

**CCFFR SCL**  
EDMONTON 2018



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# **GENERAL INFORMATION**

## **GETTING TO THE WESTIN**

The Westin is located in downtown Edmonton at 10135 100 St NW, Edmonton, AB T5J 0N7. From Edmonton International Airport (YEG) you can take a taxi (approximately \$60), Edmonton Transit (route 747, \$5 but likely > 1 hour to downtown) or a dedicated Shuttle Bus (check YEG for details). From within Edmonton, the Westin is located close to the Churchill LRT stop.

## **REGISTRATION**

<https://www.eventbrite.com/e/ccffrscl-2018-registration-37285979368>

Registration will take place in the *North Foyer*, and will be open:

Thursday January 4<sup>th</sup> from 4-8 pm  
Friday January 5<sup>th</sup> from 8-10 am  
and Saturday January 6<sup>th</sup> from 8-10 am

## **PRESENTATION UPLOAD INSTRUCTIONS**

Room for loading presentations: Leduc Room

**Presentations can be loaded from USB onto a conference laptop onsite in the Leduc Room. Files should be loaded 24h prior to your scheduled presentation. Instructions for downloading files will be provided in the Leduc Room.**

Please name you file as follows: surname-of-first-author\_time\_room, e.g.,  
ricker\_1315\_Leduc.ppt

## **POSTER SESSION INSTRUCTIONS**

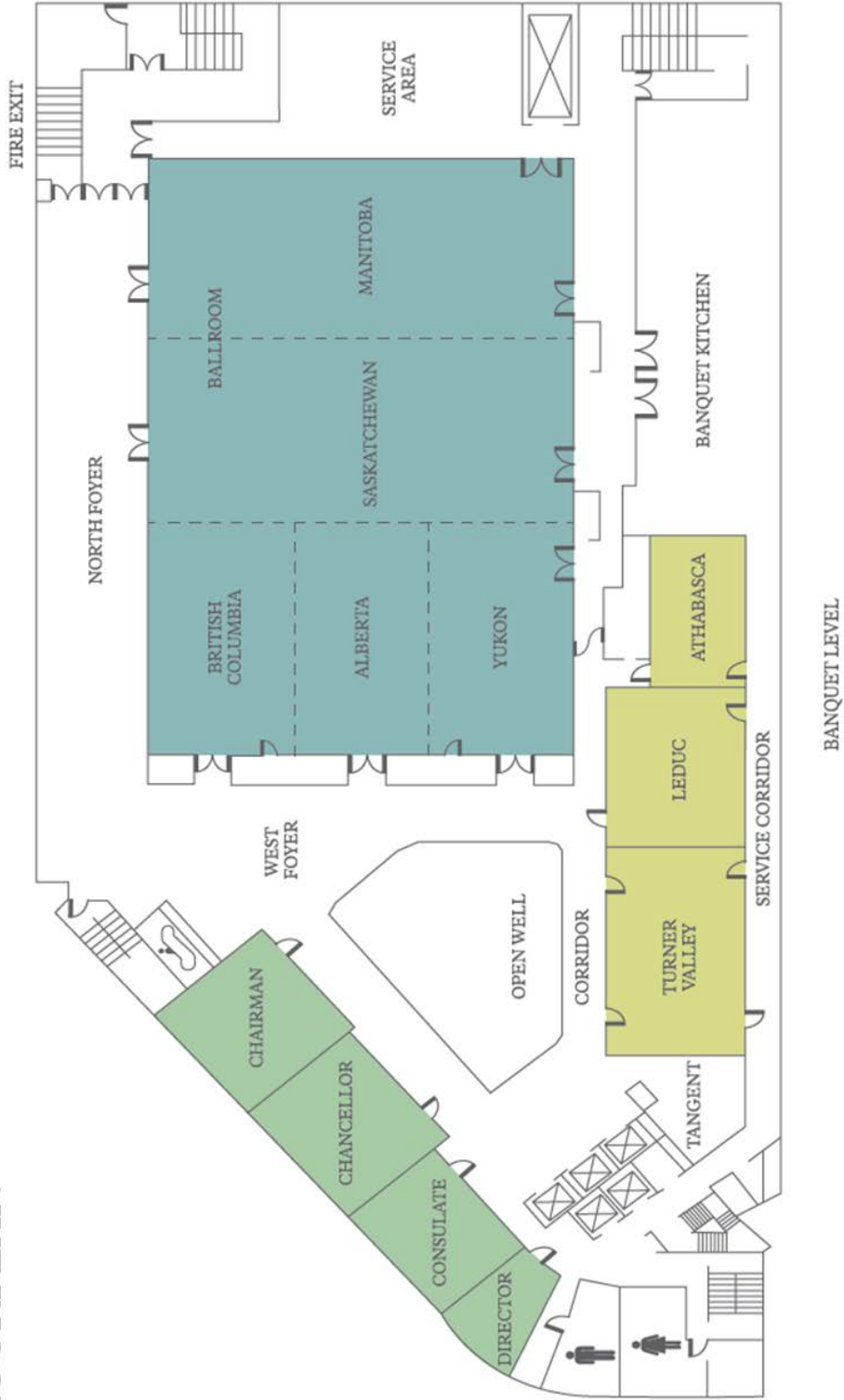
- Posters should be setup in the Manitoba Room
- Formal poster session is Friday evening January 5<sup>th</sup> from 6 – 9pm.
- Follow directions in the Manitoba room as to which areas are for presenters and which are for vendors.
- Poster locations are on first come first serve basis. There are no designated areas for different sessions.
- Posters can be set-up starting Thursday evening January 4<sup>th</sup> and must be removed by Sunday noon January 7<sup>th</sup>.

## **NOTES**

- Banquet level is the 2<sup>nd</sup> floor of the Westin. Take the elevator or escalator to the 2<sup>nd</sup> floor.
- Coffee/tea will be served during breaks in the Manitoba.
- To aid in the restructuring of rooms for conference activities, it is requested that delegates depart rooms promptly at the end of their session.
- Tickets for the banquet and conference t-shirts and other merchandise can be purchased during registration hours (see above).

# HOTEL FLOOR PLAN

## FLOORPLAN



# EVENTS

## THURSDAY

### WELCOME SOCIAL



When: 8:00 pm – 12:00 am  
Where: Craft Beer Market (50 m from the Westin),  
10013 101A Ave, Edmonton, AB T5J 0C3  
(see map on next page, item 18)  
URL: <http://craftbeermarket.ca/edmonton#>

Note: all fish offerings are Ocean Wise

## FRIDAY

Canadian Aquatic Resources Section (CARS) of American Fisheries Society Annual General Meeting: 12:00 – 1:00pm in Turner Valley Room

SCL Business Meeting: 5:00 – 6:00pm in Turner Valley Room

Poster Session: 6:00 – 9:00pm in Manitoba Room (cash bar)

### STUDENT SOCIAL



When: 9:00 pm – 12:00 am, Friday January 5  
Where: Sherlock Holmes Pub (upstairs)  
10012 101A Avenue NW, Edmonton, AB  
(see map on next page, item 19)  
URL: <http://www.sherlockshospitality.com/>

## SATURDAY

CCFFR Business Meeting: 5:00 – 6:00pm Turner Valley Room

### BANQUET



When: 6:00 pm (doors open), 6:30 pm (dinner),  
7:30 (plenary talk)  
Where: Westin Ballroom (SK/YK/BC/AB  
combined), at 10135 100 St NW, Edmonton, AB.

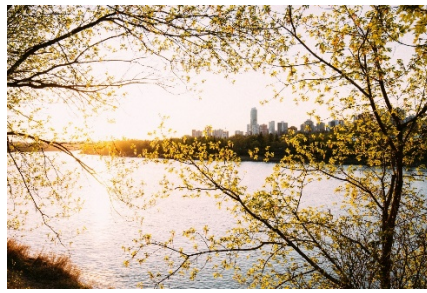




# TO DO IN AND AROUND DOWNTOWN EDMONTON



Royal Alberta Museum (*opening early 2018*)



Hike in the River Valley (*try the new funicular!*)



Appreciate art at the Art Gallery of Alberta



Shop downtown or at City Centre Mall



Party on Whyte Avenue & see Old Strathcona



Surf, swim & skate at West Edmonton Mall



Visit *new* Rogers Place & the Ice District



Watch a show at Citadel & Winspear Theatres

*Others: See bison at Elk Island National Park (48 km east of Edmonton), visit Jasper and the Rocky Mountains (366 km west of Edmonton), visit the Valley Zoo, and see Fort Edmonton Park (closed).*



## SPONSORS

CCFFR and SCL thank the following sponsors:

Gold sponsors (\$10,000 or greater)



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Canadian Journal of Fisheries and Aquatic Sciences is published by CSP



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## CCFFR 2018 OFFICERS

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## **CLEMENS-RIGLER TRAVEL FUND COMMITTEE**

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Rob Mackereth, OMNRF & Lakehead University, Advisor  
Margot Stockwell, Fisheries and Oceans Canada, Treasurer

## **SCL 2018 OFFICERS**

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## **CANADIAN AQUATIC RESOURCES SECTION OF AFS**

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### **Secretary-treasurer**

Margot Stockwell, Fisheries and Oceans Canada

## CONFERENCE AT A GLANCE

Time	Event	Location
<b>Thursday, 4 January</b>		
4:00 – 8:00 pm	Registration	North Foyer
8:00pm – 12:00am	Welcome social	Craft Beer Market (10013 - 101A Ave; 100m from Westin)
<b>Friday, 5 January</b>		
8:00 – 10:00	Registration	North Foyer
	<b>Plenary session</b>	Saskatchewan
8:50 – 9:00	Opening remarks	
9:00 - 9: 15	Dignitary introductions	
9:15 – 9:55	<b>J.C. Stevenson Memorial Lecture</b> Nigel Hussey	
9:55 – 10:35	<b>F.H. Rigler Memorial Award Lecture</b> Anthony Ricciardi - Progress toward predicting the impacts of non-native species on freshwater ecosystems	
10:35 – 11:00	Break	
11:00 – 11:30	<b>Peter Award Lecture</b> Matthew Guzzo - Behavioral responses to annual temperature variation alter the dominant energy pathway, growth, and condition of a cold-water predator	
11:30 - 12:00	<b>Invited Speaker</b> Brenda Parlee & Kevin Ahkimmachie - Changes in fishing livelihoods in northern Alberta: opportunities for linking local and traditional knowledge to fisheries governance	
<b>12:00 – 1:20 pm</b>	<b>Lunch (on your own)</b>	
12:00 – 1:20 pm	CARS-AFS General Meeting (and presentation from the Mid-Canada Chapter)	Turner Valley

<b>Time</b>	<b>Event</b>	<b>Location</b>
1:20 – 2:40	Concurrent sessions	
3:00 – 3:20	Break	
3:20 – 4:40	Concurrent sessions	
5:00-6:00	SCL Business Meeting	Turner Valley
6:00 – 9:00	Poster Session & Social (cash bar opens at 5 pm)	Manitoba
9:00 – 12:00	Student Social	Sherlock Holmes Pub (10012 - 101A Ave NW; 100m from Westin)
<b>Saturday, 6 January</b>		
8:00 – 10:00	Registration	North Foyer
	<b>Plenary session</b>	Saskatchewan
8:50 – 9:00 am	Opening remarks	
9:00 – 9:400	<b>Invited Speaker</b> Bailey McMeans - Stable isotopes in fisheries research: the good, the bad, and the benefit of coordinating our efforts	
9:40 – 10:20	<b>Invited Speaker</b> Michael Sullivan - Alberta's challenging fisheries: a responsibility to make systems work	
<b>10:20 – 11:00</b>	<b>Break</b>	
11:00 – 12:00	Concurrent sessions	
<b>12:00 – 1:20 pm</b>	<b>Lunch</b>	
1:20 – 3:00	Concurrent sessions	
3:00 – 3:20	Break	
3:20 – 5:00	Concurrent sessions	
<b>5:00-6:00</b>	CCFFR Business Meeting	Turner Valley
<b>5:00-8:30</b>	<b>Cash bar</b>	
<b>18:00 – 20:30</b>	<b>Banquet (SK/AB/BC/YK rooms)</b>	
	<b>Invited Speaker</b> Rood: The Parched Oldman: A century of river regulation from the crown of the continent	



<b>Time</b>	<b>Event</b>	<b>Location</b>
<b>Sunday, 7 January</b>		
	Concurrent sessions	
9:00 – 10:40		
10:20 – 11:00	Break	
11:40 – 12:00		
12:00	Conference concludes, see you in London ON in 2019!	

# **SPECIAL SESSION THEMES AND ORGANIZERS**

## **SS1 - Digital media as a source of contemporary and novel fisheries data**

*Paul Venturelli, Ball State University & University of Minnesota*

Digital media such as internet use, online fora, and smartphone applications (apps) are an exciting and relatively cheap source of conventional and novel fisheries data that could fundamentally change the way that we monitor and manage our fisheries. This session highlights the opportunities and challenges associated with digital fisheries data. Presentations feature cutting-edge research that shows how digital data can complement conventional approaches and provide novel insights. The session is also designed to encourage collaboration, and the development of strategies for rapid innovation and improved data collection, management, and exchange.

## **SS2 - Improving the science and management of instream flows: moving beyond traditional approaches**

*Jordan Rosenfeld, BC Ministry of Environment*

"Managing human impacts on instream flows is a key responsibility for resource management agencies. Understanding how flow regime controls biological production and ecological processes is also a fundamental science issue in basic stream ecology. Establishing environmental flow requirements to sustain aquatic life and inform tradeoffs with other (e.g. economic) values is becoming increasingly important under climate change and ever expanding water demands for industrial, domestic, and agricultural uses. Although instream flow science has a long history and well-established methods, many of these approaches remain controversial, with considerable uncertainty in the predicted biological consequences of flow alteration. Integrating new insights from basic stream ecology with more traditional approaches remains an outstanding challenge for improving instream flow science.

## **SS3 - Environmental monitoring of fish and water in the Athabasca oil sands**

*Kelly Munkittrick, Wilfrid Laurier University*

Attention on fish populations and water quality in Northern Alberta has intensified with the recent expansion in monitoring in the oil sands. Although there are significant studies underway, there are a number of challenges, including baselines for comparison, changes in methods over time and across studies, and a lack of data on mobility and residency for fish. It is hoped that this session will increase the awareness of ongoing and historical work and provide an opportunity for collaboration and improving the overall understanding on fisheries resources and threats in the oil sands.

#### **SS4 - Trace me if you can: stable isotopes, diet, and aquatic species management**

*Kathryn Peiman, Carleton University*

Stable isotopes have fast become one of the core methods for determining the habitat and prey use of animals. With the development of sophisticated analytical tools for isotope data has come their increased application to diverse research questions, including invasive species monitoring, nutrient cycling, community structure, and response to climate change and stressors. In this symposium, we will have speakers that address questions in both fundamental and applied science across different levels of biological organization and in diverse systems, highlighting both commonalities and caveats in the use of stable isotopes as tracers of fish ecology.

#### **SS5 - Native trout and salmon recovery**

*Kenton Neufeld, Government of Alberta*

This session highlights the work of those striving to recover native salmonid (trout, salmon, char, whitefish, and grayling) populations from coast to coast to coast. We welcome presenters working on research that contributes directly to the recovery of native trout and salmon populations, as well those implementing management programs aimed to do the same. Salmonids contribute large amounts of ecological, economic, cultural and recreational value to fisheries across Canada and around the world. Despite their high profile and intense management efforts, over-utilization, changing habitats, and non-native species have caused many populations to decline to precarious levels or disappear completely. Recovering these populations is a challenging endeavor given the cumulative and interacting factors that threaten most populations. The wide range of conditions that salmonids live in provide an endless array of potential recovery strategies and by sharing our experiences of success and failure we can improve the effectiveness of recovery actions

#### **SS6 - Genomic, proteomic and transcriptomic advancements in aquatic monitoring**

*Ian Bradbury, Fisheries and Oceans Canada*

The application of genomics technologies in aquatic science has increased rapidly in recent years, driven by dramatic advances in DNA sequencing technology and lower costs. The purpose of this session to provide fisheries and aquatic science researchers, professionals and students a forum to present their cutting-edge work and interact with Canada's top aquatic geneticists. This session will encompass fish genomics and transcriptomics applied to population-level processes and patterns, aquatic metagenomics involving all aquatic taxa, environmental DNA applications to aquatic invasive species and species at risk detection, transcriptomic profiling of aquatic organism's response to stressors, meta-transcriptomics in aquatic ecosystems, and novel applications to genomics in fisheries and aquatic science.

## **SS7 - Aquatic health: invasive species and disease**

*Tanya Rushcall, Government of Alberta*

Aquatic invasive species pose one of the greatest threats to Canada's freshwater resources. Impacts from harmful species and diseases range from outcompeting native species and degrading habitat for fish, wildlife and native plants, to negatively impacting the economy through impacting water-operated infrastructure, decreasing property values, restricting recreation and changing native fisheries important to Albertans.

## **SS8 - Recreational fisheries management and science: balancing conservation with angler preference**

*Brett van Poorten, Government of British Columbia*

Recreational fishing is ubiquitous across Canada, including coastal, Great Lakes, reservoir, river, stream and lake fisheries. Perhaps surprisingly, governance and social norms vary dramatically across fisheries and within fisheries in different jurisdictions. This session will explore this diversity, bringing managers and researchers together from across the country to learn from one another and to share ideas, opportunities and solutions. We will explore governance, policies, social aspects, multi-scale models, monitoring and many more aspects of this important activity from both a conservation and social perspective

## **SS10 - Impact of climate change on aquatic ecosystems**

*Joshua Thienpont, University of Ottawa*

Aquatic ecosystems are highly sensitive to climate change. For example, increases in surface water temperatures, in combination with a longer ice-free season, will fundamentally alter ecosystem processes like primary productivity and biogeochemical cycling, as well as influence the geographic distribution of aquatic organisms. Changes in the amount and timing of precipitation will alter the hydrological regimes of aquatic ecosystems, as well as modify aquatic-terrestrial linkages through altered run-off patterns. This session will explore the many ways that climate change impacts aquatic organisms and ecosystem processes in Canada and abroad

## **SS11 - Aquaculture and its impact on aquatic environments**

*Janelle Sloychuk, Alberta Environment and Parks*

Aquaculture has been one of the world's fastest growing food production sectors for the last 20 years. In addition to being a resource-efficient way to produce protein, aquaculture has also been utilized to enhance wild stocks of fish and shellfish, as well as to supplement recreationally-important species. In some cases, rapid and unregulated growth of aquaculture had led to environmental damage, conflicts over resources, and alienated public opinion. This session will explore all aspects of aquaculture, including processes, benefits and impacts of aquaculture. Other aspects, such as fish disease, nutrition, and other issues related to aquaculture, will also be present in the program.

## **SS12 - Multiple stressors and aquatic environments**

*Jana Tondu , Government of Alberta*

Understanding and managing the cumulative effects of landscape pressures (non-point contributions of pollution) and point-source contamination is fundamentally important to conserve, protect, and manage aquatic resources. Yet, the impacts of multiple stressors on aquatic environments is complicated, and establishing frameworks and decisions support-tools to manage these pressures are further challenged by our current scientific understanding, governance, and social aspects. This session will explore topics that delve into assessing the impact that multiple stressors have on the aquatic environment, including fish health and communities, and aims to catalyze conversations on appropriate methods, monitoring, governance, policies, and strategies on this important topic from a scientific and management perspective.

## **SS13 - Aquatic nutrients: dynamics and algal blooms**

*Vanessa Swarbrick, Government of Alberta*

Effective management of eutrophication requires an understanding of the factors that control the input, cycling, and sequestration of nutrients within freshwater ecosystems and their catchments. This session will investigate the conditions that influence nutrient export from catchments to a range of freshwater systems, and look at the effectiveness of various management practices at controlling diffuse nutrient pollution. We will also explore changes in nutrient cycling across spatial and temporal scales, and evaluate new tools for measuring nutrients and predicting harmful algal blooms.

## **SS14 - Indigenous resource management**

*Tracy Howlett, Government of Alberta*

Indigenous epistemologies are grounded in a deep, spiritual connection to the land, air, water, plants and animals that make up the environment of which they are part. As natural stewards of this holistic system for millennia, Indigenous peoples are ideally positioned to provide leadership in the effective governance, management and economic development of fish resources. This session invites community members, resource managers and researchers to come together to share their stories of Indigenous fisheries management across Canada. The presentations will look at unique subsistence management techniques, impacts of industrial development on fish habitats and the sacred relationship between humans and fish.

## **GS15 - General contributed papers**

## **FRIDAY PLENARY ABSTRACTS**

### **J.C. STEVENSON MEMORIAL LECTURE: TELEMETRY, DEEP-WATER ARCTIC ECOSYSTEMS AND DEVELOPING COMMERCIAL FISHERIES**

*Hussey, N.E., University of Windsor – Biological Sciences.*

The Arctic is experiencing rapid environmental shifts with largely unknown consequences for its fauna and flora and the indigenous people who are dependent on those resources. In the Eastern Canadian Arctic, commercial fisheries target Greenland halibut (*Reinhardtius hippoglossoides*), a deep-water flatfish, that occupies both inshore and offshore habitat. With continuing sea ice loss, Greenland halibut fisheries are expected to expand across the region, raising concern over the sustainable exploitation of such a deep-water species under predicted climate change. The current interdisciplinary program integrates long-term acoustic telemetry (years) with satellite tracking (up to a year), high-resolution biologgers (days), passive and active environmental sampling, fisheries surveys and marine mammal recordings to support ecosystem-based management of Arctic fisheries. Specifically, the project is monitoring the movements of Greenland halibut in the inshore environment to assist (i) the management of an established Inuit coastal fishery in Cumberland Sound and (ii) the development of coastal fisheries at three additional communities, Qikiqtarjuaq, Clyde River and Pond Inlet. In 2016 monitoring expanded into the offshore to examine Greenland halibut stock connectivity relative to existing management areas. Simultaneous monitoring of the movements of two principal bycatch species, Greenland shark (*Somniosus microcephalus*) and Arctic skate (*Amblyraja hyperborea*) is also underway. I will provide an overview of our teams' telemetry research to monitor fish at >1000m depth and principle findings that are directly shaping fisheries management in the Canadian Arctic.

### **F.H. RIGLER MEMORIAL AWARD LECTURE: PROGRESS TOWARD PREDICTING THE IMPACTS OF NON-NATIVE SPECIES ON FRESHWATER ECOSYSTEMS**

*Ricciardi, A., Redpath Museum & McGill School of Environment, McGill University*

Non-native species are invading lakes and rivers at increasing rates worldwide and the impacts of the vast majority of these invasions are poorly known. Many invasions appear to have had only minor ecological effects, whereas others have caused remarkable changes to water quality, ecosystem functioning, native biodiversity and fisheries. Managers lack risk assessment tools to identify and prioritize high-impact invasion threats. Predicting the impact of an invasion is a longstanding challenge that is complicated by several factors – most notably, the context dependencies that arise from the influence of local environmental variables. My colleagues and I are developing some promising hypotheses, statistical approaches and experimental methods that may contribute to a better predictive understanding of invader impact. These developments are based on a conceptual framework that explicitly considers the relationship of the invader to its physical and biological environment; studies that have explored this relationship have discovered patterns that explain spatial and temporal variation in impact. Identifying such patterns is a



major step toward building predictive models that can allow managers to identify, in advance of invasion, which alien species pose the greatest ecological threat and which habitats are at greatest risk of disruption. Further progress is needed to deal with heavily invaded ecosystems, as burgeoning numbers of invaders can cause synergistic effects that are difficult to anticipate and manage.

**PETERS AWARD LECTURE: BEHAVIORAL RESPONSES TO ANNUAL TEMPERATURE VARIATION ALTER THE DOMINANT ENERGY PATHWAY, GROWTH, AND CONDITION OF A COLD-WATER PREDATOR**

*Guzzo, M.M.1, \*, Blanchfield, P.J.2, & Rennie, M.D.3*

*1 - Department of Biological Sciences, University of Manitoba, Winnipeg, MB*

*2 - Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, MB*

*3 - Department of Biology, Lakehead University, Thunder Bay, ON*

There is a pressing need to understand how ecosystems will respond to climate change. To date, no long-term empirical studies have confirmed that fish populations exhibit adaptive foraging behavior in response to temperature variation and the potential implications this has on fitness. Here, we use an unparalleled 11-year acoustic telemetry, stable isotope, and mark-recapture dataset to test if a population of lake trout (*Salvelinus namaycush*), a cold-water stenotherm, adjusted its use of habitat and energy sources in response to annual variations in lake temperatures during the open-water season and how these changes translated to the growth and condition of individual fish. We found that climate influenced access to littoral regions in spring (data from telemetry), which in turn influenced energy acquisition (data from isotopes), and growth (mark-recapture data). In more stressful years, those with shorter springs and longer summers, lake trout had reduced access to littoral habitat and assimilated less littoral energy, resulting in reduced growth and condition. Annual variation in prey abundance influenced lake trout foraging tactics (i.e., the balance of the number and duration of forays) but not the overall time spent in littoral regions. Lake trout greatly reduced their use of littoral habitat and occupied deep pelagic waters during the summer. Together, our results provide clear evidence that climate-mediated behavior can influence the dominant energy pathways of top predators, with implications ranging from individual fitness to food web stability.

# INVITED PLENARY ABSTRACTS

## FRIDAY INVITED PRESENTATION

### **CHANGES IN FISHING LIVELIHOODS IN NORTHERN ALBERTA: OPPORTUNITIES FOR LINKING LOCAL AND TRADITIONAL KNOWLEDGE TO FISHERIES RESEARCH, MONITORING AND GOVERNANCE**

*Parlee, B.<sup>1</sup>, and Ahkimmachie, K.<sup>2</sup>*

*1 - University of Alberta*

*2 - Treaty 8 First Nations of Alberta*

## SATURDAY INVITED PRESENTATION

### **STABLE ISOTOPES IN FISHERIES RESEARCH: THE GOOD, THE BAD AND THE BENEFIT OF COORDINATING OUR EFFORTS**

*McMeans, Bailey C.1*

*1 - University of Toronto Mississauga, Department of Biology, Mississauga, ON*

*2 - University of Toronto, Department of Ecology & Evolutionary Biology, Toronto, ON*

The application of stable isotopes in aquatic ecology and fisheries research has increased rapidly over the last 20 years. While not without their limitations, stable isotopes remain one of the most accessible and useful tools for studying the diet and habitat use of fish. Recent research demonstrates how stable isotopes, often in combination with other tools (e.g. telemetry, fatty acids), can help address the consequences of invasive species, climate warming and other current issues of concern for fish and their food webs. Stable isotopes can be applied across a range of different ecosystem types and scales depending on the question. This includes local to landscape-level environmental gradients in space and seasonal to decadal changes in time. Emerging, compound-specific analyses are allowing for more accurate diet assessments and are helping address some of the limitations with bulk tissue analysis. Open communication among research groups and collective efforts to compile data and coordinate methodologies will ensure that stable isotopes continue to grow in their accuracy and ability to address the multiple issues facing Canada's aquatic resources.

## **ALBERTA'S CHALLENGING FISHERIES: A RESPONSIBILITY TO MAKE SYSTEMS WORK**

*Sullivan, M.G. \*, David J. Park, and Laura MacPherson  
Alberta Environment and Parks - Fisheries Management Branch*

Fisheries managers in Alberta face a uniquely difficult problem; low fisheries productivity and high threats from cumulative effects, including climate change. Alberta's short history of fisheries management began in the 1960s and focussed on maintaining harvest opportunities, but was ineffective in mitigating increasingly severe overharvest and ecosystem changes. By the 2000's, major declines in fish populations had resulted in Species-at-Risk Act interventions, infringement of Indigenous fishing rights, declines in fiscal and social benefits of recreational fishing, and the economic collapse of Alberta's freshwater commercial fisheries. These losses forced a paradigm shift in fisheries management; integrating cumulative effects modelling with quantitative fisheries science. Using a data-driven system of assessing stocks, and quantifying and mitigating cumulative effects, realistic fishery goals are now being planned and achieved. Case studies on recovery of Walleye (*Sander vitreus*), adaptive management of Bull Trout (*Salvelinus confluentus*), and Species-at-Risk planning for Athabasca Rainbow Trout (*Oncorhynchus mykiss*) demonstrate the success of this systems-based approach.

## **SATURDAY BANQUET TALK**

### **THE PARCHED OLDMAN: A CENTURY OF RIVER REGULATION FROM THE CROWN OF THE CONTINENT**

*Rood, Stewart B.  
Environmental Science Program, University of Lethbridge, Lethbridge, AB*

The intersection of the east-west Continental Divide of the Rocky Mountains and the north-south Hudson Bay Divide provides the Crown of the Continent, the transboundary headwaters for rivers flowing to the Pacific, Arctic and Atlantic Oceans. The Waterton Glacier International Peace Park provides a pristine focus, with rivers flowing from Montana into Alberta as the southern tributaries of the Oldman River Basin. The downstream zones provide fertile soils, abundant sunshine, warm summers and a sloping landscape that offer ideal conditions for irrigation development. This commenced at the end of the 19th century but early projects provoked an international dispute that contributed to the Boundary Waters Treaty. Subsequent developments expanded the river damming and diversion, supporting Canada's largest irrigation project. There was generally enthusiasm for river dams through the twentieth century but by the 1980s and 1990s growing public concern for environmental issues prompted opposition to the Oldman River Dam Project. Environmental and indigenous groups protested and legal changes advanced to the Supreme Court of Canada, related to federal versus provincial jurisdiction, and environmental impact assessment. The Project introduced major changes in regional instream flow management for that new dam and also for the existing dams within the Oldman River Basin, and more broadly for the South Saskatchewan River Basin. This presentation will describe some of the controversies and resolutions over the past century and introduce the concept of functional flows, an environmental flow strategy that was successfully implemented with the Oldman River Dam Project.



## SCHEDULE OF TALKS

Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
<b>Thursday, 4 January 2018</b>					
16:00-20:00	Registration - North Foyer				
20:00-00:00	Welcome Social: Craft Beer Market (10013 101A Ave; 50 m away from Westin)				
<b>Friday, 5 January 2018</b>					
8:00-10:00	Registration - North Foyer				
8:50	Opening Remarks				
9:00	Dignitary Introductions				
9:15	J.C. Stevenson Memorial Lecture: Nigel Hussey				
9:55	F.H. Rigler Memorial Award Lecture: Anthony Ricciardi - PROGRESS TOWARD PREDICTING THE IMPACTS OF NON-NATIVE SPECIES ON FRESHWATER ECOSYSTEMS				
10:35	Break				
11:00	Robert Peters Award Lecture: Matthew Guzzo - BEHAVIORAL RESPONSES TO ANNUAL TEMPERATURE VARIATION ALTER THE DOMINANT ENERGY PATHWAY, GROWTH, AND				

Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
	CONDITION OF A COLD-WATER PREDATOR				
11:30	Brenda Parlee & Kevin Ahkimmachie - CHANGES IN FISHING LIVELIHOODS IN NORTHERN ALBERTA: OPPORTUNITIES FOR LINKING LOCAL AND TRADITIONAL KNOWLEDGE TO FISHERIES RESEARCH, MONITORING AND GOVERNANCE				
12:00	12:00 - 13:20 Lunch (on your own)				CARS-AFS General Meeting / Réunion de la SRAC-AFS (and presentation from the Mid-Canada Chapter) - Turner Valley
	<b>SS8 Recreational fisheries management and science: balancing conservation with angler preference (Moderator - Britt Schmidt)</b>	<b>SS14 - Indigenous resource management (Moderator - Tracy Howlett)</b>	<b>SS10 - Impact of climate change on aquatic ecosystems (Moderator Joshua Thienpont)</b>	<b>SS2 - Improving the science and management of instream flows: moving beyond traditional approaches (Moderator Jordan Rosenfeld)</b>	<b>GS15 - General contributed papers (Moderator Paul Harper)</b>
13:20	SS8. - COMMUNICATING FISHERIES SCIENCE TO STAKEHOLDERS AND POLICY MAKERS: A CHALLENGE FOR THE FUTURE OF FISHERIES MANAGEMENT. - McMullin	SS14 - LILLOOET RIVER SALMON STOCK ASSESSMENT - Bruce	SS10 - OVERWINTER GROWTH AND CONDITION OF JUVENILE ATLANTIC COD (GADUS MORHUA) IN SUBARCTIC COASTAL NEWFOUNDLAND - Geissinger	SS2. - IMPROVING THE SCIENCE UNDERPINNING FLOW RECOMMENDATIONS: MOVING BEYOND TRADITIONAL APPROACHES - Rosenfeld	GS15 - AGRICULTURAL DUGOUTS AS SOURCES OR SINKS FOR GREENHOUSE GASES: A SPATIAL ASSESSMENT IN SOUTHERN SASKATCHEWAN - Webb
13:40	SS8. - ALBERTA CONSERVATION ASSOCIATION: A CASE STUDY OF AN ALTERNATIVE MODEL FOR FISHERIES CONSERVATION	SS14 - COMBINING INUIT FISHERS KNOWLEDGE AND EMPIRICAL DATA IN THE ASSESSMENT OF EMERGING FISHERIES	SS10 - CHARACTERIZING DIET AND GROWTH OF A MARINE FISH INVADING THE GULF OF ST. LAWRENCE - Zhu	SS2. - WATERSHED STRUCTURE, INTROGRESSION AND LIFE-STAGE DISPERSAL DRIVES GENETIC STRUCTURE OF A	GS15 - MODELING TURBIDITY IN LAKE DIEFENBAKER USING LANDSAT-8 OLI IMAGERY - ABIRHIRE



Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
	AND MANAGEMENT ACTIVITIES - Aku	FOR ARCTIC CHARR IN NUNAVUT - Roux		THREATENED AND DISPERSAL LIMITED SPECIES, THE ROCKY MOUNTAIN SCULPIN (COTTUS SP.) - Ruppert	
14:00	SS8. - SALTWATER ANGLER EDUCATION NEEDS AND INFORMATION DELIVERY PREFERENCES: INSIGHTS FROM A STATEWIDE, STRATIFIED-RANDOM MAIL SURVEY - Baker	SS14 - TOWARDS A SUSTAINABLE FISHERY FOR NUNAVUMMIUT: ENSURING SUSTAINABLE FISHERIES DEVELOPMENT USING A TRANSDISCIPLINARY, COMMUNITY DRIVEN RESEARCH MODEL - Chapman	SS10 - HOW DOES DISSOLVED ORGANIC MATTER QUALITY COMPARE ACROSS SUB-ARCTIC AND HIGH ARCTIC ENVIRONMENTS? - Aukes	SS2. - IMPROVEMENTS TO FISH HABITAT SUITABILITY ASSESSMENTS RELATIVE TO WEIGHTED USEABLE AREA APPROACHES - Clipperton	GS15 - FISH AND FISH HABITAT IMPACTS ASSESSMENT TOOL - Warner
14:20	SS8. - THE LANDLOCKED ATLANTIC SALMON FISHERY IN LAC SAINT-JEAN: A PARADIGM SHIFT - Lévesque	SS14 - COMMUNITY-BASED CONSERVATION OF AN ARCTIC CHAR RUN IN NUNAVUT, CANADA - Stevens	SS10 - RECENT CHANGES IN THE LONG-TERM PATTERNS OF DISSOLVED ORGANIC CARBON IN EASTERN CANADIAN LAKES AS RELATED TO REGIONAL AND GLOBAL FACTORS - Imtiaz	SS2. - A NOVEL APPROACH TO WATER MANAGEMENT USING TRADITIONAL INGREDIENTS: A CASE STUDY IN STRUCTURED-DECISION MAKING - Makowecki	GS15 - THE LOST CREEK WILDFIRE: LONG-TERM IMPACTS ON AQUATIC ECOLOGY - Martens
14:40	SS8. - THE LANDLOCKED ATLANTIC SALMON FISHERY IN LAC SAINT-JEAN: MANAGING THE PREY - Lévesque	SS14 - WHAT DOES "CONTAMINATED" MEAN? FISH MONITORING SUCCESS IN COLD LAKE FIRST NATIONS TRADITIONAL TERRITORY. - MacDermid	SS10 - ESTIMATING BOREAL STREAM AND RIVER GREENHOUSE GAS EMISSIONS, THE IMPACT OF CLIMATE AND POTENTIAL CARBON FEEDBACK - Hutchins	SS2. - FISH ASSEMBLAGE STRUCTURE AND DYNAMICS IN NOVEL ECOSYSTEMS - Roberts	GS15 - REVIEW OF SCIENTIFIC SUPPORT OF MITIGATION MEASURES FOR WORKS IN AND AROUND WATER - Warner
15:00	<b>BREAK</b>				
	<b>SS8 (continued; Moderator - Brett van Poorten)</b>	<b>SS3 - Environmental monitoring of fish and water in the Athabasca oil sands (Moderators Kelly</b>	<b>SS10 (continued; Moderator Joshua Thienpont)</b>	<b>SS2 (continued) &amp; GS15 General contributed papers (Moderator Jordan Rosenfeld)</b>	<b>GS15 (continued; Moderator Shona Derlukewich)</b>

Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
		<b>Munkittrick and Tim Arciszewski)</b>			
15:20	SS8. - WHY ARE THERE SO MANY LITTLE FISH? CASE STUDIES IN INCREASED HARVEST AND DECREASED SIZE OF FRESHWATER SALMONIDS - Sullivan	SS3. - THE SALT AND METAL COMPONENTS OF OIL SANDS PROCESS AFFECTED WATERS (OSPW) EFFECTS ON METABOLISM AND SWIMMING ABILITY IN RAINBOW TROUT (ONCORHYNCHUS MYKISS) - Mueller	SS10 - IMPACT OF CLIMATE-INDUCED WATER LEVEL DECLINES ON WATER QUALITY IN CLOSED BASIN LAKES OF THE NORTHERN GREAT PLAINS - Finlay	SS2. - FISH-BASED ESTIMATE OF IN-STREAM FLOW NEEDS - Ward	GS15 - CONSTRUCTION OF SIDE-CHANNEL FISH HABITAT ON THE BOW RIVER AS OFFSET FOR SERIOUS HARM - Harper
15:40	SS8. - FISH ON! IMPLEMENTING ALBERTA'S NORTHERN PIKE RECREATIONAL MANAGEMENT FRAMEWORK - Brown	SS3. - USE OF FLOODPLAIN LAKE SEDIMENTS TO DETERMINE PRE-INDUSTRIAL BASELINES AND EXTENT OF METAL POLLUTION OF THE ATHABASCA RIVER IN THE ALBERTA OIL SANDS REGION - Klemt	SS10 - CLIMATE DRIVES CATCHMENT-WIDE CHANGES IN MERCURY CYCLING IN THE HIGH ARCTIC'S LARGEST LAKE BY VOLUME (LAKE HAZEN, NUNAVUT, CANADA) - St. Pierre	GS15 - ARE TAGS A DRAG?THE EFFECT OF EXTERNAL TAGS ON PROFILE DRAG OF TROUT - Manouchehri	GS15 - SURVIVING THE URBAN JUNGLE: BIOTIC FACTORS DRIVE LOCAL DISPERSAL OF AN ENDANGERED STREAM FISH - Drake
16:00	SS8. - A DECADE OF SPECIAL LICENSES TO HARVEST WALLEYES; A FISHERIES MANAGEMENT TOOL THAT BRIDGES OPEN-ACCESS TO LIMITED-ACCESS FISHERY. - spencer	SS3. - SEASONAL AND TEMPORAL CHANGES IN FISH COMMUNITY STRUCTURE IN THE LOWER ATHABASCA RIVER - Munkittrick	SS10 - CONCEPTUALISING CLIMATE CHANGE IMPACTS ON FISHERIES ECOSYSTEMS - Roux	GS15 - THE LINK BETWEEN SWIMMING ABILITY AND ECOLOGICALLY RELEVANT BEHAVIOUR IN RAINBOW TROUT (ONCORHYNCHUS MYKISS) - Dehaan	GS15 - USING WATERSHED CONNECTIVITY AND ABIOTIC VARIABLES TO DESCRIBE RAINBOW TROUT COLONIZATION, GROWTH AND RECRUITMENT ACROSS A LANDSCAPE - Cantin
16:20	SS8. - PREDATOR DENSITY AND NOT LITTORAL STRUCTURE DETERMINES YOUNG-OF-YEAR BASS MORTALITY IN LAKES - Ziegler	SS3. - USING ENVIRONMENTAL DNA TO MONITOR WINTER AQUATIC BIODIVERSITY - Harrison	SS10 - CHARACTERIZING MICROBIAL COMMUNITIES IN A RAPIDLY CHANGING HIGH ARCTIC WATERSHED - Cavaco	GS15 - FUNCTIONAL DIVERSITY AND REDUNDANCY OF FRESHWATER FISH COMMUNITIES IN	GS15 - PRACTICAL GIS APPLICATIONS FOR FISHERIES AND AQUATIC SCIENCES - Farineau

Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
				ONTARIO LAKES - Lamothe	
16:40	SS8. - EVALUATING LANDSCAPE PATTERNS OF FISHING IMPACTS USING A NEW RECREATIONAL FISHERY ASSESSMENT MODEL - van Poorten	SS3. - A VALIDATION OF HYDROACOUSTIC SURVEYS TO ESTIMATE FISH ABUNDANCE AND BIOMASS IN A SMALL NORTHERN LAKE - Nuspl	SS12 - VULNERABILITY TO MULTIPLE ENVIRONMENTAL STRESS OF SMALL BODY SIZE OVIGEROUS LOBSTER - Couillard	GS15 - BIOLOGICAL EVALUATION OF FISH FRIENDLY VERY LOW HEAD TURBINE TECHNOLOGY IN CANADA. - Smokorowski	GS15 - CONNECTIVITY, PERSISTENCE, AND LOSS OF HIGH ABUNDANCE JUVENILE ATLANTIC HALIBUT AREAS IN THE NORTHWEST ATLANTIC OCEAN - Boudreau
17:00-18:00					<b>SCL Business Meeting</b>
17:00-21:00	<b>Cash bar</b>				
18:00-21:00	<b>POSTER Social- Manitoba Room (cash bar opens at 5pm)</b>				
21:00-00:00	<b>Student Social: Sherlock Holmes Pub (10012 101A Avenue NW; 50 m away from Westin)</b>				
<b>Saturday, 6 January 2018</b>					
8:00-10:00	Registration - North Foyer				
	PLENARY SESSIONS				
8:50	Opening Remarks				
9:00	PLEN - STABLE ISOTOPES IN FISHERIES RESEARCH: THE GOOD, THE BAD AND THE BENEFIT OF COORDINATING OUR EFFORTS - McMeans				
9:40	PLEN - ALBERTA'S CHALLENGING FISHERIES: A RESPONSIBILITY TO MAKE SYSTEMS WORK - Sullivan				

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10:20	<b>BREAK</b>				
	<b>SS4 Trace me if you can: stable isotopes, diet, and aquatic species management (Moderator Kathryn Peiman)</b>	<b>SS5 - Native trout and salmon recovery (Moderator Kenton Neufeld)</b>	<b>SS1 - Digital media as a source of contemporary and novel fisheries data (Moderator Paul Venturelli)</b>	<b>SS12 - Multiple stressors and aquatic environments (Moderator Jana Tondu)</b>	<b>SS7 - Aquatic health: invasive species and disease (Moderators Tanya Ruschcall, Janine Higgins and Emily Drystek)</b>
11:00	SS4. - TOP PREDATORS AS MULTI-METERS FOR QUANTIFYING CUMULATIVE STRESS IN THE GREAT LAKES - Rooney	SS5. - ALBERTA'S 'JOE' MODEL: CUMULATIVE EFFECTS MADE EASY - MacPherson		SS12 - CUMULATIVE INFLUENCE OF WASTEWATER AND TRIBUTARY INPUTS TO WINTER WATER QUALITY IN THE ATHABASCA RIVER - Tondu	SS7. - CURRENT STATUS OF THE WHIRLING DISEASE PARASITE, MYXOBOLUS CEREBRALIS, IN ALBERTA - Veillard
11:20	SS4. - UNDERSTANDING THE IMPACTS OF MULTIPLE ANTHROPOGENIC STRESSORS ON AN AQUATIC TOP PREDATOR - Ramshaw	SS5. - NORTH CENTRAL NATIVE TROUT (NCNT) RECOVERY PROGRAM: A STANDARDIZED APPROACH TO COMBATING CUMULATIVE EFFECTS IMPACTING AQUATIC SPECIES-AT RISK IN ALBERTA. - Meinke	SS1. - 10 YEARS LATER: LESSONS LEARNED FROM EARLY ATTEMPTS TO REPORT AND COLLECT DATA USING CELL PHONES - Baker	SS12 - MULTIPLE STRESSOR IMPACTS ON ALASKAN STREAM FISH PRODUCTIVITY - Murdoch	SS7. - STOP THE SPREAD: ALBERTA'S DECONTAMINATION PROTOCOL FOR THE CONTAINMENT OF WHIRLING DISEASE AND AQUATIC INVASIVE SPECIES. - Schaubel
11:40	SS4. - TROPHIC VARIATION WITHIN A PISCIVOROUS LAKE TROUT MORPH FROM GREAT BEAR LAKE, CANADA: THE INITIAL STEP TOWARD ECOLOGICAL SPECIALIZATION? - chavarie	SS5. - OVERVIEW OF ALBERTA'S WESTSLOPE CUTTHROAT TROUT RECOVERY PROGRAM - Christensen		SS12 - USING FISH HEALTH AND COMMUNITY MEASURES TO EVALUATE CUMULATIVE DOWNSTREAM EFFECTS FROM FOREST HARVEST ACTIVITIES, IN NORTHERN NEW BRUNSWICK. - White	SS7. - AQUATIC INVASIVE SPECIES MANAGEMENT IN AN URBAN MUNICIPALITY – THE STORY OF THE FRANKENFISH AND THE FLOWERING RUSH INVASION IN ST. ALBERT, ALBERTA - Logan
12:00	<b>12:00 - 13:20 (Lunch on your own)</b>				

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	<b>SS4 (continued; Moderator Kathryn Peiman)</b>	<b>SS5 (continued; Moderator Kenton Neufeld)</b>	<b>SS1 (continued; Moderator Paul Venturelli)</b>	<b>SS12 (continued; Moderator Jana Tondou)</b>	<b>SS7 (continued; Moderators Tanya Ruschcall, Janine Higgins and Emily Drystek)</b>
13:20	SS4. - INFLUENCES OF LIFE HISTORY TYPE ON LAKE TROUT (SALVELINUS NAMAYCUSH) GROWTH AND SURVIVAL IN THE WESTERN CANADIAN ARCTIC. - Kissinger	SS5. - THE COLLAPSE AND RECOVERY OF LAKE TROUT IN GREAT SLAVE LAKE, CANADA <sup>AMS</sup> MOST NORTHERN FRESHWATER COMMERCIAL FISHERY - Howland	SS1. - TIME-LAPSE AND MOTION-DETECTION PHOTOGRAPHY TO ASSESS RECREATIONAL FISHERIES - Pope	SS12 - EVALUATING ANNUAL VARIATION IN FISH COMMUNITIES AND IMPLICATIONS FOR BIOMONITORING - Prestie	SS7. - NATIVE FRESHWATER SPECIES GET OUT OF THE WAY: PRUSSIAN CARP (CARASSIUS GIBELIO) ESTABLISHMENT IMPACTS BOTH FISH AND BENTHIC INVERTEBRATE COMMUNITIES IN NORTH AMERICA - Poesch
13:40	SS4. - SEASONAL MIGRATION OF CORIXIDS (HEMIPTERA: CORIXIDAE) OUT OF WETLANDS AND CONSUMPTION BY RIVERINE FISH - Srayko	SS5. - BULL TROUT – LAKE TROUT INTERACTIONS IN A LARGE RESERVOIR REVEALED BY ACOUSTIC TELEMETRY - Ward	SS1. - COMPARING ESTIMATES OF FISHING EFFORT AND LAKE CHOICE DERIVED FROM AERIAL CREEL SURVEYS AND SMARTPHONE APPLICATION DATA IN ONTARIO, CANADA - venturelli	SS12 - THE EFFECT OF MULTIPLE STRESSORS ON SUBARCTIC AQUATIC SYSTEMS: IMPACTS OF CLIMATE CHANGE AND ROAD DUST - Zhu	SS7. - TURNING POPULATION VIABILITY ANALYSIS ON ITS HEAD: EVALUATING INVASIVE SPECIES REMOVAL SCENARIOS USING PVA IN A DECISION ANALYSIS - van Poorten
14:00	SS4. - THE USE OF SULFUR ISOTOPES TO UNDERSTAND MERCURY BIOACCUMULATION IN SIMPLE AQUATIC FOOD WEBS FROM HIGH ARCTIC LANDLOCKED LAKES - Lescord	SS5. - THE LAW ON RECOVERING ALBERTA'S WESTSLOPE CUTTHROAT TROUT TO SECURE STATUS - Fluker	SS1. - "APPY" DAYS ON THE HORIZON: INITIAL RESULTS FROM A DANISH APP FOR COLLECTING RECREATIONAL FISHERIES DATA - venturelli	SS12 - ASSESSING THE IMPACTS OF MULTIPLE ECOLOGICAL STRESSORS ON A THREATENED NATIVE SALMONID IN THE FOOTHILLS OF ALBERTA, CANADA. - Medinski	SS7. - THE EURASIAN TENCH (TINCA TINCA): A GLOBALLY INVASIVE FISH POISED TO INVADE THE GREAT LAKES - Avlijas
14:20	SS4. - USING ISOTOPES TO ASSESS PAST AND CURRENT NUTRITIONAL STATUS OF SOCKEYE SALMON - Peiman	SS5. - AN ACTION PLAN FOR RECOVERING ALBERTA'S WESTSLOPE CUTTHROAT TROUT TO SECURE STATUS - Mayhood	SS1. - DETERMINING THE UTILITY OF ELECTRONIC, SELF-REPORTED RECREATIONAL DATA FOR FISHERIES STOCK ASSESSMENT. - Ahrens	SS12 - EVALUATION OF FISH COMMUNITIES ONE YEAR AFTER THE HUSKY OIL SPILL IN THE NORTH SASKATCHEWAN RIVER - Jardine	SS7. - OPTIMAL PLACEMENT OF WATERCRAFT INSPECTION STATIONS - Fischer

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14:40	SS4. - THE EFFECTS OF INVASIVE DREISSENIID MUSSELS ON THE OFFSHORE FOOD WEB OF LAKE SIMCOE, ONTARIO. - Langen	SS5. - THE CRITICAL ROLE OF ENGOS IN PROTECTING AND RECOVERING SPECIES AT RISK IN CANADA - Skrajny	SS1. - ELECTRONIC SELF-REPORTING IN THE SOUTH ATLANTIC US: PRELIMINARY RESULTS, LESSONS LEARNED, AND FUTURE DIRECTIONS. - Fitzgerald	SS12 - THE ROLE OF SMALL RESERVOIRS FOR GREENHOUSE GAS RELEASE TO THE ATMOSPHERE: WHEN HUMANS IMPACT BEAVER POPULATIONS - Whitfield	SS7. - SEASONAL MIGRATION AND FINE-SCALE MOVEMENT OF INVASIVE ROUND GOBY IN GREAT LAKES TRIBUTARIES - Blair
15:00		<b>BREAK</b>			
	<b>SS4 (continued) &amp; GS15 General contributed papers (Moderator Kathryn Peiman)</b>	<b>SS3 - Environmental monitoring of fish and water in the Athabasca oil sands (continued; Moderators Kelly Munkittrick and Tim Arciszewski)</b>	<b>SS1 (continued; Moderator Paul Venturelli)</b>	<b>SS12 (continued; Moderator Jana Tondu)</b>	<b>SS11 - Aquaculture and its impact on aquatic environments &amp; GS15 General contributed papers (Moderator Janelle Sloychuck)</b>
15:20	SS4. - POTENTIAL IMPACTS OF AN INTRODUCED PREDATORY FISH (CICHLA MONOCULUS) ON THE DIET AND TROPHIC ECOLOGY OF A NATIVE PREDATOR (HOPLIAS MICROLEPIS) IN LAKE GATUN, PANAMA - Valverde	SS3. - HYDROACOUSTIC BASED ESTIMATES OF FISHERIES PRODUCTIVITY IN THE ATHABASCA OIL SANDS: IMPLICATIONS FOR OFFSETTING - Terry	SS1. - USING DIGITAL DATA TO TRACK FISHING EFFORT AND CATCHES; AN EXAMPLE AND OPPORTUNITIES - Martin	SS12 - THE DOWNSTREAM EFFECT OF A WASTEWATER TREATMENT PLANT UPGRADE ON IN-STREAM DENITRIFICATION - Dylla	SS11 - ENHANCING IMMUNITY AND DISEASE RESISTANCE IN FISH BY CHITOSAN-SELENIUM NANOPARTICLES - XIA
15:40	GS15 - CONSERVATION STOCKING DILEMMA OF LONG-LIVED AQUATIC SPECIES - Deslauriers	SS3. - INCREASED SIZE AND RELATIVE ABUNDANCE OF MIGRATORY FISHES OBSERVED NEAR THE ATHABASCA OIL SANDS - Arciszewski	SS1. - A FRAMEWORK FOR DESIGNING CITIZEN SCIENCE PROJECTS THAT INCORPORATE USER MOTIVATIONS AND RETENTION STRATEGIES TO OPTIMIZE PARTICIPATION. - Simmons	SS12 - UNDERSTANDING THE DISTRIBUTION, DRIVERS, AND ENVIRONMENTAL IMPACT OF POLYCYCLIC AROMATIC HYDROCARBONS IN WATERBODIES OF THE PEACE-ATHABASCA DELTA - Thienpont	SS11 - A MASS BALANCE APPROACH TO QUANTIFYING EFFECTS OF NETCAGE AQUACULTURE ON ECOSYSTEM STRUCTURE AND FUNCTION IN LAKE HURON - Moore

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16:00	GS15 - ASSESSING NATIVE LAMPREY POPULATIONS IN GREAT LAKES TRIBUTARIES TO EVALUATE THE POTENTIAL FOR INVASIVE SEA LAMPREY PRODUCTION UPSTREAM OF PHYSICAL BARRIERS - Van Kempen	SS3. - DEVELOPMENT OF AQUATIC ENVIRONMENT MONITORING TRIGGERS FOR THE LOWER ATHABASCA RIVER - Hamilton	SS1. - ELECTRONIC SELF REPORTING IN THE SOUTH ATLANTIC US: PRELIMINARY RESULTS, LESSONS LEARNED, AND FUTURE DIRECTION. - Dick	SS12 - RESPONSES OF ECOLOGICAL PROCESSES TO VARIABILITY IN WATER QUANTITY AND QUALITY - Sinnatamby	SS11 - COMMUNITY-LEVEL IMPACTS OF AN EXPERIMENTAL AQUACULTURE OPERATION - Rennie
16:20	GS15 - ON THE IMPORTANCE OF SMALL-BODIED FISHES IN FRESHWATER ECOSYSTEMS - Koops	SS3. - BIOPURIFICATION OF PB AND BIOACCUMULATION OF TL IN OTOLITHS OF TROUT-PERCH (PERCOPSIS OMISCOMAYCUS) FROM THE ATHABASCA RIVER, UPSTREAM AND DOWNSTREAM OF BITUMEN MINING AND UPGRADING - Shotyk	Open Discussion - led by Paul Venturelli	SS12 - NORMOXIA EXPOSURE REDUCES HYPOXIA TOLERANCE IN SWAMP ADAPTED FISH - Clarke	GS15 - FISHERY DEPENDENT DATA IN STOCK ASSESSMENTS - Nasmith
16:40	GS15 - ASSESSMENT OF AN ADULT LAKE STURGEON TRANSLOCATION (ACIPENSER FULVESCENS) REINTRODUCTION EFFORT IN A FRAGMENTED RIVER SYSTEM - Boothroyd			SS12 - POST-RELEASE CONDITION, PATHOGEN LOADING, AND SURVIVAL OF WILD ATLANTIC SALMON - Chapman	GS15 - LEFT HIGH AND DRY: THE IMPORTANCE OF GETTING OFF THE BEACH FOR CAPELIN SURVIVAL - Murphy
17:00-18:00					<b>CCFFR Business Meeting</b>
17:00-20:30	<b>Cash bar</b>				
18:00-20:30	<u>Banquet</u> 18:00 - Doors open 18:30 - Dinner				
	19:30 - THE PARCHED OLDMAN: A CENTURY OF RIVER REGULATION FROM THE CROWN OF THE CONTINENT - Rood				

Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
<b>Sunday, 7th January 2018</b>					
	<b>SS8. Recreational fisheries management and science (continued; Moderator Brett van Poorten)</b>	<b>SS5 - Native trout and salmon recovery (continued; Moderator Kenton Neufeld)</b>	<b>SS6 - Genomic, proteomic and transcriptomic advancements in aquatic monitoring (Moderators Ian Bradbury and Dan Heath)</b>	<b>SS13 - Aquatic nutrients: dynamics and algal blooms (Moderator Ben Kissinger)</b>	<b>GS15 - General contributed papers (Moderator Shona Derlukewich)</b>
9:00	SS8. - TRENDS IN ALBERTA'S WALLEYE FISHERY DURING 2000-2016 - Cahill	SS5. - ANCIENT ENVIRONMENTAL DNA AND HISTORICAL BIOGEOGRAPHY OF FRESHWATER ENDEMIC SPECIES - Nelson-Chorney	SS6. - NEW APPLICATIONS OF META-BARCODING TECHNOLOGY FOR FISH COMMUNITY ASSESSMENT - Heath	SS13 - USING HIGH FREQUENCY BUOY DATA TO FORECAST HARMFUL ALGAL BLOOMS - Kehoe	GS15 - SPATIAL AND TEMPORAL SCALES OF CONNECTIVITY IN ATLANTIC COD RECRUITMENT SIGNALS IN NEWFOUNDLAND - Cooke
9:20	SS8. - BALANCING FISH CONSERVATION AND ANGLER USE IN RECREATIONAL FISHERIES: EVALUATING THE BIOLOGICAL, SOCIAL AND ECONOMIC OUTCOMES FROM FISH STOCKING AND HARVEST REGULATIONS - Johnston	SS5. - ROTENONE AND RESTORATION STOCKING: THE NEW BAIT AND SWITCH. - Meagher	SS6. - GENOMIC SOLUTIONS FOR FISHERIES MANAGEMENT – THE SEARCH FOR THE MISSING FISH - Ward	SS13 - THE DYNAMICS OF NITROGEN-FIXING CYANOBACTERIA IN PRAIRIE LAKE - Boyer	GS15 - WHY HARVESTING MAGNIFIES FLUCTUATIONS IN A DAPHNIA FISHERY EXPERIMENT - Rogers
9:40	SS8. - UNDERSTANDING HARVEST DYNAMICS IN RECREATIONAL FISHERIES: DEVELOPMENT AND USE OF SPATIAL SOCIAL-ECOLOGICAL MODELS - Post	SS5. - WESTSLOPE CUTTHROAT TROUT WINTER HABITAT DISTRIBUTION AT A WATERSHED SCALE IN SMALL MOUNTAIN STREAMS OF SOUTHERN ALBERTA - Benson	SS6. - TEMPORAL DYNAMICS OF A GENETIC CLINE OF INVASIVE EUROPEAN GREEN CRAB (CARCINUS MAENAS) IN EASTERN NORTH AMERICA - Lehnert	SS13 - A COMPARISON OF TECHNIQUES FOR THE MEASUREMENT OF NO3 ALONG A LAKE GRADIENT OF SALINITY, COLOR AND NUTRIENTS - Hudson	GS15 - SPENDING THE CONSERVATION DIVIDEND; THE EFFECTS OF CLOSING ALBERTA COMMERCIAL FISHERIES - Wakeling
10:00	SS8. - VARIATION IN LANDSCAPE CONFIGURATION AND	SS5. - MULTI-SCALE CHARACTERIZATION OF BULL TROUT SPAWNING	SS6. - ENVIRONMENTAL DNA – REAL TIME RESULTS IN THE FIELD TO	SS13 - A LENS ON EBULLITION: A NOVEL SENSOR FOR HIGH	GS15 - PREVALENCE, INTENSITY AND DISTRIBUTION OF



Room	Saskatchewan	Alberta	Yukon	BC	Turner Valley
	SOCIAL-ECOLOGICAL PROCESSES DRIVES PATTERNS OF EXPLOITATION AMONG SPATIALLY-STRUCTURED RECREATIONAL FISHERIES - Wilson	LOCATIONS – APPLYING LONG-TERM MONITORING AND RESEARCH TO HABITAT REHABILITATION DESIGNS - Robinson	CONFIRM THE PRESENCE OF TARGET SPECIES - Warner	TEMPORAL RESOLUTION MEASUREMENT OF METHANE EMISSIONS IN SHALLOW LENTIC WATERS - Helmle	SALMINCOLA EDWARDSII ON RESIDENT BROOK TROUT (SALVELINUS FONTINALIS) IN TWO FORESTED CATCHMENTS OF NORTHERN NEW BRUNSWICK. - White
10:20	SS8. - MODELING FISHING AS A DISRUPTOR OF THE MATCH BETWEEN FISH AND FISH HABITAT - Gillis	SS5. - EFFECTS OF STREAM HABITAT STRUCTURE ON FORAGING IN ATLANTIC SALMON (SALMO SALAR) - Therrien	SS6. - EVALUATING HYBRIDIZATION OF ALBERTA'S THREATENED WESTSLOPE CUTTHROAT TROUT - Coombs	SS13 - MEETING PHOSPHORUS REDUCTION GOALS BY APPLYING BEST MANAGEMENT PRACTICES IN THE GRAND RIVER WATERSHED IN SOUTHERN ONTARIO - Hanief	GS15 - SPATIAL RISK: INFLUENCE OF PISCIVOROUS FISH ON SELECTION OF NURSERY HABITAT BY AGE-0 JUVENILE COD - MacRobert
10:40		BREAK			
	<b>SS8 (continued; Moderator Brett van Poorten)</b>	<b>SS5 (continued; Moderator Kenton Neufeld)</b>	<b>SS6 (continued; Moderators Ian Bradbury and Dan Heath)</b>	<b>SS13 (continued; Moderator Ben Kissinger)</b>	<b>GS15 (continued; Moderator Paul Harper)</b>
11:00	SS8. - THE RETURN OF THE STRIPED BASS (MORONE SAXATILIS) IN THE ST. LAWRENCE RIVER: DOCUMENTING EARLY LIFE HISTORY TO BASE THE MANAGEMENT OF THIS LONG-AWAITED FISHERY ON SOLID SCIENCE - Vanalderweireldt	SS5. - GENETIC ADAPTATION AND PHENOTYPIC PLASTICITY OF HEART FUNCTION IN ATLANTIC SALMON - Neff	SS6. - ADDITIVE, NON-ADDITIVE, AND MATERNAL EFFECTS ON DNA METHYLATION AMONG DIFFERENT SALMON REARING ENVIRONMENTS - Venney	SS13 - CONTRASTING NUTRIENT AND SEDIMENT RETENTION IN TWO STORMWATER PONDS DURING ATYPICALLY DRY (2016) AND WET (2017) YEARS - Lilwah	GS15 - SCENT ENHANCEMENT AND TAGGING EFFECTS IN JUVENILE LAKE STURGEON (ACIPENSER FULVESCENS) - McCabe
11:20	SS14 - USING UNDERWATER VIDEO TO INVESTIGATE THE USE OF POTTING GEAR IN THE GREENLAND	SS5. - ARCTIC GRAYLING (THYMALLUS ARCTICUS) PHYSIOLOGICAL DATA AND IMPLICATIONS OF	SS6. - MAJOR HISTOCOMPATIBILITY COMPLEX VARIATION AMONG ALTERNATIVE	SS13 - INTERACTION BETWEEN HYDROLOGY AND LAND USE IN DETERMINING RIVERINE	GS15 - PHYSICAL TIDEPOL SEASCAPES EXPLAIN SIZE CLASS DISTRIBUTION AND SITE FIDELITY IN TIDEPOL

<b>Room</b>	<b>Saskatchewan</b>	<b>Alberta</b>	<b>Yukon</b>	<b>BC</b>	<b>Turner Valley</b>
	HALIBUT (REINHARDTIUS HIPPOGLOSSOIDES) FISHERY - Folkins	HIGH-SALINE SPILLS ON NATIVE FRESHWATER SALMONIDS - Blair	REPRODUCTIVE TACTICS OF CHINOOK SALMON - Pitcher	DISSOLVED ORGANIC MATTER COMPOSITION - Silk	SCULPIN (OLIGOCOTTUS MACULOSUS) - Smith
11:40			SS6. - THERMAL EXTREMES DRIVE RANGE-WIDE AND FINE-SCALE GENOMIC DIFFERENTIATION IN ATLANTIC SALMON (SALMO SALAR) - Bradbury	SS13 - THE RISE AND FALL OF NUTRIENTS IN ICE COVERED PONDS - Cavaliere	GS15 - COMPARING FISH COMMUNITY COMPOSITION IN INVASIVE PHRAGMITES AUSTRALIS SSP. AUSTRALIS AND NATIVE EMERGENT SPECIES' IN THE ST. CLAIR RIVER DELTA – Wynia
Conference concludes, see you in London, ON in 2019!					

# **POSTERS**

**6:00 – 9:00 pm, Friday, January 5, Manitoba Room**

**Social: cash bar opens at 5 pm**

## **SS4. Trace me if you can: stable isotopes, diet, and aquatic species management**

1. Dehaan - WESTSLOPE CUTTHROAT TROUT (ONCORHYNCHUS CLARKI LEWISI) IN ALBERTA: A STUDY OF DIET COMPOSITION AND ONTOGENIC SHIFT.
2. Savage - A COMPARATIVE ANALYSIS OF TROPHIC ECOLOGIES AND MERCURY BIOACCUMULATION IN FOUR CO-HABITING PISCIVORES OF BOREAL LAKES.

## **SS5. Native trout and salmon recovery**

3. Blair - ACUTE EXPOSURE OF LARVAL RAINBOW TROUT (ONCORHYNCHUS MYKISS) TO ELEVATED TEMPERATURES INFLUENCES FUTURE THERMOTOLERANCE.

## **SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring**

4. Akotoye - FUNCTIONAL LINKS TO NUTRIENTS AND DISSOLVED ORGANIC MATTER QUALITY OF RIVER MICROBIAL COMMUNITIES VIA INTEGRATED METAGENOMICS.
5. Perriman - MORPHOLOGICAL CONSEQUENCES OF HYBRIDIZATION BETWEEN DOMESTIC AND WILD ATLANTIC SALMON, SALMO SALAR, UNDER BOTH EXPERIMENTAL AND WILD CONDITIONS.
6. Watson - A GENOMIC BASELINE FOR ASSESSING INDIRECT GENETIC IMPACTS OF AQUACULTURE ON ATLANTIC SALMON (SALMO SALAR) IN PLACENTIA BAY, NEWFOUNDLAND.

## **SS7. Aquatic health: invasive species and disease**

7. Couillard - POLYCHAETES CAUSE SHELL DAMAGE IN WHELKS FROM THE ÎLES-DE-LA-MADELEINE, QUEBEC, CANADA.

## **SS8. Recreational fisheries management and science: balancing conservation with angler preference**

8. Glaser - POPULATION DYNAMICS OF OVERHARVESTED BROOK TROUT.

### **SS10. Impact of climate change on aquatic ecosystems**

9. Kuhn - METHANE EMISSIONS FROM PEATLAND LAKES IN WESTERN CANADA: EFFECTS OF GROUNDWATER CONNECTIVITY AND PERMAFROST THAW.
10. Sherbo - EFFECTS OF BROWNIFICATION ON BOREAL LAKE METABOLISM.
11. Tonin - THE EFFECTS OF TERRESTRIAL ORGANIC MATTER INPUTS ON LAKE FOOD WEB PRODUCTIVITY.

### **SS11. Aquaculture and its impact on aquatic environments**

12. Beadle - EFFECT OF AQUACULTURE OPERATIONS ON WATER QUALITY IN LAKE DIEFENBAKER.
13. Harrington - USING NEXT GENERATION METHODS TO UNDERSTAND SEA LICE SPREAD BETWEEN SALMON FARMS.

### **SS12. Multiple stressors and aquatic environments**

14. Leslie - ASSESSING RIGHT HAND COILED COIL (RHCC) PROTEIN AS A POTENTIAL NEW PASSIVE SAMPLER MATRIX FOR BINDING POLYCYCLIC AROMATIC HYDROCARBONS (PAHS).
15. White - USING FISH HEALTH AND COMMUNITY MEASURES TO EVALUATE CUMULATIVE DOWNSTREAM EFFECTS FROM FOREST HARVEST ACTIVITIES, IN NORTHERN NEW BRUNSWICK.

### **SS13. Aquatic nutrients: dynamics and algal blooms**

16. Baulch - SOIL AND WATER MANAGEMENT FOR NUTRIENT CONTROL IN THE NORTHERN GREAT PLAINS.
17. Cavaliere - THE RISE AND FALL OF NUTRIENTS IN ICE COVERED PONDS.
18. van Klaveren - NUTRIENT CYCLING AND ALGAL COMMUNITY STRUCTURE IN AGRICULTURAL STREAMS OF ALBERTA.

### **SS14. Indigenous resource management**

19. Folkins - USING UNDERWATER VIDEO TO CONDUCT RESOURCE ASSESSMENTS FOR NEW EMERGING FISHERIES IN KIMMIRUT, NUNAVUT.
20. Tran - COMMUNITY-BASED MONITORING OF ARCTIC CHARR (SALVELINUS ALPINUS) FROM THE NEPIHJEE RIVER SYSTEM (KUUJJUAQ, NUNAVIK).

### **GS15. General contributed papers**

21. Donadt - SPATIAL PATTERNS OF MERCURY CONCENTRATIONS IN AQUATIC ECOSYSTEMS OF SOUTHERN ALBERTA.
22. Drake - EVALUATING RESEARCH PROGRESS FOR FRESHWATER SPECIES AT RISK IN THE GREAT LAKES-ST. LAWRENCE RIVER BASIN, 2004 – 2016.
23. Emmons - WHOLE SYSTEM NUTRIENT REGENERATION IN LAKE DIEFENBAKER, SK.
24. Lajoie - DIFFERENCES IN QUALITY BETWEEN HATCHERY-REARED AND WILD-ORIGIN BLOATER (COREGONUS HOYI) EGGS AND IMPLICATIONS FOR RESTORATION EFFORTS.
25. Lescord - THE RATIO OF METHYLMERCURY TO TOTAL MERCURY CONCENTRATIONS IN FISH MUSCLE VARIES WITH BODY SIZE AND BETWEEN SPECIES.
26. Maitland - NICHE PARTITIONING AND SPECIES COEXISTENCE: IMPLICATIONS FOR THE CONSERVATION OF STREAM FISH IN A CHANGING WORLD.
22. McPherson - HABITAT USE BY ARCTIC GRAYLING (THYMALLUS ARCTICUS) ACROSS LIFE STAGES IN PRISTINE NORTHERN MOUNTAIN STREAMS.
28. Theis - OFFSETTING IN AQUATIC ECOSYSTEMS, A META-ANALYSIS.

# FULL ABSTRACTS

## **MODELING TURBIDITY IN LAKE DIEFENBAKER USING LANDSAT-8 OLI IMAGERY**

*Abirhire, O.\* and J. Hudson*

*Department of Biology, University of Saskatchewan, Saskatoon, Canada.*

High turbidity in reservoirs affects the aesthetic and treatment costs of drinking water, and may also influence a variety of physical conditions (e.g., stratification, light penetration), which in turn can affect phytoplankton growth. Hence, it is an important water quality parameter that is routinely monitored in reservoirs. Lake Diefenbaker (LD) serves as an important source of water for southern Saskatchewan. However, long term records of turbidity in LD are not available and there is evidence that high turbidity may be limiting phytoplankton productivity in the reservoir as reported in other studies. Therefore, we examined the possibility of using a remote sensing based model to acquire historical turbidity in LD. To achieve this, we related field measured turbidity along the main channel of LD during the open water season from 2013- 2016 (i.e., a total of 80 field observations) to 12 Landsat-8 OLI images that were acquired within  $\pm 8$  days of field measurement of turbidity. We related 39 of our field turbidity observations to the reflectance of single band combinations (red, blue, green and near-infrared) of Landsat-8 OLI scenes using multiple linear regression analysis. We then used the other 41 field turbidity observations for model validation. Reflectance from red and near-infrared bands were strongly related to field measured turbidity in LD ( $R^2 = 0.89$ ). Finally, estimated turbidity was strongly related to the field measured turbidity ( $R^2 = 0.79$ , RMSE 0.19 NTU). Thus, our model has the potential to predict past turbidity levels with high precision in LD.

*GS15. General contributed papers*

*Oral*

## **DETERMINING THE UTILITY OF ELECTRONIC, SELF-REPORTED RECREATIONAL DATA FOR FISHERIES STOCK ASSESSMENT.**

*Robert N. M. Ahrens\*1, Ryan P. Jiorle 2, Micheal S. Allen1*

*1 - Fisheries and Aquatic Sciences Program, University of Florida, Gainesville, FL*

*2 - Virginia Marine Resources Commission, Newport News, VA*

To supplement sampling programs, fisheries professionals are exploring electronic, self-reporting platforms. The hope is that such platforms will be effective at filling data gaps and enhance fisheries assessment. We assess the utility of the iAngler smartphone “app” data, one

such sampling program in Florida, by characterizing the dataset and comparing specific metrics to those of NOAA's Marine Recreational Information Program (MRIP). These metrics were spatial distribution of trips by county, frequency of catch for the ten most commonly reported species, and species-specific catch rates. We conducted "catch frequency", catch rate, and length frequency of discard comparisons for different spatial designations in Florida, and catch rate comparisons for different fishing modes. Data from iAngler exhibits a strong spatial bias toward southeast Florida and a bias toward three common inshore species: Common Snook (*Centropomus undecimalis*), Spotted Seatrout (*Cynoscion nebulosus*), and Red Drum (*Sciaenops ocellatus*). However, iAngler catch rates for these three species were similar to MRIP. Because most trips reported to iAngler came from a relatively small number of anglers, we used a simulation to develop a proper weighting for angler avidity. Using a geometric mean that accounted for zero-catch fishing trips and angler avidity, we recalculated catch rates for Common Snook, Spotted Seatrout, and Red Drum and found avidity to have a variable yet noticeable impact on catch rates. This study shows the potential for electronic, self-reporting programs to provide reliable recreational fisheries data, if spatial and demographic coverage is sufficient and avidity is accounted for.

*SSI. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **FUNCTIONAL LINKS TO NUTRIENTS AND DISSOLVED ORGANIC MATTER QUALITY OF RIVER MICROBIAL COMMUNITIES VIA INTEGRATED METAGENOMICS**

*Christian Akotoye, Christina Fasching, Mina Bizic, Jeremy Fonvielle, Danny Ionescu, Sabateeshan Mathavarajah, Luca Zoccarato, David Walsh, Hans-Peter Grossart, and Marguerite A. Xenopoulos*

*Trent University, Peterborough, ON*

Biogeochemical processes within rivers are influenced by the microbial community composition. In this study, through the incorporation of metagenomics, functional links between dissolved organic matter (DOM) characteristics and microbial river communities were examined. Water samples were collected from 13 rivers across Southern Ontario, Canada, flowing through watersheds, varying in land use, and thus encompassing a gradient of DOM quality, nutrients, and microbial activity. Microorganisms were isolated from each site and 16sRNA samples were sequenced via Illumina Whole Shotgun Sequencing techniques. Genetic data was submitted to JGI-IMG and MG-RAST databases for functional annotation, thus, providing information on the associated proteins, the pathways they influence as well as taxa present within a given sample. Analysis was further conducted using a series of ecosystem and community-based multivariate and network analyses (e.g., Parallel Factor Analysis, Principal Coordinates Analysis, non-metric Multidimensional Scaling, and gene module analysis) to examine correlations among the DOM quality, composition of functional genes, and associated metabolic pathways of the microbial

communities. We found positive correlations between microbially-derived and protein-like DOM with gene functions associated with metabolic pathways involved in the processing of lipid, protein and carbohydrates as well as in photosynthesis. Together, our results provide further insight into the mechanisms involved in the nutrient and carbon biogeochemical cycles and the roles microbes in these processes.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Poster*

### **ALBERTA CONSERVATION ASSOCIATION: A CASE STUDY OF AN ALTERNATIVE MODEL FOR FISHERIES CONSERVATION AND MANAGEMENT ACTIVITIES**

*Peter Aku\* and Todd N. Zimmerling*

*Alberta Conservation Association, Sherwood Park, Alberta, Canada.*

As a Delegated Administrative Organization under the Alberta Wildlife Act, Alberta Conservation Association (ACA) is in a unique position to function both as an arms-length research organization of provincial government, and a not-for-profit conservation organization. Led by a Governance Board consisting of members of major conservation groups within the province and a single government representative, ACA receives direction from both public stakeholder groups and the provincial government. The governance structure, funding model and mandate of ACA makes it relatively unique in Canada and as such provides an interesting case study on the pros and cons of undertaking fisheries conservation and management activities in close relationship with, but separate from, government biologists and policy makers. In this presentation, we review the history and process from which ACA was formed, the policies under which ACA operates and the procedures used to determine ACA's fisheries activities. As part of this case study we examine the funding model where ACA receives approximately \$14.5 million per year from provincial fishing and hunting license sales, and approximately \$4.0 million per year in private donations and grants. In addition, we look at the benefits and challenges of being considered both a government agency and an independent conservation organization and discuss how these impact our activities as they relate to recreational fish stocking, lake aeration, fisheries restoration and promotion of recreational fisheries.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*



## **INCREASED SIZE AND RELATIVE ABUNDANCE OF MIGRATORY FISHES OBSERVED NEAR THE ATHABASCA OIL SANDS**

*Tim Arciszewski\* and Kelly Munkittrick*

*Alberta Energy Regulator, Calgary, AB*

Among organisms residing near the Athabasca oil sands, responses to chemical and physical stressors are commonly expected. During field studies, physiological effects have been observed in fishes, but further changes associated with development are neither clear nor consistent among species. For instance, fewer individuals of several species, including Arctic grayling (*Thymallus arcticus*) were collected by fish fences operated between 1976 and 2006. In 2009 the low catch rates persisted for most species, but a record number of white sucker (*Catostomus commersoni*) were observed. This divergence suggests incomplete understanding of fishes residing near the oil sands. However, an important challenge limiting understanding is the lack of reliable baseline or reference data. To overcome this challenge, we used iterative normal ranges and a historical dataset (electrofishing surveys done from 1987-2014) to determine if further changes have occurred in fishes residing in the lower Athabasca River. Analyses of this large dataset revealed clear increases in length of adult white sucker and walleye (*Sander vitreus*) and relative abundance during the spawning season. The occurrence of change may be associated with overwintering location of species, but reduced fishing pressure in Lake Athabasca, eutrophication, or a cumulative effect may explain the form of changes detected in this study.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **HOW DOES DISSOLVED ORGANIC MATTER QUALITY COMPARE ACROSS SUB-ARCTIC AND HIGH ARCTIC ENVIRONMENTS?**

*Aukes, P. J. K.\* (1), Schiff, S. L. (1), and M. E. English (2)*

*1 - University of Waterloo, Waterloo, ON*

*2 - Wilfrid Laurier University, Waterloo, ON*

Large stores of carbon are found within permafrost in Canada's North. As temperatures begin to warm and permafrost degrades, there is potential for this carbon to be released into surrounding surface waters as dissolved organic matter (DOM). Comprised of thousands of different molecules. DOM can influence aquatic health and drinking water quality, such as mobilize trace metals, regulate pH and thermal regimes within lakes, and act as an energy source for biogeochemical reactions. However, DOM reactivity is dependent upon the mixture of molecules that comprise it. Many northern communities rely on surface waters for drinking water provisions and fish. However, little is known over how DOM quality varies across aquatic environments in the North, and what processes dictate DOM fate. Our objective is to determine how DOM quality and quantity vary across different arctic and sub-arctic environments. We

used a ‘space for time’ approach, coupled with photolytic and microbial laboratory degradation experiments, to compare how DOM quality changes along a latitudinal gradient. DOM composition was assessed using size-exclusion chromatography, UV-visible absorbance, and DOC:DON ratios. Overall, subsurface samples contained the highest DOM concentrations of all sampled environments, yet measures of DOM quality from similar hydrologic environments transcended spatial scales. These results suggest DOM quality may be more similar than concentration in Northern waters, and provides an indication to parameters that may be sensitive indicators of DOM change.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

### **THE EURASIAN TENCH (TINCA TINCA): A GLOBALLY INVASIVE FISH POISED TO INVADE THE GREAT LAKES**

*Avlijas, Suncica\*1, Mandrak, Nicholas E.2 and Ricciardi, Anthony.1*

*1 - McGill University, Montreal;*

*2 - University of Toronto Scarborough, Toronto*

A globally invasive fish, Eurasian Tench (*Tinca tinca*), is spreading through the St. Lawrence River and poses an imminent invasion threat to the Great Lakes. Following its illegal release into a tributary of the St Lawrence River in 1991, the species has spread throughout the river’s main stem over the past decade and its abundance in commercial fishing bycatch in the river has grown exponentially. The Tench is a generalist benthic consumer with largely undocumented ecological impacts in North America. Reports from other invaded regions indicate that it can compete with other benthic fishes, host a diverse assemblage of parasites and pathogens, degrade water clarity in shallow lakes, limit submerged macrophyte growth, reduce gastropod populations, and promote benthic algal growth through top-down effects. Risk assessments and climate-match models indicate that the Great Lakes are vulnerable to Tench invasion, and they signal the need for timely comprehensive actions such as monitoring and rapid-response protocols, including prevention or slowing of its natural dispersal through canals.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **10 YEARS LATER: LESSONS LEARNED FROM EARLY ATTEMPTS TO REPORT AND COLLECT DATA USING CELL PHONES**

*M. Scott Baker, Jr.*

*North Carolina Sea Grant Extension Program, University of North Carolina Wilmington, Center for Marine Science, 5600 Marvin Moss Lane, Wilmington, NC, 28409, United States*

Successful survey programs involving angler submitted data have been able to provide fisheries managers with additional indices for comparisons to existing scientific surveys, as well as increase angler participation in the data collection process. In 2007, a friend and I developed a simple but fully customizable reporting method by which users could submit basic code for effort and catch to an online database via text messages from a cell phone. Called “RecText” – or the Reporting of Effort and Catch by Text message – the approach was successfully piloted with six local charter captains over a four month period with few issues. Results from the study (Baker and Oeschger 2009) led the way to a more comprehensive pilot study with saltwater tournament anglers at six king mackerel tournaments in 2009-2010 in an attempt to characterize tournament specific Catch-Per-Unit-Effort. Close to a decade later, cell phone (and digital) technology has changed greatly, as have the habits and expectations of both cell phone users and fisheries managers. At present, there are some situations where phone data are being utilized by marine fisheries managers. I expect that trend to increase, as long as the expectations of both data contributors and data users can be met. This plenary presentation will provide a brief overview of two early pilot studies, examine some important trends in cell phone use behavior from the last 10 years and highlight important lessons learned along the way, regardless of the technology used.

*SSI. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **SALTWATER ANGLER EDUCATION NEEDS AND INFORMATION DELIVERY PREFERENCES: INSIGHTS FROM A STATEWIDE, STRATIFIED-RANDOM MAIL SURVEY**

*M. Scott Baker, Jr.1\* and Sara E. Mirabilio2*

*1 - North Carolina Sea Grant Extension Program, University of North Carolina Wilmington, Center for Marine Science, 5600 Marvin Moss Lane, Wilmington, NC, 28409, United States*

*2 - North Carolina Sea Grant Extension Program, University of North Carolina Coastal Studies Institute, P.O. Box 699, Manteo, NC, 27954, United States.*

Stakeholder engagement in general, and many would argue fisheries management in particular, can be improved if the needs and wants of the target audience are understood. In 2016, the N.C. Division of Marine Fisheries issued more than 780,000 licenses to saltwater anglers residing in North Carolina. That’s roughly 1 out of 13 people in the state. That same year, anglers fishing in

North Carolina undertook 5.4 M trips, a number only surpassed by Florida East Coast anglers (8.8 M trips). In 2017, we conducted a statewide, stratified-random mail survey of the North Carolina resident license frame to better understand angler education needs and information delivery preferences. Using a modified version of the Tailored Design Method, we requested feedback from 1,000 anglers on the topics of boating and angling practices, conservation and habitat enhancement, and fisheries science and management. In addition, we asked when, where and how anglers would like to receive educational information about fisheries. To better understand angler motivation to complete such surveys, half of survey recipients received an upfront incentive. Results from the survey are being used by the North Carolina Sea Grant Extension Program to tailor a broad education and outreach campaign designed to address the educational interests of anglers. We anticipate that the results will be applicable to others and be of broad interest to a range of educators, resource managers and interest groups.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **SOIL AND WATER MANAGEMENT FOR NUTRIENT CONTROL IN THE NORTHERN GREAT PLAINS**

*Helen M. Baulch, Jane A. Elliott, Wilson, H.F., M. R. C. Cordeiro, D. N. Flaten, D. Lobb  
University of Saskatchewan, Saskatoon, SK*

The northern Great Plains is a key region to global food production. It is also a region of water stress that includes poor water quality associated with high nutrients. While eutrophication is often considered the primary stressor affecting water quality globally, there are local issues affecting eutrophication risk, and the success of efforts to control eutrophication. Here we review soil and water management beneficial management practices (BMPs) through a regional lens – first understanding key aspects of hydrology and hydrochemistry affecting BMP efficacy, then discussing merits of different BMPs for nutrient control. We recommend continued efforts to support ‘keeping water on the land’ via wetlands, and reservoirs. Adoption of reduced tillage practices and expansion of perennial forage may have contributed to current nutrient problems, but both practices have other benefits; hence, research is required to identify management changes to minimize nutrient export. Likewise, the expansion of tile and surface drainage raises questions about the magnitude of impact on nutrient export, and options to mitigate drainage impacts. Riparian vegetation is unlikely to significantly aid in nutrient retention, but when viewed against an alternative of extending cultivation and fertilization to the waters’ edge, continued support of buffer strip management and refinement of best practices, such as harvesting vegetation for nutrient removal are merited. Implementation of BMPs requires consideration of a complex suite of factors. Here, the low gradient, importance of snowmelt, and high proportion of dissolved nutrients are crucial considerations in identifying BMPs that are most effective in nutrient control.

*SS13. Aquatic nutrients: dynamics and algal blooms*  
*Poster*

## **EFFECT OF AQUACULTURE OPERATIONS ON WATER QUALITY IN LAKE DIEFENBAKER**

*Beadle, J.B.\*1 and J.J. Hudson11.*

*The Department of Biology, University of Saskatchewan, Saskatoon, SK.*

Lake Diefenbaker (LD) is a large reservoir located in Saskatchewan. The reservoir provides source water for the cities of Regina and Moose Jaw, hydroelectricity, water for industry and livestock, flood control and recreation. LD is also home to one of Canada's largest aquaculture operations. Residents have complained of increased algal blooms indicative of decreased water quality. Some residents have attributed the perceived decrease in water quality to increased nutrient loading from aquaculture operations on LD. The farm is estimated to contribute 18.9-23.2 metric tonnes (MT) of P and 97.3-120.4 MT of N annually to the reservoir. This study will compare the effects of nutrient loading from the fish farm relative to nutrient loading from the South Saskatchewan River. The study will analyze 4 years of previously collected data during a time when the reservoir experienced high flow events (2011-2014). If conditions permit for low flow during 2018 additional sampling will take place. Sampling design will include main channel reference sites and control embayments to compare nutrient levels to the aquaculture farm sites. We anticipate nutrient loads from the fish farm will be more significant during low flow periods and may lead to water quality issues.

*SS11. Aquaculture and its impact on aquatic environments*

*Poster*

## **WESTSLOPE CUTTHROAT TROUT WINTER HABITAT DISTRIBUTION AT A WATERSHED SCALE IN SMALL MOUNTAIN STREAMS OF SOUTHERN ALBERTA**

*Benson JW\*, Luek A, and JB Rasmussen*

*University of Lethbridge, Lethbridge, AB*

Westslope Cutthroat Trout (WCT) *Onchorhynchus clarkii lewisi* are a threatened species in Alberta, where most remaining WCT populations are restricted to small headwater streams along the Rocky Mountains' eastern slopes. Winter is a critical time, where anthropogenic effects such as land-use, resource extraction, and climate change may have amplified effects on the survival of WCT populations. We used comprehensive habitat surveys and non-invasive population estimate techniques, such as snorkeling and underwater cameras to identify key features of WCT overwintering habitat quality, quantity and its use by WCT. Our research focused on pools as the primary winter habitat for adult WCT, which is of increased importance for winter survival in small, high gradient mountainous streams. A spatial model was developed to predict WCT movement and overall winter habitat use within the watershed based on habitat characteristics. Habitat fragmentation and reduced winter refuge availability was due to naturally occurring barriers and habitat features such as deleterious ice conditions and low flow conditions, restricting movement of adult WCT populations. The model identified key overwintering

locations for threatened WCT within the study watersheds, which will lead to better informed decisions on the management of critical WCT habitat considering different land use practices and climate change.

*SS5. Native trout and salmon recovery*

*Oral*

## **ARCTIC GRAYLING (THYMALLUS ARCTICUS) PHYSIOLOGICAL DATA AND IMPLICATIONS OF HIGH-SALINE SPILLS ON NATIVE FRESHWATER SALMONIDS**

*Blair, S.D.\* 1, He, Y., Matheson, D. 2, and Goss, G.G.1*

*1 - University of Alberta, Department of Biological Sciences*

*2 - Athabasca University*

Unintentional releases of hypersaline water into freshwater environments act as an osmoregulatory stressor to many aquatic organisms including native salmonids like the Arctic grayling (*Thymallus arcticus*). With planned industrial expansion into northern areas of Canada and the USA that directly overlap grayling habitat, the threat of accidental saline water release poses a significant risk. Despite this, we understand little about the responses of grayling to hypersaline waters. A comparison was made between Arctic grayling and the rainbow trout (*Oncorhynchus mykiss*) (an environmental regulatory species) to tolerate an acute exposure to higher saline (17 ppt) waters for 96 hours. Our results demonstrated a substantially reduced salinity tolerance in grayling. Additionally, upon salinity exposure a novel salinity-induced morphological gill remodeling was demonstrated solely in Arctic grayling characterized by the rapid growth of an interlamellar cell mass (ILCM). Subsequently, we investigated whether Arctic grayling could recover in freshwater (FW) following a short-term (<48 h) salinity exposure. The 24 h post-exposure FW recovery period resulted in Arctic grayling serum ion concentrations and total osmolality returning to near normal levels. Electron microscopy data indicate the presence of mucous cells and granule containing eosinophil like cells infiltrating the ILCM suggesting a salinity-induced immune response by the Arctic grayling. Given these new data, collaboration between fisheries and the oil and gas industry will be vital in the long-term conservation strategies regarding Arctic grayling in their native habitat.

*SS5. Native trout and salmon recovery*

*Oral*

## **ACUTE EXPOSURE OF LARVAL RAINBOW TROUT (ONCORHYNCHUS MYKISS) TO ELEVATED TEMPERATURES INFLUENCES FUTURE THERMOTOLERANCE**

*Blair, S.D. 1\* and Glover, C.N. 2*

*1 - University of Alberta, Department of Biological Sciences*

*2 - Athabasca University*

Warming of the aquatic environment is a significant threat to stenothermal, poikilothermic cold water fish such as rainbow trout (*Oncorhynchus mykiss*). Temperature increases may be associated with global climate change or due to local factors such as anthropogenic thermal pollution, destruction of riparian buffer zones, and reduced water flows. Rainbow trout, and other similar species, are particularly susceptible to warming during early development, but little is known regarding the long-term consequences of thermal exposure during early development. In this study, we investigated the impacts of early-life stage high temperature exposure on the future thermotolerance of rainbow trout fry, by quantifying their critical thermal maxima (CT<sub>max</sub>) and the expression of the relevant heat shock protein isoforms, hsp70a and hsp70b. Two months after rainbow trout fry were exposed to 22°C for 96 hours during development, a significantly lower CT<sub>max</sub>, paralleled by a reduced expression of hsp70b were discerned. We suggest the lowered CT<sub>max</sub> may be linked to the reduced ability to effectively upregulate the hsp70b gene during the thermotolerance trials. This indicates that exposure to thermal stress in early life-stages of rainbow trout has negative effects on future physiological function. This finding has important implications for commercial production, and for fish in natural environments subjected to thermal pollution.

*SS5. Native trout and salmon recovery*

*Poster*

## **SEASONAL MIGRATION AND FINE-SCALE MOVEMENT OF INVASIVE ROUND GOBY IN GREAT LAKES TRIBUTARIES**

*Blair, S.G.\*1, May, C.1, Morrison, B.2 and M.G. Fox3.*

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Establishment of invasive species is often followed by range expansion based on behaviourally dependent movement strategies. We assessed population and individual movement of invasive round goby (*Neogobius melanostomus*) in a Lake Ontario tributary stream using a mark-recapture assessment generated from weekly backpack electrofishing from May until November, 2016. Round goby abundance was low in spring, peaked in summer, and decreased again in the

fall, suggesting seasonal inward and outward migration from the lake. Adult round goby movement patterns were closely linked to changes in water temperature. Observations of reproductive individuals and a lagging peak in juvenile abundance following a peak in adult abundance indicates that the tributary was used for reproduction and recruitment. Individuals with faster growth had greater net movement within the stream, especially for females compared to males. There was no difference in net movement patterns between mature and immature gobies. Downstream movement occurred primarily in the fall over a relatively short period of time, suggesting out-migration to the lake. The combined observations of seasonal population structure and individual movement suggest that tributary streams connected to large waterbodies can be used for round goby reproduction, and that rapidly growing females move the furthest upstream. This study provides the first evidence of round goby migration and their individual movement patterns within tributary streams, which must be considered when managing the potential displacement of native species.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **ASSESSMENT OF AN ADULT LAKE STURGEON TRANSLOCATION (*ACIPENSER FULVESCENS*) REINTRODUCTION EFFORT IN A FRAGMENTED RIVER SYSTEM**

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North American freshwater fishes are declining rapidly due to habitat fragmentation, degradation, and loss. In some cases, translocations can be used to reverse local extirpations by releasing species in suitable habitats that are no longer naturally accessible. Lake sturgeon (*Acipenser fulvescens*) experienced historical overharvest across their distribution, leading to endangered species listings and subsequent protection and recovery efforts. Despite harvest and habitat protections, many populations do not appear to be recovering, which has been attributed to habitat alteration and fragmentation by dams. In 2002, 51 adult lake sturgeon from the Mattagami River, Ontario, Canada were translocated 340 km upstream to a fragmented 35-km stretch of the river between two hydroelectric generating stations, where sturgeon were considered extirpated. This study assessed the translocation effort using telemetry and movement data, demographics, genetics. A portion of the translocated individuals dispersed out of the release area, and individuals radio-tagged after release used different areas than individuals



radio-tagged ten years later. Catches of juvenile lake sturgeon have increased over time, with 150 juveniles caught within the duration of this study. The reintroduced population had similar genetic diversity as the source population, with a marked reduction in effective population size ( $N_e$ ). The results indicate that the reintroduction effort was successful, with evidence of successful spawning and the presence of juvenile lake sturgeon within the reintroduction site. Overall, the results suggest adult translocations may be a useful tool for re-establishing other extirpated lake sturgeon populations.

*GS15. General contributed papers*

*Oral*

### **CONNECTIVITY, PERSISTENCE, AND LOSS OF HIGH ABUNDANCE JUVENILE ATLANTIC HALIBUT AREAS IN THE NORTHWEST ATLANTIC OCEAN**

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The Northwest Atlantic Ocean underwent a fisheries-driven ecosystem shift in the early 1990's. Today, Atlantic cod (*Gadus morhua*) remains at low levels while Atlantic halibut (*Hippoglossus hippoglossus*) has been increasing since the mid-2000's. The lack of recovery in other collapsed groundfish populations has highlighted the danger of overfishing local concentrations. We applied a Bayesian hierarchical spatio-temporal approach to model the spatial structure of juvenile Atlantic halibut over 36 years and three fisheries management regimes using three model parameters to characterize the resulting spatio-temporal abundance structure: persistence, connectivity, and spatial variance. Two areas of high juvenile abundance persisted through three decades whereas two in the northeast are now diminished, despite the increased abundance and landings throughout the management units. The persistent areas overlap with full and seasonal area closures, which may act as refuges from fishing. Connectivity was estimated to be 250 km, an order of magnitude less than the distance assumed by the definition of the Canadian management units (~2000 km).

*GS15. General contributed papers*

*Oral*

## **THE DYNAMICS OF NITROGEN-FIXING CYANOBACTERIA IN PRAIRIE LAKE**

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Nutrient-rich lakes are highly susceptible to cyanobacterial blooms. When biological fixation of nitrogen (N) is important to phytoplankton nutrition, diazotrophic processes can reduce the efficiency of management actions, leading to questions regarding the importance of nitrogen control as a mechanism for reducing the effects of eutrophication. This issue may be particularly important when cyanobacteria are the predominant component of phytoplankton communities. Here we studied rates of nitrogen fixation within four lakes of the Qu'Appelle River catchment, southern Saskatchewan. In all lakes, summer biomass was composed largely of cyanobacteria, with the proportion of heterocystous taxa varying from 38.6 – 99.9% of phytoplankton samples. Biomass of N<sub>2</sub>-fixing cyanobacteria (predominantly *Anabaena* sp. and *Aphanizomenon* sp.) ranged from ~0.8 – 6.2 mg L<sup>-1</sup> at 0.3 m depth to 4.5 – 148.9 mg L<sup>-1</sup> in the uppermost 0.1 m, with extreme values (up to 8,400 mg L<sup>-1</sup>) in shoreline surface scum formations at Buffalo Pound Lake. The density of nitrogen fixers exceeded 3.1 x 10<sup>7</sup> filaments L<sup>-1</sup> in surface water (0.1 m depth) and 1.9 x 10<sup>9</sup> filaments L<sup>-1</sup> in nearshore scums. Heterocyst frequencies were generally high, occurring at 0.28 – 1.00 heterocysts per filament in *Aphanizomenon* sp. (*A. flos-aquae* and *A. klebahnii*) and 0.0 – 2.33 heterocysts per filament in *Anabaena* sp. (*Ana. flos-aquae*, *Ana. crassa* and *Ana. solitaria*), with extremely high heterocyst counts (up to 3.99 x 10<sup>9</sup> L<sup>-1</sup>) in onshore samples. These data suggest atmospheric N<sub>2</sub> may be a strong local nutrient source in nearshore environments, where biomass tends to accumulate.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Oral*

## **THERMAL EXTREMES DRIVE RANGE-WIDE AND FINE-SCALE GENOMIC DIFFERENTIATION IN ATLANTIC SALMON (*SALMO SALAR*)**

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Clinal variation in population structure across replicated environmental gradients can reveal evidence of adaptive divergence, providing insight into the evolutionary processes shaping

intraspecific diversity. Here we explore the role that temperature variation plays in structuring Atlantic salmon (*Salmo salar*) populations both across the North Atlantic, and at finer scales in Labrador Canada. Range-wide, we used 1773 genome-wide single nucleotide polymorphisms for 134 populations of North American and European Atlantic salmon. Clinal latitudinal trends in allele frequency were observed in 5-11% of loci, with several shared between continents. Clinal SNPs were associated with temperature, particularly average spring temperature. At fine geographic scales in coastal Labrador, amplicon based sequencing of microsatellites and SNPs for 35 locations revealed regional revealed distinct differentiation between populations spawning inside a large marine embayment (Lake Melville) compared to coastal populations. Both multivariate and random forest-based approaches identified warm temperatures as the dominant structuring force. At both large and small scales, temperature associated loci were wide spread across the genome and associated with a diverse array of physiological functions and pathways. Our results support the widespread influence of thermal regimes on population structure of salmon at large and small spatial scales. The identification of climate associated genomic clines illuminates the role of climate on intraspecific diversity in this species and provides a context in which to evaluate the impacts of future climatic change.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **FISH ON! IMPLEMENTING ALBERTA'S NORTHERN PIKE RECREATIONAL MANAGEMENT FRAMEWORK**

*Brown, M\*, Sullivan, M.G.*

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Northern pike are one of Alberta's most sought after sportfish. Prior to 1999, high angling pressure coupled with liberal bag limits, limited or ineffective size restrictions, high harvest mortality from commercial fishing, and habitat loss resulted in declines in northern pike populations across the province. In 1999, Alberta's Northern Pike Management and Recovery Plan was implemented to recover populations and fisheries to a sustainable level. The broad application of a sustainable harvest regulation was an insufficient conservation measure to promote recovery to a stable, sustainability state. After 18 years of operation, many northern pike populations remain at high risk to very high risk for sustainability. The high angling catchability measured in Alberta coupled with high angling effort, low number of fish bearing waterbodies, and short growing seasons may have overwhelmed harvest regulations from allowing for recovery in most cases. The recreational management framework outlines a revised process. Using standardized assessments and cumulative effects models the sustainability and structure of pike populations are reported as a score in the Fish Sustainability Index (FSI). The FSI score for adult density and overharvest risk are aligned with options for desired fisheries defined in the framework as recreational fisheries management objectives (RFMOs). The framework provides a process and management actions that reinforce the need for population resiliency and outlines

the trade-offs associated with achieving and maintaining these objectives. Linking RFMO's to quantitative metrics and FSI thresholds provides guidance for setting effective recreational regulations to provide recovery, preservation and harvest opportunities for northern pike.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **LILLOOET RIVER SALMON STOCK ASSESSMENT**

*Bruce, Maxine J.*

*Fisheries Manager, Lil'wat Nation, Mount Currie BC*

Entsas Ihpattm. Hello, my name is Maxine Joseph Bruce, I grew up in Mount Currie, B.C., located in interior British Columbia, and I am a member of the Lilwat Nation. My parents are the late Joe and Rosie Joseph, both from the Lil'wat Nation. My parents were very active in serving the community, involved in the governance and ensuring that our traditions and culture are passed on to the next generations. Similar to my parents, I wear a number of hats, and I feel that they have taught me a lot. I left my community and lived and worked in the community of Alert Bay on the west coast of British Columbia for about 20 years. While living on the west coast I achieved skills in my role in Fisheries Management from the involvement the management of marine and freshwater resources as well as brokering commercial fishing licenses and quotas. I am currently employed as Fisheries Manager with the Lil'wat Nation with the responsibility to oversee a large-scale salmon stock assessment programs in the Lillooet River system as well as environmental monitoring efforts. The added responsibilities I hold are to support technical working groups, provide public education and awareness around the freshwater resources within the Lil'wat Nation traditional territory. One of my favorite past times is singing and dancing our Nation's songs, our culture is a reflection of the surrounding land and resources.

*SS14. Indigenous resource management*

*Oral*

## **TRENDS IN ALBERTA'S WALLEYE FISHERY DURING 2000-2016**

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Monitoring to detect temporal trends in fish populations is a key step in fisheries management. Trend determination is important because it enables the evaluation of management actions, such as whether a population has recovered to a specific level within a given timeframe, and because knowledge of a system's previous dynamics can be used to inform structured decision-making programs. Unfortunately, time-series data from monitoring surveys are typically noisy and short

in length (i.e., < 20 years), and thus determining trends using standard statistical methods is challenging. Alberta's Walleye Sander vitreus populations were monitored using a standardized Fall Walleye Index Netting (FWIN) sampling protocol from 2000 to 2016. Lakes were sampled sporadically with respect to year, and hence lake-specific time-series have both missing and unequally spaced data. We attempt to overcome some of these issues using hierarchical models, and discuss general patterns in the Alberta FWIN data.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **USING WATERSHED CONNECTIVITY AND ABIOTIC VARIABLES TO DESCRIBE RAINBOW TROUT COLONIZATION, GROWTH AND RECRUITMENT ACROSS A LANDSCAPE**

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Predicting fish population patterns from landscape data provides a tool that can be used by managers to prioritize their monitoring effort. The distribution of wide-spread fish populations is determined by both habitat, and historical connectivity. Using GIS tools, we use watershed connectivity data to assess the possibility of colonization of lakes by rainbow trout in British Columbia from known populations to systems for which species assemblage is unknown. Environmental variables are then used as proxies for the availability of early life stage habitat, a key factor regulating growth and recruitment. By incorporating connectivity and environmental proxies of habitat we can explore patterns in population dynamics that can be used by fisheries managers to identify populations sensitive to overfishing or disturbance.

*GS15. General contributed papers*

*Oral*

## **CHARACTERIZING MICROBIAL COMMUNITIES IN A RAPIDLY CHANGING HIGH ARCTIC WATERSHED**

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Arctic watersheds are being altered by climate change, with current climate models predicting increases in temperature and precipitation in the high Arctic of up to 8.3oC and 40%, respectively, by 2100. These changes will have profound impacts on the Arctic hydrological

cycle, including enhanced glacial melt and permafrost thaw. Current research has identified corresponding changes to the physicochemical parameters of downstream freshwater systems, including changes in fluxes of bioavailable nutrients, pollutants, and turbidity. Alterations to downstream freshwater systems are hypothesized to alter resident aquatic microbial communities, with far reaching and unknown consequences for many Arctic freshwater biogeochemical cycles and ecosystem services. To address these concerns, we investigated microbial communities and associated physicochemical parameters from sample sites within the Lake Hazen watershed on Northern Ellesmere Island (81N; 71W), used here as a sentinel system for environmental change. We sampled from numerous glacially fed water bodies, as well as water bodies fed by permafrost thaw, over a spring and summer season. Collected water samples were analysed for a suite of physicochemical parameters (e.g., temperature, greenhouse gas content, pH) in parallel with high-throughput 16S rRNA gene data targeting bacteria and archaea. Ordination analysis revealed that samples grouped according to site, with the Lake Hazen microbial community sharing highest overall similarity with major glacial-source rivers. Operational taxonomic units associated with *Polaromonas*, *Rhodospirillum rubrum*, and *Flavobacterium* genera dominated most waterbodies of this watershed, similar to the findings of other high Arctic freshwater studies. These rivers changed seasonally in response to chemical parameters, such as turbidity and temperature. These data help establish a baseline understanding of the microbial communities from Arctic watersheds so that future research can monitor how the quality of Arctic freshwater ecosystems and the services they provide may be changing temporally.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **THE RISE AND FALL OF NUTRIENTS IN ICE COVERED PONDS**

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Small ponds throughout Canada experience ice-cover. These ponds are hot-spots for biogeochemical cycling, yet we know little about winter and ice-out nutrient dynamics. The shallow and highly productive nature of prairie potholes, combined with isolation from the atmosphere (preventing gas exchange), and a cessation of surface flows, allows for oxygen depletion in winter. Anoxia is associated with many biogeochemical and ecological changes including changes in nitrogen cycling, phosphorus cycling, and greenhouse gas production. This period of winter change is followed by a key period of hydrologic connectivity, as wetlands are frequently subject to ‘fill and spill’ dynamics during spring melt when snow and ice fill wetlands. Here, we explore the importance of winter and spring changes in solute chemistry to understand controls on nutrient chemistry, and transport in potholes. We observed high concentrations of dissolved ammonium and phosphorus in winter followed by a rapid decline during melt for these nutrients. In parallel with these changes, we measured low sestonic nitrogen uptake in winter and higher uptake during melt, followed by a decline in uptake after

complete ice melt. Given biogeochemical changes co-occur with key hydrologic periods, snowmelt and ice-out are complex and interesting ‘hot moments’ of change within prairie potholes.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Poster*

**TOWARDS A SUSTAINABLE FISHERY FOR NUNAVUMMIUT: ENSURING SUSTAINABLE FISHERIES DEVELOPMENT USING A TRANSDISCIPLINARY, COMMUNITY DRIVEN RESEARCH MODEL**

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Subsistence fisheries provide access to affordable, safe, and culturally relevant food in Inuit communities, creating potential conflict with commercial development of Northern fisheries. To profile current fisheries suitable for commercial harvest, we must first characterize local Inuit harvesting practices, and socioeconomic drivers and barriers associated with harvesting and fisheries development in Gjoa Haven, Nunavut. To achieve this goal, the community and Carleton University have collaborated to create an innovative research model that combines biological, social, economic, and spatial analyses using a multi-dimensional research approach. The community is thoroughly integrated into all aspects of project design and field execution of the research, ensuring results directly address research questions timely and relevant to the community, and community members benefit from training and capacity building. Here we discuss the research model, preliminary results, and successes and challenges associated with this community based, community driven research model.

*SS14. Indigenous resource management*

*Oral*

## **POST-RELEASE CONDITION, PATHOGEN LOADING, AND SURVIVAL OF WILD ATLANTIC SALMON**

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*1 - Carleton University*

Understanding how fisheries interactions – including exhaustive exercise, air exposure, and handling – impact post-release condition and survival is necessary to inform mortality estimates and understand what factors influence these outcomes. Such stressors may negatively affect fish resilience to pathogen infections, particularly when fish are faced with variable environmental conditions. Here, experimental fisheries treatments were used to examine whether transcription of functional gene groups are influenced by fisheries stress in Atlantic salmon *Salmo salar*, and how such changes may be associated with pathogen infection dynamics and variable environmental temperatures. RNA extracted from gill biopsies were used to screen for pathogen presence and loads, and Atlantic salmon immune, osmoregulatory, and stress response gene expression. By combining in-situ fisheries simulations and gene expression technologies, we explore the relationship between fisheries related stressors, salmon condition, microbial pathogen productivity, and post-release survival.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **TROPHIC VARIATION WITHIN A PISCIVOROUS LAKE TROUT MORPH FROM GREAT BEAR LAKE, CANADA: THE INITIAL STEP TOWARD ECOLOGICAL SPECIALIZATION?**

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Ecological opportunities that drive divergent selection on traits to enhance the efficient use of resources are hypothesized to be an initial step toward intraspecific divergence. Thus, in a



polymorphic species, differences in resource specialization should occur among morphs, whereas homogeneity in resource use is expected within a morph. We investigated whether specialization of trophic resources occurs among individuals within a piscivorous morph of Lake Trout, one of the four previously described morphs from Great Bear Lake, Canada. We identified three distinct dietary patterns of resource use within piscivorous Lake Trout using fatty acid composition. In general, feeding habits of different groups within the piscivorous morph were not associated with detectable morphological or genetic differentiation, suggesting that behavioral plasticity within individuals may have caused patterns of trophic variation within this morph. A low level of genetic differentiation based on variation at microsatellite loci was evident between exceptionally large-sized individuals (“Giant group”) and other piscivorous individuals. Size-assortative mating could explain this low level differentiation. Investigating a geologically young system that displays high levels of intraspecific diversity and focusing on variation within one morph allowed us to further understanding of mechanisms that could drive intraspecific divergence within a species during a short evolutionary time.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **OVERVIEW OF ALBERTA’S WESTSLOPE CUTTHROAT TROUT RECOVERY PROGRAM**

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- 3., Alberta Environment and Parks, Blairmore, AB*
- 4. Alberta Environment and Parks, Edmonton, AB*

Historically abundant throughout its range in the South Saskatchewan River basin, Alberta’s Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) is listed as threatened under the provincial Wildlife Act and the federal Species at Risk Act. A combination of anthropogenic threats over the past century including overharvest, degradation of habitat and hybridization with other *Oncorhynchus* spp. following intensive fish stocking have resulted in low population densities of native cutthroat throughout their current range, and extirpation of populations in their historical range. Changes in climatic conditions pose a further challenge to Westslope Cutthroat Trout’s persistence or expansion into the future. Alberta Environment and Parks is challenged with social, political and legal mandates to recover Westslope Cutthroat Trout populations, while ensuring that recovery actions are tailored to address the myriad of threats that differ among watersheds. Cumulative effects models are used to elucidate the highest threats to recovery and provide informed targeted management actions focused on restoration of degraded habitat, angling regulations to curb overharvest (currently only catch and release angling mortality), and

prevention/reversal of further hybridization. Restoration stocking is one possible management action to restore native populations, however, detailed genetic assessments to understand genetic purity and population structure are a necessary step to inform how and where restoration stocking is appropriate. The collaborate efforts of local stakeholders, NGOs, industry, provincial and federal governments and international experts is crucial to ensure successful recovery of Westslope Cutthroat Trout in Alberta.

*SS5. Native trout and salmon recovery*

*Oral*

## **NORMOXIA EXPOSURE REDUCES HYPOXIA TOLERANCE IN SWAMP ADAPTED FISH**

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Aquatic hypoxia (low oxygen) occurs naturally in many aquatic habitats characterized by low light and mixing, but it is becoming more prevalent with increasing anthropogenic inputs to aquatic systems. For fishes, hypoxia is known to limit key aerobically driven activities, however, far less is known about its effects on sensory acquisition. Weakly electric fish provide an excellent model for exploring effects of hypoxia on sensory systems because they emit/detect electric organ discharges (EODs) that one can quantify. In this study, I measured the hypoxia tolerance and EOD response to progressive hypoxia in the weakly electric mormyrid, *Petrocephalus degeni*, from a hypoxic swamp in Uganda. Hypoxia tolerance was indexed as the critical oxygen tension ( $P_{crit}$ ), measured as the oxygen partial pressure ( $PO_2$ ) below which the fish cannot regulate its metabolic rate. The critical EOD tension ( $EOD_{crit}$ ) was estimated as the  $PO_2$  below which EOD rate declined. We compared these metrics between two groups of *P. degeni* to ask whether their critical tensions depend on their acclimation to hypoxia vs. normoxia. The first group was tested within 1-4 days of capture from a hypoxic swamp (hypoxic acclimation), while the second group was tested 50-75 days after capture (normoxic acclimation). Preliminary results suggest that the  $P_{crit}$  and  $EOD_{crit}$  increased with acclimation to normoxia indicating a lower tolerance to hypoxia. Overall, this study suggests that these fish can maintain active sensing under low oxygen levels, but that critical thresholds are flexible, which may reflect the costs of tolerance.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **IMPROVEMENTS TO FISH HABITAT SUITABILITY ASSESSMENTS RELATIVE TO WEIGHTED USEABLE AREA APPROACHES**

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Suitability indices (SIs) are used to rate the “suitability” of a given habitat variable (e.g., depth, velocity, substrate) that fish may encounter and preferentially select during a particular life stage or activity. Habitat suitability models based on the combination of multiple SIs represent a relatively cost-efficient and reliable method for assessing fish habitat quantity and quality across multiple flow conditions. Existing hydraulic models commonly used for assessing fish habitat suitability have limited geospatial capabilities. An improved tool for assessing fish habitat in riverine environments was developed using GIS software. Hydrodynamic model outputs and site-specific data can be used to generate geo-referenced depth, velocity, and substrate distributions. A GIS-based model is then used to programmatically apply SIs to the river area associated with each data point and calculate habitat suitability index (HSI) values. Habitat areas can be mapped based on their HSIs that delineate and quantify areas of suitable habitat. Model outputs can be validated with geo-referenced field observations and assessment results can be used to predict project-induced flow or footprint effects to fish habitat and inform habitat restoration efforts. The proportion, connectivity and spatial distribution of higher quality versus lower quality habitats can be quantified, which is an improvement to the normal index of weighted useable area (WUA) that often fails to identify changes to the highest quality habitats. A case study from the Fond du Lac River, Saskatchewan, is used to demonstrate the utility of this improved habitat assessment tool with a comparison of results to traditional WUA methods.

*SS2. Improving the science and management of instream flows: moving beyond traditional approaches*

*Oral*

## **SPATIAL AND TEMPORAL SCALES OF CONNECTIVITY IN ATLANTIC COD RECRUITMENT SIGNALS IN NEWFOUNDLAND**

*Cooke, E.L.L.\*1, R.S. Gregory<sup>2,3</sup>, D. Cote<sup>2,3</sup> and P.V.R. Snelgrove<sup>1</sup>.*

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*3 - Department of Biology, Memorial University of Newfoundland, St. John's, NL*

The collapse of the Newfoundland Atlantic cod (*Gadus morhua*) fishery in 1992 has motivated studies on the factors influencing population stability and the ability to forecast future cod abundance. This study investigates the potential for using coastal seine surveys of juveniles to predict offshore adult Atlantic cod recruitment at multiple spatial scales (individual bays to the offshore), and the factors influencing recruitment signal strength. Access to several multi-year

(22+) datasets on juvenile and adult cod population components, coastal nursery habitat (i.e. eelgrass), and water temperature makes this objective feasible for the first time in Newfoundland. Both eelgrass habitat availability and water temperature during early life stages mediate recruitment to commercial size. Eelgrass - designated an ecologically significant species (ESS) in Canada - provides refuge and prey, ultimately promoting juvenile growth and survival. Furthermore, thermal conditions that promote high growth likely result in reduced predation and increased overwinter survival during their first year, a critical and vulnerable period for young juveniles. Studies evaluating year-class strength often overlook the value of coastal juvenile surveys. However, the potential to forecast adult abundance from juvenile populations could aid in planning for socio-economic costs of low recruitment years, and enable inference on the response of future populations to climate change and habitat degradation.

*GS15. General contributed papers*

*Oral*

## **EVALUATING HYBRIDIZATION OF ALBERTA'S THREATENED WESTSLOPE CUTTHROAT TROUT**

*Coombs, Matthew.*

*Alberta Environment and Parks, Blairmore, AB*

Low levels of hybridization reduce fitness, with cutthroat trout perhaps the most threatened example. Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) occur on less than 5% of their historic range in Alberta due to intensive and extensive stocking of non-native trout throughout the last century. Efforts to recover Westslope Cutthroat Trout depend on the presence of pure strains, yet it remains uncertain whether any native, non-hybridized populations still occur within Alberta. Starting with allozymes in the 1980s and then microsatellites in the 2000s, Alberta has sought to assess the genetic purity of its Westslope Cutthroat Trout stocks. Allozyme results were more conclusive, because diagnostic markers were used, but were limited in scope focusing on high mountain lake populations. Microsatellite results were inconsistent and inconclusive, because a small number of non-diagnostic markers were used. Currently, based on microsatellite results from 212 sites selected where Westslope Cutthroat Trout were known to occur, 46 distinct locations have been identified where pure Westslope Cutthroat Trout populations or individuals may occur. Only 18 of these (39%) are above impassable waterfalls, suggesting some pure populations may be persisting due to other factors, despite ongoing upstream hybridization pressure. Reassessment with single nucleotide polymorphisms at 6 locations shown to contain pure Westslope Cutthroat Trout with microsatellites revealed fish from 4 of these locations actually represent hybrid swarms. Alberta is now using single nucleotide polymorphisms to reassess all locations where pure populations are suspected to occur. These data will guide conservation and recovery priorities for the species.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **VULNERABILITY TO MULTIPLE ENVIRONMENTAL STRESS OF SMALL BODY SIZE OVIGEROUS LOBSTER**

*Couillard, C.M.\**

*Maurice Lamontagne Institute, Fisheries and Oceans Canada, Mont-Joli, QC*

Body size-at-maturity of American lobster *Homarus americanus* reduces with both warming and decreasing latitude and this biometric change could affect their vulnerability to multiple other stressors. Reproductively active females are a vulnerable and key component of these stocks. This study compares the capacity of mature females from the southern and the northern Gulf of St. Lawrence, Canada to withstand environmental stress. Molt increments and responses to a short-term emersion challenge (90 min) among post-ovigerous females from two southern (Caraquet and Toney River) and two northern (Anticosti and Gaspé) sites in controlled laboratory conditions. The females from Caraquet had the smallest carapace length (CL) followed by those from Toney River and those from northern sites. Relative molt increments (% CL) were greater in smaller females, suggesting greater allocation of energy for growth. Emersion induced accumulation of haemolymph lactate, indicative of metabolic acidosis. Lactate increased with decreasing body size and with increasing haemolymph proteins, and thus, was higher in small-size, non-molted lobsters. Small-size ovigerous females are more sensitive to emersion and likely to other environmental stressors particularly those affecting the energy budget (i.e., handling, temperature, food limitations). Consequently southern Gulf stocks with higher proportions of smaller females, are more vulnerable.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **POLYCHAETES CAUSE SHELL DAMAGE IN WHELKS FROM THE ÎLES-DE-LA-MADELEINE, QUEBEC, CANADA**

*Couillard, C.M.\*, Brulotte, S., Maltais, D., Belley, R.*

*Fisheries and Oceans Canada, Mont-Joli, QC*

In 2015, a fisherman reported that commercial-sized (≈ 70 mm) common whelk, *Buccinum undatum*, had fragile shells, breaking during lifting of the traps, on the southeastern shore of the Îles-de-la-Madeleine (IM), Quebec, Canada. This study was initiated to find the cause and the extent of this problem. In August 2016, whelks were collected at four sites on the southeastern and southwestern shores of IM, using a Digby scallop dredge with four baskets lined with netting. A total number of 762 whelks, ranging from 14 to 112 mm, shell height, were examined. Shell lesions included burrows, ulcers, cracks, scars and missing parts. The percentage of the shell surface affected was rated. The prevalence and severity of shell damage increased with whelk size and were similar between sexes and among sites. More than 60 % of the commercial-sized whelks were affected. Boring polychaetes were extracted from damaged shells and identified as the main cause of shell damage. Several species were identified with predominance

of *Polydora websteri*, a widespread species associated with deleterious impacts on cultured bivalves. Further studies are needed to assess the impact of this infestation on somatic condition, reproduction and mortality of *B. undatum* and to better understand the interactions between this infestation and environmental factors or anthropogenic activities.

*SS7. Aquatic health: invasive species and disease*

*Poster*

### **THE LINK BETWEEN SWIMMING ABILITY AND ECOLOGICALLY RELEVANT BEHAVIOUR IN RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)**

*Dehaan, K.\* and K. Tierney*

*University of Alberta, Department of Biological Sciences, Edmonton, AB*

Swimming performance in fish is a key aspect of their fitness and relates to activities such as predator avoidance, prey-capture, migration, spawning, maintaining position in currents, and establishment of dominance hierarchies. Ucrit is used as a measure of a fish's maximum swimming speed and is largely fueled by aerobic metabolism, while Uburst is a measure of maximum sprinting speed which is mostly anaerobically fueled. Ucrit has been assumed to be a valid indicator of ecological performance, and we hypothesized that a change in Ucrit would result in changes to an individual's behavioural performance. To test this, we performed before and after Ucrit and Uburst tests that were followed by behavioural assays. Injections of either carbamazepine, caffeine, chlorpyrifos, pentachlorophenol, or tributyltin were used to reduce or increase Ucrit. Preliminary results suggest that neither Ucrit nor Uburst correlate with predator avoidance or prey capture behaviours. From this study, it appears that even when swim performance is significantly affected by environmental toxins, the ability of rainbow trout to avoid predators and attempt to capture prey are not significantly impacted.

*GS15. General contributed papers*

*Oral*

### **WESTSLOPE CUTTHROAT TROUT (*ONCORHYNCHUS CLARKI LEWISI*) IN ALBERTA: A STUDY OF DIET COMPOSITION AND ONTOGENIC SHIFT**

*Dehaan, K.\*, Mariola Janowicz and Xin Chen*

*Concordia University of Edmonton, Edmonton, AB*

The Westslope cutthroat trout is currently listed as threatened in Alberta, due in large part to the introduction of rainbow trout. The two species are closely related, which has caused problems of introgressive hybridization. Both the hybrids and rainbow trout are competitively superior to the Westslope cutthroat trout in warmer waters. Despite this threat, the diet of native Westslope cutthroat is not known. By analyzing the stomach contents of fish from six streams in southern

Alberta, we set out to determine the diet and any potential ontogenetic shift in diets of the Westslope cutthroat trout. Diets were analyzed by identifying invertebrate prey items to the lowest taxonomical group, followed by calculating relative importance of prey groups. Ivlev's Index of Selectivity was calculated to examine prey preference, and Schoener's Overlap Index was used to examine the potential ontogenetic shift. Prey-specific abundance was graphed against frequency of occurrence to provide a graphical representation of niche width and feeding strategy. Our results suggest that Westslope cutthroat trout are generalist predators, with a high overlap in diet across age and size classes. However, variation in diets between streams was also common, leading to some populations specializing in certain invertebrates. Due to the similarities in feeding strategy and prey types between Westslope cutthroat and rainbow trout, this reinforces the observed competition when these species are cohabitate.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Poster*

## **CONSERVATION STOCKING DILEMMA OF LONG-LIVED AQUATIC SPECIES**

*Deslauriers, David<sup>1</sup>\*, Nelson, Patrick A.<sup>2</sup>, McDougall, Craig A.<sup>2</sup>, Jeffries, Kenneth M.<sup>3</sup>, Anderson, W. Gary<sup>3</sup>*

*1 - Fisheries and Oceans Canada, Arctic and Aquatic Research Division, Winnipeg, MB*

*2 - North/South Consultants Inc., Winnipeg, MB*

*3 - Department of Biological Sciences, University of Manitoba, Winnipeg, MB*

Models that look to link fish population dynamics with energetics demands offer an attractive avenue for evaluating future outcomes of conservation stocking programs. Such an effort is particularly interesting for long-lived species because slow growth and late sexual maturation tend to bias short-term observations. The model proposed here uses an Individual-Based Modeling approach that allows for the simulation of populations dynamics through discrete individual organisms, thus allowing for stochasticity to occur. In this model, each individual is subjected to a series of biological and physiological rules, which when combined together, provide an informative picture of population structure, energy requirements, genetic diversity, and biomass production. In addition to this, the model allows for the evaluation of different stocking scenarios on population structure over time. In this presentation, data derived from a long-term Lake Sturgeon stocking program in the Nelson River (Manitoba, Canada) are used to demonstrate the applicability of the model. Current stocking strategies were used to assess the long-term survival of this population. We also identified significant processes that define long-term population effects and provide recommendations to management agencies looking to enhance their stocks under conservation framework.

*GS15. General contributed papers*

*Oral*

## **ELECTRONIC SELF REPORTING IN THE SOUTH ATLANTIC US: PRELIMINARY RESULTS, LESSONS LEARNED, AND FUTURE DIRECTION.**

*Fitzgerald, B.\* 1 Kelsey Dick\* 2, Chip Collier 2*

*1 - The Snook and Gamefish Foundation, Inc, 1505 West Terrace Drive, Lake Worth, FL, US.*

*2 - South Atlantic Fishery Management Council*

The recreational South Atlantic red snapper (*Lutjanus campechanus*) fishery has become a highly contentious fishery in the United States. The few short seasons since 2010 have resulted in a combination of regulatory discards and reduced data streams. Meanwhile the stock was assessed to be experiencing overfishing in 2014 and fishery closures continued. The closures, due to the recreational discard estimates exceeding the recommended catch levels, caused the fishing public and other stakeholders to become increasingly dissatisfied with estimates of recreational red snapper landings and discards. For the 2017 red snapper mini-season, the South Atlantic Fishery Management Council (SAFMC) piloted a red snapper recreational reporting project funded by the National Marine Fisheries Service (NMFS) in partnership with the Snook and Gamefish Foundation (SGF), the creators of the successful program iAngler along with Florida's Wildlife Research Institute. In coordination with SAFMC, SGF along with their programming partners Elemental Methods, developed a web-based reporting system MyFishCount (<http://www.myfishcount.com/>]www.MyFishCount.com) to allow anglers to report information about their 2017 red snapper trips and catch. Anglers were asked to report information including target species, length of time spent fishing, general fishing location, number and size of red snapper kept and released, release method, and more. Thanks to extensive outreach by several fishing clubs, state agencies, NMFS, and other partners, over 300 trips were reported during the six-day season. Preliminary analyses of catch information, angler behaviors, environmental factors, along with lessons learned, provide a novel insight into the fishery to aid in improving recreational management.

*SSI. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **SPATIAL PATTERNS OF MERCURY CONCENTRATIONS IN AQUATIC ECOSYSTEMS OF SOUTHERN ALBERTA**

*Donadt, Caitlyn\* and Mark Poesch*

*University of Alberta, Department of Renewable Resources, Edmonton, AB*

Mercury is a widespread heavy metal contaminant in freshwater ecosystems which can become incorporated into the tissues of living organisms through bioaccumulation. The Red Deer River system is a popular angler destination located in Southern Alberta. Some mercury concentrations



in fish tissue and water samples recently taken in this watershed surpass Alberta guidelines. In this study we assess spatial patterns of mercury contamination in fish, water and sediments in the Red Deer River Watershed. Fish tissue was collected from sport and forage fish from the river mainstem and several tributaries, then analyzed for total mercury. Water samples were also taken from the same sites and analyzed for total mercury, dissolved mercury and methyl mercury concentrations. Results show that many piscivorous fishes exceed Alberta consumption guidelines (0.5 ppm). Additionally, several water samples surpassed Alberta water quality guidelines for chronic total mercury levels in water (>0.005ppm) and methyl mercury (>0.001 ppm). Areas of particular concern are located in the badlands region of the Red Deer River. Results of this study will serve to inform human consumption guidelines and increase our understanding of heavy metal spatial patterns in this river system.

*GS15. General contributed papers*

*Poster*

### **EVALUATING RESEARCH PROGRESS FOR FRESHWATER SPECIES AT RISK IN THE GREAT LAKES-ST. LAWRENCE RIVER BASIN, 2004 - 2016**

*Drake, D.A.R. \*1, K.E. Thiessen 1, T.J. Morris 1, M.A. Koops 1, T.C. Pratt 2, S.M. Reid 3, and N.E. Mandrak 4*

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*4 - Department of Biological Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A3*

The Great Lakes-St. Lawrence River basin encompasses <4% of Canada's drainage area, yet contains 52% of Canada's SARA-listed freshwater mussels - 10 species listed as EN, THR, or SC, and 36% of Canada's SARA-listed freshwater fishes - 24 species as EN, THR, or SC. Given the conservation significance of the GLSLRB, we conducted a review of research progress for imperiled freshwater mussels and fishes to understand core research accomplishments – and outstanding gaps – in the 15 years since the implementation of SARA. Research progress was evaluated based on a four-group classification scheme (population ecology, habitat science, threat science, and recovery science) and a five-point scoring system (1 = research not initiated through 5 = research complete). Results indicated that progress for freshwater mussels and fishes has been greatest for population ecology and habitat science (mean scores, 2.85 and 2.50 out of 5), with certain groups experiencing strong success (population ecology: genetic structure, species abundance, and species distribution research, 3.18, 3.14, and 3.0 respectively; habitat science: distribution and abundance of host species, 3.8). Threat science was less well studied (2.23), while recovery science (1.89) had prominent gaps related to captive breeding and

experimental translocations. Implications of the review include a renewed interest in threat- and recovery-based science for imperiled aquatic taxa in Canada, including the development of dose-response thresholds for key stressors and research to support reintroductions. Results highlight the need for new experimental approaches to address key conservation challenges, such as experimental populations to evaluate threats that are difficult to observe in the wild.

*GS15. General contributed papers*

*Poster*

### **SURVIVING THE URBAN JUNGLE: BIOTIC FACTORS DRIVE LOCAL DISPERSAL OF AN ENDANGERED STREAM FISH**

*Drake, D.A.R.1, and M.S. Poesch 2*

*1 - Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, L7S 1A1*

*2 – University of Alberta, Department of Renewable Resources, 751 General Services Building, Edmonton, Alberta T6G 2H1*

Species dispersal increases fitness by maximizing positive stimuli and minimizing negative stimuli across heterogeneous landscapes, yet the relative role of abiotic and biotic drivers is poorly understood for many small-bodied fishes. To explore these effects, we conducted a 12-month tagging study of the endangered Redside Dace in two urbanized watersheds in southern Ontario. Visual implant elastomer tags were used to develop an index of spatial interaction between origin and destination pools across four seasonal periods. Reach-level habitat variables (e.g., overhead cover, pool depth variability, substrate type, bankside vegetation) and the abundance of co-occurring stream fishes were considered as possible explanatory factors. Boosted regression trees indicated that dispersal distance and the population abundance of small-bodied species (Leslie: Longnose Dace, Creek Chub, White Sucker, Berczy: Creek Chub, Common Shiner) explained greater than 70% of the variation in spatial interaction, indicating that biotic factors are important drivers of Redside Dace dispersal at relatively fine scales. The association between dispersal and co-occurring species may be correlative, in that Redside Dace and other species are responding to attributes of pool quality not apparent with conventional habitat assessments, or causative, in that Redside Dace are seeking refuge through schooling effects. Resolving support for the correlative vs causative hypothesis has implications for maximizing species dispersal (and by association, population viability) during species recovery planning.

*GS15. General contributed papers*

*Oral*

## **THE DOWNSTREAM EFFECT OF A WASTEWATER TREATMENT PLANT UPGRADE ON IN-STREAM DENITRIFICATION**

*Dylla, N.,\* Helen Baulch, Colin Whitfield*

*University of Saskatchewan, Saskatoon, SK*

Nutrient-rich effluents can drive biological processes in rivers and create major, well-characterized impacts on ecosystem health. However, ecosystems can also assimilate excess nutrients. Nitrate can be consumed and permanently removed by denitrifying bacteria through the process of denitrification, helping to reduce the environmental impact of sewage effluents. The Regina, Canada Wastewater Treatment Plant (WWTP) recently underwent an upgrade to reduce the concentrations of nitrogen discharged into Wascana Creek, a highly impacted system where flow can be up to 90% effluent. We assessed whether changing nitrogen loads impacted denitrification rates, testing the hypothesis that lower nitrogen concentrations could lead to lower denitrification rates, potentially limiting the downstream benefits of the upgrade. A before-after-control-impact (BACI) design was used to quantify denitrification rates upstream and downstream of the effluent, before, during, and after the upgrade. Results showed that downstream (impact) sites exhibited nitrate saturation throughout the study, while denitrification was consistently nitrate-limited at the upstream (control) site. Denitrification rates at the site immediately downstream of the WWTP were approximately 100 times greater than that of the upstream site. Clearly, effluent-impacted reaches of Wascana Creek showed a high capacity for nitrate removal via denitrification. However, our work shows that nitrate-saturation persists in Wascana Creek post-upgrade. This suggests that rates of nitrate removal via denitrification may not change substantively in the creek with the decreased nitrogen loads. However, evidence that denitrification rates remain nitrate-saturated post-upgrade remains a negative indicator of ecosystem health.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **WHOLE SYSTEM NUTRIENT REGENERATION IN LAKE DIEFENBAKER, SK**

*Emmons, S.E.\* Hudson, J.J.*

*Department of Biology, University of Saskatchewan, 112 Science Place, Saskatoon, SK*

The rate at which nutrients are released from organisms, via egestion, excretion, cell lysis, and so forth, is termed nutrient regeneration. This regenerative pathway is recognized as a significant nutrient re-supply in marine systems. The handful of planktonic phosphorus regeneration rates reported in the literature for the surface waters of lakes has also been found to be substantial. Whole system rates of planktonic regeneration in lakes (epilimnetic, metalimnetic, and hypolimnetic combined) are extremely rare. This is a significant shortcoming in our understanding of the phosphorus cycle, despite the importance of phosphorus biogeochemical pathways to water quality management. With advanced radiophosphate techniques, we will

provide some of the first whole system phosphorus regeneration rates in a large prairie reservoir (Lake Diefenbaker,  $Z_{max} = 59$  m;  $A_o = 394$  km<sup>2</sup>). We will then compare this rate to riverine input from the South Saskatchewan River. We anticipate the planktonic nutrient regeneration rates will represent a major pathway in Lake Diefenbaker (LD) despite the large loads of nutrients entering the reservoir from the South Saskatchewan River.

*GS15. General contributed papers*

*Poster*

## **PRACTICAL GIS APPLICATIONS FOR FISHERIES AND AQUATIC SCIENCES**

*Farineau A<sup>1\*</sup>, Wilson, K. I, Cantin A<sup>1</sup>, Mogensen S<sup>1</sup>, Cahill C<sup>1</sup>, Sinnatamby N<sup>1</sup>, Mee J<sup>1</sup>, Post JR<sup>1</sup>*

*1. University of Calgary, Department of Biological Sciences, Calgary, AB, Canada*

Research in fisheries and aquatic sciences can benefit from the addition and analysis of geospatial data. I present case studies of how spatial analysis can be used in a fisheries context. To showcase some benefits of adding explicit spatial data to fisheries research, I provide a brief introduction into how GIS and remote sensing can be applied to fisheries and aquatic ecology, using several practical examples. These examples include: assessing Rainbow Trout Fish Passage; Acquisition of Lake Temperature using Satellite Imagery; and Calculating Fastest Driving Times and Distances between B.C. Urban Centres and Lake Trout Lakes.

*GS15. General contributed papers*

*Oral*

## **IMPACT OF CLIMATE-INDUCED WATER LEVEL DECLINES ON WATER QUALITY IN CLOSED BASIN LAKES OF THE NORTHERN GREAT PLAINS**

*Bjorndahl J., P.R. Leavitt, K. Finlay\**

*Department of Biology, University of Regina, Regina, SK*

Climate induced water level change is known to affect lake salinity and nutrient concentrations, but the impact of water level on algal community composition and abundance is not well understood. Kenosee and White Bear Lakes are popular recreational lakes in Saskatchewan that have experienced water level fluctuations of over 8 m between 1920 and 2016. Low water levels are anecdotally correlated with declining water quality, but the relationships between water level and algal abundance and community assemblage are not well established. Paleolimnological analysis revealed an increase in phytoplankton abundance ca. 1950 in both lakes, but there was little evidence of cyanobacteria increasing relative to other phytoplankton groups. Moreover, we did not observe a linear relationship between algal abundance and community composition with water level. This was likely due to a major shift in the stratification and preservation environment of the lakes in the form of the development of a photic anoxic zone which

confounded the interpretation of results. The similarity in response of the phototrophic community and water level between the lakes suggests that climate is the primary forcing mechanism for change, with secondary effects due to differences in drainage basin size and land use practices.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **OPTIMAL PLACEMENT OF WATERCRAFT INSPECTION STATIONS**

*Fischer, S.M.\*1, Beck, M.2, Herborg, L.M.3, and Lewis, M.A.1*

*1 - Department of Mathematical and Statistical Sciences, University of Alberta, Edmonton, AB.*

*2 - BC Ministry of Environment and Climate Change Strategy, Conservation Science Section, Victoria, BC*

*3 - Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, BC*

A major spread mechanism for zebra mussels (*Dreissena polymorpha*) and many other freshwater aquatic invasive species (AIS) is the traffic of recreational boaters transporting propagules from invaded to uninvaded lakes. Therefore, cleaning, draining, and drying boats before carrying them from one waterbody to another lowers the risk of new invasions. To ensure that boaters conduct these invasion prevention measures properly, some provinces set up inspection stations on roads. There, passing watercraft are checked for AIS and washed, if necessary. Based on a hierarchical spread model, we develop a method to determine the strategically best places for these inspection stations so as to minimize the risk of new aquatic invasions. We illustrate our approach by applying it to the fight against introduction of zebra mussels to BC.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **ELECTRONIC SELF-REPORTING IN THE SOUTH ATLANTIC US: PRELIMINARY RESULTS, LESSONS LEARNED, AND FUTURE DIRECTIONS**

*Brett Fitzgerald\*, Kelsey Dick\*, Chip Collier,*

*The Snook and Gamefish Foundation, Inc, 1505 West Terrace Drive, Lake Worth, FL, US.*

The recreational South Atlantic red snapper (*Lutjanus campechanus*) fishery has become a highly contentious fishery in the United States. The few short seasons since 2010 have resulted in a combination of regulatory discards and reduced data streams. Meanwhile the stock was assessed to be experiencing overfishing in 2014 and fishery closures continued. The closures, due to the recreational discard estimates exceeding the recommended catch levels, caused the fishing public and other stakeholders to become increasingly dissatisfied with estimates of recreational red snapper landings and discards. For the 2017 red snapper mini-season, the South Atlantic Fishery

Management Council (SAFMC) piloted a red snapper recreational reporting project funded by the National Marine Fisheries Service (NMFS) in partnership with the Snook and Gamefish Foundation (SGF), the creators of the successful program iAngler along with Florida's Wildlife Research Institute. In coordination with SAFMC, SGF along with their programming partners Elemental Methods, developed a web-based reporting system MyFishCount ([www.MyFishCount.com](http://www.MyFishCount.com)) to allow anglers to report information about their 2017 red snapper trips and catch. Anglers were asked to report information including target species, length of time spent fishing, general fishing location, number and size of red snapper kept and released, release method, and more. Thanks to extensive outreach by several fishing clubs, state agencies, NMFS, and other partners, over 300 trips were reported during the six-day season. Preliminary analyses of catch information, angler behaviors, environmental factors, along with lessons learned, provide a novel insight into the fishery to aid in improving recreational management.

*SS1. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **THE LAW ON RECOVERING ALBERTA'S WESTSLOPE CUTTHROAT TROUT TO SECURE STATUS**

*Shaun Fluker\**

*University of Calgary Faculty of Law, University of Calgary, AB*

The recovery strategy for Threatened Alberta Westslope Cutthroat Trout lacks an action plan specifying how recovery will be accomplished. Here I describe and evaluate the legal requirements for such a plan as set out by the federal Species at Risk Act (Canada) (SARA) and provincial law in Alberta. My evaluation of these laws is informed by my experience litigating for the protection and recovery of this species as well as empirical research conducted by others on the application of SARA more generally. My description illustrates how federal and provincial governments share legal jurisdiction over the recovery of threatened species in Canada, and my evaluation will illustrate why effective law on the recovery of threatened species is largely a matter of provincial concern. In this regard, Alberta's legal framework is woefully inadequate and good science is not put into action while a species declines towards extirpation. The federal legal framework under SARA is only a marginal improvement, but also has limited application in the province. The crux of the matter is that recovery of threatened species entails real limits on economic development, and thus we need effective law to facilitate the recovery of a threatened species. This law must employ mechanisms to separate politics from the science. Details of how this can be done are described. Oral - Native Trout and Salmon Recovery 215 words.

*SS5. Native trout and salmon recovery*

*Oral*

## **USING UNDERWATER VIDEO TO INVESTIGATE THE USE OF POTTING GEAR IN THE GREENLAND HALIBUT (*REINHARDTIUS HIPPOGLOSSOIDES*) FISHERY**

*Folkins, M.F.\* and Grant, S.M.*

*Fisheries and Marine Institute of Memorial University of Newfoundland, 56 Freshwater Road, St. John's, NL*

Northern communities of Nunavut rely on marine resources such as fish and marine mammals for survival and economic prosperity. The most valuable groundfish fishery in eastern Nunavut is the Greenland halibut (*Reinhardtus hippoglossoides*). In Atlantic Canada, the fixed gear fishery for Greenland halibut is dominated by gillnets and to a lesser extent longlines. Longlines and gillnets produce high catch rates of Greenland halibut but are subject to high bycatch of fish, seabirds, and marine mammals. Further, capture of lower quality half eaten or rotting fish results in lower profits to industry. My work investigates a new method of fishing Greenland halibut using potting technologies. Pots can reduce the capture of non-target species and maximize revenues to industry as pot caught fish are alive when hauled to the surface. A large part of the success of experimental fishing gear technologies relies on knowing how target and non-target species react to new fishing gear so potential obstacles to acceptance on the part of industry can be addressed. My research uses video analysis and catch data of 6 pot treatments varying in pot mesh type and entrance mesh type, in an attempt to improve capture efficiency in the Greenland halibut fixed gear fishery. This research will help fill a significant research gap in the use of underwater video to address resource management of groundfish fisheries in deep-water marine environments. It will also help improve the sustainability and feasibility of a valuable fishery to Northern communities that face tremendous economic pressures and food security issues.

*SS14. Indigenous resource management*

*Oral*

## **UNDERWATER VIDEO TO CONDUCT RESOURCE ASSESSMENTS FOR NEW EMERGING FISHERIES IN KIMMIRUT, NUNAVUT**

*Folkins, M.F.\*; Walsh P.J., Grant S.M.*

*Fisheries and Marine Institute of Memorial University of Newfoundland, St. John's, NL*

Food security in small northern communities such as Kimmirut, Nunavut is in a constant fragile state. Very little is known of the benthic marine species that may be present and harvestable at a small scale or commercially near this community. Guidelines for establishing a new emerging fishery are in place to ensure an integrated approach involving science, business principles and effective involvement of government is achieved. We are partnered with the Government of Nunavut and working closely with community elders in order to achieve the primary feasibility stage of establishing a new fishery. In August 2017, we conducted preliminary fishery surveys in

areas around Kimmirut Nunavut using four types of sampling pots. I analyze catch data from these sampling pots and observe underwater video in order to determine species density and behavior on the seafloor. This is the first step to a multi-year study to determine if establishing a local or commercial fishery within these waters is possible. This research could eventually lead to a new fishery and aims to provide economic opportunities and increased food security within northern communities of Nunavut.

*SS14. Indigenous resource management*

*Poster*

### **OVERWINTER GROWTH AND CONDITION OF JUVENILE ATLANTIC COD (GADUS MORHUA) IN SUBARCTIC COASTAL NEWFOUNDLAND**

*Geissinger, E.A.\*, Gregory, R.S., Snelgrove P.V.R., and B.J. Laurel*

*Memorial University of Newfoundland, 64 Newtown Rd, St. John's, NL*

Atlantic cod (*Gadus morhua*) typically experience high mortality rates during their first year of life. In subarctic Newfoundland, cod settle into coastal habitats in several recruitment pulses throughout summer and fall, resulting in a broad length-frequency distribution prior to their first winter. The first winter likely represents a critical period in cod survival, ultimately determining cohort strength. To examine the effect of fish size and food availability on overwinter growth and condition of 0-year-olds, we collected demersal 0-year-old cod from Newman Sound, Newfoundland in November 2016 and brought them to the laboratory for 114-day feeding trials at ambient overwinter sea temperatures. For our experimental trials we reared two size classes of juvenile cod, from January 2017 to April 2017, under four daily ration levels (0.0%, 0.5%, 1.0%, and 2.0% of body mass). We then evaluated fish condition using Fulton's K condition factor and hepatosomatic index to infer the interactive role of food availability and fish size on juvenile cod survival during the overwinter period. Preliminary analyses suggest that large and small cod grow and increase condition on low rations, and that food availability increases survival and strongly influences overwinter growth and condition. Large cod will survive on low rations better than small cod, indicating that early settlement is better for overwinter survival. Our results have significant implications for the survival of juvenile cod in coastal nurseries in a changing climate. Bigger is better when food is not available, but small fish can grow and survive on some productivity.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

### **MODELING FISHING AS A DISRUPTOR OF THE MATCH BETWEEN FISH AND FISH HABITAT**

*Gillis, D.\**



*University of Manitoba, Department of Biological Sciences, Winnipeg, MB*

Fishing is known to impact natural populations in many ways beyond a simple reduction in numbers. The potential evolutionary responses to the selection pressures of harvests are well appreciated. However, ecological effects could have an immediate impact on growth and recruitment. Changes in age structure due to size selective harvest imply changes in the aggregate vital rates (mean fecundity, survival, and growth) at the population level. The spatial match between population density and the distribution of habitat quality may also be disrupted by fishing activities. This implies that growth or recruitment in fished populations will differ from unfished populations of the same size. However, this effect will be more difficult to predict due to fishery specific differences in the habitat landscape. Furthermore, the impact of fishing will vary with the ability of the fleet to respond to local changes in fish availability. I will present an individual based model of fishing activity that explores how changes in information exchange among vessels and fish habitat distributions influence the level of disruption that occurs between fish their resources. This is a source of variability that will not be captured by simple metrics such as spawning stock biomass but should be considered in the assessment of exploited fish populations.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **POPULATION DYNAMICS OF OVERHARVESTED BROOK TROUT**

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The removal of introduced brook trout in the Canadian Rockies provides a unique opportunity to explore population dynamics of salmonids. This natural experiment will measure changes in growth, reproduction, and survival of populations of brook trout in 9 isolated or semi-isolated lakes in Banff, Kootenay, and Yoho National Parks for at least 3 field seasons. Study lakes range in sizes (2-20 ha), elevation (1213-2423m), and trophic level. All lakes have a history of stocking, and negligible angler pressure. Population sizes are calculated using basic mark-recapture techniques (Schnabel Estimates) to determine rate of annual harvest, and size class targets are determined using mixed mesh gillnets. PIT tags are applied to measure individual growth rates. Subsamples of a representative size class are taken from each lake for laboratory analysis (i.e. age, GSI, stomach contents, DNA, RNA, morphometrics). Other students on this NSERC grant research community structure and genetic responses. At the completion of the project we hope to have made observations on genetic to ecosystem responses to fisheries induced evolution.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Poster*

## **DEVELOPMENT OF AQUATIC ENVIRONMENT MONITORING TRIGGERS FOR THE LOWER ATHABASCA RIVER**

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Oil sands companies currently do not release dewatered groundwater or process water to receiving environments, but there is a need and desire to do so in the future. However, there are concerns about the potential for effects of the discharge of process waters to the Athabasca River because the toxicity of oil sands process waters is largely unknown. Environmental Effects Monitoring (EEM) provides a mechanism to test predictions about the potential effects of effluent releases. EEM programs are currently in place for metal mining and pulp and paper sectors in Canada, and have proven effective at quantifying effects and identifying potential effluent-related causes of effects. Fish populations have been extensively monitored in the mainstem of the Athabasca River under the historical Regional Aquatics Monitoring Program (RAMP) and the Joint Oil Sands Monitoring Program (JOSMP). Those data can be used as a baseline to judge the potential effects of future process water releases from oil sands operations. The results herein originated from the compilation of fish population (Trout Perch) data that was collected under RAMP and JOSMP from 2009 through 2015. Normal ranges of various measures of fish population performance were modeled in relation to river discharge and air temperature. The resultant models were statistically significant and ecologically meaningful, and thus, provide predictions or forecasts of future conditions for monitoring the potential effects of point-source discharges to the Athabasca River.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **MEETING PHOSPHORUS REDUCTION GOALS BY APPLYING BEST MANAGEMENT PRACTICES IN THE GRAND RIVER WATERSHED IN SOUTHERN ONTARIO**

*\*Hanief, A., and Andrew Laursen*

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Changes in land use from forestland to agriculture over the past century in the surrounding watersheds of Lake Erie has led to altered hydrology and greater export of sediment and phosphorus resulting in widespread lake eutrophication. The Grand River Basin of Southern Ontario is mainly agricultural and is a major contributor of sediment and phosphorus into the eastern basin of L. Erie. Under the revised 2012 Canada-United States Great Lakes Water Quality Agreement, a target reduction of 40% P-loading rate was set for the surrounding

watersheds. The objective of this study was to investigate the impact of various Best Management Practices (BMPs) in reducing sediment and phosphorus loading rates on various spatial and temporal scales in the watershed using the Soil and Water Assessment Tool for the years 2001-2010. The baseline sediment and P loading from the Grand River into Lake Erie, were predicted to be 2□105 tonnes y-1 and 2□105 kg y-1, respectively. Different source, transport and water body treatment BMPs were simulated. With respect to reducing sediment and P loading into Lake Erie, implementing wide buffer strips resulted in a decrease of 23% and 50%, stabilizing channel banks in a decrease of 38% and 36%, while grassed waterways in a decrease of 15% and 17%, respectively. Although, some BMPs may be very effective in target reduction, factors such as cost or suitability may result in targets not being achieved.

*SSI3. Aquatic nutrients: dynamics and algal blooms / GS15. General contributed papers*

*Oral*

### **CONSTRUCTION OF SIDE-CHANNEL FISH HABITAT ON THE BOW RIVER AS OFFSET FOR SERIOUS HARM**

*AuCoin, L., Bigelow, J., Harper, P. \*, & Wood, M.*

*Stantec Consulting Ltd / University of Lethbridge, Lethbridge, AB*

Following the June 2013 flood, Fisheries Act authorizations were issued to the City of Calgary by Fisheries and Oceans Canada (DFO) with the provision that habitat loss during mitigation works would be compensated for at a later date. In 2016, as compensation, a 1-kilometer long side channel to the Bow River was planned by a multidisciplinary team of hydrotechnical engineers, geomorphologists, landscape architects, and fisheries biologists to maximize aquatic and riparian value of the site while following existing natural geomorphology. To augment habitat provided in shallow side-channels, habitat features are designed based on literature-supported preferred habitats and habitat suitability indices of resident sport and non-sport fish. The channel is also designed to provide varying levels of functional habitat during low flow and flood events on the Bow River. The channel was constructed in the spring and summer 2017. This presentation describes the regulatory process, design, and construction of a side channel that maximizes the habitat complexity of sport fish in the Bow River.

*GS15. General contributed papers*

*Oral*

## **USING NEXT GENERATION METHODS TO UNDERSTAND SEA LICE SPREAD BETWEEN SALMON FARMS**

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Sea lice are parasites that feed on the epidermal tissues of salmon, and present a concern for both wild and farmed salmon. They are small enough that they can easily be transmitted between open-net fish farms and migrating salmon, and they can spread rapidly between salmon farms. While salmon farms currently treat with emamectin benzoate to reduce sea lice on farms, there have been recent failures to control sea louse outbreaks, leading to increased pressure on wild and farmed salmon populations. Here we construct a stage structured model for the growth and spread of sea lice between a network of salmon farms. In the model, equations for the growth of copepodid, chalimus, pre-adult, adult, and gravid adult stages are constructed for sea lice on each salmon farm, and include the spread of nauplii between farms. The transition between each sea louse life stage and dispersal between farms are represented by distributed delays to add more realism to the model, but require more complex mathematical methods to analyse. Using next-generation operator methods, we determine the expected number of new sea lice produced on one farm from each of the other farms in the network. With this information, we can establish which salmon farms have the largest effect on sea louse growth on the entire network. This will inform more effective measures to control sea louse outbreaks, leading to decreased sea louse pressure on both farmed and wild salmon populations.

*SS11. Aquaculture and its impact on aquatic environments*

*Poster*

## **USING ENVIRONMENTAL DNA TO MONITOR WINTER AQUATIC BIODIVERSITY**

*Harrison, J.B.\*1 and Rogers, S.M.*

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The use of environmental DNA (eDNA) metabarcoding to describe aquatic biodiversity and species distribution is a rapidly developing technique. However, the capabilities and limitations of the application have not been well characterized over varying environments, such as seasonal temperatures, lending uncertainty in the interpretation of eDNA results. This study aims to develop an eDNA assay capable of distinguishing closely related salmonid species and to test predictions about the presence of eDNA in a replicated large-scale semi-naturalized system. Novel eDNA primers, capable of distinguishing between Brook trout (*Salvelinus fontinalis*), Rainbow Trout (*Oncorhynchus mykiss*), and Cutthroat Trout (*Oncorhynchus clarkii*) salmonid species were developed and a controlled winter experiment was conducted at the Advancing Canadian Wastewater Assets (ACWA)'s experimental research streams. This facility contains 12

naturalized streams 320 meters in length, with inflow from a common headwater pond. Fish species were caged at the start of each stream at varying relative densities and after 10 days of acclimatization, 2L water samples were collected from the start, middle, and end of each stream and filtered through 0.7µm filters to collect DNA. Sampling was repeated three times, and all filters were frozen at -80°C. DNA from the filters was sequenced with an Illumina NextSeq, and early results suggest eDNA from the fishes was recoverable from all points along streams. To our knowledge, this is the first eDNA experiment under a controlled, replicated design within a semi-natural system and should advance our understanding of this promising ecological application.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **NEW APPLICATIONS OF META-BARCODING TECHNOLOGY FOR FISH COMMUNITY ASSESSMENT**

*Heath, D. D. \*, Katherine Balasingham, Kyle Wellband, Timothy Johnson, Lucia Carreon-Martinez*

*GLIER, University of Windsor*

The extraction and characterization of DNA from aquatic environmental samples offers a non-invasive approach for the detection of target fish species. Environmental DNA, coupled with PCR and massively parallel (“next-generation”) sequencing (meta-barcoding), has proven to be very sensitive for the detection of rare aquatic species. However meta-barcoding has technical limitations that preclude detailed community analysis. Here we describe applications of meta-barcoding using eDNA for characterising not only fish community composition and diet, but also to quantify the number of target species and prey. We used a custom bioinformatics approach with meta-barcode data to map three species at risk; (Eastern Sand Darter, *Ammocrypta pellucida*; Northern Madtom, *Noturus stigmosus*; and Silver Shiner, *Notropis photogenis*), one invasive species (Round Goby, *Neogobius melanostomus*) and an additional 78 native species from two large Great Lakes tributary rivers in southern Ontario, Canada; the Grand River and the Sydenham River. We also used a microsatellite allele counting approach to quantify yellow perch prey numbers in the guts of predators in Lake Erie. We propose that the inclusion of alternative genetic loci for meta-barcoding offers real promise for an expansion of the utility of eDNA for fish conservation and management.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **A LENS ON EBULLITION: A NOVEL SENSOR FOR HIGH TEMPORAL RESOLUTION MEASUREMENT OF METHANE EMISSIONS IN SHALLOW LENTIC WATERS**

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Freshwater systems are important sites for biogeochemical transformation. Contributions of small water bodies to global greenhouse gas emissions may be larger than previously understood, with small systems potentially more important than their larger counterparts. A network of small headwater reservoirs implemented as a beneficial management practice in agriculturally-dominated southern Manitoba has demonstrated significant nutrient removal — improving downstream water quality. However, nutrient retention in these systems may stimulate production of the greenhouse gases carbon dioxide, methane and nitrous oxide. Likewise, rapid sedimentation here promotes anoxic conditions in benthic zones — a hotspot for the biological production of methane. This research demonstrates an innovative technique for measuring ebullitive fluxes at high resolution using a newly developed automated sensor. Ebullition can be an important pathway for methane release to the atmosphere, but as this typically remains unquantified, its role remains uncertain. In this contribution, we will describe the sensors and investigate the spatial and temporal variability of ebullition during a full open-water season at two small agricultural reservoirs. Understanding the rates and drivers of ebullition in such systems using high resolution data will provide a stronger understanding of how this process contributes to atmospheric methane fluxes and greenhouse gas budgets for these systems.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Oral*

## **THE COLLAPSE AND RECOVERY OF LAKE TROUT IN GREAT SLAVE LAKE, CANADA'S MOST NORTHERN FRESHWATER COMMERCIAL FISHERY**

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Great Slave Lake supports significant commercial, recreational and subsistence fisheries for Lake Trout. The main basin of Great Slave Lake has had an active commercial gillnet fishery since the 1940s and lake trout made up 40-60% of the historical catch prior to their decline in the 1960s. Although they currently make up less than 20% of the catch, they have gradually been increasing in relative importance and remain the next highest species in the fishery by biomass after Lake Whitefish. The East Arm of Great Slave Lake has remained closed to commercial fishing, but supports active recreational and subsistence fisheries. Comparisons of demographic data among these areas suggest that although lake trout in the main basin of Great

Slave Lake are beginning to make up a larger proportion of the commercial harvest, populations are still recovering. Preliminary estimates of biomass and sustainable yield based on data limited population modelling methods (Catch-Maximum Sustainable Yield and Depletion Corrected Average Catch) indicate that although biomass is trending upward at a lake-wide scale, area-specific overharvesting may be occurring. Results from initial testing of alternative gear types such as modified gill nets, show promise for allowing harvesters the option of reducing Lake Trout and other by-catch species while enabling capture of high quality Lake Whitefish, the target species in the fishery.

*SS5. Native trout and salmon recovery*

*Oral*

### **A COMPARISON OF TECHNIQUES FOR THE MEASUREMENT OF NO<sub>3</sub> ALONG A LAKE GRADIENT OF SALINITY, COLOR AND NUTRIENTS**

*\*Hudson J1, Hunter K1, Sutey P2 Evans D2 Anderson J2 Davies J3*

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Inland waters in many regions are increasing in salinity and DOC concentration. These changes may pose new problems for the measurement of key water quality variables. The measurement of nitrate was compared among three techniques: the 2nd derivative UV technique, the commonly used colorimetric hydrazine/copper sulfate/NED/sulfanilamide technique (henceforth the HCNS technique). Surface water was collected from Precambrian Shield and Prairie lakes and ponds which were selected for their broad range in DOC (3.4 – 44 mg/L), nutrients (TN 400-4700 µg/L) and specific conductivity (55 – 3100 µS/cm). Nitrate analyzed with the 2nd derivative UV technique had a mean concentrations of 153 µg/L (range <5 to 410), whereas those of the HCNS technique (nitrate plus nitrite) had a mean of 28 µg/L (range <5 to 180). Nitrate estimates became more dissimilar between techniques along the DOC, conductivity, or TN gradient; the 2nd derivative determined NO<sub>3</sub> was positively correlated, but the HCNS nitrate was negatively correlated with these gradients. NO<sub>3</sub> spike tests, which included a third NO<sub>3</sub> technique (ion chromatography), had better agreement, but marked differences still existed. Based on these results, the 2nd derivative UV technique provided the most consistent results over the range in DOC, conductivity and TN.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Oral*

## **ESTIMATING BOREAL STREAM AND RIVER GREENHOUSE GAS EMISSIONS, THE IMPACT OF CLIMATE AND POTENTIAL CARBON FEEDBACK**

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The boreal biome is rapidly warming due to climate change and also contains a significant portion of the world's soil organic carbon and freshwaters. Streams and rivers are closely linked to the terrestrial landscape and export large amounts of carbon. Consequently, the river network is supersaturated with greenhouse gases (GHGs), carbon dioxide and methane, and emit them to the atmosphere. The magnitude and drivers of emissions in this region and the impacts of climate change on them are uncertain. The goal of this study is to investigate the emissions of riverine carbon dioxide and methane within complex boreal fluvial networks. Here we model 315 000 kilometers squared of boreal Québec and divide it into smaller patches with a climatic gradient. Our results show net primary production (NPP) is related to the fluvial emissions per area of landscape with the fluvial network emitting 1% of NPP to the atmosphere. As the boreal warms with climate change, NPP and soil respiration will increase potentially resulting in carbon feedback. It is unclear whether the feedback will be net positive or negative but increased temperatures will disproportionately increase methane emissions which is a more potent GHG than carbon dioxide.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **RECENT CHANGES IN THE LONG-TERM PATTERNS OF DISSOLVED ORGANIC CARBON IN EASTERN CANADIAN LAKES AS RELATED TO REGIONAL AND GLOBAL FACTORS**

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Dissolved organic carbon (DOC) is an important water quality parameter that affects major biological and chemical processes in aquatic environments. Increases in DOC concentration have been reported worldwide. We re-examined the patterns in ice-free DOC reported in Zhang et al. (2010) with an additional 15 years (~2000-2015) of measurements. DOC trends in 49 eastern Canadian lakes from four sites were analyzed (8 at Dorset; 26 at Kejimikujik; 11 at Yarmouth; and 4 at Experimental Lakes Area, IISD-ELA). DOC patterns were synchronous in lakes within a site ( $p > 0.05$ ) but not across sites ( $p \leq 0.04$ ) except in Kejimikujik and Yarmouth and these two sites were pooled into a single Nova Scotia (NS) site. Increases in DOC concentration in Dorset



were evident between 1997 and 2015 (0.12 mg L<sup>-1</sup> year<sup>-1</sup> increase,  $r^2 = 0.68$ ,  $p < 0.001$ ). Similar patterns were also apparent in NS between 2000 and 2015 (0.11 mg L<sup>-1</sup> year<sup>-1</sup> increase;  $r^2 = 0.34$ ,  $p = 0.02$ ). Although DOC concentration in ELA lakes increased initially (0.10 mg L<sup>-1</sup> year<sup>-1</sup> increase;  $r^2 = 0.39$ ,  $p = 0.005$ ), such increases were not evident in last two decades ( $r^2 = 0.02$ ,  $p = 0.59$ ). Sulfate deposition was found to be the most important explanatory variable across all regions whereas summer precipitation explained a significant amount of variation in DOC in Dorset and NS (multiple linear regression and Akaike's information criteria:  $0.49 < R^2 < 0.88$ ,  $p < 0.0001$ ). Interestingly, some global variables (e.g. North Atlantic Oscillation) were found to be important explanatory variables as well.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **EVALUATION OF FISH COMMUNITIES ONE YEAR AFTER THE HUSKY OIL SPILL IN THE NORTH SASKATCHEWAN RIVER**

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In July 2016, approximately 250,000 L of diluted bitumen (dilbit) was spilled from a buried pipeline near Maidstone, SK, and much of this oil reached the North Saskatchewan River. Here we report on fish health in the vicinity of the spill and at locations upstream and downstream, one year after it occurred. Fish were collected using overnight gill net sets and shoreline seine hauls. Overall, fish communities were similar at all locations, dominated by walleye, goldeye, river shiner, spottail shiner and troutperch, with shiners particularly abundant at the spill site and the nearest downstream site. Condition factor and liver-somatic index varied significantly among sites for common species, but the spill site was typically within the range of the upstream reference sites, suggesting other factors such as food availability were responsible for these differences. Bile and tissue samples are being tested for Polycyclic Aromatic Hydrocarbons to examine exposure to oil constituents. Together, these measurements will tell us if there are lingering effects of the spill and if so, how far downstream of the spill those effects have occurred.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **BALANCING FISH CONSERVATION AND ANGLER USE IN RECREATIONAL FISHERIES: EVALUATING THE BIOLOGICAL, SOCIAL AND ECONOMIC OUTCOMES FROM FISH STOCKING AND HARVEST REGULATIONS**

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Fish stocking and harvest regulations are used in recreational fisheries to maintain or enhance fisheries, but their relative effectiveness for achieving biological, social and economic outcomes have rarely been evaluated. We examined how stocking various fish densities and sizes (fry, fingerlings and adults) performed relative to minimum-length limits alone in terms of augmenting the fish population, increasing catch rates and angler utility, minimizing per capita stocking costs, and producing a positive net economic benefit. Our model mechanistically integrated the dynamics of both angler and fish populations. The angler model was calibrated to a choice model from German anglers, and the biological model to two popular recreational species with contrasting ecology; naturally-recruiting northern pike (*Esox lucius*) and non-recruiting common carp (*Cyprinus carpio*). We found that stocking often augmented the overall fish population, but density-dependent bottlenecks minimized the number of fry and fingerlings surviving to a catchable size. Moreover, increases in catch rates resulting from management actions did not necessarily increase angler welfare, because of declines in marginal utility with increasing catch rates. Thus, stocking only lead to a positive net economic benefit when natural recruitment was impaired (e.g., overfished pike) or lacking completely (e.g., carp), stocking rates were low, and enough anglers benefited from stocking to offset the costs. In self-sustaining fish populations, minimum-length limits generated similar benefits without incurring the costs of stocking. Our study demonstrates how an integrated model that accounts for both important ecological and social dimensions is well suited to assess trade-offs in fisheries management.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **USING HIGH FREQUENCY BUOY DATA TO FORECAST HARMFUL ALGAL BLOOMS**

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Increased frequency and severity of harmful algal blooms is a major concern globally. While mitigation of blooms is a major management goal, adaptation is a key interim priority – to help ensure safe drinking water, and reduce threats from recreational exposure to cyanobacterial toxins. Our understanding of bloom dynamics has been hampered by temporal constraints, with traditional sampling programs centered at frequencies on the order of weeks to months, with blooms frequently occurring on the timescale of hours to days or weeks. Here, we explore options to forecast cyanobacterial blooms using traditional sampling programs (weekly or biweekly), demonstrating that key factors affecting drinking water treatability can be predicted with relatively long lag times. Then, we use 4 years of sensor data from a prairie lake to test the reliability of sensor-based data, the best sensor suites to understand blooms, and, key predictors of blooms – that may be applied to generate advanced warning. Ultimately, tools to forecast blooms may be lake-specific, but the methodological approaches, and physicochemical factors included in modelling, may be simpler than anticipated.

*SSI3. Aquatic nutrients: dynamics and algal blooms*

*Oral*

## **INFLUENCES OF LIFE HISTORY TYPE ON LAKE TROUT (SALVELINUS NAMAYCUSH) GROWTH AND SURVIVAL IN THE WESTERN CANADIAN ARCTIC**

*Kissinger, B.C.\* Darren M. Gillis, W. Gary Anderson, Charles Killeen, Norman M. Halden, James D. Reist*

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The interaction between genotype and environment is perhaps the primary determinant of an individual's growth rate, longevity and ultimately fitness. Such interactions and the resultant variation in growth rates are particularly prevalent in salmonids where a rich biodiversity can often be observed within a single population. Typically lake trout, *Salvelinus namaycush*, are considered freshwater resident salmonids that rarely, if ever, experience a marine environment. However, recently two life history types within the Husky Lakes estuary, NT; semi-anadromous and brackish-water resident in addition to third freshwater resident life history in connected lakes have been documented. Here, we compare otolith increment widths, as a proxy for annual fish growth, and age-at-capture among life history types. Results indicate that brackish-water residents grow significantly faster ( $p < 0.001$ ) and live longer (4 years) than do semi-anadromous and freshwater resident life history types. Additionally, brackish-water residents were the dominant life history type within Husky Lakes (82%), and there was no evidence indicating that

brackish-water resident fish leave this ecosystem suggesting a distinct benefit towards growth and longevity while living in Husky Lakes. This was further supported by the faster growth rate in semi-anadromous life history types compared to freshwater resident fish ( $p = 0.04$ ), although there was no difference in longevities between these two groups. Specific factors resulting in increased growth and longevity in the brackish-water resident fish are uncertain but are most likely a combination of environment (increased productivity and near isosmotic conditions) and local adaptation.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

### **USE OF FLOODPLAIN LAKE SEDIMENTS TO DETERMINE PRE-INDUSTRIAL BASELINES AND EXTENT OF METAL POLLUTION OF THE ATHABASCA RIVER IN THE ALBERTA OIL SANDS REGION**

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Alberta oil sands began operations in 1967, but onset of environmental monitoring for pollution of the Athabasca River (AR) and adjacent floodplain lakes began 30 years later. Consequently, no pre-industrial baseline exists upon which current river sediment quality can be compared. This undermines an ability to determine the relative importance of contaminants supplied by natural versus industrial processes to downstream environments and hinders the ability to quantify the extent of AR pollution by rapid growth of oil sands development. Here, we address this critical knowledge gap by analyzing sediment cores from flood-prone lakes located upstream and downstream of oil sands operations within the Alberta Oil Sands Region (AOSR). Radiometric, loss-on-ignition, and organic carbon and nitrogen elemental and isotope analyses were used to identify stratigraphic intervals of flood-supplied sediment and periods without flooding. When compared to the pre-industrial baseline, normalized metals concentrations in recently deposited flood-derived sediment do not show evidence of pollution of Athabasca River sediment. There is, however, a clear signal of metal enrichment in non-flood sediment in a floodplain lake located closest to mining operations, indicating local atmospheric pollution. These pre-industrial baselines provide an estimate of the natural range of variability of metal concentrations in Athabasca River sediment for assessment for evidence of pollution of the Athabasca River in the AOSR. Paleohydrological and contaminant analyses of stratigraphic records of flood-prone lakes along the Athabasca River provide a promising approach to establish baselines, reference conditions, and to discern natural and pollutant pathways of contaminant deposition.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **ON THE IMPORTANCE OF SMALL-BODIED FISHES IN FRESHWATER ECOSYSTEMS**

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Small-bodied fishes in Canadian freshwater ecosystems are under-studied, and are often considered to be important only as prey for sport fishes. However, there is evidence that small-bodied fishes can influence the structure and function of aquatic food webs with the potential to indirectly affect the productivity and sustainability of fisheries. In addition, many species at risk in freshwater ecosystems tend to be small-bodied fishes, potentially due to their increased sensitivity to habitat effects. We also know that small-bodied fishes differ in their sensitivity to catastrophes, exploitation, habitat loss, recruitment failure, and are at greater risk of extinction. If small-bodied fishes are important to the function of aquatic ecosystems and the production of fisheries, then the management of freshwater ecosystems and habitats may differ based on considerations of small-bodied fishes. However, modelling exercises that could inform management strategies have encountered challenges when including small-bodied fishes due to knowledge gaps and an apparent inability to scale down from knowledge of larger fishes. I will review the limited research and knowledge on Canadian small-bodied fishes and identify the research needed to fill some significant knowledge gaps on small-bodied fishes and their ecological role in freshwater ecosystems.

*GS15. General contributed papers*

*Oral*

## **METHANE EMISSIONS FROM PEATLAND LAKES IN WESTERN CANADA: EFFECTS OF GROUNDWATER CONNECTIVITY AND PERMAFROST THAW**

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Rising temperatures and the submergence of recently thawed permafrost ground into lakes has been identified as a major driver of methane (CH<sub>4</sub>) emissions in northern regions. Lakes on the vast Taiga Plains in western Canada represent a vital unknown with respect to CH<sub>4</sub> fluxes and their sensitivity to permafrost thaw. The Taiga Plains has several characteristics that could influence magnitude and controls on lake CH<sub>4</sub> emissions in comparison to other regions, including high soil organic carbon stores, distinct permafrost history, and complex groundwater interactions that influence availability of terminal electron acceptor concentrations among lakes.

We carried out biweekly diffusive and ebullition flux measurements and monitored sediment redox profiles from two lakes in northern Alberta. The two lakes differ in contributions of groundwater and surface water inputs and one lake is influence by permafrost thaw. Fluxes were measured from the edges to the centers of the lakes over the open water season. Preliminary redox profiles suggest the groundwater-fed lake has high concentrations of sulfides ( $>200 \mu\text{mol L}^{-1}$ ), while the surface water lake has no sulfide, but high concentrations of reduced iron ( $>200 \mu\text{mol L}^{-1}$ ). Despite high sulfide concentrations in the sediments, dissolved methane concentrations in the two lakes were the same. However, ebullition fluxes were highest from a recently thawed lake edge. The results of this project will help improve current regional  $\text{CH}_4$  models by including ground-based methane flux measurements from the vast and previously unstudied region of western Canada.

*SS10. Impact of climate change on aquatic ecosystems*

*Poster*

## **DIFFERENCES IN QUALITY BETWEEN HATCHERY-REARED AND WILD-ORIGIN BLOATER (COREGONUS HOYI) EGGS AND IMPLICATIONS FOR RESTORATION EFFORTS**

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Deepwater cisco species, such as the bloater (*Coregonus hoyi*), were once abundant in Lake Ontario and served as an important prey source for Lake Trout (*Salvelinus namaycush*) and Burbot (*Lota lota*). In the 1950s, bloaters had been presumably extirpated from Lake Ontario and as such, recent efforts have been made to re-establish a self-sustaining population using hatchery-reared bloaters. It is possible that individuals reared in captivity and released in the wild may hinder restoration efforts as they may be maladapted for the wild and have lower reproductive success than wild individuals. Egg quality, defined as the traits of an egg that allow for the successful development and survival of the embryo, can greatly affect the reproductive success of an individual. In this study, we aim to compare egg quality traits between hatchery reared bloaters and wild-sourced bloaters, specifically gonadosomatic index, egg size, lipid content and carotenoid content. Comparisons between wild and hatchery origin fish may lead to a better understanding of how released individuals may perform reproductively in the wild. Overall, this research will not only help contribute to the restoration of bloaters in Lake Ontario, but may also provide insight into the potential reproductive success of hatchery reared individuals in the wild for future restoration efforts.

*GS15. General contributed papers*

*Poster*

## **FUNCTIONAL DIVERSITY AND REDUNDANCY OF FRESHWATER FISH COMMUNITIES IN ONTARIO LAKES**

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High species richness and functional diversity have been described as important attributes related to ecosystem resilience, as greater numbers of taxa and functional groups provides a greater probability that ecosystem functions are maintained post-disturbance. Functional redundancy, or when more than one species performs the same ecological function, may be important when communities are relatively depauperate in richness. With freshwater fish community data from nearly 7,000 lakes in Ontario, we quantified the relationship between functional diversity and species richness across the province and then tested whether fish communities had less functional diversity (i.e., greater redundancy) than expected from random community assemblages. Further, we used generalized additive models to test if species richness and environmental variables explained significant variation in functional diversity across geographic scales. Our results demonstrate a saturating relationship between species richness and functional diversity, indicating redundancy in functional traits across the province. However, these results varied when investigating patterns regionally; southeastern and northwestern Ontario fish communities showed the greatest redundancy compared to northeastern communities. Species richness and maximum lake depth were the two most important variables for explaining functional diversity patterns across the province. Overall, although fish communities in Ontario lakes are relatively depauperate of species compared to other systems, functional redundancy was observed across the province, which may play a key role in providing resilience to communities against future disturbance.

*GS15. General contributed papers*

*Oral*

## **THE EFFECTS OF INVASIVE DREISSENID MUSSELS ON THE OFFSHORE FOOD WEB OF LAKE SIMCOE, ONTARIO**

*Victoria Langen\*, and. Michael Rennie*

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Zebra mussels (*Dreissena polymorpha*) are a species of great concern due to their ability to invade water bodies and cause ecological changes that can alter the structure and function of an ecosystem. Although much has been learned about the effects of these mussels on lake ecosystems, there is still some uncertainty regarding what changes seen in offshore foodwebs can be attributed to their establishment. This study evaluates the long-term changes in resource use of offshore fish in Lake Simcoe, Ontario and will determine the degree to which these changes can be associated with dreissenid mussel invasion. After analysing stable isotope signatures of carbon ( $\delta^{13}C$ ) from scales of coldwater fish species for the years 1960 - 2008, no obvious trends

in C isotopes for offshore fish were found. However, the analysis of nitrogen isotopes ( $\delta^{15}\text{N}$ ) indicated an increase over time. In addition, analysis for both of these isotopes will be conducted for the years 2009-2014. This is a time period that encompasses the more recent establishment of another invasive species, the Quagga mussel (*Dreissena rostriformis bugensis*). The results of this research will provide insight into how offshore fisheries may be altered after dreissenid invasion, and what influence Quagga mussels might have on the ecosystem.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **TEMPORAL DYNAMICS OF A GENETIC CLINE OF INVASIVE EUROPEAN GREEN CRAB (*CARCINUS MAENAS*) IN EASTERN NORTH AMERICA**

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Two genetically distinct lineages (north and south) of European green crabs (*Carcinus maenas*) were independently introduced to eastern North America. The distribution of these lineages is punctuated by a robust genetic breakpoint in southeastern Nova Scotia, Canada (NS), where lineages have recently overlapped and hybridized, resulting in secondary contact and a latitudinal genetic cline. Previous studies have documented a persistent southward shift in the cline location, consistent with existing dispersal and recruitment pathways. We evaluated current clinal structure by quantifying the distribution of lineages and fine-scale hybridization patterns across the eastern North American range (25 locations, ~39-49°N) using diagnostic single nucleotide polymorphisms (SNPs). Temporal changes in cline position were evaluated using mitochondrial DNA and microsatellite loci over a 15-year period (2000-2015). Clinal structure was consistent with prior work demonstrating both northern and southern lineages with overlap occurring between southern New Brunswick (NB) and southern NS. Extensive hybridization occurred in this region with significantly more hybrids than predicted based on relative proportions of north and south groups. Temporal genetic analysis found that the rate of the cline's southward progression has decreased over time. Current clines (all marker types) revealed fewer northern genotypes in the southern extent of the range than predicted by forecasting models. The SNP-based cline displayed the greatest discordance from these dispersal-based predictions, consistent with selection limiting the spread of pure lineages. Ultimately, the results



of our study highlight how selection, hybridization, and dispersal can collectively influence invasion success.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **THE RATIO OF METHYLMERCURY TO TOTAL MERCURY CONCENTRATIONS IN FISH MUSCLE VARIES WITH BODY SIZE AND BETWEEN SPECIES**

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Mercury (Hg) is a global pollutant that is often elevated in fish from around the world. Due to the biomagnification and retention of methylmercury (MeHg), the toxic form of Hg, it is commonly assumed that >95% of Hg analyzed in fish muscle tissue is the methylated form. However, this assumption is mainly based on studies examining the percent MeHg (%MeHg) in muscle from adult predatory fish. Little is known about the %MeHg in juveniles or smaller-bodied species, which may differ in physiology and trophic ecology from larger fish. This study analyzed [MeHg] and [total Hg] over a wide size/age range in each of three large-bodied species (walleye, northern pike, white sucker), and two small-bodied species (shiners, sculpin) from 10 boreal lakes. Within species, %MeHg significantly increased with fish length: mean %MeHg in large-bodied species was 12-25% lower in individuals <200 mm long than individuals >400 mm long. Similarly, small-bodied species had 20-25% lower %MeHg at <60 mm when compared to >80 mm long. While no relationship between the %MeHg in fish muscle and stable carbon isotopes (indicative of diet) was found across species, %MeHg was negatively related to muscle carbon:nitrogen (C:N) ratios, suggesting a lower %MeHg with higher lipid content. Overall, our results suggest that total Hg is not an appropriate proxy for MeHg in large- or small-bodied fish of <200 mm and <60 mm long, respectively. These findings hold implications for the analysis and understanding of Hg concentrations in fish and the assessment of MeHg biomagnification through food webs.

*GS15. General contributed papers*

*Poster*

## THE USE OF SULFUR ISOTOPES TO UNDERSTAND MERCURY BIOACCUMULATION IN SIMPLE AQUATIC FOOD WEBS FROM HIGH ARCTIC LANDLOCKED LAKES

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Mercury (Hg), a neurotoxic metal with global distribution, is known to biomagnify through food webs, resulting in elevated concentrations in fish including those in the Arctic. Often, stable carbon and nitrogen isotopes are used to determine dietary source of Hg in fish and model biomagnification, respectively. However, given the strong connection between sulfur and Hg cycling, we examined the more novel use of sulfur isotopes ( $\delta^{34}\text{S}$ ) to delineate sources of energy supporting lake-dwelling Arctic char and whether these analyses improve our understanding of Hg bioaccumulation in lake food webs in the Canadian Arctic. We measured  $\delta^{34}\text{S}$  values and total or methyl Hg concentrations ([MeHg]) in water, sediments and biota from 6 lakes near Resolute Bay, Nunavut. Two lakes have been historically impacted by run-off from a nearby community, whereas the other 4 are relatively remote from human activities. Differences between  $\delta^{34}\text{S}$  values in aqueous  $\text{SO}_4^{2-}$  and sediments were not consistent across lakes, but showed greater separation in the impacted lakes. Within taxa and among lakes, [MeHg] in chironomids and char were negatively related to  $\delta^{34}\text{S}$  values ( $r^2=0.25-0.29$ ), while zooplankton had a positive relationship with  $\delta^{34}\text{S}$  ( $r^2 = 0.31$ ). Relationships between [Hg] and  $\delta^{34}\text{S}$  through food webs varied by lake: impacted lakes had negative relationships ( $r^2=0.359$ ), while remote lakes had positive ( $r^2=0.435$ ) or not significant relationship within their food webs. Results suggest that  $\delta^{34}\text{S}$  explains some of the variability in Hg within and among taxa, but the underlying mechanisms are currently unclear and may be linked to differences in system biogeochemistry.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **ASSESSING RIGHT HAND COILED COIL (RHCC) PROTEIN AS A POTENTIAL NEW PASSIVE SAMPLER MATRIX FOR BINDING POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)**

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Transportation of petroleum products allows the possibility for spills to occur, necessitating monitoring efforts to determine baseline conditions prior to a spill and targets for cleanup activity. Passive sampling devices (PSDs) have been used to determine baseline conditions and are increasingly used in place of chemical analysis of abiotic and biotic ecosystem components. Current PSDs have relatively long times associated with reaching equilibrium which becomes problematic when volatile compounds are present.

To address this issue, a new PSD containing the Right Hand Coiled Coil (RHCC) protein was developed. This protein is isolated from bacteria that reside in deep sea hydrothermal vents. The protein is thermally stable, resistant to a wide range of salinity, pH and sulfide concentrations and can be custom synthesized in the laboratory in a variety of polymeric forms. We hypothesized that a PSD based on the RHCC protein will bind priority PAHs from a model ecosystem enclosure treated with diluted bitumen more effectively than the traditional PSD media, triolein and there will be a statistical relationship between uptake of the 16 priority PAHs in the RHCC PSD and in tissues of fish. We conducted a mesocosm study in 2015 to characterize the performance of the RHCC protein under controlled field conditions. Results show uptake of low molecular weight polycyclic aromatic hydrocarbons (LMW-PAHs) by the RHCC however at much lower concentrations than the triolein PSDs. Comparison between the RHCC protein and the fish tissue only showed significant relationships for two compounds and the relationship between total PAHs were not significant. When comparing fish tissue to the triolein, a marginally significant relationship was observed for total PAH but no significant relationships were observed with individual PAHs.

*SS12. Multiple stressors and aquatic environments*

*Poster*

## **THE LANDLOCKED ATLANTIC SALMON FISHERY IN LAC SAINT-JEAN: MANAGING THE PREY**

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Although the strong relationship between landlocked Atlantic salmon (*Salmo salar*) and rainbow smelt (*Osmerus mordax*) is well known, smelt in itself is rarely managed (apart from stocking). Data from the last 25 years in Lac Saint-Jean (province of Québec) showed that landlocked Atlantic salmon production is limited by juvenile rainbow smelt production. Hence, the management of the recreational fishery shifted from an emphasis on the sportfish to its prey in order to smooth the abundance cycles of landlocked Atlantic salmon. In this presentation, we will present scientific research on rainbow smelt that support the management of the Lac Saint-Jean's recreational fishery. Rainbow smelt abundance is low in Lac Saint-Jean. Its reproductive ecology turned up to be quite atypical, with a major spawning hotspot found on sand shoals, and minor hotspots found in two large tributary rivers. Given that such spawning habitats are far from optimal for the eggs' survival, 25 rocky spawning reefs (100 to 200 m<sup>2</sup> per reef) were designed, then built during winter 2017, to improve smelt's natural production. The first year of monitoring brought promising results, with rainbow smelt eggs found on almost half of the spawning reefs, and high abundance of yolk-sac larvae near the reefs. The monitoring effort will continue over the two upcoming springs in order to confirm (or disprove) the reefs' contribution to the improvement of rainbow smelt production.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **THE LANDLOCKED ATLANTIC SALMON FISHERY IN LAC SAINT-JEAN: A PARADIGM SHIFT**

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The recreational fishery of landlocked Atlantic salmon (*Salmo salar*) in Lac Saint-Jean is renowned in North America since the end of the 19th century. In this presentation, we will show how the fishery management shifted from an anadromous-salmon-based approach to an ecosystem-based management. Mistassini River's population spawning runs have been monitored yearly since 1975. For decades, managers tried to increase spawners' abundance assuming that the limiting factor was smolts' production in rivers. This assumption was based on the management of anadromous Atlantic salmon populations in Eastern Canada. Recently, scientific research showed a close interrelation between landlocked Atlantic salmon production and the abundance of its preferred prey, juvenile rainbow smelt. This observation brought to light that the bottleneck of landlocked Atlantic salmon production was not in rivers but in the lake. Since then, management of the recreational fishery shifted to an ecosystem-based approach taking into account population statistics of both the sportfish and the forage fish.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **CONTRASTING NUTRIENT AND SEDIMENT RETENTION IN TWO STORMWATER PONDS DURING ATYPICALLY DRY (2016) AND WET (2017) YEARS**

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Stormwater ponds are common features in many cities, built to retain water and reduce the probability of flooding, and also to remove pollutants from surface runoff, protecting receiving bodies of water. The purpose of this study was to evaluate the function and ecosystem services provided by two wet retention ponds in Toronto, Ontario over a two-year period, 2016 and 2017.

The Spring - early Summer, 2016 was notably dry and warm; total precipitation in April-June was 100 mm below average for this time period. Spring and early Summer, 2017, in contrast, was cool and wet, with precipitation in April-June 151 mm above average. This provided an opportunity to study normal function of these ponds near opposite ends of the normal climate spectrum. During 2016 (April - December), there was a net retention of 1415 mg of total suspended solids (TSS) at Hydro Pond East (HEP), and 1127 mg for Mattamy Pond (MAT). However, both ponds were net exporters of phosphorus (0.20 kg and 1.67 kg for HEP and MAT, respectively). HEP retained nitrogen (37.4 kg), while MAT was a net exporter of N (3.7 kg). Export of nutrients from these ponds during 2016 was low, and may reflect low inputs during a dry season coupled with loss of legacy nutrients accumulated in previous years. Data collection and analysis for 2017 is ongoing, and will be compared with 2016 to better characterize how these ponds function in nutrient and sediment retention under very different hydrological conditions.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Oral*

### **AQUATIC INVASIVE SPECIES MANAGEMENT IN AN URBAN MUNICIPALITY – THE STORY OF THE FRANKENFISH AND THE FLOWERING RUSH INVASION IN ST. ALBERT, ALBERTA**

*Logan, M.L.\*, L. Kongsrude and C. Benson\**

*City of St. Albert, St Albert, AB*

The City of St. Albert has several invasive species to manage, with the most concerning being flowering rush (*Butomus umbellatus*) and goldfish (*Carassius auratus*). Flowering rush has become widespread throughout the Sturgeon River within the City boundaries, and goldfish are present, and suspected, within several stormwater management facilities. Goldfish can be found in some catch basins within the stormwater system; the full extent of their invasion is still to be determined. Removal of these species, which is mandated by legislation, requires a tremendous interdepartmental effort by the City to coordinate logistics, communications with residents, government approvals, and disposal of what is removed. The strain on the municipality is felt not only through personnel requirements, but also through the financial commitment involved. The City of St. Albert has formed a strong relationship with Invasive Species experts at Alberta Environment and Parks and have been fortunate to receive strong support from them, including training, provision of supplies, advice, and physical participation in removal efforts. Their expertise has been used when handling concerns from residents about the use of chemical treatment, and the well established “Don’t Let It Loose” campaign provides strength to our community communication efforts. To date, the City has removed over 2,500 lbs of goldfish from two stormwater facilities, with more ponds potentially on the horizon. The management of flowering rush will involve removal and monitoring efforts for many years to come; both projects will require additional time and resource commitments from the City.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **WHAT DOES “CONTAMINATED” MEAN? FISH MONITORING SUCCESS IN COLD LAKE FIRST NATIONS TRADITIONAL TERRITORY.**

*Findlay MacDermid\* and Claire McAuley*

*Cold Lake First Nations, AB*

Between 1952 and 2001 CLFN was barred from accessing their ancestral homelands at Primrose Lake (Ha Touwe). When members returned, Elders quickly identified that the whitefish was contaminated and was declared inedible by the community in 2009. CLFN lead a study in 2016 which analyzed whitefish and pickerel for a broad suite of contaminants. Results indicate that the fish are not contaminated as defined by western science. Does this mean the elders are wrong? No - to understand their perspective one needs to have a broader view that encompasses an understanding of the language, culture and history. This presentation will outline how the term “contaminated” should be interpreted in the context of fisheries monitoring and discusses a pilot monitoring program co-designed with Alberta. The new program attempts to integrate traditional knowledge with western science as well as promote the transfer of both traditional and western science knowledge within the community. Early results of this approach indicate that the program is generating valid monitoring data while retaining community support. The project is a good candidate for inclusion into a broader Indigenous Guardian Program that CLFN is attempting to roll out in 2018.

*SSI4. Indigenous resource management*

*Oral*

## **SPATIAL RISK: INFLUENCE OF PISCIVOROUS FISH ON SELECTION OF NURSERY HABITAT BY AGE-0 JUVENILE COD**

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Fish experience elevated levels of predation during their early life history stages. Upon reaching the juvenile stage, Atlantic (*Gadus morhua*) and Greenland (*G. ogac*) cod reduce their predation risk by settling into coastal eelgrass nursery beds. Although these nursery habitats restrict predator movements, predation mortality nonetheless remains high. This pattern suggests that habitat adjacent to eelgrass beds may hold a greater predation risk than eelgrass beds. Juveniles must balance their need for food with predation avoidance, and movement of predators may therefore influence the distribution of juveniles. We characterized habitat and the distribution of Age-0 cod among habitat types through video transects. To determine how predators shaped habitat use by Age-0 juvenile cod we tagged a total of 37 predators (Age-1+ *G. morhua*, *G. ogac*, cunner *Tautoglabrus adspersus* and shorthorn sculpin *Myoxocephalus scorpius*), and used acoustic telemetry to determine their habitat use. Age-0 juvenile cod utilized shallow-water

eelgrass beds less than 7-m deep, whereas predators predominantly occupied the habitat surrounding eelgrass. From these results we infer that eelgrass habitat indeed provides protective habitat for Age-0 cod, but predators may still exert a reduced predation effect by focusing on the periphery of protective habitat and limited availability of juvenile prey.

*GS15. General contributed papers*

*Oral*

## **NICHE PARTITIONING AND SPECIES COEXISTENCE: IMPLICATIONS FOR THE CONSERVATION OF STREAM FISH IN A CHANGING WORLD**

*Maitland, B.M.\* and Frank J Rahel*

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At the heart of conservation ecology lies a central question: what mechanisms explain the distribution and diversity of organisms? While vigorously studied, ecologists still strive to understand how similar species can coexist in ecological communities, particularly when non-native species may be trumping natural drivers of biodiversity. Niche theory assumes species to be homogeneous units, and predicts species with similar feeding habits coexist by partitioning resources, a primary mechanism purported to maintain biodiversity. In lotic ecosystems, however, evidence suggests that coexistence rules depend on a local community's position along the longitudinal gradient, down which food webs are assumed to change. We predict that in high elevation reaches, where environmental variability is large, assemblage-level dietary niche breadth will be small, and niche partitioning among species will be low. Conversely, in downstream reaches where environmental variability is attenuated, niche breadth will be larger, but niche overlap among species will decrease via ecological release. We test this "Niche Expansion Hypothesis" in Rocky Mountain—Great Plains streams, measuring resource use with carbon and nitrogen stable isotopes. Preliminary data suggest an effect of the longitudinal gradient. Species richness increased moving downstream with concomitant functional modifications including larger niche breadth and decreased niche overlap among species. We propose the observed expansion of the dietary niche results from dietary niche expansion within populations via greater among-individual variation in resource use rather than greater within-individual variation. This work helps to elucidate when and where species-coexistence rules operate, and the potential consequences of non-native species on contemporary food webs.

*GS15. General contributed papers*

*Poster*



## **A NOVEL APPROACH TO WATER MANAGEMENT USING TRADITIONAL INGREDIENTS: A CASE STUDY IN STRUCTURED-DECISION MAKING**

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In 2012, industry, local, provincial, and federal governments, watershed planning groups and other stakeholders gathered in Grande Prairie, Alberta to discuss the development of water allocation limits to balance future water demand and the protection of the aquatic environment. The Wapiti River Water Management Plan was born. The group successfully completed a number of economic, social and ecological studies to inform this water management decision. While these individual studies are traditional ingredients of an instream flow study and address the riverine components of fish habitat, geomorphology, connectivity, and water quality; the process to help guide the stakeholder group to a consensus was not standard practice. The group participated in a number of structured-decision making (SDM) workshops. SDM is centered on a set of planning steps that serve as a guide for working through a decision process. It is supported by structuring tools from the decision sciences which helps groups deliberate on technically complex decisions where multiple interests are at stake. The SDM process helped the large and diverse group evaluate the scientific information and balance the trade-offs, and in 2017, resulted in accepted water allocation limits for instream flows for the Wapiti River.

*SS2. Improving the science and management of instream flows: moving beyond traditional approaches*

*Oral*

## **ARE TAGS A DRAG? THE EFFECT OF EXTERNAL TAGS ON PROFILE DRAG OF TROUT**

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The use of external tags for identification and data acquisition has been common practice in fisheries and aquatic sciences for decades. External tagging allows scientists to collect large amounts of data on fish migration, habitat, and movement in a cost-effective way. Studies that examine the effects of external tag attachment on the cost of movement of tagged fish are necessary to this ever-expanding practice. The objective of this study was to determine the effect of external active and passive tags on the profile drag of a lake trout (*Salvelinus namaycush*). A

model trout body was rendered using CAD (3D studio Max 8) and 3D printed in ABS plastic. The trout model (40 cm total length) was suspended with a custom-made load cell oriented to optimally measure axial drag force. Drag force measurements were collected in a Rolling Hills water channel at velocities ranging from 3 cm/sec to 36 cm/sec. Different types of active transmitters (radio, acoustic) and passive tags (dangler, disc) were attached to the trout model at locations typically employed in published studies on live trout and tested in consecutive trials. The presence of passive and active external tags resulted in sharper increases of profile drag force as velocity increased than observed in the control. These results can help inform models of the bioenergetic costs of locomotion and the use of external tags and the optimal external tag attachment site to minimize drag.

*GS15. General contributed papers*

*Oral*

## **THE LOST CREEK WILDFIRE: LONG-TERM IMPACTS ON AQUATIC ECOLOGY**

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Wildfire is an important disturbance in natural landscapes and can have significant impacts on stream ecosystems. The 2003 Lost Creek wildfire was one of the most severe burns on Alberta's eastern slopes. The Southern Rockies Watershed Project was established to document the effects of the wildfire and post-wildfire salvage logging on hydrology, biogeochemistry and aquatic ecology. We have collected 11 years of continuous water quality and hydro-meteorological data, which has revealed persistent elevated sediment production and nutrient (phosphorous and carbon) export in fire-affected watersheds. Increased nutrient loading and warmer temperatures contributed to substantially greater algal productivity. Periphyton biomass was between 4- and 30-times higher in burned and salvaged logged watersheds during the first seven years post-fire and has remained elevated throughout the study. We sampled aquatic fauna (benthic macroinvertebrates and fish) at discrete intervals to provide insight into wildfire effects on higher trophic levels. Four years post-fire, there was greater abundance and taxonomic richness in macroinvertebrate assemblages in burned watersheds. Eight years post-fire clear differences in macroinvertebrate assemblage structure between reference, burned and salvaged logged watersheds remained evident, despite all watersheds supporting healthy and functional invertebrate assemblages. Cutthroat trout (*Oncorhynchus clarkii*) sampled two years after the wildfire showed elevated growth rates in burned watersheds — these differences were not

evident eight years post-fire. Observed differences in faunal communities between burned and reference watersheds were likely driven by changes in habitat quality related to sediment inputs and bottom-up effects stimulated by greater primary productivity.

*GS15. General contributed papers*

*Oral*

## **USING DIGITAL DATA TO TRACK FISHING EFFORT AND CATCHES; AN EXAMPLE AND OPPORTUNITIES**

*Martin, D.R.*

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Fisheries management has evolved from reservoir to watershed management, creating a need to simultaneously gather information within and across interacting reservoirs. However, costs to gather information on the fishing effort on multiple reservoirs using traditional creel methodology are often prohibitive. Angler posts about reservoirs online provide a unique medium to test hypotheses on the distribution of fishing pressure. We show that the activity on an online fishing social network is related to fishing effort and can be used to facilitate management goals. We searched the Nebraska Fish and Game Association Fishing Forum for all references from April 2009 to December 2010 to 19 reservoirs that comprise the Salt Valley regional fishery in southeastern Nebraska. The number of posts was positively related to monthly fishing effort on a regional scale, with individual reservoirs having the most annual posts also having the most annual fishing effort. Furthermore, this relationship held temporally. Online fishing social networks provide the potential to assess effort on larger spatial scales than currently feasible. Additionally, new online sources of data, primarily driven from mobile applications (e.g., NetFish, iBobber) provide a finer spatial and temporal scale of data to explore these relationships. We will explore these data opportunities further in this presentation.

*SS1. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **AN ACTION PLAN FOR RECOVERING ALBERTA'S WESTSLOPE CUTTHROAT TROUT TO SECURE STATUS**

*Mayhood, D. W.*

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The recovery strategy for Threatened Alberta Westslope Cutthroat Trout lacks an action plan, required under Canada's Species At Risk Act (SARA), specifying how recovery will be accomplished. Here I outline such a plan based on an existing conceptual framework and recovery guidelines. Conceptual framework: This once abundant and widespread species in the

upper Bow and Oldman river drainages is now reduced to a few small, isolated populations in small, unproductive upper headwaters within the Alberta native range. Hybrid populations are widespread, pure populations are rare, and many genetically distinct, locally-adapted stocks and life-history types have been lost, reducing much of the subspecies' adaptive and evolutionary potential. Habitats of most stocks, pure and introgressed, have been dramatically altered by human land-use. Changing climate is irreversibly limiting habitat. Recovery guidelines: Any action plan must not just prevent imminent extinction; it must retain the species' capacity to survive, adapt and evolve. To accomplish these aims, Alberta cutthroat stocks must be enlarged, reconnected and distributed widely while retaining the remaining genetic diversity, adaptation to local conditions, and re-establishing lost life-history types. Any actions must meet the requirements of SARA. Action plan: Restore genetically-pure resident and migratory life-history forms in three or more sub-drainages in each of the Bow and Oldman river watersheds, reducing overall probability of extinction to  $< 0.05$  over 40 generations (at least 200 years). Details of how this can be done are described.

*SS5. Native trout and salmon recovery*

*Oral*

## **SCENT ENHANCEMENT AND TAGGING EFFECTS IN JUVENILE LAKE STURGEON (*ACIPENSER FULVESCENS*)**

*McCabe, M.M.\*, Zielinski, B.S., Boase, J.C., Chiotti, J.A., and Pitcher, T.E.*

*University of Windsor*

Anthropogenic stressors negatively impact natural populations and lead to their declines. As such, ex-situ conservation practices are becoming essential to maintain biodiversity and prevent extirpation of vulnerable populations of many species. One species currently undergoing restoration efforts, to supplement Huron-Erie Corridor populations, is the threatened lake sturgeon (*Acipenser fulvescens*). Knowledge is limited on effective supportive breeding programs for lake sturgeon. My research aims to explore whether a supportive breeding program can be effective by focusing on a potential barrier to success. Lake sturgeon rely on imprinting behaviour to find appropriate spawning grounds. To ensure successful restoration of captively released sturgeon, I will examine whether scent enhancement can impact imprinting behavior using choice flume behavioral trials. The results of these studies will have implications for future conservation groups in rearing effective lake sturgeon populations while enhancing research in successful supportive breeding of species at risk.

*GS15. General contributed papers*

*Oral*

## **COMMUNICATING FISHERIES SCIENCE TO STAKEHOLDERS AND POLICY MAKERS: A CHALLENGE FOR THE FUTURE OF FISHERIES MANAGEMENT**

*McMullin, Steve L.\**

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A recent survey of employers in the fisheries profession in North America confirmed that many fisheries scientists lack the communication skills needed to succeed in their jobs. Employers across all employment sectors ranked communication skills and the ability to think critically as the most important skills young fisheries professionals needed to succeed in entry-level positions. However, employers ranked performance in communication by recent entry-level hires substantially below desired levels. The inability of fisheries scientists to effectively communicate the underlying basis for fisheries management recommendations has increased in importance as stakeholders and policy makers frequently challenge the science behind those recommendations. Challenges, and in some cases, total disregard for the science, are likely to increase in frequency in the current political climate of dismissing scientific evidence that does not confirm policy makers' desired courses of action. Scientists may exacerbate the problem if their criticism of policy choices is perceived as arrogance and disregard for public opinion. I suggest that to reverse the trend and maintain a solid scientific basis for future resource management, fisheries scientists must do three things: (1) they must drastically improve their ability to explain the science and technical aspects of fisheries in language that stakeholders and policy makers can understand, (2) they must do a better job of demonstrating the value of good science by pointing out successful cases of its application, and (3) they must accept that policy makers have the right to make choices that may not seem "right" to the scientists.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **HABITAT USE BY ARCTIC GRAYLING (THYMALLUS ARCTICUS) ACROSS LIFE STAGES IN PRISTINE NORTHERN MOUNTAIN STREAMS**

*McPherson, M.D.\*1,2, Lewis, J.B. 3,4, Cott P.A.1, Mochnacz, N.J. 5 and M.S. Poesch 1*

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Northern aquatic ecosystems face increasing pressures from climate change and natural resource development, raising conservation concerns for species in these understudied regions. The Arctic grayling (*Thymallus arcticus*) is a widely distributed but sensitive freshwater fish that is a good

indicator of general aquatic health. Our research objectives are to characterize Arctic grayling distribution among mountain streams in the Northwest Territories, and to determine habitat characteristics and ecological factors that influence Arctic grayling habitat use. Sampling sites (n=180) were selected in four sub-basins within the Little Nahanni River watershed. A step-wise logistic regression was used to explore the relationship between the occurrence of Arctic grayling and stream habitat characteristics. Redundancy analysis (RDA) was used to determine potential size-specific habitat relationships and multivariate regression tree (MRT) analysis was used to identify environmental thresholds and habitat-based size-class segregation. Results show that adult Arctic grayling used habitats with higher mean elevation (>1200 m) and lower mean temperature (7oC) than juveniles (<1050 m and >10oC). Habitat selection by juvenile Arctic grayling changed with increasing length, showing larger juveniles utilized wider, riffle-dominated downstream habitats. These results demonstrate important ontogenetic shifts in Arctic grayling habitat use. The dynamic nature of Arctic grayling habitat use in mountain streams highlights the need to consider habitat complexes at the watershed scale when defining species life-stage requirements and assessing potential impacts. Improved understanding of the distribution, habitat requirements and ecology of Arctic grayling is crucial for the effective management of this species and monitoring of aquatic health in northern regions.

*GS15. General contributed papers*

*Poster*

## **ROTENONE AND RESTORATION STOCKING: THE NEW BAIT AND SWITCH**

*Meagher, Brian\**

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Fisheries management in the east slopes of Alberta is a delicate balance between meeting anglers' recreational expectations while meeting social and legal obligations to recover native species. Attempts have been made provincially to stock Westslope Cutthroat Trout (WSCT) (*Oncorhynchus clarkii lewisi*) in combination with eliminating retention of fish, but fisheries managers have seen no appreciable recovery of these populations. Concurrently, non-native genetics continue to expand upstream, compromising remaining native populations through introgression. WSCT utilized for recreational stocking have historically been sourced from a single (previously fishless) lake. There likely has been a fitness consequence as a result of utilizing this genetically depauperate broodstock. Alberta is identifying stocking strategies to artificially expand genetic diversity while simultaneously taking advantage of the genetic plasticity of WSCT to meet the dual objectives of species restoration and recreational angling opportunities. Selective crossbreeding of known genetic stock from multiple unique locations is expected to maximize genetic diversity through the development of a provincial composite broodstock which could achieve both objectives over time. Composite stock maintains or increases genetic diversity, takes advantage of local adaptations and preserves local genetics. Prior to stocking of a composite WSCT broodstock, chemical piscicide treatments may be

required to address non-native introgression or Rainbow Trout that have fully displaced native species within known WSCT native range. Genetic assessment is an essential tool and component of this recovery strategy; assessing possible donor populations during the building of a composite broodstock and determining where chemical treatments can facilitate recovery without imperiling existing pure stocks.

*SS5. Native trout and salmon recovery*

*Oral*

## **ASSESSING THE IMPACTS OF MULTIPLE ECOLOGICAL STRESSORS ON A THREATENED NATIVE SALMONID IN THE FOOTHILLS OF ALBERTA, CANADA**

*Medinski, N.A. and M.S. Poesch*

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Native freshwater salmonids face substantial ecological stressors in the foothills of west-central Alberta, Canada. Among the most limiting stressors are impacts associated with invasive species and habitat degradation. In this study we assess the impacts of a large ecological disturbance, the Obed coal mine tailings release of 2013, on fish community composition, and Athabasca rainbow trout distribution and abundance in streams of the area. We also assess the impacts that brook trout, an introduced salmonid stocked into streams in the region, has on rainbow trout abundance and distribution. Our results indicate that both turbidity and brook trout abundance are negatively correlated with rainbow trout abundance. There is no indication that the tailings release specifically has impacted rainbow trout populations more so than landscape level impacts associated with mining and other resource development in the Obed region. Our results indicate that though short-term effects of this tailings release on rainbow trout appear to be minor, there is potential for more negative chronic impacts to this threatened rainbow trout population associated with habitat degradation in tailings disturbed streams. This likely depends on the success of ongoing stream restoration efforts. We also used stable isotope analysis to determine the impacts of both ecological stressors on Athabasca rainbow trout food resource use in the foothills of western Alberta.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **NORTH CENTRAL NATIVE TROUT (NCNT) RECOVERY PROGRAM: A STANDARDIZED APPROACH TO COMBATING CUMULATIVE EFFECTS IMPACTING AQUATIC SPECIES-AT RISK IN ALBERTA**

*Reilly, J., Blackburn, M., and \*A. Meinke*

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Fisheries management is an integrated process of fish, habitat and people. Together changes in landscapes, angling pressure, and non-native species introductions shape present species distributions and population levels. Within Alberta, significant reductions in native fish species - bull trout, Arctic grayling and Athabasca rainbow trout - have been observed resulting in their classification as species-at-risk. To combat species declines, the North Central Native Trout (NCNT) recovery program was created. Through this program, various cumulative effects are modeled using species relative abundance data at a watershed scale to identify key influences. Following these assessment, focal watersheds are selected where 1. populations have a reasonable chance of recovery; 2. there are past or current efforts to restore fish; and 3. anglers' attitudes support proposed long-term management actions. Based on model results and social factors; a variety of management actions are applied to focal watersheds (fishing closures, habitat remediation, a combination of both or removal of non-natives). To determine the success of treatments within this program, trends in species relative abundance will be assessed over the next five years (minimum). To date, seven treatment watersheds have been selected, surveyed, and local stakeholders have been consulted. Results from online surveys indicate a majority of stakeholders support proposed management actions (ranging from 60 to 70% support). Using this approach, management actions can be assessed in a standardized fashion to determine the most effective method for improving populations levels of fish within Albertan waters.

*SS5. Native trout and salmon recovery*

*Oral*

## **A MASS BALANCE APPROACH TO QUANTIFYING EFFECTS OF NETCAGE AQUACULTURE ON ECOSYSTEM STRUCTURE AND FUNCTION IN LAKE HURON**

*Moore, Chelsea \* Kevin McCann Rich Moccia Neil Rooney*

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Freshwater aquaculture operations have the potential to influence biogeochemical cycles and food web properties of adjacent habitats. While there has historically been concern about the potential detrimental effects waste and feed from netcage operations on local habitats, recent work has suggested that energetic subsidies from waste and feed to local ecosystems could have a positive effect on local native populations. Specifically, stable isotope and fatty acid analysis has indicated that native lake trout in Georgian Bay, Lake Huron derive energy from rainbow



trout aquaculture operations. Here, we take a mass balance approach to quantifying subsidies from 6 rainbow trout netcage operations to the local habitats. Using energetic models, we quantify the potentials for these subsidies to support local lake trout populations and compare these values to estimates from the stable isotope and fatty acid analysis. This approach will aid in quantifying both potentially positive and negative effects of netcage operations on the structure and functioning of Great Lakes food webs.

*SS11. Aquaculture and its impact on aquatic environments*

*Oral*

### **THE SALT AND METAL COMPONENTS OF OIL SANDS PROCESS AFFECTED WATERS (OSPW) EFFECTS ON METABOLISM AND SWIMMING ABILITY IN RAINBOW TROUT (ONCORHYNCHUS MYKISS)**

*Mueller, Z.D.\* and K.B. Tierney*

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Oil sands process affected (OSPW) is created as a by-product of bitumen extraction in Athabasca region of Alberta. Given that demand for oil is increase and OSPW has a shelf life for oil extraction, tailing ponds containing OSPW has vastly increased in the previous decade. Herein we investigate how the metals and salts similar to that found in OSPW may alter swim performance and metabolic rate in rainbow trout (*Oncorhynchus mykiss*). Three salts (Na, Ca, & Mg) and five metals (Al, Mo, Cu, Ni, & Zn) were selected and fish we exposed for 96 hr with a 48 hr static refresh. Fish were swam swim tunnel respirometer pre and post exposure. We found that metal and salts similar to OSPW decreased the repeatability of swim performance after exposure. Metals and salts at twice the concentration of OSPW decreased swim performance. Those same fish also had a decrease in maximum metabolic rate. Carbonic anhydrase and sodium/potassium ATPase activity within fish gills were significantly decreased. Prolonged exposure to metals and salts similar to OSPW may have profound effects on the activity and metabolism in rainbow trout. Although metals and salts in OSPW are not the primary driver of toxicity, they may impact fish physiology. Whether, OSPW has convergent results with the metal and salt mixture used here needs to be assessed. Futures studies should examine how exposure period and methods of OSPW impacts swim performance, osmoregulation, and metabolism in rainbow trout.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **SEASONAL AND TEMPORAL CHANGES IN FISH COMMUNITY STRUCTURE IN THE LOWER ATHABASCA RIVER**

*Munkittrick, Kelly\*, Tim J. Arciszewski*

*Wilfrid Laurier University (WLU), Waterloo, ON*

The Regional Aquatic Monitoring Program (RAMP) conducted a fish community survey in the lower Athabasca River between 1987 and 2014, with a total of 662 sampling events in different seasons and years, at different sites. While 32 fish species have been reported from the FWMIS database, only 28 were collected in the regular RAMP program. There were seasonal changes in relative abundance of species, and only 8 species were collected in more than 50% of sampling events. There were some changes in methodology that affect data quality, but given the large amount of data available, there has not been a detectable change in community structure over the >25 years of data that are available. The information provides a baseline for evaluating a variety of indicators, including the relative sensitivity of community indicators of health, including richness and Alberta's index of native fish integrity, relative to population-level information such as changes in size structure, size-at-age, and traditional EEM endpoints.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **MULTIPLE STRESSOR IMPACTS ON ALASKAN STREAM FISH PRODUCTIVITY**

*Murdoch, A\* and S. Sharma*

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Northern watersheds are experiencing rapid changes including accelerated climate warming, increased resource development, and encroaching human population growth. We investigated the relationships between multiple stressors (land use, climate, and water quality) and stream fish abundance from over 1600 stream sites across Alaska using general linear and generalized additive models. We aimed to determine if northern stream fish populations are: 1) influenced by individual stress impacts; and 2) whether these stressors are cumulative. All fish abundance and aquatic habitat data (e.g., stream size, water quality, elevation, gradient, substrate) were obtained from the Alaska Freshwater Fish Inventory online database. Land use and climate data were obtained from multiple sources including the Climatic Research Unit (CRU), US Census Bureau, US Geological Survey and the Alaska State Geospatial Data Clearinghouse. Warmer and wetter regions had higher total fish abundance, whereas sites at higher altitudes and conductivity tended to have fewer fish. Species-specific analyses showed similar trends, with the exception of Dolly Varden abundance which was positively related to stream gradient ( $r = 0.24$ ) and negatively related to mean growing degree days ( $r = -0.18$ ). In general, long-term climatic averages were more correlated with fish abundances than short-term measures closer to the year of capture. There were no significant relationships between fish abundance and development. Results from this study indicate that natural environmental variability and long-term climate trends may be

currently overriding potential impacts from development. However, early and continued monitoring of northern areas will be critical for avoiding future cumulative effects.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **LEFT HIGH AND DRY: THE IMPORTANCE OF GETTING OFF THE BEACH FOR CAPELIN SURVIVAL**

*Murphy, Hanna\**

*Science Branch, Fisheries and Oceans Canada, St. Johns, NL*

Capelin (*Mallotus villosus*) is a small forage fish that plays a key role in the transfer of energy from secondary producers to vertebrate predators in Arcto-boreal food webs. Profound changes in abundance and distribution of capelin occurred in 1991 in Newfoundland, which corresponded with the collapse of the groundfish stocks. Capelin biomass has yet to return to pre-1991 levels. Capelin spawn on beaches as well as in nearshore demersal areas (< 40 m water depth). Previous research found that capelin larval survival and year-class strength was related to onshore winds, which act as a mechanism to release larval capelin in pulses from the beach sediments. However, post-1991, which has been characterized by small adult size and late spawning, there is now a mismatch between capelin spawning and onshore wind events. Capelin larvae are now stuck for longer periods on the beach. I characterized the magnitude and duration of larval pulses from the beach into the nearshore area post-1991 and related to age-2 recruitment. For the years 2001-2016, three variables explained 91% variation of age-2 recruitment: spawning times, duration of the larval pulses from the beach, and larval prey availability (*Pseudocalanus* spp.). This suggests that earlier spawning times, longer duration of larval pulses over the emergence period, and increased prey availability for larvae in the nearshore area are all important for increased survival of capelin post-1991. Unfortunately, most years are characterized by late spawning, which is likely inhibiting the recovery of this important forage fish species.

*GS15. General contributed papers*

*Oral*

## **FISHERY DEPENDENT DATA IN STOCK ASSESSMENTS**

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*1. Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, NS*

The Arctic surfclam (*Mactromeris polynyma*) is a large, slow growing, and long lived species found mainly in coarse sandy bottoms. In the Maritimes Region, the surfclam has been fished on Banquereau since 1987. Since the start of the fishery, only three fishery independent surveys have been conducted, with the last in 2010. The only new data to inform the current status of the

fishable biomass comes from a catch per unit effort (CPUE) index derived from the commercial fishery. The fishery footprint (derived from vessel monitoring system positional data) was used to delineate suitable surfclam habitat and create five spatial assessment areas. Commercial catch and CPUE information was then used to incorporate biomass dynamics into the analysis in the form of a surplus production model; the model was fit simultaneously to each assessment area. This method produces a biomass estimate for the fished area of the bank and does not extrapolate to the entire bank. It also allows for the estimation of maximum sustainable yield-based reference points. In 2016, biomass estimated by the model for the fished area of the Bank was 475,947 tonnes, which is in the Healthy Zone relative to the proposed upper stock reference point. Given the well documented limitations of using CPUE as a stock status indicator there remains a critical need to continue surveys and provide a fishery independent estimate of stock biomass.

*GS15. General contributed papers*

*Oral*

## **GENETIC ADAPTATION AND PHENOTYPIC PLASTICITY OF HEART FUNCTION IN ATLANTIC SALMON**

*Neff, Bryan\*, Carlie Muir, Sashko Damjanovski*

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Hatchery stocking programs are a major tool used to support vulnerable fish populations and enhance recreational fishing opportunities. One of the major challenges associated with these programs is ensuring that stocked fish are successful after release into natural habitats. This challenge is increasingly complicated by climate change, which can lead to a mismatch between the thermal performance of stocked fishes and their environments. The ability of fishes to succeed in warmer environments depends on their capacity to maintain oxygen supply to tissues, which in turn is determined largely by the heart. Here I discuss my lab's work in this area, particularly as it relates to the choice of source populations and the design of hatchery rearing environments. Our work shows that heart function and morphology may be affected by both existing genetic adaptations and phenotypic plasticity associated with rearing temperatures. Genetic and genomic approaches have been central to identifying the mechanisms underlying this phenotypic plasticity, demonstrating that rearing temperature shapes heart development through consistent changes in the expression of early cardiogenesis genes. These data are discussed within the context of ongoing efforts to establish a recreational Atlantic salmon fishery in Lake Ontario.

*SS5. Native trout and salmon recovery*

*Oral*

## **ANCIENT ENVIRONMENTAL DNA AND HISTORICAL BIOGEOGRAPHY OF FRESHWATER ENDEMIC SPECIES**

*Nelson-Chorney, H.T.\* 1,2, Davis, C. 3, Taylor, M. 1,2, Vinebrooke, R. 3, and M.S. Poesch 1*

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*3 - Department of Biological Sciences, University of Alberta, Edmonton, AB*

Understanding historical species distributions is vital to the conservation and restoration of native species, yet such information is often qualitative. We show that the history of threatened salmonids can be reconstructed using species-specific markers amplified from ancient environmental DNA (aeDNA) found in lake sediment cores. Proof of concept was achieved through the detection of aeDNA from yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*), which corroborated with records of anthropogenic introductions of an unknown cutthroat trout subspecies. Elsewhere, we discovered westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) aeDNA in lake sediments that predated anthropogenic introductions of salmonids in a watershed with high topographical relief. This unexpected result revealed that the population was of native origin and requires additional conservation protection. Our findings demonstrate that aeDNA can be used to determine the colonization history of salmonids while simultaneously exploring the potentially detrimental impacts that aquatic invasive species have on endemic organisms (e.g., hybridization).

*SS5. Native trout and salmon recovery*

*Oral*

## **A VALIDATION OF HYDROACOUSTIC SURVEYS TO ESTIMATE FISH ABUNDANCE AND BIOMASS IN A SMALL NORTHERN LAKE**

*Nuspl, K.\*1, C. Stevens 1, K. Clipperton 2, M. Day 2, G. Ash 1, and C. Lee 3,*

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Hydroacoustics is a non-invasive sonar technique that can collect fish and fish habitat information over large areas within a short timeframe. The method also has the potential for estimating population and biomass when combined with limited sampling by traditional methods such as gill netting. We examined the reliability of echo integration and echo counting abundance estimates generated from repeated hydroacoustic surveys of a small lake in the Northwest Territories over four days in June 2015, when the lake was mixed and fish were most likely to be dispersed throughout the water column. Hydroacoustic estimates were compared to catch results from the fish-out of the waterbody that occurred immediately afterwards, prior to

dewatering for mine development. That dataset included 397 fish (188 kg biomass) from gill netting during the first phase, and 633 fish (225 kg biomass) total from the deployment of multiple gear types to complete the fish-out. For fish longer than 50 mm, mean survey abundance estimates were lower than the fish catch of all species combined (by 17% for echo counting and 10% for echo integration), and were slightly higher than the catch of Lake Trout and Lake Whitefish (by 4% for echo counting and 13% for echo integration), where the higher hydroacoustic estimate may reflect some sonar detection of benthic species. Although hydroacoustic-based estimates varied across surveys, and appeared to be sensitive to changing fish distributions during the survey period, the results demonstrate that hydroacoustics can accurately estimate fish abundance and biomass in lakes with relatively low field effort.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **USING ISOTOPES TO ASSESS PAST AND CURRENT NUTRITIONAL STATUS OF SOCKEYE SALMON**

*Peiman KS\*1, Power M 2, Patterson D 3, Hinch S 4, Casselman M 4, Cooke, S.J. 1*

*1 - Carleton University*

*2 - University of Waterloo*

*3 - Fisheries and Oceans Canada*

*4 - University of British Columbia*

Carryover effects occur when events experienced in one part of an individual's life affect subsequent performance. Carryover effects can be an important source of variation among individuals as they limit plasticity and affect population dynamics, and may be especially constraining when individuals only have one chance to reproduce. We tracked semelparous sockeye salmon (*Oncorhynchus nerka*) in the Fraser River, BC during the last phase of their spawning migration until death. We used stable isotopes from adipose tissue, blood and scales to assess nutritional stress during migration and diet/habitat use during their last summer in the ocean, used passive integrated transponders to measure migration timing, and then collected individuals upon death to assess spawning success. This combination of methods allowed us to link migration timing and spawning success to diet and habitat experienced months earlier and to assess whether isotope values changed during spawning, providing insight into how the ecological experience of salmon during their oceanic phase translates into fitness.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **MORPHOLOGICAL CONSEQUENCES OF HYBRIDIZATION BETWEEN DOMESTIC AND WILD ATLANTIC SALMON, SALMO SALAR, UNDER BOTH EXPERIMENTAL AND WILD CONDITIONS**

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The escape of aquaculture salmon has been identified as a significant threat to the persistence and stability of wild Atlantic salmon (*Salmo salar*) both in Europe and North America, yet the magnitude of possible impacts remains unresolved. Southern Newfoundland, with repeated escapes of farmed salmon and a large escape in 2013, provides a rare opportunity to evaluate the phenotypic consequences of interbreeding between wild and escaped farmed salmon. Laboratory reared wild, farmed, and hybrid salmon were grown in tank and stream-like conditions to investigate morphological consequences of interbreeding. Geometric morphometrics was used to quantify shape differences among types, and revealed significant differences between wild and farmed, and wild and hybrid at days 0, 40, and 80 in both tank and stream-like conditions. Shape differences were greater in tank conditions, but decreased in both over time. Overall, farmed and hybrid salmon were characterized by a greater body depth than the more streamlined wild salmon. Juvenile Atlantic salmon were collected in 2015 and 2016 from 13 southern Newfoundland rivers and classified as wild, farmed, or F1 hybrid using a diagnostic panel of 96 single nucleotide polymorphisms. As predicted by the lab experiments, farmed and hybrid had greater body depth than pure wild individuals. The observed shape differences represent one of the consequences of interbreeding between wild and escaped farmed salmon, and is consistent with phenotypic and genetic changes reported elsewhere. This supports hypotheses of significant impacts of introgression with domestic salmon on wild salmon populations.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Poster*

## **MAJOR HISTOCOMPATIBILITY COMPLEX VARIATION AMONG ALTERNATIVE REPRODUCTIVE TACTICS OF CHINOOK SALMON**

*Pitcher, T.E\*, Lehnert, S., Heath, D.D., Lewis, J.A. and Peters, K.*

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To investigate genetic diversity in Lake Ontario Chinook salmon, we genotyped males representing two alternative reproductive tactics, jacks (small sneaker males) and hooknoses (large guarding males). We genotyped fish from the population at neutral (microsatellites) and

functional (MHC II  $\beta$ 1) markers. Estimates of genetic diversity, including number of alleles, allelic richness and heterozygosity, were greatest for jacks compared to both hooknoses and females at the MHC. Females showed the lowest levels of genetic diversity, where only 50% of the females were heterozygous. Pairwise genetic divergence was calculated between the groups. Jacks and females were significantly genetically divergent, whereas all other pairwise comparisons were not genetically divergent. Genetic diversity estimates from neutral markers were similar among groups, with the exception of number of alleles, likely due to differences in number of individuals genotyped. There was no significant genetic divergence between jacks, hooknoses and females. These results suggest that there are genetic differences between alternative reproductive tactics that ought to be taken into account when examining the genetic make-up of the Lake Ontario population of Chinook salmon.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

### **NATIVE FRESHWATER SPECIES GET OUT OF THE WAY: PRUSSIAN CARP (CARASSIUS GIBELIO) ESTABLISHMENT IMPACTS BOTH FISH AND BENTHIC INVERTEBRATE COMMUNITIES IN NORTH AMERICA**

*Ruppert, J.L.W. and M.S. Poesch \**

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Prussian Carp (*Carassius gibelio*) are one of the most noxious non-native species in Eurasia. Recently, Prussian Carp were genetically confirmed in Alberta, Canada and have been rapidly expanding their range in North America since establishment. Given their rapid range expansion, there is an increasing need to determine how Prussian Carp may impact native species. We assessed the severity of the Prussian Carp invasion by 1) determining their impact on fish communities, 2) assessing their impact on benthic invertebrate communities, 3) evaluating if Prussian Carp alter abiotic conditions, and 4) identifying where we find higher abundances of Prussian Carp. When Prussian Carp were established, we found significant changes to the fish community. Correspondingly, the degree of impact to benthic invertebrate communities was related to the stage of invasion (none, early, or recent), where changes in fish communities were significantly concordant with changes in benthic invertebrate communities. Finally, we found that higher abundances of Prussian Carp were significantly associated with lower abundances of a majority of native fish species. Altogether, using three lines of evidence, we determine that Prussian Carp can have wide ranging impacts on freshwater ecosystems in North America, pressing the need for management intervention.

*SS7. Aquatic health: invasive species and disease*

*Oral*



## **TIME-LAPSE AND MOTION-DETECTION PHOTOGRAPHY TO ASSESS RECREATIONAL FISHERIES**

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Inland recreational fisheries generate many ecosystem services. Most of these services are generated cumulatively by numerous, small fisheries; yet, most monitoring and management attention is directed at a few, large fisheries because of their accessibility and visibility. Coincidentally, traditional sampling techniques are more amendable to these large fisheries. Recent technological advances provide opportunities to increase efficiency of monitoring small fisheries. We will present preliminary results of data being gathered by time-lapse and motion-detection cameras to highlight the potential for qualitative assessments of inland recreational fisheries. We will also discuss tradeoffs associated with this approach.

*SSI. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **UNDERSTANDING HARVEST DYNAMICS IN RECREATIONAL FISHERIES: DEVELOPMENT AND USE OF SPATIAL SOCIAL-ECOLOGICAL MODELS**

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We developed the first relatively complete landscape scale social-ecological system (SES) simulation model of a recreational fishery and ground-truthed it with independent landscape scale data on fishing effort. The empirical system on which it is based is a multi-stock recreational fishery for rainbow trout, *Onchorynchus mykiss*, with hundreds of individual lake fisheries, hundreds of thousands of anglers, originating from tens of communities, connected by complex road and trail networks, all spread over a landscape of approximately half a million square kilometers. The approach is unique in that it incorporates realistic and empirically derived behavioural interactions within and among the three key players in the SES: angler community, fish populations and management policies. Angler behavior was collected from a large spatially-stratified random sample of anglers and modelled with a latent class choice model that assessed anglers' behaviours when faced with fishing options that varied in catch and non-catch attributes. Angler class specific catchability and propensity to fish were parameterized empirically. Fish

population density-dependent growth and harvest dynamics were estimated empirically and modelled with size- and age-structured approaches. Management policies were characterized as the status quo in the fishery and alternate policies assessed through simulation. The patterns that we simulated at the landscape scale emerged from the dynamic behavioural interactions among anglers and fish populations that occurred at the lake scale, based on local management policy related to stocking rates and fishing regulations.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **EVALUATING ANNUAL VARIATION IN FISH COMMUNITIES AND IMPLICATIONS FOR BIOMONITORING**

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Freshwater ecosystems and fishery resources are vulnerable to anthropogenic influences and multiple stressors, and proper management techniques are required to assess, conserve or restore aquatic health. Biological assessment is a useful method for measuring and evaluating the effects of anthropogenic stressors on the ecological condition of water resources. Saskatchewan's fishery is of economic, cultural and ecological importance; however, incorporation of fish into monitoring programs has been limited, despite being useful indicators of aquatic health. We are developing a systematic approach for assessing stream and river health within Saskatchewan's boreal region, by adapting, applying and evaluating a fish-based Index of Biotic Integrity (IBI). A potential limitation of fish-biomonitoring studies is the effect of seasonality and timing of sampling on the interpretation of results, especially in northern regions where temperature extremes likely influence fish reproduction and mobility. The capability of the IBI to distinguish between natural and anthropogenic variability through time will determine its' efficacy in Saskatchewan. To evaluate potential annual variance in fish species richness, abundance and condition, we electrofished five streams in the late summer of 2016 and 2017 and measured water quality and habitat variables. These wadeable streams cover a gradient of disturbance in the Beaver River watershed. Results suggest that fish species richness remained constant between years; however, we found changes in species composition and abundance to be site specific. This test of annual variance in fish communities and environmental variables will help critically evaluate the reliability of IBI-type approaches in this biogeographic region.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **UNDERSTANDING THE IMPACTS OF MULTIPLE ANTHROPOGENIC STRESSORS ON AN AQUATIC TOP PREDATOR**

*Ramshaw, J. \*, Neil Rooney*

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The assessment of environmental impacts from multiple anthropogenic stressors has been a major concern for environmental managers. While influences on natural environments may seem insignificant individually, they become collectively substantial over space and time. These perturbations can manifest at the ecosystem level, causing changes to energy flow and food web attributes, as well as at the individual level where condition and performance of organisms are impaired. Broad-scale assessments of cumulative anthropogenic stressors on the Laurentian Great Lakes have presented an opportunity for understanding impacts on aquatic systems. We hypothesize that food web attributes and condition indices of top predators will respond to a gradient of human stressors. To investigate these hypotheses, Lake Trout (*Salvelinus namaycush*) from differentially stressed sites of Georgian Bay were collected. Lake Trout are native top predators and mobile generalist feeders, which integrate environmental effects across space and time. Individuals were dissected to obtain livers, gonads, stomachs, brains and stable isotope signatures. Stable isotopes and stomach contents are used in concert to assess differences in food web attributes across sites. Body condition, liver weight, gonad weight and brain weight were compared to assess organism responses to stress. Differences in the diet and isotope signatures of Lake Trout were found between sites. Lake Trout liver weight was lowest ( $p < 0.01$ ) in the least anthropogenically stressed site, while brain weight was highest ( $p = 0.01$ ). Understanding these responses in respect to the presence of specific anthropogenic stressors is of utmost importance for establishing effective restoration objectives for the Laurentian Great Lakes.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **ALBERTA'S 'JOE' MODEL: CUMULATIVE EFFECTS MADE EASY**

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Today's fisheries managers are faced with the daunting task of managing fish while trying to account for the multiple stressors and their complex interactions. A common dilemma in fisheries management or species-at-risk recovery is how to meaningfully deal with these cumulative effects and complex scenarios, beyond the typical and frustrating activity of simply writing long "grocery lists" of potential threats. In Alberta, we've solved this impasse by creating functional cumulative effects models, termed "Joe models" (after our mentor and hero, ichthyologist Dr. Joe Nelson). These are strategic-level tools used to combine and understand

cumulative effects on fish abundance. Each threat (e.g., harvest, exotic species, siltation) is treated as an independent dose-response curve acting on a single universal parameter (fish adult abundance). In workshop settings, any threats that participants believe to be significant are added to the model, and each is then quantified with a best-available-science dose-response curve. The final model combines these threat curves, with the end result being a quantified cumulative effects model. Any fish population can then be assessed with the degree that threats influence abundance, and therefore, what actions will be most effective in recovering that fish. These models are not predictive descriptors of fisheries status and responses. Instead, these models use the best-available science to create reasonable, quantitative hypotheses of cumulative effects and management actions. In Alberta, we are using them as the functional base for our fisheries recovery plans and actions, as well as developing effective fishing regulations. Oral-Native Trout and Salmon Recovery

*SS5. Native trout and salmon recovery*

*Oral*

## **COMMUNITY-LEVEL IMPACTS OF AN EXPERIMENTAL AQUACULTURE OPERATION**

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In order to evaluate the whole-ecosystem environmental impacts of aquaculture, an experimental aquaculture operation raised 10,000 rainbow trout in Lake 375 of the IISD-Experimental Lakes Area 2003-2008. Prey fish densities increased dramatically during aquaculture and declined sharply following aquaculture operations. High densities of littoral minnows in the fall did not translate into high spring catches, suggesting significant overwinter mortality of prey fishes. Lake trout, the top predator in the lake, increased in density while also increasing growth rates. This increase appears to have resulted from a decline in annual mortality and younger age at maturation at larger sizes during aquaculture. In the last year of aquaculture operations, the abundance of lake trout declined by 1/3 to background levels and continued to decline until 2011, 4 years after operations ceased. This was accompanied by a sharp decline in survival 2007-08. Age at maturity was delayed following operations. White sucker abundance and body condition declined during and after aquaculture, whereas size-at-age increased during aquaculture but returned to background levels shortly after cessation of operations. Similar changes were not observed in a nearby reference lake. While aquaculture appeared to benefit

many species for most of the duration of the experiment, declines in white sucker abundance and of lake trout abundance, condition and survival in the last year of operations suggest potential negative impacts in the long term (> 5 years) when operating in small boreal lakes. Importantly, this experiment suggests indicator variables for monitoring freshwater aquaculture impacts on native fish communities.

*SS11. Aquaculture and its impact on aquatic environments*

*Oral*

## **FISH ASSEMBLAGE STRUCTURE AND DYNAMICS IN NOVEL ECOSYSTEMS**

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Novel ecosystems are becoming increasingly common due to the reclamation of disturbed lands, the increasing popularity of constructing new habitats as biodiversity offsets, and continued anthropogenic modification of landscapes, such as the damming of rivers for hydroelectric development. Understanding the structure and dynamics of species assemblages in novel ecosystems and how they compare with what is expected or observed in natural systems is essential for understanding how novel ecosystems may enhance or conserve biodiversity, in the case of habitat offsets and reclamation, or erode and threaten biodiversity, in the case of landscape modifications. Furthermore, from a management standpoint understanding when, if ever, the species assemblages of novel ecosystems begin to resemble their natural counterparts is necessary for the formation of long-term management plans, determining appropriate management and monitoring end-points, and, in the case of biodiversity offsets, assessing projects in terms of their offsetting goals and targets. This work uses reservoirs and compensation lakes as examples of novel ecosystems and investigates whether the structure and temporal dynamics of fish assemblages in these systems is similar to what we find in natural lakes. Multi-variate statistical methods will be employed to explore patterns of community structure and temporal dynamics in lakes, reservoirs, and compensation lakes. Special attention will be paid to compensation lakes: fisheries offsets constructed in the Alberta oil sands to compensate for lost or degraded natural fish habitat due to open-pit mining.

*SS2. Improving the science and management of instream flows: moving beyond traditional approaches*

*Oral*

## **MULTI-SCALE CHARACTERIZATION OF BULL TROUT SPAWNING LOCATIONS – APPLYING LONG-TERM MONITORING AND RESEARCH TO HABITAT REHABILITATION DESIGNS**

*Robinson, M.D.\*1, Goodbrand, A.2, MacDonald, R.J. 2 and M. Gaboury 3*

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Line Creek is an important spawning tributary for Bull Trout (BT; *Salvelinus confluentus*) inhabiting the Elk River upstream of a migratory barrier at Elko BC. Ongoing fisheries monitoring has shown BT spawning to be associated with the pool/glide habitat typically created by large woody debris jams. In June 2013, a large flood mobilized much of the wood from Line Creek. Results from annual monitoring confirmed the loss of wood and associated pool habitat, as well as the lowest BT spawning counts on record. In 2014, we completed a multi-scale characterization of BT spawning locations in Line Creek to document habitat characteristics at watershed, reach, and channel unit scales. This study successfully described preferred spawning use in portions of the watershed, reaches within the creek, channel units, and hydraulic conditions within individual channel units. At the channel unit scale, we were able to develop a Habitat Suitability Index (HSI) based on water depth, water velocity, and vertical hydraulic gradient. This information was applied to rehabilitation designs at a variety of scales. At the watershed scale, this study is guided work into portions of the watershed suitable to BT spawning (corroborated by previous assessments) and guided work along reaches that lack the necessary habitat qualities required to support spawning. At the channel unit, or rehabilitation structure scale, these results coupled with habitat assessments are informing the designs to select structures that mimic the natural large woody debris jams displaced in June 2013. Rehabilitation work was completed in summer 2017.

*SS5. Native trout and salmon recovery*

*Oral*

## **WHY HARVESTING MAGNIFIES FLUCTUATIONS IN A DAPHNIA FISHERY EXPERIMENT**

*Rogers, L.A.\*1, Moore, Z.1, Daigle, A.1,2, Luijckx, P.1,3 and M. Krkosek 1*

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Fishing commonly magnifies fluctuations in exploited fish stocks, but the reasons remain unclear. This presents a problem for fishery managers because increased temporal variability in

fish abundance risks undesirable ecological (e.g. extinction) and economic consequences (e.g. fishery closures). We conducted a multi-generation *Daphnia magna* fishery experiment in order to resolve two leading hypotheses. Namely, that fishery-induced age-truncation leads to (1) more direct tracking of environmental variability by removing stabilizing size or age classes; or to (2) amplified deterministic nonlinear dynamics by changing underlying demographic rates. We found concurrence between our *Daphnia* fishery dynamics and wild fisheries. Harvested *Daphnia* populations exhibited greater temporal variability than control populations (measured by the coefficient of variation in abundance), and a stronger nonlinear signature indicative of an amplified deterministic nonlinear process. To explain the elevated variability, we tailored a mathematical model to the dynamics of the experimental *Daphnia* populations to identify (1) the relative importance of stochastic and deterministic processes, and (2) the mechanism underlying the deterministic process. We focused on age-structure in our model to reconcile the apparent contradiction that age-truncation, hence lower reproductive rates, led to amplified nonlinear dynamics.

*GS15. General contributed papers*

*Oral*

### **TOP PREDATORS AS MULTI-METERS FOR QUANTIFYING CUMULATIVE STRESS IN THE GREAT LAKES**

*Rooney, Neil\*, William Barbour, Kevin McCann, Jeremy Ramshaw, Rachel Salt*

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Assessing the effects of cumulative stressors on ecosystem structure and function presents one of the most important yet vexing problems for environmental management. Measurements to quantify cumulative effects must reflect the long lived and widespread effects of such cumulative stressors. Recent advances in food web ecology have identified ecosystem structures that are essential for the maintained and stable functioning of the ecosystems upon which we rely. Specifically, the roles of top predators and distinct energy channels in the maintenance of ecosystem function have been highlighted, and it is these very structures that must be maintained in the face of multiple stressors. We propose that using a suite of top predator metrics (growth parameters, feeding behaviours and physiological markers) as indicators of cumulative ecosystem stress addresses the problematic multi-scale nature of multiple stressors in aquatic ecosystems. Importantly, the different metrics quantified on the same individuals can highlight impacts of stressors that range from effects on individuals up to ecosystems. We present results from the Lake Huron and Georgian Bay top predators that suggest that predator indices have the potential to be useful tools in quantifying cumulative effects in an effective and efficient manner.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **IMPROVING THE SCIENCE UNDERPINNING FLOW RECOMMENDATIONS: MOVING BEYOND TRADITIONAL APPROACHES**

*Rosenfeld, Jordan*

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Managing human impacts on instream flows is a key responsibility for resource management agencies. Establishing environmental flow thresholds to protect aquatic life is becoming increasingly important under climate change and increasing industrial, domestic, and agricultural demands for water. Although instream flow science has a long history and well-established methods, many traditional approaches remain controversial, with considerable uncertainty in the predicted biological consequences of flow alteration. Reconciling emerging and traditional approaches remains an outstanding challenge for instream flow science; in this presentation I contrast traditional instream flow approaches (e.g. PHABSIM) with emerging ones (e.g. ELOHA, the Ecological Limits of Hydrologic Alteration). I provide an overview of the key role of flow-ecology relationships in determining environmental flows under ELOHA; the need for responsible agencies to invest in developing credible flow-ecology relationships; and the main elements that such a research program would include.

*SS2. Improving the science and management of instream flows: moving beyond traditional approaches*

*Oral*

## **CONCEPTUALISING CLIMATE CHANGE IMPACTS ON FISHERIES ECOSYSTEMS**

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The understanding of measured and anticipated impacts of climate change is essential to ensure sustainable resource use. Ecosystem-based fisheries management aims to preserve the integrity and function of aquatic communities and ecosystems, whilst balancing long-term sustainable use of fishery resources against shorter-term social and economic benefits. In practice, this remains focused on the evaluation and prediction of species abundance and productivity under different harvest strategies. Fisheries assessments are based on biological and relative abundance data and on assumptions pertaining to population structure and productivity, fishery catchability, species-environment interactions and other density-dependent processes. A changing climate affects the availability and suitability of aquatic habitats, the productivity and distribution of aquatic organisms, and community composition and interactions, in both space and time. This challenges fundamental assumptions in stock assessment and ecosystem models and the validity and representativeness of data collected using standard sampling protocols. Conceptualising direct and indirect implications of climate change for fisheries can assist with 1) effectively framing the biological, demographic, ecological and harvesting processes subject to climate forcing; 2)



identifying response mechanisms and potential trade-offs; and 3) provide a context within which to map areas requiring additional sensitivity testing and areas requiring methodological development in order to address emerging uncertainties. This paper will systematise pieces of the climate puzzle for fisheries ecosystems, and contribute to define a conceptual model that can facilitate the integration of environmental variables in fisheries assessments and advance integrated management of climate and fishing effects.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **COMBINING INUIT FISHERS KNOWLEDGE AND EMPIRICAL DATA IN THE ASSESSMENT OF EMERGING FISHERIES FOR ARCTIC CHARR IN NUNAVUT**

*Roux, Marie-Julie \*, Ross F. Tallman, Martin, Z.A.*

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Small-scale fisheries for Arctic charr *Salvelinus alpinus* are key to food security and economic growth in Arctic communities. Sustainable management of these fisheries is complicated by data paucity; by the widespread distribution and biological complexity of Arctic charr stocks; and by ongoing climate change impacts on Arctic fish and ecosystems. Inuit fishers have detailed knowledge of Arctic charr resources and their environment, which typically exceed the available empirical data in sample size and recurrence of observations. Inuit fishers knowledge (IFK) is highly relevant to Arctic charr fisheries management, yet methods are required to effectively incorporate IFK in stock assessments and management practice. In this paper, we implement a productivity-susceptibility analysis (PSA) for assessing the risk from fishing to Arctic charr stocks and incorporate IFK in the assessment process. The PSA consists of scoring productivity attributes of fish populations and susceptibility attributes related to fisheries exposure and intensity. The method can be adapted to incorporate IFK in the validation of biological data (indirect inclusion) and in the definition and scoring of IFK attributes (direct inclusion). The results serve to identify areas and stocks most vulnerable to fishing activities and formulate science advice for prioritisation and management. We demonstrate the method on Arctic charr stocks from Cumberland Sound, Baffin Island, Nunavut. Risk outcomes are compared between PSA performed with and without the inclusion of IFK. This represents a first step toward the integration of IFK in data-limited assessments of Arctic charr resources in Canada's Arctic.

*SS14. Indigenous resource management*

*Oral*

## **WATERSHED STRUCTURE, INTROGRESSION AND LIFE-STAGE DISPERSAL DRIVES GENETIC STRUCTURE OF A THREATENED AND DISPERSAL LIMITED SPECIES, THE ROCKY MOUNTAIN SCULPIN (COTTUS SP.)**

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Rocky Mountain Sculpin (*Cottus* sp.; hereafter RMS) are listed as a threatened species within Canada due to their limited distribution, drought, flow augmentation, and land-use change. To ensure the population viability of RMS we need to improve our understanding of genetic differentiation, which includes knowledge of dispersal ability, habitat configuration, introgression, and how ontogeny contributes to gene flow. Here we examined a combination of movement data from Passive Integrated Transponder (PIT) tags, Visible Internal Elastomer (VIE) tags, and genetic samples to characterize movement, spatial population genetic structure and introgression. RMS are sedentary, because 50% of adult (>65 mm) individuals only moved a maximum distance of 10 meters (upstream or downstream) over a 5-month period. We also find that watershed structure has a large influence on population genetic structure, where we identified four populations of RMS in Canada. Additionally, we confirm that introgression with Slimy Sculpin (*Cottus cognatus*) occurs due to niche partitioning throughout the Flathead River watershed, leading to the persistence of hybrid individuals. Lastly, while smaller adults (including juveniles; ≤ 65 mm) have similar dispersal to larger adults (>65 mm), we find that larval dispersal may be important to the maintenance of genetic differentiation. Our study demonstrates that genetic differentiation in RMS is closely dependent on watershed structure and flow, meaning that RMS are susceptible to stressors that alter flow regimes. Thus, conservation management plans need to consider the impact of future drought, flow augmentation, and land-use change within each watershed to ensure long-term viability of RMS populations.

*SS2. Improving the science and management of instream flows: moving beyond traditional approaches*

*Oral*

## **A COMPARATIVE ANALYSIS OF TROPHIC ECOLOGIES AND MERCURY BIOACCUMULATION IN FOUR CO-HABITING PISCIVORES OF BOREAL LAKES**

*Savage, Pascale-Laure\*1, Johnston, T.A. 1,2, and J.M. Gunn 1*

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At a landscape scale, much of the observed variability in fish total mercury (THg) concentrations across the boreal shield is among waterbodies, suggesting ecosystem-level effects on methylmercury production. However, there is also considerable variation among trophic guilds of fishes within waterbodies, with piscivores usually having the highest THg concentrations relative to other feeding groups. For a standard body size, variation in THg concentrations may also be substantial among species within a trophic guild, though the reasons for this have not been closely investigated. We examined the relative roles of food web position and growth rate in accounting for variation in THg concentration among four co-habiting, native piscivore species (walleye, northern pike, lake trout and burbot) in boreal shield lakes of Ontario, Canada. Linear mixed effects models relating THg concentration to carbon source (inferred from  $\delta^{13}\text{C}$ ), trophic position (inferred from  $\delta^{15}\text{N}$ ) and lifetime growth rate in a standard size of fish (1 kg) were compared using Akaike's Information Criterion (AIC). In general, variation among lakes was higher than variation among piscivore species, but in all instances models containing  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  ranked highest. These results suggest that subtle differences in food web position can account for more interspecific THg variation than growth rate in boreal piscivores.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Poster*

## **STOP THE SPREAD: ALBERTA'S DECONTAMINATION PROTOCOL FOR THE CONTAINMENT OF WHIRLING DISEASE AND AQUATIC INVASIVE SPECIES**

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In August 2016, whirling disease was detected for the first time in Canada, at Johnson Lake in Banff National Park. In effort to contain early detections and not inadvertently spread whirling disease and other aquatic invasive species to uninfected waters, a provincial multi-agency task team within the Government of Alberta created a decontamination protocol using with the best available standards and research. In August 2017, the Decontamination Protocol for Watercraft and Equipment became policy and mandatory for all government staff and contractors working in or near water and has been highly encouraged for industry and stakeholders to adopt. The protocol incorporates three levels of cleaning and decontamination; the level used is dependent

on the risk of spread based on work location. The risk of spread is coded geographically across the province on a decontamination risk map as: White zone (low risk), Yellow zone (moderate risk) and Red zone (high risk) and includes suspect positives not yet confirmed by the Canadian Food Inspection Agency (CFIA). The decontamination risk map is continually updated to reflect the most current risk conditions and detections to provide a precautionary approach for curbing the spread associated with the movement of contaminated vehicles, watercraft and equipment. The protocol fits within the provincial whirling disease program's immediate objective of detection, delineation and containment for the protection of Alberta's wild fish populations.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **EFFECTS OF BROWNIFICATION ON BOREAL LAKE METABOLISM**

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Terrestrial derived organic matter (t-OM) has been increasingly recognized as a factor controlling boreal lake productivity. Inputs of t-OM are increasing in many lakes across North America and Europe, which can stain lake water through a process colloquially known as 'brownification'. Lake brownification causes sunlight to attenuate more rapidly, reducing the amount of light available for primary producers. Canada is dominated by boreal forests with many lakes, of which, t-OM is the most abundant particulate and dissolved substance, originating from catchments surrounding lakes. The carbon balance in lake ecosystems is a delicate equilibrium between respiration and photosynthesis; t-OM dominates the carbon cycle. As CO<sub>2</sub> emissions increase, this equilibrium could shift, altering the energy balance of lake ecosystems, little is known about its' potential impacts on lake metabolism. This study will occur at the IISD-Experimental Lakes Area, using nine pristine boreal lakes spanning a t-OM gradient (3-14 mg DOC L<sup>-1</sup>). I hypothesize that higher concentrations of t-OM will have strongest (negative) effects on benthic producers, which are generally considered light limited, in response to reductions in light availability. In contrast, I hypothesize that higher concentrations of t-OM will increase phytoplankton and bacterial production as a result of increased loadings of organic nutrients. The importance of t-OM and bacterial production in supporting higher trophic levels remains highly controversial, this study will contribute to a separate assessment of energy sources supporting boreal lake food webs. With t-OM inputs anticipated to increase it is important to understand the effects it will have on autotrophic and heterotrophic production.

*SS10. Impact of climate change on aquatic ecosystems*

*Poster*

## **BIOPURIFICATION OF PB AND BIOACCUMULATION OF TL IN OTOLITHS OF TROUT-PERCH (PERCOPSIS OMISCOMAYCUS) FROM THE ATHABASCA RIVER, UPSTREAM AND DOWNSTREAM OF BITUMEN MINING AND UPGRADING**

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It has been suggested that open pit mining and upgrading of bitumen in northern Alberta releases Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl and Zn to the Athabasca River and its watershed. To assess this claim, trace elements were determined in otoliths of Trout-perch (*Percopsis omiscomaycus*), a non-migratory fish species, collected along the Athabasca River, to determine whether these elements are more abundant downstream compared to upstream of industry. Otoliths were analyzed using ICP-QMS, following acid digestion, in the metal-free, ultraclean SWAMP lab at the University of Alberta. Compared to the average abundance of trace elements in the dissolved (< 0.45 micron) fraction of Athabasca River water, enrichments of trace elements in fish otoliths decrease in the following sequence: Tl, Sr, Ag, Ba, Zn, Mn, Rb, Th, Cu, Sb, Cr, Fe, Pb, Ni, Co, Li, Y, Re, Al, Cd, Mo and U. The average Pb/Ba ratio in the otoliths is ca. 10 % of that of the Athabasca River, and 1 % of that of the Upper Continental Crust, due to "biopurification". In contrast, the Tl/Rb ratio of the otoliths is an order of magnitude greater than that of the river, due to "bioaccumulation". The Pb/Ba and Tl/Rb ratios of fish downstream from industry (sites BM, A8, A5 and A1) are not significantly different from sites upstream of industry (sites CW1, CWR2, UA5, A20, and A19). In fact, none of the elements analyzed in our study of otoliths is more abundant downstream versus upstream of industry.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **INTERACTION BETWEEN HYDROLOGY AND LAND USE IN DETERMINING RIVERINE DISSOLVED ORGANIC MATTER COMPOSITION**

*Silk, Peter\*, Christina Fasching, Marguerite A. Xenopoulos*

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Dissolved organic matter (DOM) is a critical constituent of stream ecosystems, and is controlled by hydrology and variation in the catchment landscape. The effects of land use and hydrology on DOM composition have been studied previously, albeit independently, and as such we lack a clear understanding of their combined effects. To address this, we sampled DOM in 13 catchments that vary in land use while also capturing several hydrological events (e.g., rising and falling limb of a flood and baseflow). We assessed DOM composition using its optical

properties. Using a combination of multivariate statistics, we found that land use factors are the primary driver controlling DOM composition, modulated by hydrological conditions. The amount of wetland area is a strong predictor of the DOM humification index in baseflow and falling limb conditions. Wetland area strongly influences aromaticity, but not during falling limb conditions. Additionally, the amount of agricultural area is correlated with aromaticity and the molecular size of DOM in falling limb conditions. The amount of microbially-derived DOM is controlled by the amount of cropland during peakflow. This suggests that both land use and hydrology are important factors in regulating DOM composition, but that in combination, their effects are altered. As such, both hydrology and land use must be taken into consideration when studying stream DOM.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Oral*

## **A FRAMEWORK FOR DESIGNING CITIZEN SCIENCE PROJECTS THAT INCORPORATE USER MOTIVATIONS AND RETENTION STRATEGIES TO OPTIMIZE PARTICIPATION.**

*Simmons, Sean\**

*Angler's Atlas*

Angler's Atlas is an online platform that has been collecting user generated data from anglers for over a decade. Through our platform we have developed a community of over 100,000 anglers, many of whom contribute information back to the platform. These data include fish species, access information (eg. boat launches), hot fishing spots, and thousands of fishing photos. Through the platform we have been able to test a wide range of data collection models and learned valuable lessons in how to engage anglers so they are willing to contribute data. In this seminar we will share with you the framework we have developed to engage and retain users, and how you can use these techniques to develop your own "Citizen Science" initiatives.

*SS1. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **RESPONSES OF ECOLOGICAL PROCESSES TO VARIABILITY IN WATER QUANTITY AND QUALITY**

*Sinnatamby\*, R.N. and J.R. Post*

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Increasing demands on water resources, and anthropogenic effects on aquatic ecosystems have long term consequences for water quality and quantity in rivers. The combined impacts of multiple stressors from climate change, flow regulation and different land use applications can

result in complex responses of ecological processes at various abiotic and biotic levels. Despite the increasing impact of these stressors on water resources, there is no clear conceptual framework in which to view these spatial and temporal alterations to these landscapes. In this study, we present a series of case-studies within a conceptual framework to illustrate how anthropogenic changes in abiotic conditions along the Bow River have altered ecological conditions and biological outcomes such as fish species composition and biomass.

*SS12. Multiple stressors and aquatic environments*

*Oral*

### **THE CRITICAL ROLE OF ENGOS IN PROTECTING AND RECOVERING SPECIES AT RISK IN CANADA**

*Skrajny, J.\**

*Alberta Wilderness Association, Calgary, AB*

Alberta Wilderness Association's (AWA's) work on westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) in Alberta is presented as a case study in order to highlight the critical role that ENGOS play in ensuring the protection of species at risk in Canada. Despite having been assessed by the Committee on the Status of Endangered Wildlife in Canada as threatened over ten years ago, few steps have been made towards westslope cutthroat trout recovery in Alberta. Most remaining populations are small, highly vulnerable, and exposed to ongoing habitat damage. Critical habitat protection was urgently needed, but repeated requests to the Minister of Fisheries and Oceans (DFO) went unheeded. In September 2015, AWA and Timberwolf Wilderness Society filed a notice of application in Federal Court, compelling the DFO Minister to issue a Critical Habitat Order. The Order was issued shortly thereafter, in December of 2015. Now that a critical habitat order has been issued, AWA's work in ensuring protection and recovery of this species becomes increasingly critical. AWA's current work includes ensuring that an Action Plan - outlining how the federal government intends to recover this species - is produced and that recovery and survival of this species is more than just a paper exercise: it will require significant changes to the way in which Alberta's forested headwaters are managed. Oral - Native Trout and Salmon Recovery.

*SS5. Native trout and salmon recovery*

*Oral*

## **PHYSICAL TIDEPOOL SEASCAPES EXPLAIN SIZE CLASS DISTRIBUTION AND SITE FIDELITY IN TIDEPOOL SCULPIN (OLIGOCOTTUS MACULOSUS)**

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Rapidly changing environments pose unique challenges to the organisms that reside under these shifting conditions. Tidepools vary in biophysical characteristics, which determine their suitability as a habitat and therefore influence the distributions of tidepool organisms. The effects on distribution could differ between age classes, depending on the intrinsic ontogenetic requirements and dominance relations. In this study, we investigate the influence of physical pool characteristics on the site fidelity and population distribution of Tidepool Sculpin, *Oligocottus maculosus*. We assessed short-term recapture of marked individuals and size class distribution among four pool sets. We found that variation in the proportion of adults between pools was primarily attributed to water temperature and pool volume, while rugosity significantly impacted the probability of recapture in adults. Smaller adult and larger juvenile fish were found in warmer, lower volume pools, while larger adults were found in larger, cooler pools. These results illustrate how intrinsic habitat features influence size class distributions in a resident tidepool sculpin species with corresponding impacts on site fidelity, and the tight fit between organisms and their environment.

*GS15. General contributed papers*

*Oral*

## **BIOLOGICAL EVALUATION OF 'FISH FRIENDLY' VERY LOW HEAD TURBINE TECHNOLOGY IN CANADA**

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*2 - Carleton University, 1125 Colonel By Dr., Ottawa, ON*

Novel turbine technologies are being proposed at river infrastructures (weirs, non-power dams), which need to be assessed for their fish friendliness and Canadian application. Very Low Head (VLH) turbine technology is unique, cost-effective, and developed to address a head of <5m and up to 500kW of capacity. A newly constructed VLH turbine on the Severn River, ON, provides a unique site for the first study of this technology in Canada. Our objectives are to assess a) the risk of entrainment to fishes in the vicinity of the turbine, and b) the injury/mortality rate of fish that are entrained, in order to quantify the serious harm potential for Fisheries Act decision-making related to VLH. In 2017 we implanted 138 telemetry tags on key fish species, and



deployed 18 datalogging hydrophones at strategic locations upstream and downstream to provide broad and fine-scale movement of tagged fish, including dam passage. These data will quantify the risk of entrainment to fish on a seasonal basis. In 2018 we will also capture fish most at risk of entrainment specifically to flush through the turbine and recapture downstream to quantify fish injury and mortality rates. Preliminary analysis of telemetry data indicate that, within one month, 4 individuals from 4 species out of a total 84 tagged at the time were detected downstream of the dam. Results will guide Fisheries and Oceans Canada on the potential of serious harm to fish from VLH installations, mitigation and/or offsetting recommendations, and if the technology can be considered ‘fish-friendly’.

*GS15. General contributed papers*

*Oral*

### **A DECADE OF SPECIAL LICENSES TO HARVEST WALLEYES; A FISHERIES MANAGEMENT TOOL THAT BRIDGES OPEN-ACCESS TO LIMITED-ACCESS FISHERY**

*Spencer, Stephen C.\**

*Alberta Environment and Parks, Spruce Grove, AB.*

When compared to other jurisdictions, Alberta has been described as a pressure point for fisheries management. Alberta has relatively fewer waterbodies, lower productivity, an expanding human population, and fish with high catchability. These limitations have resulted in several province-wide fishery collapses including local extirpations. Fisheries Managers experimented with ‘passive’ management tools such as shortened fishing seasons, adjustments to bag and size limits, with minimal success attributed to overwhelming angler effort. With the recovering fish populations, Alberta needed a management tool to provide harvest while protecting fish populations. The Special Harvest Licence program allows for tags identified through surveys for abundant fish by size category while accounting for other sources of mortality. Initially, this program was not well received by stakeholders, but recent license sales have indicated acceptance. However, there is considerations including the effects on other species in the fishery, additional costs to management and stakeholders, and indications that the Special Harvest Licence program will not provide sufficient protection with increasing catch and release mortality.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **SEASONAL MIGRATION OF CORIXIDS (HEMIPTERA: CORIXIDAE) OUT OF WETLANDS AND CONSUMPTION BY RIVERINE FISH**

*Srayko, S.H.\*1, Jardine, T.D.2, Phillips, I.D.1 and Chivers, D.P.1*

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Migratory insects that act as food web subsidies can be instrumental to fish production in lotic ecosystems. We have identified a potentially important subsidy in the form of migratory corixids (Hemiptera: Corixidae) that move from wetlands into Great Plains rivers during the fall. Results from 2015 and 2016 have indicated that corixid migration begins in late September, marked by tremendous increases in abundance in the rivers and decreased numbers in wetlands. A shift in species composition also occurred as wetland migrants arrived in the rivers. Gut content analyses from fish collected in the fall have shown that corixids were the predominant prey item in 14 out of 16 goldeye (*Hiodon alosoides*) and mooneye (*Hiodon tergisus*), in 11 out of 11 longnose sucker (*Catostomus catostomus*), and in 20 out of 38 white sucker (*Catostomus commersoni*), collected from multiple locations in two large rivers. These species were not found to feed extensively on corixids until the fall migration was underway. Stable isotope ratios of sulphur,  $\delta^{34}\text{S}$ , were used as a tracer of corixid movement, and preliminary results indicate that a distinctly negative  $\delta^{34}\text{S}$  value could be useful in discerning corixid origins and their importance to fish nutrition. This wetland based forage subsidy acts as a linkage between spatially separated wetland and river ecosystems, and underscores the need to conserve both habitat types together.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **CLIMATE DRIVES CATCHMENT-WIDE CHANGES IN MERCURY CYCLING IN THE HIGH ARCTIC'S LARGEST LAKE BY VOLUME (LAKE HAZEN, NUNAVUT, CANADA)**

*St. Pierre, K.A.\* , V.L. St. Louis , I. Lehnherr, A. Gardner, J. Serbu, L. Szostek, D.C.G. Muir, and C. Talbot*

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Across the Arctic, glaciers are melting and permafrost is thawing at unprecedented rates, releasing not only water to downstream aquatic systems but also contaminants, like methylmercury (MeHg) and total mercury (THg), archived over centuries in ice and soils. The Lake Hazen watershed, located in Quttinirpaaq National Park, on northern Ellesmere Island, (81.8°N, 71.8°W) has warmed considerably since the start of the century, but how this impacts the mercury cycle through the arctic freshwater continuum is yet unknown. Combining surveys of snow, glacial meltwaters, permafrost thaw streams and lakes, conducted between 2014 and 2017, we calculate annual mass balances of MeHg and THg for Lake Hazen, the world's largest

high arctic lake by volume, highlighting the seasonality of the high arctic freshwater mercury cycle. Annually, glacial rivers were the most important source of mercury ( $0.25 \pm 0.19$  kg MeHg/yr;  $9.3 \pm 8.3$  kg THg/yr) to Lake Hazen, accounting for more than 70% of the inputs to the lake; however, this mercury was largely particulate-bound and deposited to the depths of the lake, making the lake itself a mercury sink. Lake Hazen outputs to the Ruggles River were consequently very low ( $0.026 \pm 0.014$  kg MeHg/yr;  $2.0 \pm 1.1$  kg THg/yr), but erosion and permafrost slumping downstream of the lake increased Ruggles River MeHg and THg concentrations before waters flowed into Chandler Fjord. Dramatic increases in glacial melt since 2001 have increased MeHg and THg release to Lake Hazen from glacial archives by 0.01 kg/yr and 0.4 kg/yr, respectively, potentially negating the impact of recent reductions in global emissions.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **COMMUNITY-BASED CONSERVATION OF AN ARCTIC CHAR RUN IN NUNAVUT, CANADA**

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The Coppermine Inuit are concerned about the current state of the Arctic Char fishery in the Coronation Gulf. Management of the fishery is confounded by the potential effects of climate change and some stocks may be more vulnerable to habitat changes than others. In 2012, the Kugluktuk Hunters and Trappers Organization (HTO) initiated a conservation program for a stock associated with Nulahugyuk Creek where Traditional Knowledge identified a run in decline. The status of the run was monitored over multiple years using a two-way trap net at the creek mouth. Annual data from up to 425 spawners described an upstream run with a unique movement window peaking in late spring and with movements continuing through July as stream conditions quickly deteriorate. Low flows and elevated water temperatures reduce migration success of fish navigating the naturally shallow, boulder strewn creek. Less than 35% of migrants reach their spawning destination based on multiple years of PIT data. In 2012, the HTO tested the application of traditional rock weirs and instream engineering for extending the duration of suitable conditions for fish passage. Low-flow channels were constructed at five pinch-point locations where substrate was manipulated by hand to direct flows and fish. Post-manipulation water depth increased by up to 100% providing passage for fish. Five years later the low-flow channels remain intact and 13 other channels have been constructed. This

community-based approach may provide a novel, cost-effective solution for increasing the productivity of the fishery.

*SS14. Indigenous resource management*

*Oral*

### **WHY ARE THERE SO MANY LITTLE FISH? CASE STUDIES IN INCREASED HARVEST AND DECREASED SIZE OF FRESHWATER SALMONIDS**

*Sullivan, S.L. \* (University of British Columbia). Sullivan, M.G. (Government of Alberta)*

Fisheries managers are frequently pressured to create high-quality recreational fisheries, often defined as high catch rates of large fish. A common perspective is that “thinning-out” fish in high-density populations will allow them to become larger and establish a higher-quality sport fishery. Density-dependent growth, where individual growth rate declines in populations nearing carrying capacity, is the theoretical basis for this perspective. However, fish population responses to increased harvest can be varied and surprising, particularly in cold-water, low-productivity ecosystems. We demonstrate three case studies where increased fish size was not the result of increasing harvest. In two cases, increased mortality simply caused fish to live shorter lives, and in one case, resulted in drastic increases in compensatory recruitment, creating a fishery with innumerable small fish. These case studies act as a word of caution: increasing harvest to artificially create a specified population structure may have surprising and unintentional effects.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

### **HYDROACOUSTIC BASED ESTIMATES OF FISHERIES PRODUCTIVITY IN THE ATHABASCA OIL SANDS: IMPLICATIONS FOR OFFSETTING**

*Terry, Michael W. \*, Jonathan L.W. Ruppert, Mark S. Poesch*

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Projects in the Athabasca oil sands occur on such a vast spatial and temporal scale that completely avoiding or mitigating serious harm to fish is generally not feasible and achieving ecological equivalency in offsetting is rarely possible. As a result, developers have recently turned to the construction of compensation lakes to counterbalance, or offset, any residual impacts to the productivity of the affected fishery. However, these new lake systems are being constructed despite numerous conceptual and practical challenges, including the difficulty of quantifying the amount of offset required to ensure fisheries productivity is maintained or improved. In an effort to address this issue hydroacoustic surveys were conducted on six natural,

relatively undisturbed, lakes in the region to (1) establish a baseline for fisheries productivity in the oil sands, and (2) provide insight into the relationship between the provisioning of habitat and fisheries productivity. While more conventional survey methods rely on extensive direct sampling of fish populations, hydroacoustics provides a cost-effective, low impact alternative for monitoring both the biological and physical components of a water body. The results of this study provide an improved understanding of natural levels of productivity in the region and will aid in the development of appropriate offsetting strategies, improving the predictability and long-term performance of compensation lakes in the region.

*SS3. Environmental monitoring of fish and water in the Athabasca oil sands*

*Oral*

## **OFFSETTING IN AQUATIC ECOSYSTEMS, A META-ANALYSIS**

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Despite spending billions of dollars to restore or enhance degraded watersheds or compensate for their loss by creating entirely new aquatic ecosystems, studies evaluating project effectiveness remain rare. While most countries differ in aspects like implementation or execution of offsetting projects, adequate replacement of lost or degraded ecosystems prevails as a common denominator. Under this aspect, we conducted a meta-analysis assessing offsetting projects in aquatic systems on a global scale. A literature scan produced usable data for 548 offsetting projects which were included in the analysis. Four basic metrics were recorded for each project: project size, type of aquatic system, mitigation type and a measurement assessing the projects' success. Success criteria were converted to a common metric for either function or compliance to allow for among-project comparisons. To further understand different offsetting paradigms, case studies were divided into productivity, habitat, function and banking-based approaches. Results of this global analysis show that despite the considerable investment into offsetting, crucial key issues still persist. Overall acceptable compliance scores stood in sharp contrast to often very low function scores. While many countries have already considered including ecological assessments in offsetting projects (e.g. Rapid Assessment Method, Hydro-Geomorphologic-Method) a consistent and binding inclusion of such procedures is still lacking. Thus many projects, though fully compliant in meeting institutional requirements, do not adequately offset the long-term loss of ecosystem function. Both compensation science and institutional agencies have to improve their cooperation in order to bridge this gap.

*GS15. General contributed papers*

*Poster*

## **EFFECTS OF STREAM HABITAT STRUCTURE ON FORAGING IN ATLANTIC SALMON (*SALMO SALAR*)**

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Stream restoration programs frequently focus on increasing habitat complexity and the availability of shelters for small fishes. However, the consequences of shelter availability on the foraging behavior and growth of important native species such as Atlantic salmon (*Salmo salar*) are not well-understood. Moreover, little is known about how different strains of the same species might differ in their response to shelter availability. Atlantic salmon were extirpated from Lake Ontario due to human activity and since their extirpation; restoration attempts have focused on evaluating the suitability of two candidate strains (LaHave and Sebago). How these two candidate strains respond to an increase in shelter availability in Lake Ontario's tributaries may be an important factor that can influence their juvenile performance during restoration attempts. To address these knowledge gaps, I measured the feeding and activity of juvenile Atlantic salmon from the two populations while they were held in net pens erected in a Lake Ontario tributary that differed in their level of shelter. Fish from both populations foraged more and had greater activity when shelter was abundant. However the Sebago salmon showed a significantly greater difference in behavior between the high and low shelter treatments than LaHave salmon. Overall, the results suggest that high shelter availability is beneficial for Atlantic salmon, although the effect differed among strains, with Sebago showing a greater sensitivity to low shelter availability than the LaHave strain. I will discuss how our data might help direct recovery efforts for Atlantic salmon.

*SS5. Native trout and salmon recovery*

*Oral*

## **UNDERSTANDING THE DISTRIBUTION, DRIVERS, AND ENVIRONMENTAL IMPACT OF POLYCYCLIC AROMATIC HYDROCARBONS IN WATERBODIES OF THE PEACE-ATHABASCA DELTA**

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The Peace-Athabasca Delta (PAD) in northern Alberta, is the world's largest freshwater inland delta ecosystem. The ecological importance of the region has been identified through its classification as a wetland of global significance, and as a UNESCO World Heritage Site. The 30,000 ha PAD is ecologically important for a diverse community of organisms, and culturally and economically significant for indigenous communities that maintain a strong association with

the delta's landscape and wildlife. The location of the PAD, at the confluence of the Peace and Athabasca rivers, results in the potential for upstream environmental changes to impact the delta. This includes the potential for impacts due to water-level regulation for hydroelectric generation on the Peace River, as well as the input of contaminants from the Athabasca oil sands region. As part of an ongoing project to assess and monitor changing conditions, we are examining the distribution of polycyclic aromatic hydrocarbons (PAHs) in aquatic ecosystems of the PAD. PAHs are a group of organic compounds widely distributed in nature, which enter ecosystems through both natural and anthropogenic processes. As PAHs are known to be contaminants of environmental concern, understanding the controls on their distribution, and the potential for increased burdens from industrial activities, is critical. We will present data on the distribution of PAHs in sediment and in water in lake ecosystems. We will identify patterns and drivers of PAH concentrations, as well as explore the microbial community found in lake sediments and how community composition relates to the presence of contaminants.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **CUMULATIVE INFLUENCE OF WASTEWATER AND TRIBUTARY INPUTS TO WINTER WATER QUALITY IN THE ATHABASCA RIVER**

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Water is not only a resource, it's a life source. Alberta Environment and Parks (AEP) is committed to ensuring Albertans have good water quality and healthy ecosystems. Integral to this commitment is the collection of scientific data to understand how human activities influence spatial patterns and temporal trends in water quality. During the winter of 2015, AEP conducted a synoptic survey on the Athabasca River to a) evaluate winter spatial patterns in water quality, b) assess the cumulative effects of industrial and municipal point-source discharges on the Athabasca River during winter low flow, while considering major tributaries, and c) compare current water quality conditions in the Athabasca River to data collected in 1990-1993. Eighty sites were sampled along the length of the river including: the mainstem (Athabasca River), major tributaries, and wastewater for a broad suite of water quality parameters including in situ measurements, inorganics, nutrients, total and dissolved metals, coliforms, and organics (resin and fatty acids, phenolic material, chlorinated phenolics, priority pollutants, total recoverable hydrocarbons, alkylated polycyclic hydrocarbons, naphthenic acids, and pesticides). The Clearwater River had the largest influence on water quality in the Athabasca River, having both an increasing and diluting effect on certain parameters. The discharge of treated wastewater into the Athabasca River resulted in local impacts to water quality for many parameters, in particular colour and nutrients. Data comparisons between the 2015 and 1990-1993 surveys indicated that most parameters had similar concentration ranges and spatial patterns. Exceptions to this generalization include potassium, total nitrogen, and total arsenic that had higher levels in 2015

within the Lower Athabasca compared to previous surveys. Results illustrate how spatial water quality patterns in the Athabasca River is influenced by natural transitions in the landscape, special landscape features, inputs from tributaries, and inputs from treated wastewater.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **THE EFFECTS OF TERRESTRIAL ORGANIC MATTER INPUTS ON LAKE FOOD WEB PRODUCTIVITY**

*Tonin, Joseph \*, Michael Paterson*

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Boreal lakes are intimately connected to their surrounding catchments by the flow of energy and nutrients. Many lakes receive substantial inputs of terrestrial organic matter (t-OM; allochthonous energy), which may be several orders of magnitude greater than the organic matter generated within a lake. There is increasing interest in the effects of allochthonous energy on lake food webs as inputs of t-OM into boreal lakes are anticipated to increase with climate change. Using nine lakes spanning a gradient t-OM concentration as space for time substitution, I will test how the relative utilization of different basal resources (autochthonous vs. allochthonous energy) by invertebrates varies among lakes, and how utilization of these resources influences food web productivity. Our results suggest benthic invertebrate biomass productivity is primarily driven by indirect effects of t-OM on habitat availability (e.g. water temperature and oxygen), rather than direct effects on basal resource availability. These findings add our basic understanding of lake food webs and can inform managers to better assess the long-term impacts of increasing t-OM concentrations on boreal lake food webs.

*SS10. Impact of climate change on aquatic ecosystems*

*Poster*

## **COMMUNITY-BASED MONITORING OF ARCTIC CHARR (SALVELINUS ALPINUS) FROM THE NEPIHJEE RIVER SYSTEM (KUUJJUAQ, NUNAVIK)**

*Tran, L. \*, B. Ford and S. Suppa*

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In 1998, local Inuit-led management initiatives were put in place to introduce anadromous Arctic charr to the Nepihjee River watershed. A fishway was constructed at the mouth of the Nepihjee River to allow anadromous Arctic charr to migrate past an impassable waterfall. Complimentary to the fishway, an Arctic charr hatchery was established to further support population development. The main goal is to provide the community of Kuujjuaq with a sustainable Arctic charr fishery. Monitoring of the Nepihjee River Arctic charr population has since taken place



every summer, with the objective of building up a long-term Nepihjee River Arctic charr dataset. Sampling includes identifying, counting, and measuring all fish species going through the fishway, as well as identifying previously tagged fish. This has produced one of only a few long-term data series on Arctic charr in Nunavik. It provides an excellent opportunity to transfer valuable knowledge and skills in scientific fisheries sampling and population assessment techniques and has been hugely successful in terms of involving graduate students and local students as well as creating youth employment opportunities over the years. This project is an example of a long-standing Inuit-led conservation initiative that prioritizes community capacity-building, education, and northern cultural values.

*SS14. Indigenous resource management*

*Poster*

**POTENTIAL IMPACTS OF AN INTRODUCED PREDATORY FISH (CICHLA MONOCULUS) ON THE DIET AND TROPHIC ECOLOGY OF A NATIVE PREDATOR (HOPLIAS MICROLEPIS) IN LAKE GATUN, PANAMA**

*Valverde, M.\* Diana Sharpe, Mark Torchin and Chapman, L.*

*McGill University/Smithsonian Tropical Research Institute (STRI) - McGill University/STRI - STRI David Buck- Biodiversity Research Institute (BRI)*

In the context of invasive species, fish are among the most commonly introduced organisms in freshwater systems. Some of the most dramatic outcomes following an invasion have been linked to the introduction of predatory fishes. Introduced predators can greatly affect native prey through predation, but they can also strongly impact native predators through predation on juveniles and/or competition. This can result in important ecological changes to the native predators, such as shifts in diet and trophic position. In this study, we focus on the predatory peacock bass (*Cichla monoculus*) that was introduced into Lake Gatun, Panama in the late 1960's, and explore its potential effects on the diet and trophic position of a native predatory fish: *Hoplias microlepis*. During the 2016 dry season in Panama, we sampled lakes and reservoirs that differed in their invasion status by the peacock bass (presence or absence) and used stomach content and stable isotope analyses to test for dietary and/or trophic position changes. Our results suggest that in the presence of the introduced peacock bass, *H. microlepis* enlarged its isotopic niche and diversified its diet, but with a loss of body condition. Furthermore (and unexpectedly), the invasive predator seems to be facilitating the native predator by providing a trophic subsidy, as *H. microlepis* was found to scavenge on remains of the invasive *C. monoculus* returned to the system by fishermen. Our results highlight the complexity of interactions occurring in invaded systems, as well as the importance of using complementary approaches to study them.

*SS4. Trace me if you can: stable isotopes, diet, and aquatic species management*

*Oral*

## **ASSESSING NATIVE LAMPREY POPULATIONS IN GREAT LAKES TRIBUTARIES TO EVALUATE THE POTENTIAL FOR INVASIVE SEA LAMPREY PRODUCTION UPSTREAM OF PHYSICAL BARRIERS**

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Physical barriers have been constructed in 49 tributaries in the Great Lakes basin to restrict migrating sea lamprey (*Petromyzon marinus*) access to upstream spawning habitat as a component of the bi-national Sea Lamprey Control Program (SLCP). Hundreds of other dams, which were built for other purposes, also provide a sea lamprey control function. The SLCP has implemented a watershed-based initiative to assess the production potential for sea lamprey in reaches upstream of barriers using extant native lamprey populations as a surrogate. Production assessments provide a method to evaluate sea lamprey control alternatives and allow for the completion of risk assessments. In such studies, larval abundance is estimated by quantitatively sampling wadeable waters using backpack electrofishing. Habitat is characterized in relation to larval lamprey preference. Empirical and quantitative data are then used to estimate the annual production potential of metamorphosed individuals by linking time, growth, and logistic regressions to estimate the proportion of larvae that will metamorphose in the following year. The results of these analyses allow for a better understanding of the importance of specific structures to the SLCP while analogously characterizing native lamprey populations and habitat available upstream of the structure. Often, these studies represent the only contemporary data available on the status of native lamprey populations in their respective watersheds.

*GS15. General contributed papers*

*Oral*

## **NUTRIENT CYCLING AND ALGAL COMMUNITY STRUCTURE IN AGRICULTURAL STREAMS OF ALBERTA**

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Streams provide important ecosystem services such as organic matter transformation, nutrient uptake, provision of water for livestock and irrigation, and fish habitat. Streams run through anthropogenically altered areas including municipalities, crop lands, and pastures, which can affect in-stream nutrient status through point and nonpoint source inputs. When large quantities of nutrients enter streams, nutrient cycles can become impaired, leading to increased transport to downstream systems with consequent effects for eutrophication. Three potential metrics for quantifying stream health and function are nutrient uptake potential, algal taxonomic composition, and aquatic community thresholds. Algal community structure is being investigated

at 58 streams within the agricultural regions of Alberta, half in the Grassland and half in the Parkland ecoregions. Periphyton samplers were left in each stream for one month in late-spring and mid-summer, to collect and identify algal communities to genus. These data will be analyzed using NMDS ordinations and threshold analyses to determine whether algal community structure is related to nutrient concentrations. Nutrient injections using Cl<sup>-</sup>, NH<sub>4</sub>-N, and PO<sub>4</sub>-P tracers are being used to calculate mass transfer coefficients (vf) in up to 30 of the selected streams, and an information theoretic approach will be used to evaluate which stream characteristics best explain variation in vf across streams. This presentation will provide preliminary results, including a comparison of stream water chemistry across the study systems. The results of this research are intended to guide watershed management programs in Alberta's agricultural region by suggesting nutrient endpoints that maintain aquatic ecosystem services in streams.

*SS13. Aquatic nutrients: dynamics and algal blooms*

*Poster*

## **TURNING POPULATION VIABILITY ANALYSIS ON ITS HEAD: EVALUATING INVASIVE SPECIES REMOVAL SCENARIOS USING PVA IN A DECISION ANALYSIS**

*van Poorten, Brett T.\*, Martina Beck, and Matthias Herborg*

*British Columbia Ministry of Environment, Vancouver, BC Beck, Martina: British Columbia Ministry of Environment, Victoria, BC Herborg, Matthias: Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, BC*

Removal or control of many invasive species is an important part of freshwater management for many agencies, but how do you evaluate which removal methods to use? Each removal method or combination of methods will have different costs and their efficacy is difficult to determine because of possible density-dependent feedbacks. Moreover, getting the money to begin control is often difficult so there is uncertainty in the cost of inaction. We suggest that population viability analysis (PVA), commonly used to evaluate extirpation probabilities for species at risk, may be a useful tool to evaluate removal strategies. The PVA rapidly calculates a number of stochastic events over time to provide the probability of eradication when different management actions are taken. We demonstrate how a PVA can be used to evaluate various combinations of removal strategies on several case studies, namely smallmouth bass in lakes and northern pike in the upper Columbia River. We further show how results can be incorporated into a decision analysis, thereby simultaneously communicating a variety of metrics to decision makers. This new tool will help quickly evaluate and communicate plans of action so limited budgets can be allocated to the most appropriate responses to protect native fauna.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **EVALUATING LANDSCAPE PATTERNS OF FISHING IMPACTS USING A NEW RECREATIONAL FISHERY ASSESSMENT MODEL**

*van Poorten, Brett, and Divya Varkey*

*British Columbia Ministry of Environment, Department of Fisheries and Oceans*

Assessment models are valuable in evaluating the state of a fish population and characterizing the risk to overfishing. However, there are relatively few assessment methods developed for recreational fisheries, partly because of their numbers and difficulty gathering data. Recreational fisheries provided by stocked fish are a special case: there is no conservation concern (to the stocked population), but they provide a particular social experience by varying size and numbers at stocking. Because of the cost in rearing and stocking these populations, stocked fisheries are often surveyed to ensure the fishery they provide meets expectations of managers and anglers. However, there are still few assessment methods that can utilize these data to return estimates of fishing mortality and therefore the utilization of the stocked fish by anglers. We present a new assessment model that can take advantage of infrequent catch-at-age and -length data from gill net or trawl surveys to estimate key parameters related to the fish population and fishing impacts on it. Simulation-evaluation demonstrates the model is able to recover model parameters with reasonable accuracy. We use the model to estimate parameters for 250 assessed stocked rainbow trout fisheries in British Columbia to evaluate fisheries impacts across the landscape. This exercise helps managers understand areas that may be prone to higher fishing mortality, either suggesting higher stocking rates are needed or additional fishing regulations should be put in place to provide fish for more anglers.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **THE RETURN OF THE STRIPED BASS (MORONE SAXATILIS) IN THE ST. LAWRENCE RIVER: DOCUMENTING EARLY LIFE HISTORY TO BASE THE MANAGEMENT OF THIS LONG-AWAITED FISHERY ON SOLID SCIENCE**

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The Striped Bass (*Morone saxatilis*) is highly exploited in North America and generate considerable economic benefits. In the St. Lawrence River (SLR), the population was extirpated by the mid-1960, due to cumulative effects of habitat destruction and overfishing. A

reintroduction program started in 2002 and it is now recognized that the population self-reproduced during the last decade. However, very little is known about the ecology of this new striped bass population in the SLR, especially the habitats used during early life that are essential for recruitment. In this study, we tested the hypothesis that (1) the estuarine turbidity maximum (ETM) and (2) migratory behaviours provide the most suitable conditions for the growth of early life stages in the SLR. Based on physico-chemical parameters, four habitats were defined in the SLR: an upstream freshwater section (UFS), an oligohaline and mesohaline estuarine turbidity maximum habitats (O-ETM and M-ETM) and a downstream mesohaline section (DMS). Growth trajectories were reconstructed for 305 larvae and juveniles using otolith microstructure. For juveniles sampled in September, we reconstructed habitat utilization using otolith microchemistry. This analysis revealed the coexistence of migratory contingents early in life: freshwater residents and ETM migrants. Along the growing season, results showed a higher growth rates in the UFS and O-ETM habitat compared to downstream habitats. Freshwater residents exhibited the fastest-growth compared to ETM migrants. This study provided results on Striped Bass early life stages that will contribute to the conservation of this re-established population and to the debate of the re-opening of the recreational fishery.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

## **CURRENT STATUS OF THE WHIRLING DISEASE PARASITE, MYXOBOLUS CEREBRALIS, IN ALBERTA**

*Veillard, M.\*, James, C., and Giamberardino, P.*

*Government of Alberta, Edmonton, AB*

In August 2016, the first detection of whirling disease in Canada was confirmed in Alberta at Johnson Lake, Banff National Park. Since its discovery, whirling disease has become a prominent issue in Alberta and has prompted Alberta Environment and Parks to initiate a Whirling Disease Program dedicated to managing the disease throughout the province. The foundation of this program is a three-pillared approach built around delineation, education and mitigation. As part of the delineation plan, surveillance efforts were conducted in 2016 and 2017 to help define the current distribution of the whirling disease parasite, *Myxobolus cerebralis*, in Alberta. To date, the disease has been confirmed in the Oldman River, Bow River, and Red Deer River watersheds. The parasite has been detected in low numbers in the North Saskatchewan River and supplementary sampling is underway to confirm if the parasite has established in the North Saskatchewan River watershed. In this talk we provide a detailed update on the current known extent of *M. cerebralis* in Alberta in addition to ongoing initiatives of the Whirling Disease Program for future surveillance.

*SS7. Aquatic health: invasive species and disease*

*Oral*

## **ADDITIVE, NON-ADDITIVE, AND MATERNAL EFFECTS ON DNA METHYLATION AMONG DIFFERENT SALMON REARING ENVIRONMENTS**

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Chinook salmon are an important sport fish in the Pacific Ocean. Millions of dollars are spent on enhancement programs each year to restore salmon runs across British Columbia, though differences in fitness and phenotype have been observed between wild and first-generation hatchery-reared fish. It has been proposed that hatchery environments induce epigenetic differences in salmon that cause these differences, though a direct link between hatchery environment and altered DNA methylation has not been established. Here we created 6x6 factorial breeding crosses using Chinook salmon and reared them in both a typical hatchery environment and in a semi-natural spawning channel at Yellow Island Aquaculture, Ltd. We measured DNA methylation for 16 genes involved in development, metabolism, immune and stress response using a PCR-based DNA methylation assay for Next-Generation sequencing. We tested for environment-specific differences in DNA methylation and partitioned the variance in DNA methylation to additive, non-additive, and maternal effects to test for genotype-by-environment effects on DNA methylation. Our results will determine whether early environments induce epigenetic changes in the genetic architecture of Chinook salmon, which could improve future conservation and supplementation practices.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **COMPARING ESTIMATES OF FISHING EFFORT AND LAKE CHOICE DERIVED FROM AERIAL CREEL SURVEYS AND SMARTPHONE APPLICATION DATA IN ONTARIO, CANADA**

*Martin, T.J.1, and P.A. Venturelli,\*2*

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*2 - Department of Biology, Ball State University*

Mobile smartphone applications (apps) are a potentially lucrative source of conventional and novel data that describe angler behaviour. In this study, we compare results from app and aerial creel survey data from Ontario, Canada. A standard major axis regression of angler effort estimated from creel and app data found low agreement ( $n=111$ ,  $R^2=0.20$ ,  $p<0.001$ ), and app-based effort was poorly explained by lake characteristics in a random forest analysis (7.66% vs. 29.52% for creels). Explained variation improved when we included all lakes with app data (rather than only lakes with both app and creel data), but province-wide predictions of effort

based on lake characteristics did not agree between the two data sources. We attribute these inconsistent results to low sample sizes for app data, and inherent differences in the way that app and creel data were analyzed. These results highlight the need for big data, big data approaches, and innovative analytics for incorporating app data into fisheries science.

*SSI. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **"APPY" DAYS ON THE HORIZON: INITIAL RESULTS FROM A DANISH APP FOR COLLECTING RECREATIONAL FISHERIES DATA**

*Skov, C.1 and P.A. Venturelli\*2*

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Smartphone applications (apps) that allow anglers and other recreational fishers to record the details of their fishing trips and catches have emerged during recent years. If well designed, such apps can be a valuable and low-cost source of data that can feed into recreational fisheries management. This includes traditional, fisheries-dependent data on catch (harvest and release) and more novel data that explore how anglers interact with management as well as the resource. Clearly, there are multiple challenges related to angler apps and future research needs to understand the weakness and limitations as well as the strengths and benefits. This study presents preliminary data from the app “Fangstjournalen”, which was developed to generate quality data for research and management. The platform, which includes a browser version, is primarily financed by the Danish national fishing license, and has received support from ministries as well as fishing clubs. The numbers of users has grown steadily since the app was launched in 2016. Here, we present patterns of app user demography and compare them with those of non-app users to explore potential patterns of user bias. We present data on retention time (i.e., how long the anglers use the app) and explore why some anglers stopped using the app. As examples of strengths and benefits, we present examples of traditional fisheries data from the app (e.g., species-specific catch rates, release rates, size distributions) and compare these to creel-based data.

*SSI. Digital media as a source of contemporary and novel fisheries data*

*Oral*

## **SPENDING THE CONSERVATION DIVIDEND; THE EFFECTS OF CLOSING ALBERTA COMMERCIAL FISHERIES**

*Wakeling, K.W.\* 1, Sullivan, M.G. 2, Brown, M. 1*

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*2 - Alberta Environment and Parks, Alberta Fish and Wildlife Policy, Edmonton, AB*

Prairie Provinces are not always the first places thought of when discussing commercial fisheries. Alberta has previously supported more commercial licences than the British Columbia coastal commercial fisheries. Limited fisheries resources are a significant management challenge in Alberta, too many users competing for too few fish. Commercial fisheries generated considerable social and political conflict between stakeholders with competing objectives. Cumulative harvest pressures on slow growing fish stocks with few growing degree-days coupled with unsustainable fishing practices and repeated overharvest of fish stocks resulted in the collapse of many fisheries. Escalating conflict between biologists and commercial fishers stemming from management decisions aimed at recovering fish stocks and a growing instability of the commercial fishery lead to an external review. The outcome was the closure of commercial fishing by the Government of Alberta in 2014. Monitoring the changes in fish stocks and population dynamics resulting from the reduction in mortality is important. There are many unknowns about how the fish populations may change. Comparisons of assessment data before and after the closure on lakes across the province looking at metrics like abundance, size and age structure and growth rates has been conducted to determine if changes have occurred and are detectable. Initial information suggests that population recovery of sport fish is slow but ‘overpopulation’ leading to a collapse is likely not a risk. Clarifying the ecosystem results has biological, social and political implications to setting and achieving fisheries management objectives and meeting our obligations for fisheries allocations as a management organization.

*GS15. General contributed papers*

*Oral*

## **FISH-BASED ESTIMATE OF IN-STREAM FLOW NEEDS**

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*Ministry of Forests, Lands and Natural Resource Operations. Penticton BC*

Developing in-stream flow targets for spawning fish is challenging. Traditional methods rely on habitat simulation models and estimates of wetted usable width. However, these methods are rarely validated using biological data and the relationship between water quantity and spawner success is unknown. Wood Lake kokanee spawn in Middle Vernon Creek and this system has experienced large fluctuations in the kokanee population due to water quantity issues in the spawning habitat. We have compiled data on spawner abundance and fry production at various flow levels to better understand the relationship between flow and fry production, while



accounting for recruitment dynamics. Results suggest minimum flow targets for this system are approximately 50 L/s.

*SS2. Improving the science and management of instream flows: moving beyond traditional approaches*

*Oral*

## **BULL TROUT – LAKE TROUT INTERACTIONS IN A LARGE RESERVOIR REVEALED BY ACOUSTIC TELEMETRY**

*Ward, T. \*1, Dirk Algera 1, Phil Harrison 1,2, James Crossman 3, Alf Leake 3, Michael Power 2, & Cooke, S.J. 1*

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*3 - BC Hydro Fish and Aquatics, E11 – 6911 Southpoint Drive, Burnaby, BC*

Bull trout are a cold-water specialised salmonid of conservation concern, with populations designated as special concern or threatened within their Canadian range. In the upper Peace River, one of the main threats to native bull trout populations is competition from introduced lake trout. While bull and lake trout are sympatric in their native ranges, they historically occupied distinct ecosystems as a result of environmental filtering. Bull trout abundance has declined in response to lake trout introductions, a phenomenon attributed to competitive exclusion by lake trout, although the mechanisms of this interaction are not well understood. Here, we investigate bull trout – lake trout interactions in Williston Lake, BC using a large acoustic telemetry array, spanning 100 km of habitat and 160 individual fish. We find seasonal variation of habitat use, and corresponding long range movements indicative of spawning migrations. Our results provide evidence of substantial overlap in space use between species, as well as potential indicators of habitat partitioning. We also note substantial movement among fisheries management units, suggesting there may be a spatial mismatch in the scale of management for these species. This work provides a foundation for further investigation into the ecological interactions of competing species, and may have broad reaching implications for our understanding of these species coexistence.

*SS5. Native trout and salmon recovery*

*Oral*

## **GENOMIC SOLUTIONS FOR FISHERIES MANAGEMENT – THE SEARCH FOR THE MISSING FISH**

*Ward, H.\*1, P. Askey 2 and M. Russello 3*

*1 - Ministry of Forests, Lands and Natural Resource Operations. Penticton BC*

*2 - Freshwater Fisheries Society of BC, Summerland BC3. University of British Columbia, Kelowna BC*

The kokanee population on Wood Lake in British Columbia exists as two reproductively distinct eco-types (shore and stream spawners) and is an example of a multi-stock fishery where high quality stock assessment data are required to make fisheries management decisions. The enumeration of shore spawning kokanee is difficult using visual surveys and a new method is required to accurately assess this stock. The objective of our study was to develop a method to use genetic data from angler harvest to estimate the number of shore spawning kokanee. Our results demonstrate that shore and stream spawning kokanee were genetically distinct and that the eco-type proportions observed in the angler harvest are representative of the spawning cohort. The proportion of shore spawning kokanee seen in the standard visual survey varied between 0.01 and 0.36. Genetic estimates of shore spawning kokanee varied from 1,975 to 16,513 between 2002 and 2016, which is four times higher than previously estimated.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **REVIEW OF SCIENTIFIC SUPPORT OF MITIGATION MEASURES FOR WORKS IN AND AROUND WATER**

*Warner, L.A.\* and Chipperzak, D.*

*Stantec Consulting Ltd., 200-325 25th Street SE, Calgary, AB*

Pipeline associated watercourse crossing activities have the potential to cause serious harm to fish and fish habitat, as defined in the Fisheries Act. Most of the effects from pipeline associated watercourse crossings can either be avoided or the pathways of these effects (PoEs) can be broken through the effective implementation of mitigation measures. Mitigation to break PoEs has been used and accepted by regulators; however, the effectiveness of some mitigation has not yet been demonstrated by science-based evidence. To assess the knowledge on the effectiveness of watercourse crossing mitigation, Stantec completed a comprehensive literature review of the PoEs and science-based support for mitigation measures commonly implemented during pipeline associated watercourse crossings. The most common and important effect on fish and fish habitat was found to be erosion and disturbance of the streambed and bank, resulting in sedimentation within a watercourse. Other potential effects include changes in habitat structure and cover, access to habitat, direct mortality, changes in nutrient concentration, food supply, temperature, baseflow and hydrodynamics, and addition of contaminants. Where mitigation measures have

not effectively broken PoEs, it is typically due to improper application of the mitigation measures or unforeseen events. We identify where science-based support for mitigation is not available and where limitations or gaps in our knowledge exist. Further research is recommended on the effects to fish and fish habitat related to the scale of activities observed at pipeline watercourse crossings and on the effectiveness of mitigation used to break PoEs.

*GS15. General contributed papers*

*Oral*

## **FISH AND FISH HABITAT IMPACTS ASSESSMENT TOOL**

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*Stantec Consulting Ltd., 200-325 25th Street SE, Calgary, AB*

Stantec has developed a Fish and Fish Habitat Impacts Assessment Tool which standardizes assessments and reporting for pipeline and associated temporary vehicle crossing projects to be compliant with the Fisheries Act and Species at Risk Act. The tool was funded by the Canadian Energy Pipeline Association, along with its partners the Canadian Gas Association and the Canadian Association of Petroleum Producers, and developed in collaboration with the National Energy Board and Fisheries and Oceans Canada (DFO). The tool uses DFO's Pathways of Effects (PoEs) to identify the potential stressors, pathways, and effects for a given activity, and then applies avoidance and mitigation measures to "break" these pathways. A comprehensive literature review was completed to provide the science and evidence based support for the operational guidance in the tool; this review was summarized in a science support document that underwent review by DFO's Canadian Science Advisory Secretariat, a DFO scientific peer review and analysis process. As PoEs remain consistent over time, it is anticipated the tool will be largely unaffected by the anticipated amendments to the Fisheries Act. Although it was developed for the pipeline industry, the tool can be adapted for transportation infrastructure projects, such as roads, rail, and utility lines.

*GS15. General contributed papers*

*Oral*

## **ENVIRONMENTAL DNA – REAL TIME RESULTS IN THE FIELD TO CONFIRM THE PRESENCE OF TARGET SPECIES**

*Murdoch, M.,<sup>1</sup> Chipertzak, D.,<sup>1</sup> Warner, L.,\*<sup>1</sup> Thomas, M.,<sup>2</sup> Hanner, R.,<sup>2</sup> and Crookes, S.<sup>2</sup>*

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Environmental approvals and investment decisions by project proponents require rapid and reliable means to detect and monitor potential environmental constraints such as species at risk,

invasive species, keystone species and pathogens. Sampling the environment for DNA (eDNA) has recently emerged as a reliable and cost effective method for assessments and biomonitoring. eDNA is DNA shed by organisms into their surrounding environment. The environment is sampled and then tested for the presence of DNA from the target species of interest. This approach does not require the capture, or visual confirmation of the target species. As compared with conventional field surveys, sampling for eDNA is rapid, less labor-intensive, and provides an objective way to confirm species presence or absence. It also provides distinct advantages with respect to worker safety. While the promise of benefits is high, a substantial constraint remains in that the analysis of eDNA is predominantly performed by academic research laboratories that lack a commercial model for delivery of timely and reliable results, with predictable costs. A field-based eDNA sampling and testing tool has recently emerged and provides real-time results in the field. We will review the proof-of-concept testing that has been conducted to demonstrate the benefits of this eDNA field tool to confirm the presence of aquatic species, along with the quality control measures built into the tool to provide reliable results. We will also review examples of how eDNA sampling has been incorporated into projects to augment conventional survey approaches used for different industry sectors.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Oral*

## **A GENOMIC BASELINE FOR ASSESSING INDIRECT GENETIC IMPACTS OF AQUACULTURE ON ATLANTIC SALMON (*SALMO SALAR*) IN PLACENTIA BAY, NEWFOUNDLAND**

*Watson, K.B. \*, Bentzen P., Waples R., Duffy S., Grant C., Dempson B., Paterson I.G. & Bradbury I.*

*Dalhousie University, Bedford Institute of Oceanography, Fisheries and Oceans Canada, Halifax, NS*

Genetic interactions between domesticated and wild Atlantic salmon (*Salmo salar*) have been identified as a significant threat to the persistence of wild populations. However, uncertainty remains regarding the relative magnitude of direct and indirect genetic interactions and the consequences for wild salmon. In 2016, the expansion of net-pen salmon aquaculture into Placentia Bay, Newfoundland was approved, which when operational will more than double production in the region. This expansion will use largely all-female triploids to minimize direct genetic interactions (i.e., hybridization and introgression). As such, this provides an unprecedented opportunity to better understand indirect genetic impacts of farm-wild interactions including both changes in population size and adaptive diversity due to ecological interactions with aquaculture activities (e.g., competition, disease, predation). We will generate a multi-year genomic baseline, which will allow the estimation of effective population size and an exploration of adaptive diversity prior to the proposed expansion. Juvenile salmon were collected in 2016 from 26 locations in Placentia Bay. Population structure and effective population size were

preliminarily investigated with a panel of 101 highly polymorphic microsatellite loci ( $F_{ST} = 0.072$ , average number of alleles per locus = 9.5). Estimates of effective population size and structure indicate small populations structured along an east-west divide. Ongoing work will utilize large SNP arrays (220K) to characterize spatial diversity and better quantify effective population size. The baseline information collected will allow accurate quantification of indirect genetic effects of open net-pen salmon aquaculture on wild populations, and directly inform conservation of wild salmon in Atlantic Canada.

*SS6. Genomic, proteomic and transcriptomic advancements in aquatic monitoring*

*Poster*

### **AGRICULTURAL DUGOUTS AS SOURCES OR SINKS FOR GREENHOUSE GASES: A SPATIAL ASSESSMENT IN SOUTHERN SASKATCHEWAN**

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Ponds and small lakes are known to be hotspots for carbon and nutrient cycling in landscapes, but are currently underappreciated in global inland water cycles. Such water bodies are particularly important in agricultural landscapes as they receive, store and process large quantities of organic matter and nutrients which would otherwise enter downstream waterways. Small reservoirs, including artificially-constructed farm ‘dugouts’, are estimated to cover 77,000 km<sup>2</sup> globally and feature prominently throughout the Canadian Prairies; however, most research on greenhouse gas (GHG) fluxes to date has focused on natural lakes and wetlands. The purpose of this program was to examine the GHG balance of farm dugouts by directly measuring dissolved concentrations of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). Here, we present preliminary findings on dissolved GHG levels from a spatial survey of 101 dugouts distributed across southern Saskatchewan. All gases exhibited a wide range of concentrations, ranging from 0.05-110 nM (N<sub>2</sub>O), through 0.1-65 μM (CH<sub>4</sub>) and 1-340 μM (CO<sub>2</sub>). Dugout CO<sub>2</sub> values were in the range of those observed in regional wetlands (130-472 μM) and lakes (0.1-2,000 μM), with an average CO<sub>2</sub> concentration (~45 μM) below that of other hardwater and saline sites (70-100 μM). Less is known of regional CH<sub>4</sub> concentrations, although mean dugout CH<sub>4</sub> values (~5 μM) were similar to that of global ponds (7.6 μM). Unexpectedly, ~70% of dugouts exhibited N<sub>2</sub>O levels below that of the atmosphere and show promise of being an N<sub>2</sub>O sink. Although no spatial trends were observed, a range of environmental drivers were identified which offer opportunities to inform best management practices to maximise GHG capture.

*GS15. General contributed papers*

*Oral*

## **USING FISH HEALTH AND COMMUNITY MEASURES TO EVALUATE CUMULATIVE DOWNSTREAM EFFECTS FROM FOREST HARVEST ACTIVITIES, IN NORTHERN NEW BRUNSWICK**

*White, C.F.H\* 1, M.A. Gray 1, K.A. Kidd 2, J. Lento 3 and W.A. Monk 4.*

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Effects of forest harvesting on headwater aquatic ecosystems are well studied in North America, however, the cumulative downstream effects are not well understood. Northern New Brunswick is an area of widespread forest operations, with the potential for past and present forest management to have lasting effects on receiving waters. We assessed the effects of cumulative disturbances on individual fish health and community measures of Brook Trout > age 1 at increasing catchment scales, in watersheds with varying degrees of forest harvest intensities (intensive, extensive and minimally managed; 6 sites in each watershed, 18 total). Environmental (i.e., temperature, water quality and landscape variables) and fish habitat measures (i.e., # pools/100m, wetted depth-width-ratio) explained 35.0% and 29.1% of the variance among sample sites (PCA1 and PCA2 axes, respectively). The spread in PCA1 was driven by log<sub>10</sub> turbidity and the separation between treatment catchments was influenced by log<sub>10</sub> alkalinity, log<sub>10</sub> forest harvest (% harvested 2006-2016) and cumulative degree days above 15°C. There was no effect of harvest intensity on condition (weight-length relationship) or densities of Brook Trout across the gradient of catchment scales. However, relative densities of Brook Trout decreased with increasing catchment scales across all levels of forest harvest intensity. These catchment-scale assessments are important for increasing our understanding of downstream effects of forest harvesting and facilitate informed decisions around the extent and types of harvesting in a catchment.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **PREVALENCE, INTENSITY AND DISTRIBUTION OF SALMINCOLA EDWARDSII ON RESIDENT BROOK TROUT (SALVELINUS FONTINALIS) IN TWO FORESTED CATCHMENTS OF NORTHERN NEW BRUNSWICK**

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Parasites can have significant effects on the functioning of freshwater communities, acting as a stressor on the health and fitness of individual fish hosts. Developing baseline information on poorly studied parasites and mapping their distribution and prevalence is important for monitoring freshwater fish populations under changing climatic conditions. We assessed infestation prevalence (% fish sampled with parasites present), infestation intensity (# parasites/infested fish), and attachment location of an ectoparasitic copepod on brook trout (*Salvelinus fontinalis*) at ten sites in two forested catchments in Northern New Brunswick. The putative morphological identification is *Salmincola edwardsii* but integrative diagnosis will be made in combination with sequencing of a variable region of the 28S rDNA. Prevalence ranged from 19.0 –79.6 % across sites, with an overall average prevalence of 48.9%. Mean infestation intensity was  $1.5 \pm 0.9$  copepods/fish, with a maximum of 7 on one individual. Parasites were located almost exclusively in the dorsal and adipose region (49.1% and 48.5%, respectively) and were observed to attach to the operculum, fin rays and bases of fins. Chi-square analysis indicated that the size of trout was not related to parasite prevalence or the site of attachment. The occurrence of parasites was greater in the dorsal region of trout with 2 or more parasites, which could have resulted from space limitations on preferred attachment locations. Infestations of these ectoparasites are noteworthy in wild populations as they can reduce fitness and thus have impacts on local populations. Educating recreational anglers on the identification and reporting of this parasite will help to create a better understanding of the distribution and extent of infestation across a broader geographic area.

*GS15. General contributed papers*

*Oral*

## **THE ROLE OF SMALL RESERVOIRS FOR GREENHOUSE GAS RELEASE TO THE ATMOSPHERE: WHEN HUMANS IMPACT BEAVER POPULATIONS**

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Emissions of biogenic greenhouse gases from freshwater systems are an important component of global carbon and nitrogen cycles. Recent syntheses have highlighted the important role of reservoirs for greenhouse gas release to the atmosphere, with artificial reservoirs perceived as having enhanced emissions. Much of the extant data are for large, human-constructed reservoirs; comparatively little is known about small and natural reservoirs, including those established by beavers through dam building. This gap was addressed by quantifying global methane emissions from beaver ponds and through a subsequent study of beaver pond greenhouse gas (carbon dioxide, methane, nitrous oxide) dynamics in a region of South America where these mammals were introduced. Currently, beaver facilitate significant emission of methane globally, and the importance of human impacts on this mammal are evident through large temporal changes in this methane source. In Tierra del Fuego, where rapid beaver population expansion resulted following their introduction, this aquatic methane efflux is suggested to constitute an important regional source. Open-water season measurements of diffuse and ebullitive fluxes of greenhouse gases for these beaver ponds (n = 36) are used to demonstrate whether establishment of ponds in landscapes that were relatively undisturbed prior to beaver introduction can also stimulate emission of carbon dioxide or nitrous oxide.

*SS12. Multiple stressors and aquatic environments*

*Oral*

## **VARIATION IN LANDSCAPE CONFIGURATION AND SOCIAL-ECOLOGICAL PROCESSES DRIVES PATTERNS OF EXPLOITATION AMONG SPATIALLY-STRUCTURED RECREATIONAL FISHERIES**

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Spatially-structured recreational fisheries are complex adaptive social-ecological systems. Macro-scale patterns, like the distribution of overfished populations, can emerge from local-scale interactions between fish and people which occurs across space and time. There is thus a need to understand how these macro-scale patterns emerge to help guide management. We present a generalizable and stochastic social-ecological model that varies (1) the spatial-configuration of a recreational fishery, (2) fish population production, and (3) heterogeneity in angler preferences for site-attributes. We then modelled different combinations of these processes (e.g., angler heterogeneity versus homogeneity, or patchy versus diffuse distribution of a lake-to-town network) to test how changes in these processes drive macro-scale patterns in the fishery, like



angling effort and fish population collapses. Our general findings corroborate expectations of the systematic depletion of fish populations adjacent to towns. Individual fish populations exhibit wide boom-bust cycles due to site-switching behavior of catch-oriented anglers, however the aggregate fishery (i.e., the landscape-scale) is more stable than these individual populations. Diverse and asynchronous fish population dynamics tended to provide a mechanism for this stability. Heterogeneity in angler preferences tended to increase the risk of collapse, but this depended on the preferences for catch-attributes in the angler population. Results of our theoretical model have general implications for spatially-oriented management, with different scale-dependent patterns emerging from different combinations of spatial, social, and ecological processes.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

### **COMPARING FISH COMMUNITY COMPOSITION IN INVASIVE PHRAGMITES AUSTRALIS SSP. AUSTRALIS AND NATIVE EMERGENT SPECIES' IN THE ST. CLAIR RIVER DELTA**

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Invasive *Phragmites australis* ssp. *australis* (herein “*Phragmites*”) has established and rapidly spread throughout many coastal areas of the Great Lakes. In several locations it has displaced native emergent species potentially changing spawning, nursery and foraging habitat for fishes. The extent to which *Phragmites* provides habitat for freshwater fishes is currently unquantified, although it is widely suspected to be unsuitable. This study assesses whether fish assemblages and production in stands of *Phragmites* differ from that in stands of two native emergent species, *Typha* spp. and *Schoenoplectus* spp. The focus is on marshes within the St. Clair River Delta, which are similar in terms of species pool, water levels and the degree of shoreline disturbance that may also influence fish assemblages. Habitat data (e.g., water quality, water temperature, stem density, and substrate type) was collected concurrently to help identify potential drivers that may influence fish richness and production. The preliminary results of this study suggest that invasive *Phragmites* does provide suitable habitat for freshwater fishes, although not entirely comparable to that provided by native emergent habitats. This study will provide collaborating management agencies, Walpole Island First Nation and Fisheries and Oceans Canada, with quantitative data on potential impacts to fish and fish habitat associated with the spread of this invasive species.

*GS15. General contributed papers*

*Oral*

## **ENHANCING IMMUNITY AND DISEASE RESISTANCE IN FISH BY CHITOSAN-SELENIUM NANOPARTICLES**

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A food grade immunostimulant with broad reactivity across the immune system is highly desirable for aquaculture. Chitosan stabilized selenium nanoparticles (CTS-SeNPs) was developed using controlled reduction of sodium selenite at room temperature and was added to commercial fish feed. Zebrafish (*Danio rerio*) were supplemented with 0, 2, 5, 10 and 20 ppm CTS-SeNPs for 9 days and immune responses was determined. At 5 ppm and 10 ppm CTS-SeNPs, these fish also showed improved survivorship to 25.57% and 25% compared with the control (5%) when challenged by a common aquaculture pathogen, *Aeromonas hydrophila*. Moreover, lysozyme activity (1.8-fold) and respiratory burst (2.4-fold) were all significantly enhanced by using 10 µg/g CTS-SeNPs. In term of adaptive immune responses, lymphocyte (T cell and B cell) proliferation, and immunoglobulin M expression were also improved and helped host against pathogen infection. The results show that CTS-SeNP is a good potential immunostimulant. In addition, we will discuss a novel method of Orbitrap LC-MS/MS based analysis of serum immune proteins using just 2 µg of serum protein. This method might be suitable for non-destructive testing fish immune condition in the future.

*SS11. Aquaculture and its impact on aquatic environments*

*Oral*

## **CHARACTERIZING DIET AND GROWTH OF A MARINE FISH INVADING THE GULF OF ST. LAWRENCE**

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Increases in ocean temperatures are driving the shift of marine species' distributions towards the poles and to greater depths worldwide. Incursions by marine organisms into regions that had previously been unsuitable for their establishment may result in ecological consequences for native species including altered predator-prey interactions. An example of such a species in the

Northwest Atlantic silver hake (*Merluccius bilinearis*), a small gadoid species historically distributed from Georges Bank to the Scotian Shelf. Following the occurrence of exceptionally warm temperatures in Southern Newfoundland and the Gulf of St. Lawrence (GSL) since 2010, anomalous abundances of silver hake have been recorded by DFO RV surveys in the northern GSL. In the past, lower ocean temperatures in the GSL were considered a biogeographic barrier for silver hake, but the rapid warming of the region provided an opportunity for a dramatic expansion of this species' northern range. Silver hake is of interest because it matures rapidly and is known to be an important predator of both invertebrates and fishes. Using silver hake samples caught during survey trawls from 2015-2017, we quantified the trophic role of this species in its new habitat using stomach contents analyses. Age estimation and measurement of otoliths from the same samples were used to determine the rate of growth of these fish. Our study provides new insights on the implications of shifts in geographic distributions and interactions at the northern edge of a geographic range.

*SS10. Impact of climate change on aquatic ecosystems*

*Oral*

## **THE EFFECT OF MULTIPLE STRESSORS ON SUBARCTIC AQUATIC SYSTEMS: IMPACTS OF CLIMATE CHANGE AND ROAD DUST**

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Arctic regions are experiencing rapid warming rates that far exceed the global mean, often resulting in fundamental aquatic ecosystem changes. Furthermore, many Arctic regions are being subjected to additional anthropogenic stressors from increasing human development. For example, the release of calcareous dust from gravel highways has been shown to physically and chemically alter terrestrial landscapes, whereas little is known of its effect on aquatic systems. We investigated the potential impact of road dust on water chemistry and diatom assemblage composition in lakes near the Dempster Highway in the Peel Plateau region, Northwest Territories, Canada. Water chemistry from 28 lakes revealed that lakes within 1 km of the highway generally exhibited elevated levels of conductivity and related variables compared to lakes farther from the highway, suggesting that calcareous road dust has affected the chemistry of these lakes. To determine whether road dust and/or regional warming have affected algal

communities, a paleolimnological analysis was undertaken using diatoms, spectrally-inferred chlorophyll-a, and chrysophyte scale to diatom valve ratios from dated sediment cores (two impacted lakes within 1 km of the highway and one reference lake situated outside the expected range of dust transport). Our results indicated that the main driver of algal changes of both impacted and reference lakes has been regional warming, with minimal impact associated with dust from road construction and use. Although the limnological changes associated with the half century old highway corridor appear clear, they are not yet of sufficient magnitude to elicit a directional biological response in algal communities.

*SS12. Multiple stressors and aquatic environments*

*Oral*

### **PREDATOR DENSITY AND NOT LITTORAL STRUCTURE DETERMINES YOUNG-OF-YEAR BASS MORTALITY IN LAKES**

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Productive fish populations that can successfully recover from fishing pressure depend on survival of their young of the year (YOY). Littoral structure, like coarse woody habitat (CWH), is sensitive to human development and is widely hypothesized to regulate YOY survival by providing refuge from predation pressure on YOY. From the perspective of freshwater recreational fisheries managers, understanding the shape of the relationship between fish productivity and habitat is vital for restoring or protecting sport fish populations, yet we lack a basic understanding of this relationship. We estimated YOY largemouth bass mortality in 13 lakes in Northern Wisconsin and Michigan that exist along a lakeshore development and CWH gradient using repeated measures of relative abundance of YOY over the open water season. YOY mortality estimates were strongly correlated with YOY predator densities, explaining 70% of the variation in mortality estimates. Despite a clear predation effect, there was no detectable effect of CWH on YOY largemouth bass mortality. At the given level of uncertainty in our YOY mortality estimates, bootstrap analysis suggested only relatively weak positive or negative effects of CWH on YOY mortality were possible. These results challenge our current understanding of the functional role of CWH and littoral structure in lakes and their usefulness as a recreational fisheries management tool to alleviate YOY mortality.

*SS8. Recreational fisheries management and science: balancing conservation with angler preference*

*Oral*

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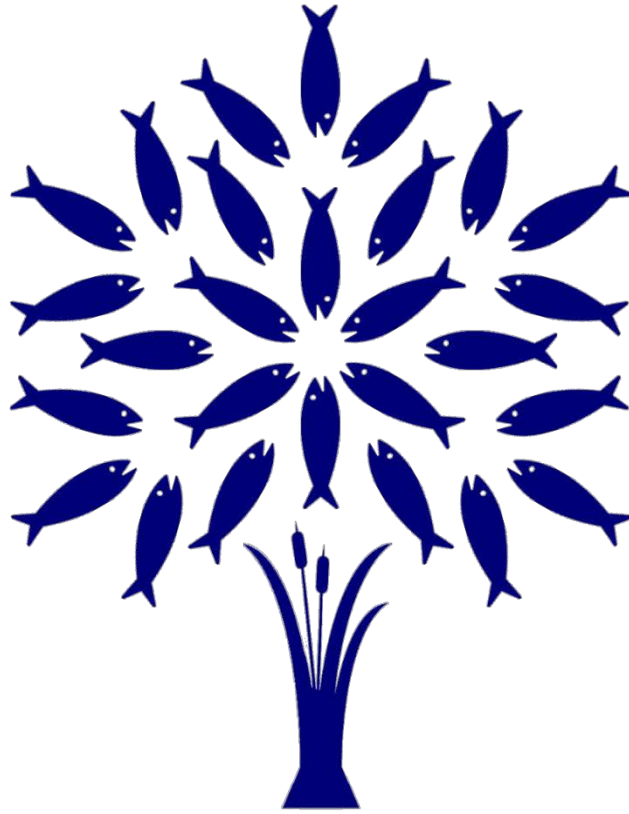
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# **CCFFR SCL 2019**

*Resilience, Adaptation, and Mitigation  
Strategies for Conserving Canada's  
Aquatic Resources*

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