AMERICAN FISHERIES SOCIETY

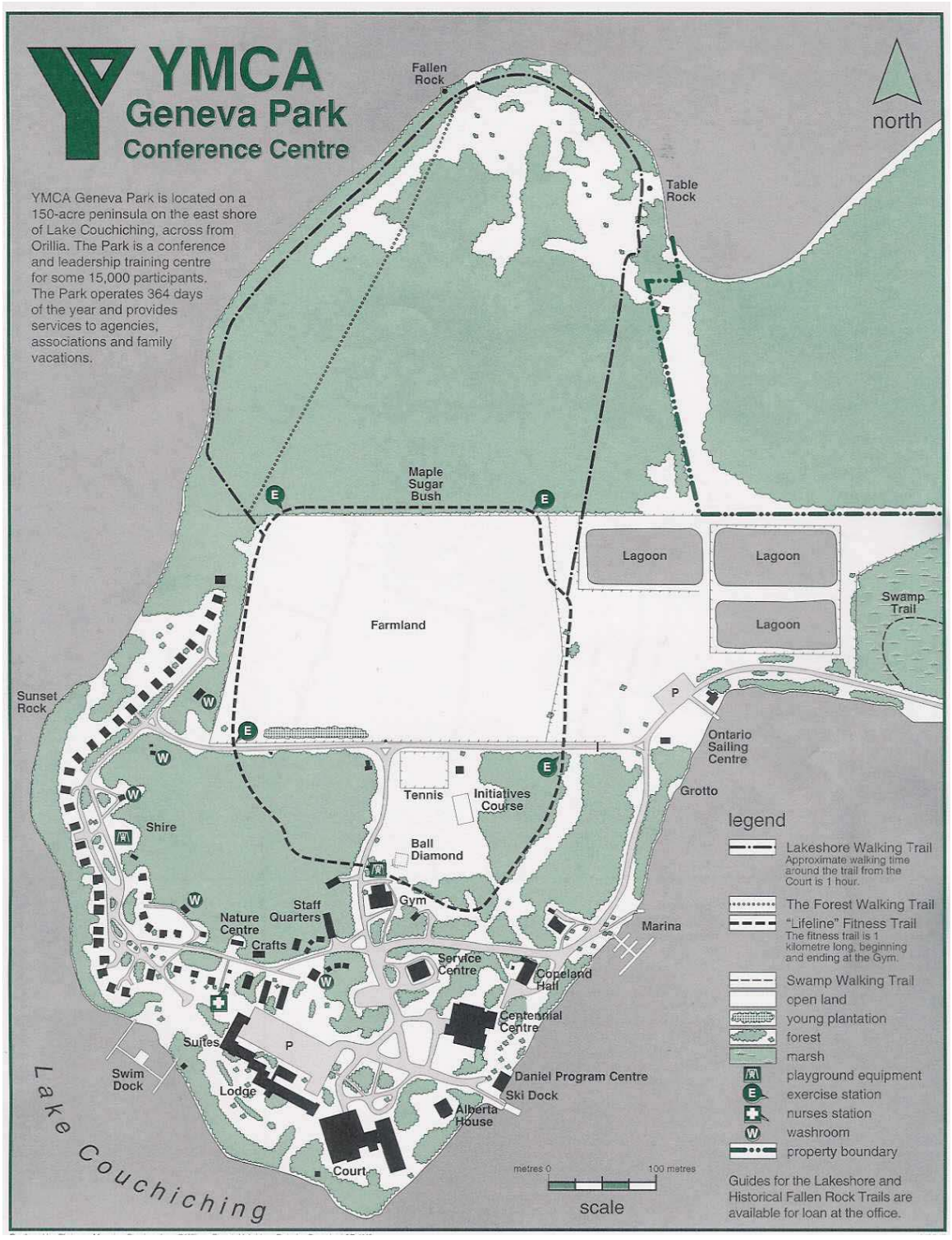
ONTARIO CHAPTER

ANNUAL GENERAL MEETING

March 1st – 3rd, 2007

Geneva Park, Orillia

"Applying Inter-disciplinary Science on the Ground: Theory and Practice"



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"Applying Inter-disciplinary Science on the Ground: Theory and Practice"

Thursday March 1st

Evening **Arrival, Registration & Opening Mixer (Geneva Lodge Lounge)**

Friday March 2nd

07:30 **BREAKFAST (Geneva Court)**

08:20 **Greeting and Conference Outline (Centennial Centre Room 15)**

08:30 ***Applying a hierarchy of scales to the monitoring of fish communities*** *- Les Stanfield, (OMNR, Aquatic Ecosystem Research)*

09:00 ***Aquatic Ecosystem Planning – Application of Landscape and Stream Assessment Tool (LSAT) by the Toronto Region Conservation Authority*** *Christine Tu* and Dave Lawrie. Toronto and Region Conservation Authority.*

09:30 ***Physical, Chemical and Biological Barriers to Fish Movement –*** *Dr. Chris Bunt (Biotactic Fish and Wildlife Research Inc., Kitchener)*

10:00 ***Ontario's Waterpower Future: Collaborative Opportunities in Fisheries Science*** *- Paul Norris (Executive Director, OWA)*

10:30 **Coffee & Poster Session (Room 15 Lounge)**

11:00 ***Establishing a Dynamic Equilibrium in an Urban Stream Rehabilitation Project: A Case Study Overview of Red Hill Creek, Hamilton, Ontario*** *– Dr. W.K. Annable (University of Waterloo)*

11:30 ***Determining the response of Fish and Invertebrates to a new stream and corridor on Redhill Creek –*** *Cam Portt (Portt and Associates)*

12:00 **Application of Natural Channel Designs to Two Differing Watersheds - Case studies from Grindstone Creek and the Clearwater River -** *Wolfgang,Wolter, TSH, Kitchener*

12:30 **LUNCH (Geneva Court) & Poster Session (Room 15 Lounge)**

Student Session

13:40 ***Greenside Darters and the Grand River Paradox*** *- Courtney Beneteau [1], N.E. Mandrak, and D.D. Heath (University of Windsor)*

14:00 ***Bridging the gap for modeling species at risk habitats: The importance of using consensus modeling to predict areas of high conservation value****- Mark Poos and Donald Jackson (University of Toronto)*

14:20 ***Recreational Fishing and Global Fish Conservation:: A Life History and Imperilment Assessment of Game Fish and Non-game Fish Species*** *- Michael R. Donaldson[1]*, Sascha E. Danylchuk, René R. Duplain, Andrew J. Gingerich, Connie M. O'Connor, Lisa A. Thompson and Steven J. Cooke (Carleton University)*

14:40 ***Effects of barotrauma on the post-tournament behaviour and survival of smallmouth bass in Rainy Lake, Ontario****- Marie-Ange Gravel and Steven J. Cooke, (Carleton University)*

15:00 **Coffee & Poster Session (Room 15 Lounge)**

15:30 ***Largemouth bass movement and distribution in relation to dissolved oxygen. -*** *C.T. Hasler*[1], K.C. Hanson, C.D. Suski, S.J. Cooke, and B.L. Tufts (Queen's University)*

15:50 ***Tracking Salmonids using strontium isotope (^{87}Sr) signatures originating from geological formations-*** *Eric Michell, S. Frape and W.K. Annable (University of Waterloo)*

16:10 ***Hydrodynamic Properties of Brown Trout and Rainbow Trout Redd's –*** *Mason Marchildon and W.K. Annable (University of Waterloo)*

16:30 ***What's your next move? Perspectives on employment and post-graduate education for young fisheries professionals. –*** *Dr. Steven J. Cooke, Carleton University – This will be a presentation with a facilitated discussion and Q&A*

17:30-19:00 ***Annual Business Meeting***

19:00- ??? **BBQ SUPPER and Social**

Saturday March 3rd

07:30 **BREAKFAST (Geneva Court)**

08:30 ***Ecosystem research at the terrestrial-aquatic interface in southern, central and boreal Ontario forests*** *–Dr. Andrew Gordon and Dr. Paul Sibley (University of Guelph)*

09:00 ***South Nation Fishway design: A collaborative project between biology and engineering –*** *Naomi Langlois-Anderson and Sandra Mancini (South Nation Conservation Authority)*

09:30 ***An Ecological Flow Assessment Framework Providing a Bridge to Implementation in Canada with Application to Develop Design Flow Regimes for Wilmot Creek, Ontario*** *– Dr. Andrea Bradford (University of Guelph)*

10:00 ***Modes of lampricide toxicity in lampreys and non-target fishes –*** *Dr. Michael Wilkie, (Wilfrid Laurier University)*

10:30 **COFFEE (Room 15 Lounge)**

11:00 ***"Natural Channel Design" projects in Toronto, Ontario, Canada: Initial results in the development of a monitoring protocol and performance thresholds. –*** *Ryan Ness, Jeff Borisko* and Paul Villard, Toronto Region Conservation Authority, Toronto, ON*

11:30 ***Aquatic Invasive Species: Stopping the spread by spreading the word*** *- April Trantor, (OMNR and Ontario Streams)*

12:00 ***Conference Wrap***

12:30 **LUNCH (Geneva Court)**

Student Posters:

Linking the physiological status of largemouth bass (Micropterus salmoides) with behaviour and fate following catch-and-release angling: "airing" on the side of caution - *Lisa A. Thompson, Michael R. Donaldson, Kyle C. Hanson, Robert Arlinghaus, Steven J. Cooke (Carleton University)*

Evaluating the interactive effects of air exposure duration and water temperature associated with recreational catch-and-release fisheries - *Andrew Gingrich, Steven J. Cooke, Kyle C. Hanson, Michael R. Donaldson, Caleb Hasler, Cory D. Suski, and Robert Arlinghaus (Carleton University)*

The mis-measure of function diversity (FD): The importance of choice.- *Mark Poos, Stephen* Walker, Donald Jackson (*University of Toronto)*

Fish response to fluctuating flow in regulated rivers: research methods, effects and opportunities - *K. Murchie, K. Hair, C. Pullen, T. Redpath, H. Stephens, and S.J. Cooke (Carleton University)*

Evaluating the effects of noise disturbance from recreational boating activities on the cardiovascular physiology of largemouth bass (Micropterus salmoides) - *Ashley Graham and Steven J. Cooke (Carleton University)*

Sub-lethal physiological disturbance resulting from laboratory induced decompression in smallmouth bass -*M. J. DeMille et al., Department of Biology, Queen's University, Kingston, ON*

Force-feeding to sustain wild juvenile largemouth bass and yellow perch in captivity - *V.B. Li, R.S.* Dhillon, C.D. Suski, and B.L. Tufts *(Queen's University)*

Oral Presentation Abstracts

"Applying Inter-disciplinary Science on the Ground: Theory and Practice"

Friday, March 2nd – 8:30AM

Les W. Stanfield*,
(Ministry of Natural Resources, R.R. # 9, Picton, ON KOK 2T0; 613/476-3255; FAX 613/476-7131; Les.Stanfield@MNR.gov.on.ca)

A methodology for summarizing fisheries data from sites to ecological reporting areas and all scales in between

In this study, we developed and tested techniques for summarizing the condition of stream fish communities, using techniques that incorporated their hierarchical organization. We used previously developed models and their datasets to compare existing and hindcasted reference conditions for various sizes of reporting areas: i.e. sites to segments>subwatersheds>watersheds>quaternary watersheds etc. Areas were classified as unimpaired, likely impaired, or impaired and were given a confidence rating for the classification based on consistency and number of observations available. Ratings for sites were based on thresholds of the distribution of data around the model regressions (standard deviations), such that unimpaired sites were within 2 SD and impaired sites were > 3 SD. Data were summarized to larger reporting areas based on the median classification of sites within a segment and then a rank sum approach based on the length of stream sampled for each of sub-watersheds, watersheds, quaternary and tertiary watersheds. Thresholds for reporting on the condition of each reporting area were based on school report cards (e.g. < 50 = F). We also tested the ability of model predictions to summarize condition in areas without field data by comparing both the fish community predictions and the distribution of brook trout for each reporting area.

The approach is a clear and defensible means of summarizing condition across hierarchies. This approach resulted in a consistent trend of higher impairment in proximity to Toronto and the Lake Ontario shore, and improving conditions with increasing distance from Toronto. The approach was able to classify smaller reporting units (segments and sub-watersheds), both unimpaired or impaired. Reporting areas classified as likely impaired often contained all three categories of conditions. These results suggest that local land use/land cover conditions were influencing stream condition. This classification was identified as being in need of additional data to determine management directions and may offer the optimal area to apply local stewardship actions to remedy limiting factors. Field data assisted with diagnosing condition in likely impaired areas, when information was sufficient to capture up and downstream effects. Overall ratings decreased as data from downstream and less-

managed areas were added. As a result all tertiary watersheds had ratings of < 50 ("F"). Brook trout distribution is currently highly restricted in the study area. However, limitations with landscape data reduced predictability of brook trout distribution in areas where field data were not available. Ours is the first report on the state of the tributaries for this region. As well, we make recommendations that set a benchmark for measuring a reversal in the incremental loss of fish habitat and fisheries. The recommendations will also improve the transference of this approach to other areas.

Les W. Stanfield*
(Ministry of Natural Resources, R.R. # 9, Picton, ON KOK 2T0; 613/476-3255; FAX 613/476-7131; Les.Stanfield@MNR.gov.on.ca)

Towards a stream monitoring network for Ontario: a new way of doing business.

In Ontario monitoring environmental health is the mandate of thousands of individuals representing NGO's, private sector, municipal, provincial and federal agencies. All share a common interest in tracking change in ecosystem health, but for years, their efforts have been on parallel tracks that precluded a comprehensive picture of the true state of the ecosystem. Methodologies differ, bureaucratic barriers, professional mistrust, incompatibility of data and lack of knowledge of how to conduct large scale surveys or integrate methodologies all contributed to a sense that integrated comprehensive monitoring was unachievable. Recently, a grassroots initiative has established that a network of like minded organizations can develop a broad-based stream monitoring program. The group recognizes the benefits in sharing data collected using comparable methods and in sharing the responsibility for analyzing the data to further scientific understanding around large scale questions. The network works because each partner has a responsibility to help develop and adopt standard protocols, establish, use and share applications for data management, share in designating priorities for analysis and providing training and support for field crews. In the demonstration area, two universities, 4 conservation authorities, 3 federal departments and a provincial ministry have collectively obtained field data from 1800 sites in the last ten years. In this presentation we focus on how network collected data can be linked with GIS applications to develop quantitative relationships between biophysical properties of streams and overall land use in the catchment. Biophysical data (fish, inverts, instream habitat, temperature and baseflow) were collected on wadeable streams flowing into the Lake Ontario basin. The methodology includes a novel approach (hindcasting) for characterizing the health of a site (deviations from expected) that we use to demonstrate how model results can be used to classify sites or stream segments based on predicted conditions and how results can be used to generate coarse population estimates for keystone species.

Friday, March 2nd – 9:00AM

Christine Tu* and Dave Lawrie
Toronto Region Conservation Authority, (P*) 416-661-6600 ext 5707, email*: ctu@trca.on.ca.

Aquatic Ecosystem Planning – Application of Landscape and Stream Assessment Tool (LSAT) by the Toronto Region Conservation Authority

As part of the development of the watershed and fisheries management plans for the Rouge River watershed, TRCA incorporated modelled relationships between stream condition and landscape properties (i.e., catchment area, slope, baseflow index and a landscape disturbance index (LDI)) using the Landscape and Stream Assessment Tool (LSAT), a GIS application developed by MNR. LSAT provides a means for resource managers to obtain information about the landscape, riparian and proximal conditions and incorporates the modelled relationships of these features with measures of stream condition, such as fish and habitat, to enable managers to predict how stream properties are likely to change under varying land cover\land use scenarios. Interpretation, based on the model results coupled with ecological understanding, was completed on fisheries management zones (FMZs). These zones reflected areas of relative hydrogeological and biological homogeneity. We examined 7 modelled results: Fish CA1 Axis, Standardized Temperature, Width to Depth, Mean Stream Width, Hilsenhoff (Benthic Invertebrates), Brook Trout and Rainbow Trout Densities. The fish CA1 Axis scores, which summarizes the fish assemblage along a gradient from cold sensitive to warm tolerant assemblages, were found to have the broadest application with sufficient sensitivity and were therefore applied across all the FMZ's as a means of evaluating condition and sensitivity to significant change. Fish CA1 Axis scores for each FMZ were mapped in GIS so that visual changes could be seen and compared. The information was used to understand how specific fish assemblages and habitats may be impacted as the watershed becomes more disturbed or restored (includes the concept of imperviousness). We used approved or proposed future land use scenarios to conduct this analysis. A key finding was that implementation of the TRCA Terrestrial Natural Heritage Strategy of increasing forest cover is predicted to benefit fish assemblages in all FMZs (particularly in headwaters) under the Official Plan scenario of increased urbanization and to a slightly lesser extent under the "full build-out" scenario. This suggests that the total amount of terrestrial natural cover is a driver of the quality of aquatic habitat that can be supported as the landscape form is altered. The second finding is that the predicted CA1 Axis score at which rainbow darter begins to disappear from sampling records was being approached and potentially exceeded in the lower watershed under the Official Plan development scenario. The extirpation of this species has been observed in neighbouring watersheds and the modelling provides supporting evidence that this species may be at risk of extirpation in the Rouge. This species may provide an early warning system that declines of this species are indicative of a forthcoming and severe impairment of biotic systems and provides a rationale for priority management recommendations. A similar modelling exercise is under way in the Humber River Watershed Plan.

Friday, March 2nd – 9:30AM

Chris Bunt
Biotactic Fish and Wildlife Research Inc., 691 Hidden Valley Rd., Kitchener, ON N2C 2S4 www.biotactic.com

Physical, Chemical and Biological Barriers to Fish Movement

Barriers or obstacles that fish encounter during upstream and downstream migrations have the potential to affect reproductive success, fish productivity, fish distributions and ecological processes in rivers worldwide. Physical barriers to movement such as dams, weirs, waterfalls, and logjams are usually impassable without provisions such as fish ladders, and fishways. However, these devices are of limited effectiveness in both attracting and passing fish successfully. Efficiencies of several types of fish passage facilities for numerous species from all available international sources will be reviewed and discussed. Chemical barriers to fish movement such as noxious or toxic plumes also affect fish movement and fish distribution. Several sulphur springs exist on the Niagara Peninsula, and a series of experiments designed to illustrate the biological ramifications of these springs on fish movement and survival will be presented. Biological barriers to fish movement consist of high velocity chutes or other flows that cannot be negotiated due to water velocities that exceed fish swimming abilities, darkened culverts or fishways that fish may be reluctant to enter, aqueducts with high degrees of thermal variability or areas where fish crowding occurs. Several examples of these types of barriers will be presented in relation to field observations and potential remediation or rectification opportunities.

Friday, March 2nd – 10:00AM

Paul Norris
Executive Director, Ontario Waterpower Association, Peterborough, ON

Ontario's Waterpower Future: Collaborative Opportunities in Fisheries Science

The province of Ontario has set an aggressive plan forward for electricity supply over the next twenty (20) years, and a target of doubling the contribution of renewable energy, including waterpower. Importantly, the overall "supply mix" objectives will place an increased emphasis and reliance on "flexible" hydro operations and new large-scale development in northern Ontario. Within this context, assumptions regarding priorities for fisheries science must be tested and approaches to resource management policy assessed. The presentation will provide an overview of the evolving role for waterpower in Ontario's electricity system, observations regarding the challenges presented by current resource management direction and suggestions on how the existing collaborative efforts between the industry and fisheries professionals could be focused and expanded.

Friday, March 2nd – 11:00AM

W.K. Annable
Department of Civil & Environmental Engineering, University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1 Phone: 519-888-4567 x 32955, Email: wkannabl@uwaterloo.ca

Establishing a Dynamic Equilibrium in a Urban Stream Rehabilitation Project: A Case Study Overview of Red Hill Creek, Hamilton, Ontario

Since the summer of 2004 an approximate 7km continuous reach of Red Hill Creek, located in Hamilton, Ontario, has been constructed and rehabilitated to establish a channel in dynamic equilibrium with the urban discharge and sediment receiving conditions. Although approximately a 5km long portion of the project was moved to accommodate a four lane expressway, the upper two kilometres of the rehabilitation project were undertaken to correct legacy infrastructure modifications of the valley over the past 60 years.

The rehabilitation efforts balanced the urban societal demands, infrastructure constraints, differing agency requirements but also addressed many technical considerations unique to urban river scapes. Of particular note was addressing the issue of what is a stable urban channel form? Technical issues identified the differences in bridge spans to facilitate 100-year return conveyance vs. channel stability, applicability of flow frequency analysis in urban watersheds, sediment supply and the stable urban channel form, flood plain connectivity, in-stream structure utilization and placement and construction techniques (specifically in-stream vs. dry bed construction).

This presentation will highlight many of the technical issues dealt with on channel slopes ranging from 3.8% to 0.0002%, varying flood plain expanses, infrastructure outfalls, retrofitting existing infrastructure, construction techniques and monitoring.

Friday, March 2nd – 11:30AM

Cam Portt[1], George Coker[1], Jim Reid[1] and Chris Murray[2]
C. Portt and Associates, Guelph, ON, 2 City of Hamilton

Determining the response of Fish and Invertebrates to a new stream and corridor on Redhill Creek

Slightly more than seven kilometres of Red Hill Creek, which is most of the creek that lies below the Niagara Escarpment, has been realigned since the fall of 2004. The scale of this project, and the fact that the falls at the Niagara Escarpment is a barrier to fish migration, affords an opportunity to examine the consequences of stream realignment in a situation where there is little potential for the effects of the channel works to be masked by the influences of the surrounding, unaltered habitats. A monitoring program was initiated in 2003. Since 2004, fish biomass has been estimated and habitat has been characterized at several stations in Red Hill Creek and in 'reference' streams. Benthic

invertebrate samples have also been collected annually from Red Hill Creek. The monitoring program and key findings from the pre- and during-construction period will be presented.

Friday, March 2nd – 12:00 noon

Wolfgang Wolter
Manager of Environmental Restoration, TSH Consultants, Kitchener, ON

Application of natural channel design to two differing watersheds – Case studies from Grindstone Creek and Clearwater Creek

This presentation examines the diverse nature of two selected watercourses and their respective restoration approach discussing the science of stream restoration, the analysis undertaken and the indicators to suggest that the environmental objectives are being met.

As a 1.2 km long creek restoration project completed in 2001, Grindstone Creek in the city of Burlington, Ontario continues to reinforce that the application of natural design principles can be successful in an urban setting. The watercourse is bed rock based on the upper half and alluvial based on the lower downstream half. Distinct bed incision controls needed to be applied to ensure it's stability in restoring a well balanced stream function both to control erosion and to enhance fish habitat. The implementation of specifically graded substrate, bioengineering techniques and creation of riffle and pool habitat have all contributed to its success.

Designed to restore a rich fishery resource, Clearwater Creek in Nipigon Ontario was reconstructed to provide improved water quality, fish habitat and aesthetics. The endeavour was primarily aimed at restoring a previous realignment originally initiated to resolve conveyance issues. Natural channel design principles were applied to provide a new dynamic channel which encompasses enhanced hydraulic and habitat attributes suitable for fish spawning potential. Appropriately designed pool and riffle features resulting from a geomorphic study provided the basis for a new plan form created within a parkland area. (*Major Contributors with involvement in these projects are*: Ray Tufgar: Director and Head of Water Resources at TSH; Wolfgang Wolter: Manager of Environmental Restoration for TSH; John Parish: President of Parish Geomorphic)

Saturday, March 3rd – 8:30AM

Andrew M. Gordon and Paul K. Sibley
Department of Environmental Biology, University of Guelph, Guelph, Ontario, N1G 2W1 (agordon@uoguelph.ca, psibley@uoguelph.ca)

Ecosystem Research at the Terrestrial-Aquatic Interface in Southern, Central and Boreal Ontario Forests

While the links between terrestrial and aquatic systems are evident both as inputs to lakes and rivers (groundwater, litter and treefall, terrestrial insects eaten by fish, beaver activity, etc.) and outputs (emergence of adult insects, salamander movement, etc.) there has been little study of the ecological implications of these links, especially under conditions of disturbance as might result from timber harvesting, cottage development, etc. There is an obvious need for a comprehensive understanding of the interactions between land and water, especially in order to analyse environmental issues at a landscape scale. We are concerned with the impact on aquatic ecosystems and organisms of chronic and episodic disturbances brought about by adjacent land management activities. As such, there is an urgent need for information on natural processes and functions in the ecotone in order that we may judge our ability to maintain underlying biological and physical components of productivity in managed landscapes, and to translate this into proactive and biologically sound policy.

University of Guelph researchers have been investigating some of these interactions at various scales in both lakes and streams for over 25 years. In this brief presentation, the results of several long-term and on-going ecosystem-level research projects will be discussed. We start first with a glimpse at streambank rehabilitation using fast-growing tree species planted on the banks of Washington Creek, a formerly degraded stream draining into the Nith River. Results are then presented from a variety of studies conducted at Scott Lake, Algonquin Park, addressing litterfall, nutrient cycling and litter colonization at the ecotone and at the Esker Lakes Research Area, north of Cochrane, where we have been analyzing the impacts of timber harvesting on a variety of ecological processes at the terrestrial-aquatic interface.

Saturday, March 3rd – 9:00AM

Naomi Langlois-Anderson and Sandra Mancini
South Nation Conservation, P. O. Box 69, 15 Union Street, Berwick, ON K0C 1G0, Telephone: 613-984-2948 ext. 286, Fax: 613-984-2872, Toll Free: 877-984-2948
NLanglois-Anderson@nation.on.ca and SMancini@nation.on.ca

South Nation Fishway design: A collaborative project between biology and engineering

The Indian Creek is a tributary of the South Nation River. The headwater is located around Lot 23 Concession 8 in Augusta Township and flows easterly to the South

Nation River. The Indian Creek dam is located west of the Village of Spencerville on private property, just North of County Road 21.

Originally, the Indian Creek was dammed for a sawmill operation; although we have not been able to determine when the dam was built, its construction has meant that several species of native fish cannot access historical spawning areas above the dam. Anecdotal information suggests there was a historically reproducing population of Northern Pike *Esox lucius* above the dam site prior to construction; however, minimal spawning activity has been reported above the dam since its installation.

The Indian Creek Dam consists of a concrete gravity structure. The dam dimensions are approximately 11.10 m long by 1.45 m height. A stop board sits in the notch of the weir, located approximately in the middle of the dam, and is 0.85 m wide by the same height.

Although there is no floodplain mapping for the area, the landowner has reported that spring flow conditions on the Indian Creek often result in the dam being overtopped. Even though the landowner reported to remove the stop board from the sluiceway during spring runoff, flows in this period exceed local fish swimming capabilities. The landowner intends to use the structure to generate energy in the near future.
High velocity flows in the sluiceway, even when fully open, prevent all fish passage including Northern Pike migration past the dam.

South Nation River Conservation Authority (SNC) developed a plan to provide fish passage during the spring spawning period on Indian Creek which would maintain normal flow conditions at the reservoir. This project was undertaken to introduce a bi-pass for Northern Pike by constructing an off-line channel allowing fish to circumnavigate the dam structure.

The fishway is constructed so that water will be diverted from the current impoundment above the dam only during high-flow conditions, like those typical during the spring melt (March and April). This design will maximize the benefits to Northern Pike and other warm water species that spawn during these high-flow periods, yet will also allow the landowner the continued use of the dam structure.

The Indian Creek Fishway was constructed during the summer and fall of 2006. It has not yet experienced spring high-flow conditions, so we are unable to conclude that it works! This presentation simply highlights the design and measurement components from biological and engineering perspectives. It shows what can be accomplished on a shoestring budget and handful of hard-working volunteers.

Saturday, March 3rd – 9:30AM

Andrea Bradford
School of Engineering, University of Guelph, Guelph, ON abradfor@uoguelph.ca

An Ecological Flow Assessment Framework Providing a Bridge to Implementation in Canada with Application to Develop Design Flow Regimes for Wilmot Creek, Ontario

A framework to support Ecological Flow Assessment in Canada has been developed. It is integrated with the broader watershed management framework, holistic in addressing ecological integrity or health rather than only the needs of selected aquatic species, and hierarchical (or tiered) with increasing effort applied to particularly sensitive areas or areas under greater stress. It is also adaptive with explicit requirements to monitor thresholds of potential concern and modify, as necessary, the design flow regime and the management measures implemented to achieve the targets. A context setting phase uses multi-disciplinary expert input to qualify cause-response linkages and identify the particular needs of habitat specialists. This focuses subsequent analyses on appropriate ecological processes and determines the hierarchical level of analysis needed. A design flow setting phase combines tools to develop the design regime from a reference regime and tools to quantify flows required to sustain particular ecological processes. A case study application of this EFA framework is underway to develop spatially variable design flow regimes for the Wilmot Creek, Ontario. The Wilmot Creek, which drains an area of about 78 km^2, originates on the Oak Ridges Moraine and has significant gaining and losing reaches owing to the variable physiography and complex hydrogeology of the area. Changes in fish communities are correlated with changes in surficial geology. Portions of the stream are undergoing geomorphic adjustments in response to historic watershed activities. Water takings for municipal supply and other uses are of potential concern. The study is intended to provide design flow regimes to direct watershed management activities in the Wilmot Creek watershed and to develop refinements of the EFA framework and tools used to design the target flow regimes.

Saturday, March 3rd – 10:00AM

Michael P. Wilkie
Department of Biology, Wilfrid Laurier University, 75 University Avenue West, Waterloo, ON, N2L 3C5. Email: mwilkie@wlu.ca

New Insight into the Toxic Mode of Action of the Selective Lampricide, TFM, Used to Control Sea Lamprey (*Petromyzon marinus*) Populations in the Great Lakes.

The invasion of the Great Lakes by the sea lamprey (*Petromyzon marinus*) and their parasitism (or predation when the host is killed) of fishes contributed to massive declines in commercial and recreational fisheries, including the near collapse of the lake trout fishery. In 1958 the selective lampricide, 3-trifluoromethyl-4-nitrophenol (TFM), was first successfully used in larval lamprey-infested streams of Lake Superior. Due to

the success of these treatments, TFM use was later expanded to streams in all of the Great Lakes. Although TFM treatments have been highly effective for controlling sea lamprey populations, we know little about its toxic mode of action. The goal of this investigation was to test two hypotheses of TFM toxicity in larval sea lampreys exposed to TFM over 12 h, the typical length of lampricide treatments in the field. The first hypothesis was that by interfering with oxidative ATP production in the mitochondria, TFM would cause a depletion of fuel stores in the blood and body tissues, and eventually death by metabolic arrest. The second was that TFM caused death by interfering with gill mediated ion exchange processes, leading to altered internal electrolyte and osmotic balance, and eventually circulatory collapse. These hypotheses were tested simultaneously by monitoring internal fuel stores [ATP, phosphocreatine (PCr), glycogen, glucose], Cl^- balance, and haematology in larval lamprey exposed to TFM for 12 h. Exposure of larval lampreys to TFM concentrations of 2 mg L^{-1} did not alter ATP stores, but it did lead to a 25 % reduction in PCr after 3 h, and a 60 % reduction between 6 and 12 h. This was accompanied by 6- to 10-fold increases in plasma and tissue lactate. After 12 h, there was an almost complete depletion of plasma glucose in the five surviving lamprey. However, there were no biologically relevant changes in plasma Cl^-, haematocrit, haemoglobin and ammonia concentration during TFM exposure. Thus, TFM-mediated gill damage and ionic failure are not likely the underlying cause of TFM toxicity. Rather, it is more likely that TFM interferes with oxidative ATP production, leading to reductions in tissue PCr stores, and eventually profound hypoglycaemia, which starves the nervous system of glucose, leading to death.

Saturday, March 3rd – 11:00AM

Ryan Ness, Jeff Borisko* and Paul Villard
Toronto and Region Conservation Authority, Toronto, ON

Toronto and Region Conservation (TRCA) is one of 36 Conservation Authorities (CAs) in Ontario, Canada. CAs are responsible for the conservation, restoration and management of Ontario's water, land and natural habitats on a watershed basis. TRCA's jurisdiction includes nine watersheds ranging in size from 24 km^2 to 890 km^2 that drain into the northshore of Lake Ontario. Four of these watersheds originate on the Oak Ridges Moraine (i.e. Humber River, Don River, Rouge River and Duffins Creek). Since its creation, the TRCA has had a significant role in the application of 'natural' channel design approaches to the realignment and restoration of watercourses within its jurisdiction, including the approval of such projects under the Conservation Authorities Act. There have been no fewer than 30 documented 'natural' channel design projects constructed within the TRCA jurisdiction to date with many more expected given a widely-perceived need to physically intervene in degraded area watercourses. To fulfil its mandate for the responsible review and approval of channel alteration projects including 'natural' channel designs, the TRCA is undertaking a process to evaluate how "natural" the outcomes of historic projects are and, looking forward, how to appropriately design new projects. As part of this initiative, the TRCA has implemented a monitoring program that is attempting to assess the physical and ecological conditions

of historic "NCD" projects and to develop a data collection protocol, performance thresholds, etc. for monitoring of both historic and future projects. This presentation will include the results of a preliminary evaluation of historic projects conducted in 2005 and 2006. It will also include a summary of preliminary findings from more detailed monitoring of aquatic habitat and species (fish, benthos, in-stream habitat and temperature) conducted at seven of the historic project sites.

Saturday, March 4th – 11:30AM

April Tranter[1] and Becky Cudmore[2]
[1]Aurora District, Ontario Streams/MNR, 2Fisheries and Oceans Canada, Burlington, ON

Stopping the Spread, By Spreading the Word: The Water Garden and Aquarium Industries as Invasive Species Pathways

The introduction and spread of non-native species represents one of the most pressing ecological issues today and is ranked as the second worst threat to biodiversity after habitat loss. Alien aquatic species can have a devastating impact on our lakes, rivers and wetlands through the introduction of parasites/diseases, competition and hybridization with endemic populations, and ultimately, extirpation of native species. In addition, the economic impacts on fisheries, tourism and human infrastructure are immense. Accidental and intentional release of non-native aquatic species from water gardens and aquariums represents a significant pathway for the introduction and spread of invasive species. Presently, both the water garden and aquarium industries are experiencing accelerated growth rates and not surprisingly, a concurrent increase in the alien aquatic invasion frequency is being observed. Efforts are currently being focused on retailer outreach and educational exhibits at environmental forums and consumer and industry trade shows. Important survey information on the species utilized within the trade is also being gathered which is facilitating species risk assessments efforts. This information is critical in understanding the capacity for existing and new introductions of aquatic invasive species. It is hoped that by raising awareness of the potential impacts associated with non-native aquatic introductions a stewardship approach to the issue will be fostered whereby prevention will be a shared responsibility of government, NGOs, industry, stakeholders and the general public as a whole.

Student Oral Presentations

Friday, March 2nd – 13:40

Beneteau, C. L[1], Mandrak, N. E.[2] and Heath, D. D.[1]
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Greenside darters and the Grand River paradox

This study examines the genetic population structure of the greenside darter, *Etheostoma blennioides,* in southwestern Ontario. In Canada, this species is believed to be native to three, and introduced into one, Great Lakes watersheds. In 1990, the species was assessed as Special Concern by COSEWIC but has since increased in numbers to the extent that it is no longer considered at risk in Canada. Also in 1990, greenside darters were discovered for the first time in the Grand River. This unusual scenario of a rare species becoming common raises some interesting questions: Were greenside darters introduced to the Grand River, or were they simply undetected until 1990? Is this species naturally increasing in abundance, or expanding its range following introduction? To address these questions and to characterize the genetic structure of the Canadian greenside darter, we used nine polymorphic microsatellite markers to genotype fish from both known native watersheds and the Grand River watershed. Preliminary results show high heterozygosities in the Grand River, similar to those found in watersheds where greenside darters are known to be native. Also, no individuals caught in the Grand assigned back to any other river, indicating the Grand River populations were not introduced from any other river in Canada. This may suggest that the relationships among populations in the Grand River watershed are consistent with native populations and not indicative of recent, rapid range expansion.

Friday, March 2nd – 14:00

Mark S. Poos, * and Donald A. Jackson.
Department of Ecology and Evolutionary, University of Toronto, Toronto, Ontario, Canada. Email correspondence: markpoos@zoo.utoronto.ca .

Bridging the gap for modeling species at risk habitats: The importance of using consensus modeling to predict areas of high conservation value

As rates of species imperilment continually expand due to anthropogenic stress, resource managers are faced with the difficult task of identifying and protecting the habitats of imperiled species. Aside from numerous difficulties related to sampling rarely occurring species and determining their habitats, managers are faced with the

much more challenging dilemma of choosing an appropriate statistical method which reflects the underlying weak biological pattern. The objective of this study was to determine: 1) the adequacy of modeling approaches for predicting the imperiled species redside dace (Clinostomus elongatus); 2) whether in-stream, landscape or physical habitat characteristics increased predictive success; and 3) whether the model outputs could be used to identify potential areas of conservation value. The predictive success varied across each of the models and the metrics we used (between 50-73% overall classification). Each model isolated in-stream environmental features as important variables for improving redside dace predictive models, but the identified variables differed across the modeling approaches. As a result, the model outputs, taken separately, predicted high conservation value in vastly different locations. We demonstrate the utility of using a consensus approach where multiple models were in agreement. This approach improved congruency as it derived a single model output from the several competing and often dissimilar models. This study highlights the importance of bridging the gap for model selection for imperiled species by using a consensus approach, as on one side we are faced with the naivety of singular approaches, while on the other we are faced with competing models.

Friday, March 2nd – 14:20

Michael R. Donaldson[1]*, Sascha E. Danylchuk[2], René R. Duplain[3], Andrew J. Gingerich[1,4], Connie M. O'Connor[1], Lisa A. Thompson[1,4] and Steven J. Cooke[1,4]
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Recreational fishing and global fish conservation: a life history and imperilment assessment of game fish and non-game fish species.

Several studies have assessed the life history characteristics of commercially harvested fish to determine the traits that may predispose these species to imperilment, but similar studies are lacking for recreationally-targeted species (herein referred to as "game fish"). The purpose of this analysis is to describe the life history, biological, and ecological traits that define game fish versus non-game fish species and to evaluate the factors that may predispose certain species to imperilment. We compared 328 game fish species from the International Game Fish Association (IGFA) world record list to 328 randomly selected non-game fish species to determine differences in life history, biological, and ecological traits in relation to World Conservation Union (IUCN) red-list status. Relative to non-game fish, game fish tend to be significantly larger, occupy higher trophic levels, are more likely to be carnivorous, tend to be marine species, occupy shallower waters and are more likely to be associated with benthopelagic, reef-associated and pelagic habitats, occur in tropical, subtropical and temperate climates, tend to have larger latitude ranges, occupy the equatorial regions or northern hemisphere, are more migratory, tend to be

targeted by commercial fisheries, and are less resilient. In our study, game fish were more represented on the IUCN red-list (i.e., imperiled) compared to non-game fish. We highlight several imperiled game fish species (and populations) that occur in Canada and provide a summary of the intrinsic and extrinsic factors that may lead these species to imperilment under both the IUCN and Committee on the Status of Endangered Wildlife in Canada (COSEWIC) classification schemes. Globally, many of the IUCN red-listed game fish were also targeted by commercial fisheries. Accordingly, there is need to jointly consider the recreational and commercial fisheries sectors when attempting to manage and conserve fisheries resources. We suggest that the generalized approach used in this study could be applied to the management of data-limited fisheries for *a priori* identification of vulnerable species at a global scale.

Friday, March 2nd – 14:40

Marie-Ange Gravel* and Steven J. Cooke
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Effects of barotrauma on the post-tournament behaviour and survival of smallmouth bass in Rainy Lake, Ontario

In North America, live-release tournaments involving black bass (*Micropterus spp*) are becoming increasingly popular with recreational anglers. Much work has examined the physiological effects of tournaments, but little is known about post-tournament behaviour and survival of released fish. In addition, one consequence of recreational fishing that has received little attention is barotrauma, when a fish is rapidly brought from depth and experiences dramatic changes in ambient pressure. Our goal was to examine this phenomenon at a fall bass tournament in Northwestern Ontario on Rainy Lake. We examined the incidence of barotrauma at the tournament. We also evaluated whether barotrauma could affected post-tournament behaviour and survival and if the severity of barotrauma was related to physiological indicators such as plasma lactate and glucose. Of the 63 fish randomly sampled from the tournament, over 60 % showed signs of bloating, while over 40 % showed signs of hemorrhaging. Taken together, these well-known indicators of barotrauma showed that over 25 % of these randomly selected fish exhibited severe barotrauma (i.e., two or more signs). To determine post-tournament behaviour and survival, we selected another group of fish from the tournament (n = 23) and classified them to be in good (one or no signs of barotrauma; n = 12) or poor condition (two or more signs of barotraumas; n = 11). These fish were released at a common site and radio-tracked for 5-6 days. We found that poor condition fish took significantly longer to leave the release site than good condition fish. Mortality (up to 50 %) was only observed in fish of poor condition. In addition, physiological indicators differed significantly between fish with and without signs of barotraumas. This study is the first to document the behaviour and survival of fish showing signs of barotrauma after release in the wild.

Friday, March 2nd – 15:30

C.T. Hasler*[1], K.C. Hanson[2], C.D. Suski[1], S.J. Cooke[3], and B.L. Tufts[1]
[1] Department of Biology, Queen's University, [2] Ottawa-Carleton Institute of Biology, Department of Biology, Carleton University, [3] Department of Biology and Institute of Environmental Science, Carleton University

Largemouth bass movement and distribution in relation to dissolved oxygen.

Past research has shown that when habitat parameters become sub-optimal (ie. increased temperature), fish may move to more advantageous areas to seek out more favourable environmental conditions, find adequate resources and to avoid interactions with competitors. Low dissolved oxygen concentrations have been shown to cause physiological stress and behavioural changes for a number of fish species, including largemouth bass which have been shown to avoid dissolved oxygen concentrations below 1.5mg/L. Most of what we know about the affect of dissolved oxygen on fishes however comes from laboratory studies; few field studies have quantified the role of low dissolved oxygen on fish movement and distribution in the wild. We used a 3-dimensional acoustic telemetry system to quantify seasonal movements of nine largemouth bass in relation to lake-wide dissolved oxygen concentrations. Results showed that when water becomes oxygen deficient as winter progresses, fish alter their behaviour and move to areas with greater oxygen, but utilized depths that are hypoxic. To investigate the affect of selecting hypoxic water we exposed largemouth bass to increasingly hypoxic water in a laboratory setting and measured behaviour and lactate concentrations. Our laboratory results suggest largemouth bass increase swimming activity and gulping but demonstrate no change in lactate concentration which lends support for our field analysis. Results are further discussed in the context of oxygen requirements of largemouth bass and habitat selection theories.

Friday, March 2nd – 15:50

Eric Michell[1], S.K. Frape[1], W.K. Annable[2].
[1]Department of Earth Sciences, [2]Department of Civil & Environmental Engineering, University of Waterloo, Waterloo, Ontario, Canada

Tracking Salmonids using strontium isotope (^{87}Sr) signatures originating from geological formations

Fisheries managers for decades have employed various techniques (e.g. tag and release, and telemetry) to determine the origins of fish stocks and their migratory patterns. Recent developments in microelemental analysis and their applications to biomineral structures of fish (otoliths, vertebrae and fish scales, for example) have given researchers great insight into differentiating the origins of spawning grounds and life cycle changes of fish stocks. One such microelemental analysis is the application of strontium isotopes. Strontium is geochemically incorporated into the calcium biomineral structures of fish through cation exchange. The specific geochemical signature of the strontium is derived

from the weathering processes of geological formations by groundwaters or overland flow. Recent research has focused on the analysis of a particular strontium isotope (^{87}Sr) in fish otoliths, which has been proven to be very useful in tracking the origins of various fish populations. Each geological unit can be identified by a unique strontium isotopic signatures and hence where groundwaters discharge into rivers along spawning grounds, salmonids will be "tagged" with the strontium isotopic signature(s) of groundwater(s) and river water(s) that a species encounters throughout its migration history.

The current research focuses on the ^{87}Sr signature in salmonids (*Salmo salar*) scales from different areas of the world to begin to develop a data base of fish stock origins and associate these locations with various geologic units. Results show that there is a difference in the ^{87}Sr isotopic signatures between *S. salar* originating from Norway ($^{87}Sr/^{86}Sr$ = 0.71000) and; Newfoundland and New Brunswick - which have similar ^{87}Sr signatures of $^{87}Sr/^{86}Sr$ =0.70935 and $^{87}Sr/^{86}Sr$ =0.70929 respectively. Scale analysis from two other fish species (ocean-dwelling mackerel and Atlantic ocean-farmed *S. salar*) were analyzed and their strontium isotopic signatures $^{87}Sr/^{86}Sr$ =0.70903 and $^{87}Sr/^{86}Sr$= 0.70915 respectively. The ^{87}Sr signature found in the ocean dwelling species compares very well with the current Strontium signature of the average Atlantic Oceans waters of $^{87}Sr/^{86}Sr$ =0.70906. All three wild *S. salar* were different compared to both the mackerel and ocean-farmed *S. salar* since the signature of the freshwater portion of the scales is generally more enriched compared to the ocean signature.

Friday, March 2nd – 16:10

M.A. Marchildon, W.K. Annable
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Hydrodynamic Properties of Brown Trout and Rainbow Trout Redd's

This study examines the hydrodynamic properties of river spawning fish nests commonly referred to as redd's. Little is known about the hydrodynamic properties, spatial location preference and persistence of such structures, relative to flow complexity and channel morphology under varying flood conditions. Many biological studies and inventories of brown Trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) have been conducted which identify that redd's are typically found in riffle and run morphologies of gravel bed streams, however, the site specific fluid and sedimentological properties of fish staging locations and nest persistence remain unknown.

An approximate 1km reach of Whitemans Creek in Southern Ontario has been studied in great detail to elucidate the hydrodynamic properties of redd's immediately after spawning has taken place and throughout a series of higher discharge events while the ova remain in the nests. A Pulse Coherent Acoustic Doppler Profiler (PCADP) was used

in conjunction with a 20 cm square sampling grid suspended above a series of redd's, in a non-invasive manner, to measure the boundary layer shear and three dimensional velocity profiles within the limits of each redd and the surrounding region. Three-dimensional velocity profiles have been constructed at each redd where 210 discrete velocity profiles are measured within each nest. Pavement samples were collected in the region surrounding each redd to characterize the sediment transport processes and tractive force conditions of the channel bed proximal to each redd location.

Results are presented for the fall 2006 brown trout. Findings will be presented that address the stability of the redd shape and persistence over a series of high discharge events in addition to the flow dimension complexity in redd location selection.

STUDENT POSTER ABSTRACTS

Lisa A. Thompson[1,2,*], Michael R. Donaldson[2], Kyle C. Hanson[2], Robert Arlinghaus[3], Steven J. Cooke[1,2],
[1]Institute of Environmental Science, Carleton University, Ottawa, Ontario, Canada, [2]Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, Ontario, Canada, [3]Leibniz Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany

Linking the physiological status of largemouth bass (*Micropterus salmoides*) with behaviour and fate following catch-and-release angling: "airing" on the side of caution

Catch-and-release practices are common in recreational fisheries, yet little is known about the behaviour and ultimate fate of fish upon release. Using a combination of radio telemetry (external attachment) and non-lethal blood sampling procedures (to assess blood concentrations of lactate, glucose, aspartate aminotransferase [AST], Na^+, K^+, and Cl^-), the relationship between pre-release physiological status and post-release behaviour and mortality was assessed for largemouth bass. Experiments were replicated at two temperatures (i.e., approx. 15°C [N = 27] and 21°C [N = 31]) and involved exposing fish to air immediately after capture for periods from 0 to 900 seconds to assess the consequences of air exposure on fish at two moderate temperatures. Fish exposed to long periods of air exposure (mean = 598 ± 194 sec) had significantly higher concentrations of blood lactate (measured 30 minutes after air exposure) and took significantly longer to regain equilibrium than fish exposed to shorter periods of air exposure (mean = 179 ± 95 sec). Other physiological indicators were inconsistent in their response although it was clear that AST and glucose increased for almost all fish (including controls) after capture, blood sampling, and air exposure but that the extent of the disturbance was unrelated to air exposure duration or water temperature. Interestingly, males had greater initial concentrations of glucose and AST than females at lower water temperatures even though we avoided targeting nesting males, revealing the importance of considering inter-sexual responses to angling stress. The fish exposed to longer air exposure durations tended to exhibit behavioural impairments and remained close to the release site for longer periods than those fish exposed to short periods of air exposure, however, there was no relationship between individual physiology and individual behaviour. Despite exposing largemouth bass to air for lengthy periods (up to 15 min), we observed no post-release mortality during the 5 day monitoring period. We must caution that water temperatures in this study (max of 22°C) were moderate for this species and we saw no evidence of a temperature-specific response. However, a number of sublethal physiological responses were evident in the long air exposure treatment group. In the face of other stressors (e.g., longer angling duration, higher water temperatures, tournament weigh-ins), these levels of air exposure may be harmful and lead to post-release mortality. We suggest that all efforts be made to reduce or eliminate air exposure associated with angling as it is one of the factors that an

angler can easily control, thus reducing the chance for additive effects from other less controllable factors.

Andrew J. Gingerich[1,*], Steven J. Cooke[1,2], Kyle C. Hanson[2], Michael R. Donaldson[2], Caleb Hasler[3], Cory D. Suski[3], and Robert Arlinghaus[4] ,
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Evaluating the interactive effects of air exposure duration and water temperature associated with recreational catch-and-release fisheries

At present, there is a reasonable understanding of the independent effects of catch-and-release (C&R) angling stressors, such as air exposure and water temperature, on endpoints such as physiological disturbances, behavioural impairments, or mortality. However, little is known about the interaction between these different C&R stressors during an angling event. This study used bluegill (*Lepomis macrochirus*) as a model to evaluate the interactive effects of water temperature and air exposure on fish behaviour, condition (e.g., equilibrium status), and short-term mortality in a C&R setting. Experiments were replicated over three days with different water temperatures (18.3 °C, 22.8 °C, and 27.4 °C). On each day, fish were captured by standard angling techniques, exposed to a range of air exposure durations (0, 30, 60, 120, 240, 480, and 960 s), and then monitored for behavioural changes as well as short- and long-term mortality. Fish captured by seine were used as controls. There was a significant interactive effect on equilibrium status, and opercular rate with increasing air exposure and water temperature. Immediate mortality at the lowest temperatures was negligible, however, we noted significant delayed mortality (up to 80%) at the highest water temperature (27.4 °C) in fish exposed to the three longest air exposure groups. In addition, at 27.4 °C, fish exposed to 480 and 960 s died sooner than any other group. Significant sublethal effects were noted at all water temperatures for even short air exposure durations. These results indicate that at low to moderate water temperatures, extended air exposure for bluegill results in little mortality. However, at high water temperatures, mortality can be substantial, especially for fish that experience extended air exposures. More emphasis should be devoted to studying the interactive effects of different angling stressors and on educating anglers on the need to minimize additive stressors on fish that are to be released.

Poos, Mark*, Walker, Stephen, Jackson, Donald
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The mis-measure of function diversity (FD): the importance of choice.

Measuring of functional diversity is a means to determine potential losses in ecosystem function caused by decreasing biodiversity. To date, different approaches to quantify functional diversity have been hindered by the lack of a good metric which encompasses the relationship between relevant functional traits of species. Recent metrics of functional diversity rely on clustering techniques, where species traits are segregated in multivariate space using the total branch length of a functional dendrogram. Such methodologies are based on the implicit assumption that the decisions inherent in the analyses are minor compared the differences among species and traits. Here, we evaluate whether current metrics of functional diversity are robust to different choices in the measure of resemblance or clustering used. We use five field data sets from previously published studies measuring functional diversity, as well as simulated data where functional relationships were pre-defined, to quantify the changes in the total branch lengths of functional dendrograms. Our results indicate that current metrics of functional diversity are not robust to decisions regarding choice of resemblance and clustering methods. The choice of clustering algorithm or distance measure not only have major impacts on the grouping of species based on functional traits, but can alter functional groups completely. As the metrics of functional diversity are used to evaluate and quantify redundancies amongst species traits, we caution researchers in their use of current metrics of functional diversity for species assessments and their related management implications.

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Fish response to fluctuating flow in regulated rivers: Research methods, effects and opportunities

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

Ashley Graham* and Steven J. Cooke,
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Evaluating the effects of noise disturbance from recreational boating activities on the cardiovascular physiology of largemouth bass (*Micropterus salmoides*)

Recreational boating continues to grow in popularity, yet little is known about the effects of associated noise disturbance on fish. We conducted a study to evaluate the organismal-level disturbance associated with different recreational boating activities using largemouth bass as a model. Doppler flow probes were used to monitor cardiac output and its components (heart rate and stroke volume) in real time, providing the capability to determine the magnitude of disturbance and the time required for recovery. We contrasted fish responses to three noise disturbances (canoe paddling, trolling motor, and combustion engine [9.9hp]) for 60 seconds using a Latin squares design where each fish served as its own control based on values obtained prior to disturbance. Fish were held in specially designed chambers in a laboratory setting where they were protected from water displacement and visual distraction associated with the above mentioned activities. Exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume. The level of change in cardiac output and its components increased in magnitude from the canoe treatment to the trolling motor treatment with the most extreme response in the combustion engine treatment. Furthermore, time required for cardiovascular variables to recover varied across treatments with shortest periods for the canoe paddling disturbance (approx. 15 min), the longest periods for the combustion engine (approx. 40 min), and intermediate recovery periods for the trolling motor (approx. 25 min). Our results demonstrate that fish experience significant cardiovascular disturbance in response to the noise propagated from recreational boating activities which have an energetic cost. Future research should evaluate how free-swimming fish in the wild respond to such stressors relative to frequency of exposure and proximity to noise and to what extent they are able to compensate for this disturbance.

M. J. DeMille*, C.D. Suski, and B.L. Tufts
Department of Biology, Queen's University

The effect of fizzing on sub-lethal physiological disturbance resulting from decompression in smallmouth bass

Decompression has been shown to cause mortality in smallmouth bass caught during recreational angling events. Artificial swim bladder deflation (fizzing) has been proposed as a possible method to alleviate the disturbances associated with decompression; at present, little is known about the effects of fizzing on sub-lethal physiological parameters. In this study, a suite of physiological measurements were

used to determine whether fizzing would speed physiological recovery in decompressed fish. For this, fish were acclimated to 12.2 m depth (40 feet), quickly brought to surface pressures to replicate an angling event, and then sampled for plasma after 0, 4 and 10 h of surface recovery. After 4 h recovery, plasma LDH activity in the fizzed treatment was not significantly different than resting controls; however the non-fizzed treatments showed a 4-fold increase compared to the LDH activity of resting controls. After 10 h, both fizzed and non-fizzed treatments showed a 3 to 4-fold increase in plasma LDH activity from resting controls. This suggests that fizzing delays the onset of tissue damage following decompression. The plasma lactate concentrations of both fizzed and non-fizzed fish had returned to resting control levels after 4 h of recovery, and plasma glucose concentrations did not differ between the two treatments at any sampling period. Results of this study are discussed in the context of fisheries management as it pertains to decompression during live-release angling.

V.B. Li*, R.S. Dhillon, C.D. Suski, and B.L. Tufts
Department of Biology, Queen's University

Force-feeding to sustain wild juvenile largemouth bass and yellow perch in captivity

Many laboratory experiments rely on the use of wild fish. However, wild fish removed from their natural habitats rarely eat in captivity. During prolonged periods of holding, the physiological condition of wild fish therefore deteriorates and the quality of experimental results may be compromised. In this study, we used a method of force-feeding to sustain juvenile largemouth bass and juvenile yellow perch in the laboratory, and we compared this technique to feed training and saline controls. We found that, for largemouth bass, force-feeding produced a 7-fold increase in hepatosomatic index, a 2-fold increase in liver glycogen, and a 3-fold increase in muscle glycogen stores compared to control and saline treatments. For yellow perch, force-feeding resulted in an increased relative weight and a 10-fold increase in muscle glycogen stores compared to the control treatment. These results indicate that force-feeding can improve the physiological condition of wild fish, despite the handling associated with this procedure. The present study may therefore prove valuable in modifying current rearing practices for wild fish held in captivity, as well as for general animal husbandry.

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