 2000 km range, river-/sea-type sockeye salmon showed very little genetic differentiation between populations, much less than that displayed by the highly divergent lake-type sockeye salmon. Genetic similarity among river-/sea-type sockeye salmon in this study is likely a result of common ancestry and a high level of historical gene flow among river-/sea-type sockeye salmon populations. .

[FRI. 16:00]

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

Distribution And Movement Of Brook Trout (*Salvelinus fontinalis*) Within And Between Headwater Tributaries In A Discrete Lake Basin In South-Central Ontario

The purpose of this study was to investigate habitat use and seasonal movements of brook trout (*Salvelinus fontinalis*) in six tributaries in the Fairy and Peninsula lakes watershed in south-central Ontario. Fairy and Peninsula Lakes, 712 ha and 865 ha respectively, are connected by a 1km canal which allows free passage of fish during all seasons. There is no known lake fishery for brook trout and recent field surveys have failed to capture brook trout in the lake. Brook trout habitat within the Fairy-Peninsula lake basin is extremely patchy only eight of thirty nine tributaries providing adequate groundwater flows to support year round residency. Land-use development that threatens the integrity of many of the tributaries has prompted our studies of brook trout population structure. Electro-fishing surveys have identified eight tributaries that support brook trout, three in each lake, which appear to provide year round habitat. Small body sizes of mature adults and headwater spawning suggest that these populations are stream resident stocks that are at least partially independent from local populations in neighboring streams. During spring and summer 2001 we operated weirs and conducted PIT tagging studies on three tributaries in each lake to determine the extent of movement within and between streams. A total of 259 brook trout were implanted with PIT tags. During fall 2001, 56 (22%) individuals were recaptured. Of these 14 (25% of recaptures) had lost their tag. Recapture rate by stream ranged from 0% to 38% and averaged 19%. The largest distance between recaptures was 1km. Most of the recaptured individuals were found in close proximity to the original tagging site (<200m) and all recaptures were in the stream in which they were originally tagged. Capture of a few large individuals >0.5 kg, primarily during spring and fall, suggested some straying between tributaries and a mechanism for persistence of the metapopulation. Small size of the local populations (a few hundred individuals) and their vulnerability to depletion or even local extinctions through habitat disturbance or loss, underlines the importance of protecting the diversity of habitats provided by the existing cold-water tributaries.

[POSTER]

Wootton*, B.1, D. O. Evans², and C. Wilson². 1. Watershed Ecosystem Graduate Program, Trent University, Peterborough, Ontario. 2. Ministry of Natural Resources and Trent University, Peterborough, Ontario.

Genetic Evidence Of Metapopulation Structure In Brook Trout (*Salvelinus fontinalis*) Inhabiting Small Tributaries Of Two Precambrian Shield Lakes In South-Central Ontario

The purpose of this study was to characterize the metapopulation structure of brook trout in the Fairy and Peninsula lakes watershed in the Muskoka region of south-central Ontario. ♦ Fairy and Peninsula lakes, 712 and 865 ha respectively, are connected by 1 km canal which is freely passable by fishes during all seasons. ♦ Fairy Lake is on the urban fringe of the town of Huntsville and both lakes have extensive recreational development. Thirty nine small tributaries drain the lake catchments, but only eight streams provide adequate ground water to support brook trout populations. ♦ Land-use activities threaten the integrity of these streams, hence our interest in describing the ecology and genetics of their brook trout populations. Electro-fishing was used to non-lethally sample 30 adults and 30 young-of-year in each of three streams in each lake. ♦ Genetic analyses of multi-locus microsatellite DNA genotypes from the six collecting sites indicated contemporary fragmentation of the historical metapopulation, with varying but hierarchical isolation among tributary stream populations. These results suggest that altered conditions within the lake catchments may have disrupted historical linkages, changing this former metapopulation into a set of isolated remnant populations.

[\[POSTER\]](#)

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Lake Fertilization As A Restoration Technique For Columbia Basin Kokanee

The construction of hydroelectric dams on Kootenay Lake caused the retention of nutrients and the subsequent reduction of salmonid stocks by the mid-1980♦s. Fertilization was initiated in 1992 as a mitigation technique to restore the nutrient balance within the lake and assist in the recovery of kokanee and rainbow trout populations which had suffered from a lack of forage. Kootenay Lake was fertilized using an agricultural blend of phosphorus and nitrogen. Phytoplankton populations at sampling stations closest to the fertilization zone responded positively (up to 4 times mean biomass) to fertilizer loading. Zooplankton and mysid populations increased in abundance and biomass with high fertilization loading (1992-1996). Kokanee populations increased in both escapement and in-lake abundance to levels previously observed in the late 1970♦s. In years when fertilizer loading was reduced (1997-2000), phytoplankton, zooplankton and kokanee populations began to decline. Monitoring has shown that phytoplankton and kokanee abundances appear to track the fertilizer loading fairly closely (i.e., decreased fertilizer loads causes reduced phytoplankton and kokanee abundances). Resulting from the positive changes in Kootenay Lake, a fertilization operation was initiated on the Arrow Lakes Reservoir in 1999 in response to dramatic declines in kokanee escapement, spawner size and low in-lake abundance. After only three years of fertilization there have been documented improvements to the Arrow Reservoir food web. Specifically, phytoplankton populations have increased throughout the reservoir and the abundances of zooplankton and mysid populations have improved from pre-fertilization levels. Initial changes in kokanee populations have been similar to changes observed in Kootenay Lake with improvements to in-lake abundance, escapement, spawner size and fecundity. A multi-disciplinary team of biologists and technicians continues to monitor the progress of two of the world♦s largest lake fertilization operations and many of the changes to these ecosystems will be discussed.

[\[POSTER\]](#)

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Towards Understanding The Diversity Of Fish Assemblages In Eelgrass, Zostera-marina L, Ecosystems In British Columbia

Seagrass beds play an important global role in supporting marine biodiversity by providing food and habitat for fish, invertebrates, birds and mammals, and by supporting the functioning of marine food webs (e.g., productivity and nutrient cycling). ♦ It remains unclear in the literature however, if ♦ emperate eelgrass

beds (Z. marina) are equivalent in their supporting roles, or if there is variable diversity among component species and processes. This is an important issue for agencies, such as Parks Canada, that have a mandate to conserve the ecological integrity of nearshore marine ecosystems within National Park boundaries. In this study, we have examined the question of differential diversity among eelgrass beds by sampling their component fish assemblages. We sampled fish Assemblages in 15 eelgrass beds in Clayoquot Sound during the summer of 2001. Beach seining was conducted in triplicate within 2 hours of low tide, and all fish caught were identified to species and counted. More than 40 fish species were identified among all sites combined, with an average of 17-20 species found in any one bed. The 12 most abundant fish species, including threespine sticklebacks, shiner perch, kelp clingfish, staghorn sculpins, and bay pipefish were found ubiquitously among the 15 beds. Each bed appears to have a relatively unique assemblage of 5-10 rare fish species. Additional sampling of fish assemblages and eelgrass bed structure is required to more fully understand the role marine protected areas play in conserving representative eelgrass biodiversity.

[\[POSTER\]](#)

Yonemitsu, N. and T.M. Hoover

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Development Of Field Deployable Turbulence Measurement Devices And Their Applications To Stream Ecology

A Thin Film-based Turbulence Intensity Measuring Device (TF-TIM device) was developed. A short flag, constructed of a thin flexible film, was attached to a rigid metal shaft. The flag length is sufficiently small that the problems associated with self-induced oscillation are prevented. As the flag has very little inertia, it is capable of following the direction of instantaneous local velocity vectors with very high temporal and spatial resolution. The deflection angles of the flag from the mean velocity direction have been calibrated in laboratory, and are correlated with the turbulence intensity component v/U (perpendicular to the mean flow direction). Using Piezoelectric thin film and Rotational Direct Current Differential Transducers (R-DCDT), the TF-TIM device converts the deflection angles into a DC output that is directly proportional to the R.M.S. of the local turbulence intensity. When used in conjunction with conventional velocimeters such as the Constant Temperature Thermistor Anemometer (CTTA), TF-TIM devices will provide researchers and practitioners with an inexpensive, compact, robust, yet reliable means of measuring turbulence properties that cannot currently be quantified in field environments.

[\[SAT. 11:00\]](#)

Young, K. A.

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Evolution Of Fighting Behaviour Under Asymmetric Competition: An Experimental Test With Juvenile Salmonids

Large-dominant and small-subordinate species engaging in asymmetric interference competition optimize behaviour under different trade-offs between the chance of winning and the cost of fighting. If fighting behaviour is under selection, theory suggests that large-dominant and small-subordinate species should evolve "aggressive" and "passive" fighting behaviours, respectively. To test this prediction, I manipulated the size/competitive asymmetry of juveniles from sympatric populations of large-dominant coho salmon (*Oncorhynchus kisutch*) and small-subordinate steelhead trout (*O. mykiss*) and asked whether differences in fighting behaviour persisted independently of competitive ability. I observed fighting behaviour during dyadic contests in two habitats, mutually preferred pools and energetically demanding riffles, under each of three size treatments: natural size asymmetry, asymmetry removed, and reversed size

asymmetry. ♦ The results supported the prediction. ♦ Competitive ability depended primarily on size; large individuals of both species dominated smaller heterospecifics and neither species dominated when size matched. ♦ Fighting behaviour depended primarily on species identity; coho used a higher proportion of aggressive chases, whereas steelhead used a higher proportion of passive displays. ♦ Large individuals were more likely to chase and small individuals more likely to display. ♦ As evidence that asymmetric competition is associated with behavioural divergence, these results compliment previous work on morphological divergence under asymmetric competition and provide a richer context for other features of the coho-steelhead system.

[\[SAT. 10:40\]](#)

Zhang*, Y., J. Negishi, R. I. Kolodziejczyk, and J. S. Richardson, Department of Forest Sciences, University of British Columbia, Vancouver, British Columbia

Effects Of Salmon Carcasses On An Ecosystem Function - Leaf Litter Decomposition

Marine-derived nutrients from spawning salmon can strongly influence consumer-resource interaction, community dynamics, and ecosystem function in streams. We investigated the effects of salmon carcasses on alder leaf litter breakdown. Three replicated treatments (salmon carcass with leaf litter, leaf litter, and artificial leaf litter) were set up in streamside channels. We collected the litter packs on three occasions during a 111-day period. Litter breakdown rates were significantly lower in the carcass-enriched channels than those without carcasses. The artificial leaf litter had very low invertebrate abundance. The difference between remaining litter mass, under different treatments, increased with experiment duration. It is apparent that carcasses attracted shredders to shift their diet from leaf litter to the higher nutrition resource. Both abundance and biomass of a key shredder (Limnephilidae) in the litter packs in carcass-enriched channels were significantly lower than those without carcass addition. After day 85, a carcass was stolen by a terrestrial mammal, which dramatically speeded up leaf litter breakdown by increasing large shredder density in the litter pack. We conclude that salmon carcass-derived nutrients indirectly reduced leaf litter breakdown in the running water system within a short term, but may enhance litter decomposition with positive long-term effects on lotic ecosystem processes.

[\[POSTER\]](#)

Zhao, X.*1, M. G. Fox2 and D. C. Lasenby3 ♦ 1 Watershed Ecosystem Graduate Programs, Trent University. 2 Environmental & Resource Studies Program and Department of Biology, Trent University. 3 Department of Biology, Trent University.

Effects Of Prey Size, Mobility And Habitat Structure On Prey Selection By Pumpkinseed (Lepomis gibbosus)

To examine prey selection by pumpkinseed (*Lepomis gibbosus*) as influenced by prey size, mobility and habitat structure, feeding experiments were conducted on 95-105 mm (total length) pumpkinseed, given four sizes (<4 mm; 4-6 mm; 6-9 mm; >9 mm) of amphipod (*Gammarus pseudolimnaeus*) as prey. The experiments involved the assessment of predation rate, proportion eaten, prey size preference, capture efficiency and handling time. It was found that predation rate increased with prey size in unstructured habitat, whereas a higher proportion of small prey were consumed in the presence of artificial vegetation. Behavioural observations of the prey helped explain this result in that large amphipods moved less and spent more time in artificial vegetation than small amphipods. The mobility of prey strongly affected the behaviour and foraging efficiency of the predator. In choice experiments with mobile and immobile prey, prey selection was more skewed towards immobile prey in habitat structured trials, but not in unstructured trials. We conclude that habitat structure has a significant effect on the overall prey selection.

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