CCFFR-SCL 2022 Abstracts

Plenary lectures

J.C. Stevenson Award — Dr. Chelsea M. Rochman

Rochman, C.M.*, Mcllwraith, H. University of Toronto. **Plastic pollution in the Laurentian Great Lakes: the state of the science and how it informs policy.** Plastic debris is accumulating in ecosystems across the globe. As concern rises around the risks of plastic debris in valued ecosystems, more studies have documented the presence of plastic debris, both macro- and micro-, in the Laurentian Great Lakes basin. Plastic pollution has been reported in sediments, surface waters, and biota across the Great Lakes basin. It has also been reported in drinking water. In addition, studies have demonstrated that microplastics can lead to toxicity in local fauna, and risk assessment frameworks suggest some species may be at risk. This talk will: 1) characterize the monitoring and research efforts regarding plastic pollution across the Great Lakes; 2) synthesize the current understanding of plastic pollution in the Great Lakes; 3) suggest effective strategies to track and report plastic pollution in the Great Lakes based on management objectives; and 4) propose metrics for using plastic as a science-based ecosystem indicator.

Frank H. Rigler Award — Dr. Sherry Schiff

Schiff, S.* University of Waterloo. **Paths to Discovery: Eureka, Surprise or "Of Course"?** Aquatic scientists work on problems relevant to human society. Yet Discovery is at the heart of science. The perceived pressure to contribute original research can be daunting and a source of anxiety for young scientists. Here, examples from the latter part of my career will be selected to explore some of the many paths to discovery including failure. Research spans a range in field sites from small boreal headwater lakes, a high Arctic great lake to a highly impacted urban river, and encompasses processes on isotopic, DNA to whole watershed scales, and organisms from microbes to fish to humans.

Friday sessions

Applied Science: Barriers, Flows, and Connectivity

Mazany-Wright, N.*, Laudadio, A., Noseworthy, J., Sra, S., Norris, S.M., Rebellato, B., & Lapointe, N.W.R. Canadian Wildlife Federation. **New tools for fish passage restoration: a national barrier database and watershed-based planning framework**. Assessing and improving connectivity of Canada's freshwater systems by remediating barriers to fish passage is vital to restoring ecosystem structure and function; however, this is resource intensive and scarce resources must be allocated strategically to maximize ecological benefits. The Watershed Connectivity Remediation Planning framework can assist teams in strategically addressing barriers to fish passage through collaborative planning. It supports estimating

the connectivity status of a watershed, setting quantitative goals to improve connectivity, prioritizing barriers for assessment and remediation, and action planning for implementation. Spatial analysis tools were developed to identify movement corridors and habitats, calculate connectivity status, and identify priority barriers. Such strategic planning requires comprehensive barrier data. The Canadian Aquatic Barriers Database (CABD) fulfills this need by mapping barriers with standardized attributes. The CABD comprises a clean hydrographic network, datasets for multiple barrier types, and an accessible web mapping interface. Data for pilot regions were released in fall 2021.

Sherker, Z.*, Zubick, P., Lapointe, N.W.R., Maloney, D., Lotto, A.G., & Hinch, S.G. The University of British Columbia. **Rivers and roads: Effectiveness monitoring for culvert remediations to improve salmon passage.** Pacific salmon cannot access thousands of kilometers of spawning and rearing habitat in B.C. because of culvert barriers. Tens of millions of dollars have been spent to remediate these barriers by either retrofitting culverts with baffles and weirs, or replacing them with bridges. Very little monitoring has been done to assess the effectiveness and longevity of these remediations. We are assessing fish passage at 20 bridge replacement and 20 culvert retrofit sites (aged 10-15 years) by comparing fish community structure and abundance upstream and downstream of remediated sites. We collected data for 14 retrofit sites in 2021, and found that over a third of these had no anadromous salmonids upstream, and two thirds had lower species richness above the culvert, suggesting that these sites were again barriers. Structural assessments of the remediated culverts indicated that failed rock weirs and unresolved stream constriction issues were the biggest inhibitors to fish passage.

Enright, D.* & Rosenfeld, J. University of British Columbia. E**valuating the consistency of ecological responses to minimum flows by salmonids.** Determining instream flow needs for aquatic species is essential for effective flow regulation and conservation of fish populations. However, conducting research to determine the effects of flow in individual streams can be costly and time-consuming. Consequently, management actions may need to be taken with limited information. We conducted a literature review to extract relationships between flow and salmonid abundance and performance metrics (e.g., growth, survival). We will standardize and aggregate these data for analysis to determine if consistent relationships and thresholds exist between salmonids and flow across studies. This meta-analysis will provide insight into the mechanisms that drive flow-ecology relationships, and hopefully generate quantitative guidance to instream flow managers for data-deficient management contexts.

Bergman, J.*, Landsman, S., LaRochelle, L., Glassman, D., Neigel, K., Rennie, C., Bennett, J., & Cooke., S.J. Carleton University. **What are the ecological impacts of winter water level drawdowns on muskellunge in Canada's historic Rideau Canal?** Winter is an ecologically challenging time for fish in Canada. In systems that experience annual winter water drawdowns, many of the pressures that already threaten fish survival during winter can be exacerbated. In a northern portion of the Rideau Canal, water levels are lowered each October by almost 3-metres; because much of the area is relatively narrow (~250-metres) and shallow (<6-metres), the drawdown considerably reduces the availability of overwintering habitat to fish. The Rideau Canal is home to one of the few wild, urban muskellunge populations in North America – a population threatened by persistent anthropogenic disturbances and

potentially in decline. By ensuring critical habitats are protected, like overwintering areas, we can proactively work against further population declines. To determine key winter habitats, we tracked 15 muskellunge during winter 2020-2021 using acoustic telemetry, and blended movement data with water-level data to determine focal areas used. We discovered several interesting movement patterns that will support management and conservation of this iconic species.

Glowa, S.*, Enders, E., Jardine, T., & Watkinson, D. DFO and University of Saskatchewan. **Modelling the risk of fish stranding due to hydropeaking in a large continental river.** Hydropower is a large contributor to the world's electricity production but hydroelectric generating stations are often operated under a hydropeaking regime that leads to daily fluctuations in discharge downstream. The rapid down ramping of discharge can result in fish stranding when the water level drops rapidly and traps fish on the river edge or in pools that become disconnected from the thalweg. Analyzing fish stranding in relation to geomorphological characteristics and water level fluctuations identified habitats that are most prone to fish stranding. The developed stranding prediction model enhances our understanding of the impact of hydropeaking on the local fish community and allows for better environmental management of hydropower operations which are numerous in central Canada and other inland waters. At present, there are no regulatory policies for ramping rates in place in Canada. The developed models will provide crucial information for the expansion of scientific evidence-based regulation for hydropeaking operations.

Scott, D., MacDuffee, M., & Hinch, S.G. (Roper, P.*) University of British Columbia, Raincoast Conservation Foundation. **Three Years of Juvenile Pacific Salmon Movement through a Previously Impassable Barrier and Roles of Estuarine Connectivity in the Fraser River Estuary, British Columbia, Canada.** Tidal estuaries provide critical nursery habitats for juvenile Pacific salmon. The Fraser River is the largest producer of Pacific salmon in Canada with millions of juveniles out-migrating each spring. However, many migratory pathways are altered by anthropogenic barriers. In 2019, three 50-meter linear breaches were created in the Steveston Jetty, a barrier separating the river's main arm from tidal marsh habitat. Following construction in 2019, we directly monitored juvenile Pacific salmon movement through the breaches. Early results indicate juveniles immediately began using the breaches as new migratory corridors during peak outmigration periods. In 2020, we observed increased fish passage at our breach locations where passage rates of juvenile Chinook and chum peaked at 76-Chinook/hour and 159-Chum/hour respectively. In 2021, Pacific salmon and overall fish passage rates decreased significantly. We will discuss the initial effectiveness of these breaches and the role of estuarine re-connectivity for juvenile salmon.

Fish Habitat

Manning, M.A.*, Arismendi, I., Giannico, G., & Olivos, J.A. Oregon State University. **Assessing hybridization risk between native Bull trout and introduced Brook trout using habitat modeling.** Using a spatially-explicit GIS Hybridization Risk Model (HRM) between native ESA-listed Bull Trout and

introduced Brook Trout by combining an intrinsic potential model (IPM) of Brook Trout spawning habitat and existing empirical datasets of Bull Trout in Oregon.

Ward, T.*, Algera, D., Harrison, P., Crossman, J., Leake, A., Power, M., & Cooke, S.J. Carleton University, BC Hydro. **Spatial ecology of co-occurring bull trout and lake trout in a large reservoir.** One of the primary threats to bull trout populations is competition from introduced lake trout. Bull trout abundance has been observed to decline 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. While bull and lake trout are sympatric in their native ranges, they historically occupied distinct ecosystems as a result of environmental filtering. Here, we investigate bull trout – lake trout habitat associations in Williston Lake, BC using a large acoustic telemetry array spanning over 100 kms, 160 individual fish, and over a 3 year period. Our results provide evidence of home range overlap, indications of habitat partitioning, and highlights phenological differences in depth use and activity rates.

Menard, J.*, Hamilton, S., & Somers, C. University of Regina. **Understanding the distribution and life history of invasive Prussian carp: field biology augmented by citizen science.** Aquatic invasive species are a major threat to freshwater ecosystems. The Prussian carp (*Carassius gibelio*), an invasive fish native to Eurasia, was recently discovered in Saskatchewan. A Citizen Science reporting system enhanced our knowledge of Prussian carp distribution; 12/13 (92%) confirmed locations were reported by citizen scientists. This species is present throughout the South Saskatchewan River system. We collected Prussian carp for ploidy assessment using silver-nitrate staining of cell nuclei, as well as to isolate otoliths for age determination. Fish were captured by us using nets, as well as donated by anglers. We have documented multiple ploidy states (2n, 3n, 4n), as well as the presence of male fish, demonstrating that the invasive population is not all-female and triploid. Some adult fish were found to be at least 12 years old based on otolith aging. Citizen scientists made important contributions to our Prussian carp research, and substantially enhanced the program.

Huard, J.*, Proudfoot, B., Rooper, C.N., Martin, T.G., & Robinson, C.L.K. University of British Columbia. **Intertidal beach habitat suitability model for Pacific sand lance, Ammodytes personatus, in the Salish Sea, Canada.** Pacific sand lance (*Ammodytes personatus*) support marine food webs in the Salish Sea, yet our knowledge of intertidal spawning habitat for this species is limited. Community science surveys for intertidal sand lance spawning has provided eggs detections on over 90 beaches in the Salish Sea since 2001. We developed a MaxEnt habitat suitability model with 6 environmental variables. We estimate that only 5.4% of the intertidal zone of the Canadian Salish Sea has suitable sand lance spawning habitat. This uncommon habitat was best predicted by its proximity to estuaries. Our model could be used as the basis for a Pacific coast-wide model in areas with less available information and where coastal development pressures are high. Identifying and conserving intertidal spawning habitat of sand lance will ensure a key food source for higher trophic level species of cultural and economic significance, including salmon, seabirds and whales.

Nonis, A.*, Hinch, S.G., Coops., N., & Dakin Kuiper, S. University of British Columbia. **Assessing habitat associations of juvenile salmonids using stream metrics derived from Airborne Laser Scanning.** We

used Airborne Laser Scanning (ALS) derived measurements of small stream characteristics to assess habitat associations of juvenile salmonids on Vancouver Island, British Columbia. Our main objectives were to examine which key habitat characteristics could be accurately derived from ALS-metrics and assess whether these ALS-based habitat variables provided similar explanatory power in predicting fish presence as conventional field-based surveys. ALS estimates of gradient and canopy cover had significant correlations ($P = 0.003$ and <0.001, respectively) with on the ground field measures ($r = 0.30$ and 0.74, respectively). Fish presence was associated with pool and glide habitats classified by the ALS-data, with fish presence being 89% higher in pools. Field-classified habitats yielded a similar association, with fish presence being 88% higher in pools. Our study illustrates the potential of ALS to be employed as a predictive tool to assess juvenile salmonid distributions at a broad scale in a timely and cost-effective way.

Curry, A.*, Clarke, K., Scruton, D., McCarthy, J., O'Sullivan, A., & Noakes, D. Canadian Rivers Institute. **A Spawning and Incubation Habitat Matrix for Brook Trout (*Salvelinus fontinalis*).** We report on the spawning and incubation habitats selected by Brook trout in a watershed of Newfoundland, Canada. The freshwater populations on this island in the Atlantic Ocean have been isolated from the mainland for at least 40,000 years. The isolation has generated some unique characteristics among Brook trout populations that can shed light on adaptation and life history tactics. We use this population that inhabits interconnected streams and lakes as a springboard to develop a matrix of spawning and incubation habitat for the species.

Rosenfeld, J.*, Fang, M., Gray, J., & Pearson, M. B.C. Ministry of Environment and Climate Change Strategy. **Water quality and habitat effects on larval Nooksack dace growth, survival, and recruitment.** To better understand effects of habitat on larval Nooksack dace survival, growth, and recruitment, we i) stocked enclosures with larval dace and monitored their short-term mortality (over 10-12 days) in the absence of predation risk; ii) estimated apparent survival (over ~20 days) based on changes in dace abundance in natural pool habitats outside of enclosures; and iii) compared larval dace counts in 2021 with baseline counts from 2015 in two representative stream reaches. We observed no larval dace mortality in enclosures, and normal survival rates outside of enclosures (~20%/month), suggesting favourable post-hatch conditions for larval growth and survival. Despite favourable post-hatch conditions, we observed recruitment failure of larval dace over a linear kilometer of stream channel at the upstream monitoring reach; although the cause of recruitment failure remains uncertain, egg mortality from hypoxia triggered by eutrophication and low flows is implicated.

Brooks, J.*, Ledee, E., Cooke, S.J., Larocque, S., & Midwood, J. Carleton University. **Hypoxia induced habitat compression and broad-scale walleye (*Sander vitreus*) movements**. Globally, temperate lakes are experiencing increasing surface water temperatures, extended periods of summer stratification, and decreasing levels of both surface and deep water dissolved oxygen. The distribution of fish is influenced by a variety of factors, but water temperature and dissolved oxygen are known to be particularly constraining such that with climate change fish will likely feel the “squeeze” from above and below. This study explored the effects of both thermal stratification and the deoxygenation of the hypolimnion on walleye (*Sander vitreus*) broad-scale movements in a coastal embayment in Lake Ontario. We

documented seasonal and annual fluctuations in both 'suitable' (all temperatures, DO > 3mg/l) and 'physiologically optimum' (temperatures 18-22 °C, DO > 5mg/L) abiotic habitat for walleye and determined a significant positive and linear relationship between the volume of physiologically optimum habitat and walleye movement distances, with significant inter annual and inter-individual variability. Rodrigues, T.* & Blanchfield, P. Queen's University. What Happens When the Streams Turn Off? Consequences of Boreal Lake Isolation for Lake Trout (*Salvelinus namaycush*) Habitat Use. Despite widespread declines in hydrologic connectivity due to industry-driven water diversions, few studies have examined how this impacts lacustrine fishes. The loss of a lake's inflow may reduce nutrient input, increase water clarity, and thereby reduce the availability of suitable habitat for coldwater oxygen-sensitive fishes. In November 2010, the inflow of fourth-order Lake 626 in Northwestern Ontario was diverted, turning it into a headwater lake. We compare long-term limnological and fish telemetry data from Lake 626 (2008-2019) and a reference headwater lake (2002-2019) to assess the effect of loss of hydrologic connectivity on lake trout (*Salvelinus namaycush*). We observe deepening of lake trout in Lake 626 from 2010-2015 (e.g., in fall: 2010 mean = 5.5 m, 2015 mean = 7.3 m), after which mean depths returned to or become shallower than those observed pre-diversion (2019 mean = 4.9 m). Changes in vertical migration patterns and activity will also be discussed.

Ramirez, S.* & Rosenfeld, J. University of British Columbia. **Modelling future risk of hypoxia in lower Fraser Valley streams.** Streams are subject to a variety of impacts from human development. Land use, flow regulation, and climate change can increase nutrients, light availability, and water temperatures, leading to changes in key water quality parameters like dissolved oxygen (DO), gross primary productivity (GPP), and ecosystem respiration (ER). To better understand drivers of and impacts on water quality in salmonid rearing habitat and Salish sucker and Nooksack Dace critical habitat, I deployed DO loggers at 40 stream sites throughout the highly developed lower Fraser Valley to: i) identify the role of GPP and ER as drivers of hypoxia; ii) to predict the cumulative and interactive effects of temperature, nutrients, flow, and channel structure on the frequency and distribution of hypoxia. Preliminary results indicate increasing likelihood of hypoxia at eutrophic sites with low summer flows. Identification of vulnerable habitats and instream flow needs to mitigate hypoxia is a management priority for species at risk in highly modified landscapes.

Evolution and Genomics

Judson, B.*, Leblanc, C., Kristjánsson, B., & Ferguson, M. University of Guelph. **Neutral evolutionary processes promote fine-scale differentiation among small populations of cave-dwelling Icelandic Arctic charr (Salvelinus alpinus)**. The adaptability of small, isolated populations is a key question in evolutionary biology. We addressed this question by examining patterns of genetic and phenotypic variation among cave-dwelling populations of Icelandic Arctic charr with varying degrees of physical connectivity and ecological heterogeneity. We tested the effects of colonization history (Isolation by Colonization), distance (Isolation by Distance (IBD)), and ecology (Isolation by Adaptation (IBA)) on contemporary patterns of genetic and phenotypic variation. Genetic structuring is largely the product of

drift and reduced gene flow after colonization, where populations more distant from the presumed source population were isolated first. We also found evidence of IBD among populations arising from the same colonization event. There was no support for IBA as patterns of genetic and phenotypic variation were not related to patterns of ecological variation. Our results suggest that system-wide variation is largely the result of neutral processes, despite varying ecological conditions.

Wong, C.*, Hasler, C. University of Winnipeg. **Assessing genetic structure and diversity of sauger (*Sander canadensis*) populations in Manitoba**. The Sauger (*Sander canadensis*) is an important commercial and recreational fish that is experiencing population declines throughout its native range. These declines are largely attributed to habitat fragmentation and degradation and commercial overfishing. In Manitoba, Sauger populations have declined in Lake Winnipeg and Lake Manitoba and are considered extirpated in Lake Winnipegosis. The Hasler Lab is currently using microsatellite markers (STRs; simple tandem repeats) to assess the genetic diversity, health, and relationship of Sauger populations in Manitoba. These results will be integrated with historical landscape and fisheries assessment data to identify the root causes of population delineation and decline. Findings will contribute to the development of a Sauger recovery plan in Manitoba and may also serve as a reference for future Sauger conservation projects.

Delgado, M.L.*, Van Wyngaarden, M., Einfeldt, T., McCracken, G., Paterson, I., Bradbury, I., Bentzen, P., & Ruzzante, D.E. Dalhousie University. **Temporal genomic variation of Atlantic Cod's (*Gadus morhua*) inshore and offshore populations in NW Atlantic**. The collapse of the Atlantic cod (Gadus morhua) fishery in the early 1990s was accompanied by a loss of biocomplexity with the virtual disappearance of components of the population complex in Northeast Newfoundland (Northern cod). Here we use low coverage whole genome sequencing (lcWGS) of historical inshore and offshore (1990s; N=188) and contemporary offshore (2016-2017, N=107) Atlantic cod collections to re-examine the evidence of population differentiation that was observed in the historical collections using a handful of microsatellite DNA markers. We then examine the question of whether there are temporal changes in genetic structure between historical and contemporary collections. Our study aims to provide a better understanding of patterns of genetic diversity and structure among cod populations in the Northwest Atlantic as this information can help assess the effectiveness of current policies and conservation efforts.

Hechler, R.*, Yates, M., Chain, F., & Cristescu, M. McGill University. Non-invasive gene expression profiling: Using environmental RNA (eRNA) to detect heat-stress in Daphnia pulex. Harnessing functional information from environmental RNA (eRNA; extra-organismal RNA released into the environment) has been proposed as a non-invasive method to assess the physiological status of aquatic organisms. We collected eRNA and organismal RNA from water and tissue samples, respectively, of Daphnia pulex exposed to 20°C and 28°C. We explored the feasibility of recovering an eRNA-based stress signal that is representative of the organisms' response to heat stress. We conducted differential expression analyses to identify genes involved in D. pulex temperature stress response and reveal the overall heat-stress signal of the organism. We found that although more differentially expressed genes (DEGs) were recovered in organismal than eRNA samples, the DEGs commonly shared between eRNA and organismal samples exhibited similar relative expression levels. Our proof-of-concept study demonstrates the

potential of eRNA to reveal the physiological status of progenitor organisms, with broad potential implications for biological monitoring applications.

Thorstensen, M.J.*, Jeffies, K.M., & Anderson, W.G. University of Manitoba. **A resource of thirteen tissue-specific transcriptomes for the lake sturgeon (*Acipenser fulvescens*)**. Lake sturgeon (*Acipenser fulvescens*) is an octoploid, long lived fish faced with conservation issues across its range. Tissue-specific transcriptomes enable molecular analyses of ecologically-relevant physiological responses. Here, we present 13 tissue-specific transcriptomes: brain, esophagus, gill, head kidney, heart, white muscle, liver, proximal stomach, distal stomach, anterior intestine, pyloric ceca, spiral valve, and rectum. These transcriptomes were assembled from a mean 57.9 million (±6.0 million std. dev.) reads for each tissue. Analyses were performed on transcriptome annotations, with tissue-specific implications for lake sturgeon physiology. The transcriptomes were used as a resource for research on lake sturgeon molecular physiology, used in various applications including thermal tolerance, thermal acclimation, diet, and hypoxia.

Bugg, W.S.*, Thorstensen, M.J., Marshall, K.E., Anderson, W.G., & Jeffries, K.M. University of Manitoba. **Transcriptome-wide patterns reveal population-specific responses to increasing temperatures in developing lake sturgeon (*Acipenser fulvescens*)**. Rising mean and variance in temperatures are elevating threats to endangered freshwater species like the lake sturgeon, Acipenser fulvescens. Higher temperatures in early development result in physiological consequences for latitudinally distributed lake sturgeon populations. These physiological changes include alteration of metabolic rate, thermal tolerance, transcriptional responses, growth, and mortality. Therefore, we acclimated developing lake sturgeon from northern and southern populations in Manitoba to current and future projected environmental temperatures of 16, 20, and 24 °C for 30 days, and measured gill transcriptional responses using RNA-seq. Population- and acclimation-specific responses to thermal acclimation were observed, as well as conserved molecular responses between northern and southern sturgeon populations. Generally, these conserved responses included oxygen sensing/transport, pathogens, and DNA damage as well as pre- and post-transcriptional modification (methylation, alternative splicing, gene silencing). Ultimately these transcriptional responses highlight molecular consequences of increasing temperatures for genetically distinct lake sturgeon populations during vulnerable early development periods.

Josephson, M.*, Bull, J., & Rogers, S. University of Calgary. **How environmental enrichment in hatcheries effects long term gene expression changes in Coho Salmon (*Oncorhynchus kisutch*)**. Hatchery-origin salmon are exposed to different early life environments compared to wild-origin salmon. These differences likely have behavioral consequences that lead to decreases in survival of hatchery-origin fish. The Nitnat River Hatchery which is located on the traditional territory of the Ditidaht First Nation on west Vancouver Island has implemented an environmental enrichment program for Coho Salmon (*Oncorhynchus kisutch*). Enriched fish are raised in a more wild-like environment that includes lower temperatures, irregular feeding schedules, simulated predator attacks, lower fish density, and additional structure in holding tanks. In this study we examine the gene expression profiles of wild-origin, enriched hatchery-origin, and traditionally hatchery-origin juvenile and adult Coho Salmon. Pairing of juvenile and

adult fish allows for examining how early rearing environment can have long term consequences on gene expression. Ultimately we aim to understand how rearing conditions can be altered to create more wild-like fish.

Frank C.*, St. Louis, B., Warriner, T.R., Heath, D.D., & Semeniuk, C.A.D. University of Windsor. **Examining Effects of Triploidization and Probiotic Therapy on Triploid Chinook Salmon (*Oncorhynchus tshawytscha*): A Behavioural Genomics Approach**. Commercial aquaculture accounts for a significant portion of seafood production, with salmonids composing the majority. Hatcheries must produce large quantities of biomass without compromising product quality. Some hatcheries implement triploidization (altering ploidy from 2N to 3N) to induce sterility in fish and avoid energy investment towards reproductive efforts. However, triploidy can result in behavioural changes (e.g., lowered aggression, increased stress reactions, and lowered responsiveness). We examined probiotic therapies to overcome drawbacks of triploidization in juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Through a behavioural genomics approach, we identified behavioural profiles via behavioural assays (open field, novel object, predator, and mirror tests) and combined profiles with neural transcription levels (expression relating to synaptic plasticity/neurogenesis, stress response, appetite/metabolism, and growth) of Chinook salmon from four treatment groups (2N-regular feed, 2N-probiotic feed, 3N-regular feed, and 3N-probiotic feed). Compared to counterparts, those on a probiotic diet are expected to have improved performances in the hatchery environment.

Bass, A.L.*, Anderson, S.C., Bateman, A.W., Connors, B.M., Kaulkinen, K.H., Li, S., Patterson, D.A., Peña, A., Staton, B.A., Teffer, A.K., Hinch, S.G., & Miller. K.M. University of British Columbia. **The spatial distribution of infectious agents in early marine Pacific salmon and associations between infection and cohort survival**. Few researchers studying salmon marine survival have considered the potential role of infectious agents in the declines of Pacific salmon populations. Furthermore, knowledge of the spatial distributions of infectious agents in wild Pacific salmon and the factors associated with these distributions is limited, especially in the marine environment. As part of the Strategic Salmon Health Initiative, we sought to address some of these knowledge deficiencies by applying a multi-agent (>50 assay) qPCR platform to early marine resident salmon (n > 10,000) collected along the British Columbia coastline from 2008 – 2018. Here we present results from three intertwined studies which included: 1) The use of a spatial epidemiological tool to identify geographic infection “hotspots”, 2) Identification of intrinsic and extrinsic factors associated with infectious agent prevalence, and 3) Bayesian multi-level modelling to determine whether any pathogens were associated with cohort strength and body condition.

Di Cicco, E.*, Zielke, K. , Mantha-Rensi, K., Archambault, J., Okey, T., Dedeluk, N., & Miller-Saunders, K.M. Pacific Salmon Foundation. **Evaluation of the efficiency of eDNA testing to monitor the fish health status of salmon farms in the Broughton Archipelago.** Environmental DNA (eDNA) analysis is a technology currently utilized in several sectors to assess the presence and concentration of organisms in different substrates (water, air, soil, etc.) for biodiversity monitoring and conservation purposes. A collaborative agreement between the three First Nations located in the Broughton Archipelago and the Department of Fisheries and Oceans - Canada led to the implementation of the eDNA-BATI project, that

is aimed to test the efficiency of eDNA technology to monitor the fish health status of the salmon farms as well as the potential spillover dynamics that could affect the survival of wild pacific salmon. The goal of the project is to compare the fish health data collected through the current standard monitoring operations (i.e. destructive samples) with the data obtained by testing and analysing eDNA water samples concurrently collected in and around the salmon farms. This comparison will assess the sensitivity and accuracy of the eDNA technology for this new application.

Benoit, N.*, Kellogg, C., Lemay, M., Robinson, K.M., & Hunt, B.P.V. University of British Columbia, Hakai Institute. **Using environmental DNA to assess density of juvenile *Oncorhynchus tshawytcha* (Chinook salmon).** During the outmigration of Pacific Salmon, the early marine phase is a critical period when high mortality can occur. Traditional sampling and monitoring of juvenile salmon can be limited by logistically intensive gear requirements, accessibility, and cost. Improved understanding of the early marine phase, e.g., migration duration and habitat use, requires innovative techniques that can improve the spatial and temporal coverage of monitoring. Environmental DNA (eDNA) uses genetic material as a proxy for organism presence in the environment and can be effectively and efficiently collected through water samples. However, estimating fish abundance from eDNA data requires calibration. Using a controlled mesocosm experiment we found that eDNA concentration scaled with Chinook salmon density. Here we will discuss the experimental approach, findings, and their implications for field application of eDNA monitoring of salmon outmigration.

Deeg, C.M.*, Kanzeparova, A., Somov, A., Esenkulova, S., Di Cicco, E., Kaukinen, K.H., Tabata, A., Ming, T.J., Li, S., Mordecai, G., Schulze, A., Wallace, C., Jonsen, K., Flynn, K.L., Rondeau, E.B., & Beacham, T.D. University of British Columbia, Pacific Salmon Foundation. **Exploring the winter salmonosphere in the open ocean with genomic tools.** A key objective of the International Year of the Salmon initiative (IYS) is the exploration of the open ocean winter environment that salmon experience ("winter salmonosphere"), thought to be a critical period for survival at sea. Here we present findings of our genomic research during the IYS winter expeditions to the Gulf of Alaska in 2019 and 2020 and highlight ongoing efforts. We report on the development and trial of a novel at-sea genetic stock identification (GSI) by single nucleotide sequencing method. Our genomic surveys of salmon health illuminate key pathogens and stressors faced by salmon during the oceanic winter. Finally, our environmental DNA surveys provide unprecedented insights into open ocean ecosystem composition around salmon, their prey, competitors, and predators. For the ongoing 2022 pan-Pacific expedition we are expanding our eDNA and genomic health surveys to the entire oceanic winter range of Pacific salmon from North America to Asia.

Miller-Saunders, K.M.*, Akbarzadeh, A., Bass, A., Bateman, A., Deeg, C.M., Di Cicco, E., Gunther, O., Houde, A.L., Kaukinen, K.H., Vollset, K.W., Lennox, R., Li, S., Mordecai, G., Schulze, A.D., & Teffer, A. Fisheries and Oceans Canada. **Cumulative stressor impacts: towards a holistic measure of salmon health and condition.** Wild salmon are experiencing declines worldwide. Cumulative and synergistic biotic and abiotic stressors associated with climate warming affecting salmon in their vulnerable smolt out-migration stage are critical, but teasing out factors of greatest impact is difficult. An intensive investigation of the role of infectious disease in salmon declines has revealed several pathogens

associated with physiological impact, increased risk of predation, and smolt to adult survival trends. More holistic assessments of health are now underway with a new generation of genomic technology, Salmon Fit-Chips. Fit-Chips simultaneously apply curated biomarker panels to identify exposure to biotic (harmful algal blooms, sea lice) and abiotic stressors (temperature, low oxygen, osmotic) and states associated with physiological compromise (inflammation, differential immune activation, viral disease, imminent mortality), all based on small non-lethal gill biopsy samples. Together, these tools are resolving patterns of cumulative stressors and diseases impacting salmon and trout in North America and Norway.

Mercer, K.* & Weir, L. Saint Mary's University. **Variability in egg hatching time as evidence of a bet-hedging strategy in Japanese medaka (*Oryzias latipes*)**. Understanding life-history strategies is essential for developing a clear picture of how organisms have evolved and how they may perform under future conditions. Bet-hedging is a risk-reduction life history strategy that lowers generational fitness while decreasing fitness variability across generations, enabling lineage survival when conditions are not optimal. Japanese medaka (*Oryzias latipes*) is a small fish that lives in a highly variable habitat in the wild. These fish demonstrate significant variability in egg hatching times, which does not appear to be influenced by abiotic conditions. The goal of this study was to quantify within-clutch and within-population variability and to examine consistency across social environments. Clutch size was not correlated with variability, but did have a negative relationship with average hatch time. Yolk distribution will be briefly discussed as a potential mechanism. The observed similarity in variability across all treatments provides support for a bet-hedging theory in medaka egg hatching time.

Ruzzante, D.*, Flemming, J.M., Fisher, J., den Heyer, N., Le Bris, A., Weise, E.., & Van Wyngaarden, M. Dalhousie University. **The estimation of population abundance in Atlantic halibut using genomics and the CKMR approach**. The estimation of population abundance is fundamental for fisheries management and conservation. In this presentation we will introduce an ongoing 5-yr project aimed at estimating the population abundance of Atlantic halibut on the Scotia Shelf using genomics and the close kin mark recapture (CKMR) approach. The approach is based on the principle that an individual's genotype can be considered a "recapture" of the genotypes of each of its parents. Assuming offspring and parents are sampled independently, the number of Parent-Offspring- and Half-Sib Pairs genetically identified in a large collection of individuals can be used to estimate abundance and survivorship rate. Over a period of 4 years, we aim to genotype (and age) 12,000 fish with an Illumina custom designed microarray containing 4000 SNPs distributed over 24 chromosomes including some 100 SNPs associated with sex determination. This is a collaborative project involving Dalhousie University, Memorial University and DFO.

Contaminants & Water Quality

Pomerleau, R.* & Avery, T. Biology Department, Acadia University. **Monitoring contaminant loads in FSC fishes in Southern Labrador.** The Southern Labrador coast is home to many small fishing communities within NunatuKavut, a territory of the Inuit, whose governing body is Nunatukvut Community Council

(NCC). Here, Indigenous communities rely primarily on coastal and endemic fish species as part of a traditional diet. Although fish have many health benefits, they are also repositories for known pollutants including heavy metals such as mercury and cadmium, the metalloid arsenic, and nonmetal selenium – all of which have been associated with negative effects on fish and human health. Currently, there exists little to no contaminants data or consumption guidelines for coastal fishes in Labrador. This is problematic, considering many of these species serve as food, social and ceremonial (FSC) fish. To fill existing data gaps and inform fish consumption guidelines in Labrador, fish tissues typically consumed in traditional diets such as fillets (muscle) and roe (gonad), along with liver were quantified for total mercury, arsenic, cadmium and selenium.

Rennie, M.D.*, Hayhurst, L.D., Geils, K., Slongo, B., Ripku, T., & Metcalfe, C. Lakehead University. **Where's the beef? Nanosilver exposure reduces food web energy transfer in natural fish populations by half**. Nanosilver (AgNP) is a ubiquitous antimicrobial agent, with high potential for environmental release due to its broad distribution in a wide range of consumer products. We used a bioenergetic approach to evaluate changes in the transfer of energy through an ecosystem during a whole-lake AgNP addition experiment at the IISD Experimental Lakes Area. Yellow Perch and Northern Pike were the dominant benthivore and piscivore in the lake, respectively. Perch consumption and abundance declined after two years of AgNP additions, resulting in a reduction in annual gross consumption (AGC) of perch from 1200 kg/ha to 600 kg/ha after AgNP additions. Consumption, though not abundance, declined in pike after AgNP additions, and pike AGC fell from 100 kg/ha to 40 kg/ha. This consistent halving of energy transfer at two trophic levels suggests major changes in resource availability following AgNP additions. Fish production estimates will also be evaluated for similar declines.

Arnott, S.E.&, Hintz, W., Symons, C., Derry, A., Melles, S., Cañedo-Argüelles, M., Brentrup, J., Downing, A., Gray, D., Greco, D., McClymont, A., Relyea, R. Rusak, J., Searle, C., Steiner, C., Hébert, M-P., Langenheder, S., Langvall, O., Hylander, S., Lind, L., Astorg, L., Beisner, B., Baker, H., Ersoy, Z., Espinosa, C., Franceschini, J., Giorgio, A., Göbeler, N., Hassal, E., Huynh, M., Jonasen, K., Kirkwood, A., Laudon, H., Lundgren, M., Moffett, E., Proia, L., Schuler, M., Shurin, J., Striebel, M., Thibodeau, S., Cordero, P.U., Vendrell-Puigmitja, L., & Weyhenmeyer, G. Department of Biology, Queen's University. **Current water quality guidelines for chloride do not protect aquatic ecosystems.** Freshwater ecosystems are experiencing increasing salinization resulting from human activities, including mining, agriculture, and urbanization. Chloride, a chemical tracer for these forms of salt pollution, has increased in lakes and rivers worldwide, threatening biodiversity and ecosystem function. Consequently, Canada has developed water quality guidelines to protect aquatic life – with one of the world's lowest thresholds for chronic exposure. However, there is increasing evidence that zooplankton are sensitive to change below this threshold. To assess zooplankton response to chloride across diverse habitat conditions, we conducted coordinated mesoscosm experiments in Canada, USA, Spain, and Sweden. We tested population and community responses across a gradient of 20-30 chloride concentrations over 6 weeks. Responses varied among sites, but in the majority of sites we observed large declines in abundance at the current water quality guideline. This provides compelling evidence that governments should reassess water quality guidelines for chloride to protect freshwater organisms.

Sinn, C.* & Porern B. Alberta Lake Management Society. **General Findings, Program Development, and Trajectory of Winter LakeKeepers, a Citizen Science Program Enabling Winter Lake Monitoring in Alberta.** To address the lack of winter lake information in Alberta, the Alberta Lake Management Society (ALMS) has delivered the Winter LakeKeepers program for three winters, (2018 – 2021). Since 2018, the sampling effort has increased from 11 to 90 sampling events. Information collected includes water temperature and dissolved oxygen (DO) profiles, water chemistry data including nutrients, and supplementary environmental data. Results are shared through annual reports, and raw data is uploaded to the Gordon Foundation's DataStream. General findings point to a diversity of winter nutrient and productivity regimes, and the seasonal dynamics of temperature and DO. Program development has focused on optimizing volunteer sampling logistics, determining suitable sampling frequency, and examining sampling site spatial distribution for large lakes. Future plans include exploring the utility of sensor arrays, and developing interactive web apps that improve accessibility of winter lake data relevant to winter anglers and interested citizens alike.

Hannan, M.& & Gray, D. Wilfrid Laurier University. **Does Road Proximity Affect Aquatic Invertebrates in Arctic Lakes?** We studied the potential effects of gravel highways on water quality and zooplankton found in small lakes adjacent to major highways in the Northwest Territories. We sampled zooplankton and measured water quality in 18 lakes across the boreal-tundra transition located at a range of distances from the road. Preliminary results suggest that there were not clear differences in the richness, diversity, or abundance of zooplankton according to distance from the highway or region of study (boreal vs. tundra). However, there were differences in the relative abundance of species dependent on distance, with lakes closer to the road having a higher abundance of Bosmina and D. longiremis, while those further from the road appear to have more of the calanoid copepods Leptodiptomus spp. Further exploration of the data is needed to determine if these differences are caused by pre-existing water quality differences or are directly caused by contaminants from the road.

Bucci, K.*, Bayoumi, M., Stevack, K., Watson-Leung, T., & Rochman, C. University of Toronto. **Polyethylene microplastics collected from Lake Ontario induce trans-generational impacts to fathead minnows.** We exposed fathead minnows to polyethylene microplastics directly from a manufacturer and collected from Lake Ontario, with the goal of comparing the effects of microplastics with and without an additional chemical cocktail. We exposed fathead minnows to microplastics for a full life cycle and raised a subset of their offspring in clean water. The results of this experiment showed that microplastics purchased from a manufacturer had limited effects on the parental generation and offspring. Microplastics from Lake Ontario also had limited effects on the parental generation, but significantly impacted the viability and development of the offspring generation. I am also conducting histopathological analysis of the gonads of the parental generation, the results of which will also be presented. The results of our study suggest that microplastics with sorbed environmental contaminants can impact wildlife. Furthermore, testing with environmentally realistc microplastics is critically important to understanding the true effects of microplastic pollution.

Vermaire, J.C.*, Sivarajah, B., Forrest, S., Lara, R., Provencher, J., & Lapen, D. Carleton University. **Microplastic composition and concentration in the Ottawa River and agricultural biosolid applications**

as potential sources of microplastics to aquatic ecosystems. Microplastics are a contaminant of emerging concern in aquatic ecosystems, however, the sources, sinks, and spatial distribution of microplastics in aquatic ecosystems remains poorly understood. We present data on microplastic concentrations and composition for the Ottawa River watershed (area of ~146,300 km2) and show that nearly all areas of this large watershed have microplastics present with over 90% of all microplastic particles being microfibers. Microplastic concentrations tended to be greater in urban areas of the watershed, however, some of the greatest concentrations of microplastics were observed in more remote regions, potentially linked to industrial or agricultural activities. We further report on microplastic concentrations and compositions in biosolid from 27 wastewater treatment plants across Canada where microplastic concentrations ranged from ~100 to >1000 microplastic particles/g dry weight of biosolid and present early results from an experimental biosolid application in an experimental field examining microplastic export through the tile drainage system.

Vermaire, J.C. & Sivarajah, B. (Rahman, M.*) Rahman Mubashshera. Carleton University. **A paleolimnological study to assess the water quality changing trend of currently eutrophic Colonel By and Dog lakes of Cataraqui watershed.** Colonel By and Dog Lakes were originated and extended in 1832, by flooding over wetlands during Rideau canal construction. They are now used for recreational purposes, but residents are presently worried about recurrent cyanobacterial blooms. However, we don't have any clear idea about the lakes' water-quality change since their origin, because of inadequate long-term data, which is crucial for lake management. Therefore, we used a diatom-based paleolimnological study to infer lakes' trophic status. Our data revealed that the lakes were naturally productive and became a little more eutrophic just after the canal construction. This was a significant bump on lakes' water-quality trend. Distinct shifts in diatom species composition are largely controlled by lake-depth, water-level fluctuations, and are correlated with the land-use alteration. The data also suggested a recent water quality recovering trend, and a weak climate-change signal. Overall, there has not been much change in lakes' productivity since their origin.

Armstrong, I.*, Moir, K., Ridal, J.J., & Cumming, B.F. Queen's University. **Paleolimnological analysis of cumulative stress effects on ecological recovery in the historically impacted St. Lawrence River at Cornwall, ON.** Twentieth-century industrial activity loaded high amounts of organic matter and heavy metal(oids) to the St. Lawrence River at Cornwall, ON. While industrial improvements and closure of point-source polluters have reduced contaminant loading, contaminants remain in waterfront sediments in concentrations above provincial safety guidelines. Effective management of the Cornwall waterfront is crucial to mitigating both human and ecological health risks. Management is complicated by the effects of cumulative stress (i.e., interactions between climate warming, nutrients, and metals) which obscure interpretations of ecological impact and recovery. Our research disentangles multiple stressor impacts within the ecological record by examining benthic invertebrate chironomid assemblages in sediment cores from the waterfront. By selecting sites with similar regional warming signals but which were exposed to different effluent sources, we can parse out the effects of individual stressors to better describe and interpret ecological recovery, and thus assist ecosystem management and the development of remediation strategies.

Moir, K.*, Ridal, J., & Cumming, B.F. Queen's University. **Spatiotemporal analyses of diatom assemblages from metal-contaminated sediments in the St. Lawrence River (Cornwall, Ontario).** Throughout the 20th century, waterfront industries in the city of Cornwall (Ontario) produced significant quantities of mercury (Hg) and other industrial by-products, which were discharged to the St. Lawrence River. These contaminants accumulated in downstream sediments and presently persist in some nearshore areas. While the bioavailability and movement of this legacy contamination up the food web is well-researched, less is understood about its impacts on algae living on these contaminated sediments. We examined diatom (Class: Bacillariophyceae) responses to a spatiotemporal gradient of sedimentary contamination through analyses of surface sediments and a dated sediment core from contaminated zones. Diatom assemblage shifts and cell deformations (teratologies) suggest that elevated sedimentary metal concentrations have a small but significant effect on diatom assemblage structure and incidence of sub-lethal teratologies. However, historical changes in the diatom assemblage are more consistent with impacts of nutrients than with impacts of elevated metals from industrial effluents.

St. Pierre, K.*, Hunt, B.P.V., Giesbrecht, I., Tank, S., & Lertzmann, K. University of British Columbia. **What happens on land does not stay on land: extending the watershed to nearshore waters on British Columbia's Central Coast.** Coastal rivers and streams of the North Pacific Coastal Temperate Rainforest region transport large volumes of rain, snow, and glacial melt waters, thus acting as critical connectors between land and the northeast Pacific Ocean. From 2014-2019, we conducted routine monthly and targeted rainfall event surveys of carbon (concentration, "δ13C") and key nutrients (nitrogen, phosphorus, iron, silica) at seven freshwater streams and across multiple marine stations along the Central Coast of British Columbia. This five-year dataset enables the assessment of freshwater influence on nearshore biogeochemistry across scales from single rainfall events, to seasonal and interannual variability. We explore patterns in and drivers of the quality of freshwater exports from coastal watersheds of the region and follow the downstream impact of these exports on nearshore ecosystems, highlighting the dynamic role that freshwaters can play across spatial and temporal scales.

Klemet-N'Guessan, S.* & Xenopoulos, M.A. Trent University. **Effects of latitude, dissolved organic carbon, and phosphorus on nutrient excretion of aquatic animals.** Animals play a key role in mediating nutrient recycling in aquatic ecosystems. The importance and the characteristics of nutrients recycled by aquatic animals may vary relative to the animal taxonomic classification (vertebrate vs. invertebrate), trophic position, and abiotic factors such as climate, dissolved organic carbon (DOC), and ambient nutrient conditions. In this study, we assessed the effect of latitude, DOC, and phosphorus on invertebrate and vertebrate nitrogen and phosphorus excretion using global nutrient excretion data of freshwater and marine animals. Globally, we found that invertebrates N and P excretion decrease with latitude. More locally in North America, we found that N and P excretion by stream vertebrates that feed on algae and detritus increased with DOC and decreased with TP. Together, our findings could shed light on future variations in animal-mediated nutrient recycling as climates, ambient nutrients, and DOC quality and quantity continue to change.

Lightbrown, J.,*, Cavaco, M., Holzer, H., Buendia-Fores, C., Wyatt, F., Emmerton, C.A., & Bhatia, M. University of Alberta, Environment and Parks Alberta. **Examining the relationship between water**

quality, microbial communities, and land use in the North Saskatchewan River basin. As anthropogenic activities force a shift in land use, runoff draining into rivers that traverse through these landscapes are affected, with concomitant effects on downstream water quality. To assess these effects this project examines the relationship between water quality and land use in the North Saskatchewan river (NSR) basin, the freshwater source for the city of Edmonton. Over three summers (2019-2021), samples for 40 water chemistry parameters and microbial community composition were collected from 93 NSR tributaries spanning the full range of land types (from alpine to agriculture) present in the basin. Preliminary analyses show lower nutrient and carbon concentrations in alpine and forested regions compared to agricultural lands and city centres, and a unique microbial community associated with each land type. These results illustrate the value of paired biological and chemical observations to gain an integrated understanding of the role of land use on elemental cycling in aquatic ecosystems.

Gushulak, C.A.C.*, Bateson, D., & Leavitt, P.R. University of Regina. **Eutrophication of agricultural wetlands through direct additions of nitrogenous fertilizer urea: implications for regional water quality.** Agricultural fertilization is a major driver of eutrophication including toxic algal and cyanobacterial bloom formation. However, there is little evidence regarding the impacts of urea, the world's most prolific nitrogenous fertilizer, on water quality. We examined the impacts of urea through direct additions to a series of agricultural wetlands in southeastern Saskatchewan, Canada. Wetlands were selected for urea addition after initial investigations revealed low N:P ratios, moderate levels of chlorophyll a, and a low degree of cyanobacterial production. Experimental wetlands received urea additions of 5 mg/L weekly over a 6-week period and experienced stark increases in the concentration of chlorophyll a and pigments indicative of green algae and cyanobacteria. This eutrophication also resulted in wetland deoxygenation in some sites and suggests that additions of urea may result in severe degradation of freshwater systems including the release of sedimentary nutrients, and may lead to ecological state changes.

Bogard, M.J.*, Gunawardana, P., & Soued, C. University of Lethbridge. **Patterns of productivity and net metabolism in a hypereutrophic wetland receiving effluent from multiple sources.** Globally, wetland ecosystems are used to process many types of wastewater. The treatment capacity of wetlands is often explored using mass balance approaches or the evaluation of static chemical parameters. Deploying sensor platforms that enable modelling of the rates of productivity and metabolic balance (auto- or heterotrophic status) of food webs provides a different angle to evaluate wetland functioning that compliments other techniques, yielding new insight into nutrient and organic matter processing. Here we present a metabolic survey of one of Canada's largest restored mineral wetlands in southern Alberta that receives nutrient rich effluent from three sources (a beef processing facility, two sources of municipal waste). We deployed sensors to monitor dissolved oxygen content and temperature at the outflows of three sequential basins and will use these data, alongside complimentary water quality data, to evaluate the rates and patterns of productivity in each basin and the entire wetland.

Zhou, X., Johnston, S.E., & Bogard, M.J. University of Lethbridge. **Effluent and dissolved organic matter cycling in one of Canada's largest restored treatment wetlands.** Wetlands have been used for wastewater treatment for decades due to their ability to efficiently cycle and remove nutrients. Less is

known regarding their capacity to cycle effluent-derived dissolved organic matter (DOM). Here, we combined a mass balance with surveys of optical properties and microbial incubations to define the patterns and controls of DOM processing in the Frank Lake wetland complex (FL; southern Alberta), one of Canada's largest effluent receiving mineral wetlands. While FL was a net overall DOC source across years in our mass balance, microbial incubations indicated effluent DOM was efficiently mineralized and replaced by wetland-derived DOM prior to export. Additionally, optical measurements showed a qualitative shift in the DOM pool in transit through the wetland toward more aromatic DOM likely derived from wetland soils and riparian vegetation. In summary, FL appears to efficiently process effluent DOM, despite being a net DOC source to downstream ecosystems.

Smith, E.* & Kirkwood, A. Ontario Tech University. **Investigating nearshore water quality and ecological condition in the Kawartha Lakes, Ontario.** The Kawartha Lakes are the gateway to cottage country in south-central Ontario, but face increasing development pressure around shorelines as year-round residential populations increase. The nearshore zone of these lakes has historically been the least studied, yet is the first location to receive inputs from the watershed. Human activities in the watershed can have significant impacts on in-lake water quality, and the nearshore zone could mitigate these impacts depending on local site conditions. As part of a larger study of nearshore ecological condition the Kawartha Lakes, we recruited local volunteers and trained them using a community science approach. Lake water samples were collected monthly from June - September in 2019 and 2021, and an array of water quality parameters were measured. Water quality was analyzed as a function of land-use at different drainage scales and site conditions. The results indicate that different parameters, such as nutrients and conductivity, are driven by different land-use scales (i.e., subwatershed and buffer scales), which has important implications for water quality management.

Kirkwood, A.*, Taylor, A., Hassal, E., & Harrow-Lyle, T. Ontario Tech University. **Water quality profiles and plankton communities vary according to water hardness category in lakes and tributaries across the Land Between ecotone.** The Land Between (TLB) is an ecotone in south-central Ontario spanning the shores of Georgian Bay in the west to the Frontenac Arch in the east. The Land Between is a biodiversity hotspot where terrestrial and aquatic community composition shifts in response to an underlying geological mosaic. Limestone-dominated bedrock gives way to granite-dominated bedrock on a south to north axis, creating a heterogeneous land-cover and calcium gradient across the landscape. Analyzing long-term data from the Provincial Water Quality Monitoring Network (PWQMN) database, we found that distinct water quality profiles corresponded to distinct water hardness classifications, where soft water, moderately hard water, hard water, and very hard water categories were statistically different from each other. Land-use across sub-catchments in TLB is an important driver of water quality patterns, particularly urban land-use and chloride concentration. In a study of plankton communities from 60 lakes in TLB, calcium was a statistically significant positive explanatory variable for biomass. Zooplankton and phytoplankton communities varied according to calcium concentration (low, medium, high). Based on these results, we recommend that TLB surface water management consider water hardness classification when developing management goals and targets.

Recreational Fisheries: The Human and Biological Dimensions

Johnston, S.D.*, Hendriks, B.J., Hinch, S.G., Zinn, K., Cooke, E., Portner, A., Rechisky, E.L., & Welch, D.W. University of British Columbia. **Reel Impacts: Post-release mortality of capture and released Chinook salmon in marine recreational fisheries.** Catch and release is being used more as Chinook salmon (*Oncorhynchus tshawytscha*) populations decline. However incidental mortality could be high, though has largely been unquantified. Using acoustic telemetry and large-scale receiver arrays we are tracking fate of capture and released Chinook within the Salish Sea, BC. We have found that eye injuries or notable bleeds were 3.8 times more likely if fish were captured with larger hooks, and these injuries reduced survival of Chinook from 84% to 73% over their first ~20 km (mean = 40 day) segment of migration. Chinook landed with smaller hooks (n = 95) and not netted (n=23), had 100% detection beyond 10-days post-release, while those that were netted (n = 72) only demonstrated 76% detection beyond 10-days. We provide evidence that specific injuries greatly reduce probability of reaching spawning sites and both gear and behaviour modifications by anglers can improve post-release survival.

Chhor, A.*, Reid, J., Holder, P., Nowell, L., Brownscombe, J., Danylchuk, A., & Cooke, S.J. InStream Fisheries Research. **Temporary retention in cold water reduces post-release behavioural impairment in angled Rainbow Trout (*Oncorhynchus mykiss*).** Angling related stressors often impair a fish's ability to engage in normal swimming behaviour upon release. In these scenarios, it may be beneficial for anglers to assist recovery in some manner. We compared the effectiveness of a flow box and a water filled cooler for assisting recovery before release. Additionally, we compared recovery in warm water (24ºC) and cool water (14ºC). Rainbow trout were air exposed for a short duration then placed in a flow box or a water filled cooler for 3 minutes. Tri-axial accelerometers were temporarily fixed around the trunk of the fish with Velcro to observe post-release swimming behaviour. Trout that were held in assisted recovery devices regained equilibrium faster than those that were immediately released, and fish that were recovered in cool water regained equilibrium quickest. Our study demonstrates that for Rainbow Trout, assisted recovery devices can reduce equilibrium impairment, especially when cool water was used.

Lunzmann-Cooke, E.L.*, Hendriks, B.J., Johnston, S.D., Porter, A.D., Welch, D.W., Rechisky, E.L., & Hinch, S.G. University of British Columbia. **Investigating post-release mortality of coho salmon in a marine recreational fishery.** Although many recreationally caught Pacific salmon are harvested in British Columbia, a substantial number of fish are released after capture. Released fish are often assumed to survive; however, actual catch-and- release mortality rates are largely unknown for Pacific salmon. This study examines the factors influencing post-release mortality of coho salmon (*Oncorhynchus kisutch*) in a marine recreational fishery in British Columbia. Coho were angled in the marine environment, affixed with acoustic transmitters, and tracked using an existing network of acoustic receivers located at multiple locations frequented by coho including the Salish Sea, Puget Sound, and the Fraser River. We found short-term mortality was higher in air exposed coho (53%) compared to non-air exposed coho (15%). Quantifying mortality rates and understanding how capture and handling factors influence behaviour and survival success will provide information vital to developing management tools and fishing best practices to reduce post-release mortality of wild fish.

Hendriks, B.J., Johnston, S.D., Watson, J., Trites, A.W., Welch, D.W., Rechisky, E.L., Porter, A.D., & Hinch, S.D. University of British Columbia. **Depth and rates of movements of marine captured and released adult Chinook salmon.** The Salish Sea is an important corridor for returning migrating adult Chinook salmon (*Oncorhynchus tshawytscha*), attracting both anglers and marine mammals. The continual decline of both Chinook salmon and Southern Resident Killer Whales (Orcinus orca; SRKW) has led to closures covering large portions throughout this area. Yet, information on fine scale movements and depth utilization of Chinook salmon are limited. To address this, 150 adult Chinook salmon were angled, tagged with depth sensing acoustic transmitters and released during summer of 2019 and 2020 near Port Renfrew, B.C. Tracking data revealed high usage of nearshore waters for homeward migrations, slower travel rates as individuals approached terminal rivers, and diel movement patterns with individuals at greater depths during daylight periods. These results can help managers improve decision-making with fisheries locations and openings, and further our understanding of the SRKW-Chinook interactions.

Zinn, K.*, Johnston, S.D., & Hinch, S.G. University of British Columbia. **Effects of angling approaches and riverine water temperature on survival to spawning grounds of marine captured and released Chinook salmon.** In 2021, we used acoustic telemetry, PIT tagging and temperature loggers to link the thermal experience of 283 angled and released adult Chinook salmon in Barkley Sound British Columbia to their migration rates and survival to spawning grounds. Fight time, reflex, blood loss, wound, eye damage, fin condition, and scale loss assessments were performed following various air exposure treatments once fish were captured. Of 85 Chinook tagged with acoustic transmitters, 65% were detected in Alberni inlet, 38% made it from the inlet to the lower Somass river, and 12% made it to spawning grounds. Most fish are likely from one population, but survival rates are conservative as DNA stock ID is still not complete. Fish that made it to the inlet had low levels to moderate hook-related eye damage (2%). Salmon frequently encountered >21 °C in the riverine migration, and high thermal exposure likely contributed to poor survival to spawning grounds.

Matte, J-M.*, Glasner, D.M., Post, J.R., & Fraser, D.J. Concordia University. **Divergent responses to experimental size-selective harvesting in wild brook trout populations.** Disentangling the importance of density-dependence and size-selective harvesting in exploited populations is critical for fisheries, but the extent to which natural populations respond differently to size-selective harvesting remains unclear. We conducted a field experiment applying standardized size-selective harvesting for three consecutive summers in five alpine brook trout (*Salvelinus fontinalis*) populations with different life histories, with four other unharvested populations as controls. We show that both harvested and control populations exhibit similar density-dependent increases in specific growth, juvenile survival, and earlier maturation at reduced densities. However, size-selective harvesting simultaneously induced important changes to size- and age-structure that varied drastically among harvested populations. While the general prediction is that fish from harvested populations should become younger and smaller over time, we demonstrate that this is only a subset of possible trajectories in natural populations. Collectively, our results highlight the importance of accounting for population-level variation when managing harvested populations for sustainable fisheries.

Margetts, W. & Heise, B*. Thompson Rivers University. **Walk Before you Run: Laying the Groundwork for Smallmouth Bass Suppression in Cultus Lake, BC.** In 2017, smallmouth bass (*Micropterus dolomieu*) were detected in Cultus Lake, British Columbia (BC). This was the first confirmed presence of the species within the lower mainland, an area categorized in a 2011 risk assessment as having a very high probability of establishment and spread for smallmouth bass. Through both visual and DNA barcoding analyses, the bass were found to be preying on two species-at-risk, Cultus sockeye salmon (*Oncorhynchus nerka*) and Cultus pygmy sculpin (*Cottus aleuticus*), as well as many other taxa of invertebrates and fish. During two field seasons (2020-2021), 43 bass were also tagged with Vemco acoustic transmitters and tracked throughout the lake. Bass were found to have spatial overlap with the sockeye salmon, spawning in a small area directly in the salmon's outmigration route. Based on our distribution and diet data, population suppression will take place in the coming years, focusing on nest destruction, and targeting multiple life stages.

Guay, J.*, Ngyuen, V.M.*, Lennon, R., Vollset, K.W., Thorstad, E., Stensland, S., & Jaakko, E. Carleton University. **Impacts of non-native species on fishing experiences and angler behaviour: The case of pink salmon in Norwegian rivers.** Non-native species expansions are becoming increasingly common worldwide, including in Canada. Their establishment may affect various activities including recreational fishing. Understanding angler experiences and perceptions of non-native species can provide management with data on how anglers will perceive the threat and potentially change their behaviour. Our presentation focuses on the recent pink salmon (*Oncorhynchus gorbuscha*) expansion in Norwegian rivers. Because pink salmon occupy the same niche as wild Atlantic salmon (*Salmo salar*), they may pose competition over food or spawning territory. Atlantic salmon is a valued game species in Norway and supports several culturally and economically important recreational fisheries that may be at risk should pink salmon populations establish. We distributed a web-survey to recreational anglers to investigate their attitudes on the presence of pink salmon in Norway, and how the species may impact fishing experiences and behaviour. We present findings from our survey and highlight potential applications for Canadian fisheries management.

Ngyuen, V.M.* Carleton University. **"Provisional Fisheries": a potential important subsection of recreational fisheries in the Great Lakes.** Recreational fisheries contribute billions of dollars to the North American economy. Although there is increasing recognition that these fisheries support social and cultural needs, current management do not consider the socio-economic importance, extent, and impact of "provisional fisheries" – defined and distinguished from other fisheries as fulfilling personal social needs and dietary needs of poor and vulnerable people, many of whom are new migrants to North America. As a result, provisioning fisheries are currently unrepresented in fisheries assessment, governance, and management of the Great Lakes and other regions , with a corresponding lack of information about their impact on aquatic ecosystems and leaving the associated user groups vulnerable to food insecurity. This presentation proposes that provisioning fisheries are: 1) a distinct fishery within the recreational fishing sector that are likely composed of poor and vulnerable people (often new migrants), and 2) have unique socio-cultural and nutritional value different from a traditional recreational angler closer related to small-scale inland fisheries.

Schreier, S.* **Fraser River Sturgeon Conservation Society. Force Marriage or Perfect Union? Learnings from over 20 years of building and maintaining relationships between people and science, for the recovery and protection of Fraser River White Sturgeon.** White Sturgeon is significant for communities all along the Fraser River. This prehistoric species is culturally, socially and economically important for First Nations heritage, recreational enthusiasts and sport fishing professionals. In order to ensure the long-term sustainability of this species, the Fraser River Sturgeon Conservation Society launched its Lower Fraser White Sturgeon Monitoring and Assessment program in 1999. For over 20 years, this program has relied on the efforts and contributions from many volunteers collecting data. Because angling is the least invasive method for data collection, anglers provide the majority of FRSCS program information. This contribution has resulted in one of the best baseline population models on a species like this in the world and created a solid foundation for ongoing research. However, relationships between angler and science communities aren't always easy. This presentation highlights learning's from these key relationships that support the FRSCS's conservation efforts for White Sturgeon.

Avery, T., Levangie, P.*, Czenze, A., Bauer, W., & MacLeod, C. Acadia University. **Social media as a source for recreational fishing data: Striped Bass (*Morone saxatilis*) in Nova Scotia.** Current social media outlets Facebook and Twitter distribute information about many topics. Online communities with focus on recreational fisheries are common; Facebook group Nova Scotia Striped Bass (NSSB) created in 2016 has allowed members to post photos and videos detailing striped bass catches, techniques, and tips. This study analyzes data quality and cost of existing fisheries-based or research-directed methods in comparison to social media web-scraping, by creating a recreational NSSB database using data scraping software and comparing it to existing fisheries-independent data for the same region. We compiled fish length, weight, catch date, and associated fishing ‘event’ data from 30.16% of all NSSB scraped posts (1,188 of 3,939) between 2016 and 2020. We present best practices for using social media in fisheries-based data collection for researchers and social media sites to increase data quantity and quality.

Simmons, S.* Angler's Atlas. **Growing Fisheries Research and Management Through Angler Engagement.** How do Texas anglers help monitor alligator gar? How do Florida anglers fill an important data gap on trophy bass populations across the state? And how do BC anglers help scientists track the Fraser River sturgeon population? In this presentation, we showcase highlights from a one-day symposium recently held at the American Fisheries Society conference in Baltimore that demonstrates how scientists and managers work with anglers to address important research and management objectives. Other examples from the one day event include angler tagging programs in Virginia and South Carolina, collaboration with Muskie anglers in Ontario, and the use of catch-photo-release tournaments across Canada to collect high quality fisheries data that can address a wide range of fisheries research and management questions. The symposium was also live streamed on Facebook, so anglers had the opportunity to participate remotely.

Quinn, D.*, Simmons, S., & Hamilton, S. Anglers Atlas. **MyCatch: A Digital Platform for Angler-Collected Fisheries Data.** MyCatch by AnglersAtlas is a mobile application used by recreational and tournament

anglers to submit high quality fisheries data across broad temporal-spatial scales, including date, time and location (GPS coordinates) of catch, species, length, and effort metrics. Tournament anglers are also required to submit a photo of each fish on a measuring board; these records alone account for 52,707 catch records since 2020, representing 27,738 hours of angling effort in 702 waterbodies across Canada. Our user-friendly, interactive data dashboard allows partners and researchers to access, query, and analyze these data in real time and can be customized to fit your needs. This talk is intended to present the scope of the existing data and infrastructure, highlight some of the ways that fisheries researchers and managers are already incorporating this data into ongoing projects, and start conversations about how MyCatch may provide insights to your own research.

Hamilton, S., Simmons, S.* & Quinn, D.* Anglers Atlas. **MyCatch Tournaments: Customized Catch-Photo-Release Events and Angler Engagement Strategies to Enhance the Quality of Angler-Collected Data.** MyCatch by AnglersAtlas is a mobile application used by recreational and tournament anglers to submit high quality fisheries data across broad temporal-spatial scales. In 2020, COVID-19 restrictions forced the cancellation of fishing tournaments across Canada and drastically scaled back primary fisheries research. To address this situation, MyCatch was modified to host Covid-safe fishing tournaments. MyCatch has hosted 50+ tournaments to date, engaging over 2,000 anglers to contribute >52,000 catch records. Our infrastructure allows catch-photo-release/retain fishing tournaments to be set up with customized parameters in minutes in collaboration with partners and researchers. Experimenting with strategic entry fees, prizing, and tournament structures has facilitated the collection of data coordinating to specific analytical goals of fisheries researchers and managers. This talk will present real-world examples of how these customizations have worked to target specific goals and how the MyCatch communication channels have encouraged changes to angler behaviour in near-real time.

Avery, T.*, Creaser, L., O'Halloran, L., Pomerleau, R., Quinn, D., Yang, J., Klum, J., & Easy, R. Acadia University. **Angling for recreational fisheries data.** Recreational fisheries data for coastal fish species is difficult to obtain, yet necessary to monitor populations. Typical research projects lack enough funding to support monitoring efforts over large areas and long periods. Fishing mobile phone apps have accelerated data acquisition in recent years changing the landscape of how fisheries data is collected and show great promise to complement or replace traditional monitoring methods. We present data acquired using the MyCatch app from Angler's Atlas during fishing tournaments: Miramichi Striper Cup and Atlantic Anglers Challenge and compare it to data collected by research-driven methods.

Fish Movement

O'Connor, B.*, Auger-Méthé, M., Power, M., Pattrson, D.A., Shrimpton, M., Cooke, S.J., & Martins, E.G. University of Northern British Columbia. **Linking spatial stream network modeling and telemetry data to investigate thermal habitat use by Arctic Grayling.** Rivers have a high amount of thermal habitat heterogeneity which is a critical abiotic factor driving freshwater fish distribution. Our objectives were to

explore thermal habitat availability and use by Arctic grayling in the Parsnip River Watershed in Northern British Columbia. The presence of a thermal gradient in the watershed was revealed by the spatial stream network model and its influence on Arctic Grayling summer distributions in the watershed was explored with site occupancy modeling using telemetry data. Preliminary results revealed a mean 2019 and 2020 August occurrence temperature of 10.8ºC ± 1.3ºC and 9.4ºC ± 1.9ºC respectively. Arctic grayling occurrence temperatures sat within a narrower range (80%) of the temperatures available in the entire river network.

Brownscombe, J.W., Shipley, O.N., Griffin, L.P., Morley, D., Acosta, A., Adams, A.J., Boucek, R., Danylchuk, A.J., Cooke, S.J., & Power, M. Fisheries and Oceans Canada. **Application of telemetry and stable isotope analyses to inform the resource ecology and management of a marine fish.** Telemetry has major potential for application to fish habitat science and management, but to date it is underutilized in this regard. We will discuss various ways in which telemetry can contribute to fish habitat science and present some considerations for improving its application to this field. To date, most fish telemetry studies have been descriptive (e.g., fish use area A more than B); greater adoption of more inferential study approaches that assess causal ecological drivers of movement and space use would be of value and require more extensive measurement of environmental conditions. We will conclude by presenting a conceptual framework for scaling from individual studies to broad applications in habitat management. Established telemetry networks can readily support synthesis activities, although fish tracking data and environmental data are rarely stored together and current disconnects amongst repositories may constrain broad integration and scalability.

Hlina, B.L.*, Glassman, D.M., Ledee, E.J.I., Nowell, L.B., Claussen, J.E., Philipp, D.P., Power, M., Marsden, J.E., & Cooke, S.J. Carleton University. **Thermal Habitat Constraints Influence the Space Use of a Cold-Water Fish in a Multibasin Lake.** Water temperature is the largest driver of biological processes for fish as it regulates physiological mechanisms which dictate movement and behaviour, growth, reproduction, and survival. Natural processes and manmade disturbances can fragment and disrupt thermal habitats which can be detrimental to some fish species (e.g. cold-water fish). Here, we evaluate the spatial use and trophic status of a cold-water fish, lake trout, to determine how the species persists in a complex multibasin freshwater ecosystem with potentially limiting resources. Current findings suggest thermal habitats for lake trout become seasonally fragmented forcing lake trout to utilize more sub-optimal thermal habitats (≥ 12°C). The seasonal reduction in spatial occupancy appears to result in slower growth rates and reduced bioenergetics. In the context of fisheries management, incorporating habitat usage into current sampling designs and modeling could improve current practices.

Jetter, C.*, Crossman, J., & Martins, E.G. University of Northern British Columbia. **Fine-scale movement patterns and behavior states of white sturgeon in a regulated river.** In 2014, a VEMCO positioning system (VPS) was used to examine the fine-scale movements of endangered white sturgeon (Acipenser transmontanus) who occupy critical habitat immediately below a hydroelectric facility on the regulated Upper Columbia River. The VPS study saw limited correlation between fish movement and river regulation (e.g. discharge, temperature). Our goal was to utilize more advanced analytical techniques, including hidden Markov models (HMMs) and Bayesian multilevel models (MLMs), to further investigate

sturgeon movement patterns and behavior states in relation to facility operations. Specifically, our objectives were to 1) identify movement behavior states and 2) assess how factors of river regulation influence behavior dynamics across time and space. Our study saw that water temperature largely influenced switches between movement behaviors, while discharge influenced the spatial distribution of movement behaviors. Results will help inform recovery measures, such as overall flow management and optimization of operations to reduce impacts of river regulation.

Piczak, M.*, Brooks, J., Doka, S., Portiss, R., Lapointe, N., Midwood, J., & Cooke, S.J. Carleton University, Fisheries and Oceans Canada. **Spatial ecology of non-native common carp (*Cyprinus carpio*) in Lake Ontario with implications for management.** Common carp, Cyprinus carpio, is a non-native species that established within the Laurentian Great Lakes more than a century ago. Common carp have negatively affected freshwater ecosystems, by increasing turbidity and decreasing vegetation through foraging and/or spawning activities. The aim of this study was to examine the spatial ecology of common carp across multiple spatial scales within Lake Ontario using passive acoustic telemetry to aid in the development of management strategies. We identified sites within Lake Ontario where common carp could be spawning. Knowledge of spawning habitat could inform efforts to exclude common carp from these specific locations. We also determined that common carp undertook extensive movements throughout the basin of Lake Ontario along the nearshore, which could be indicative of a lake-wide population. Management implications of these extensive movements could include rapid colonization of sites without control structures, therefore compromising remedial efforts within Lake Ontario.

Bergman, J.*, Raby, G., Neigel, K., Rennie, C., Balshine, S., Bennett, J., Fisk, A., & Cooke, S.J. Carleton University. **Tracking the early stages of an invasion with biotelemetry: behaviour of round goby in Canada's historic Rideau Canal.** The round goby, native to the Black and Caspian seas, is one of the most globally widespread invasive fish species. In January 2019, round goby were discovered to have invaded and colonized a distinct, central portion of the Rideau Canal near Smiths Falls, Ontario. Passage through locks is the most likely means by which round goby can naturally disperse throughout the system, so modifying lock operations and/or infrastructure to minimize passage could reduce their spread. We combined acoustic telemetry with hydraulic data to characterize sex- and size-specific movements, identify entry and exit pathways through a lock, and assess dispersal rates and probability. We tracked 45 round goby during the Rideau Canal's 2019 navigation season and found that although locks act mostly as a barrier, if round goby did enter the lock chamber, certain lock operations could enable upstream dispersal. With invasive species being a driving cause of global freshwater biodiversity reductions, our work can serve as a model for future use of telemetry to assess, and potentially manage, invasive species in other canal systems.

A Tribute to Kim Hyatt

Irvine, J. & Bailey, R.* Fisheries and Oceans Canada. **A Tribute to Kim Hyatt - Background and Introduction.** Sadly, Dr. Kim Hyatt passed away on May 25, 2021 after battling aggressive cancer. Kim's

impressive career began several years before receiving his PhD from UBC in 1980, covering a broad range of topics pertaining to salmonids and the aquatic ecosystem. Kim's contributions continue as evidenced by several papers published posthumously and ongoing work by numerous colleagues who carry on research initiated or inspired by him. The goal of today's session is to pay tribute to Kim by providing an opportunity for colleagues and friends who worked with or were inspired by him to describe their research. We begin with a brief chronological summary of his major contributions, beginning with theoretical contributions to foraging theory leading to applied and impactful research on a Risk Assessment Method for Salmon (RAMS) and Fish Water Management Tools.

MacKinlay, D.* Fisheries and Oceans Canada. **Lake fertilization in BC: Past, Present, and Future?** Lake Enrichment started in BC with a multi-disciplinary study by an oceanographer on Great Central Lake in 1970. The techniques were refined by a DFO Science research program until 1997 and now lake enrichment makes up a very small routine component of the Salmonid Enhancement Program. However, as the review by Hyatt et al. (2004) showed, the methodology is well-proven and can lead to annual restoration of historic lake productivities leading to substantial gains in adult abundance. The future potential of lake enrichment in BC is enormous since there are over 2400 km2 of active sockeye nursery lakes in the Fraser watershed alone, historically nurturing populations of 50-100 million spawners. There is another 1400 km2 of potential nursery lakes above fish passage barriers in the Fraser, not to mention thousands more square kilometers in the Skeena, Columbia and coastal watersheds that could be enriched. The potential of this salmon enhancement technique has hardly even been tapped.

Hyatt, K., Luedke, W.* & Pearsall, I. Fisheries and Oceans Canada, Pacific Salmon Foundation. **Risk Assessment Method for Salmon (RAMS).** This talk describes the RAMS process as a blueprint for the rebuilding of the Cowichan River Chinook population, one of the few Canadian success stories of salmon recovery. By 2009, Cowichan River Chinook, once a driver for fisheries in the Strait of Georgia and an important part of Cowichan Tribes life, hit a low of only a few hundred natural spawners. Kim Hyatt provided significant support and leadership in the development of a made in Canada approach to rebuild this stock. RAMS, a structured process to prioritize actions was applied by prioritizing restoration and conservation actions. Instead of beginning with a focus on human activities as causal mechanisms, RAMS starts from the point of view of the fish. Using available knowledge, the RAMS approach identifies and investigates potential biological bottlenecks (mortalities), including when and where they act on the fish during its life cycle and ecosystem. Identification of causal mechanisms and options for mitigation follow the prioritization of key factors limiting survival. The process is iterative, low hanging mitigations are addressed, and identified knowledge gaps are identified and guide research.

Dobson, D.* Fisheries and Oceans Canada. **Adaptation responses of fisheries and fisheries managers to climate induced impacts on sockeye salmon returns to Barkley Sound, British Columbia: Kim Hyatt's meaningful contribution to innovation in salmon management.** The application of the precautionary approach in responding to the potential impacts of climate change is limited. Stock or fishery reference points developed under productive periods may not be robust to climate-induced changes in productivity. Moreover, a narrow stock approach to management often fails without either the proper consideration of uncertainty, which increases under climate-change scenarios, or consideration of

broader ecological factors and interactions. Perhaps even more importantly, when socio-economic factors are not considered in developing fishery objectives and management plans the oversight often leads to implementation failure through lack of incentive. The Barkley Sound sockeye salmon management system is an innovative example of adaptive management supported by a First Nation and stakeholder driven co-management approach to confronting these issues. Kim Hyatt was a major contributor to this innovation and the success of the system. Over many years, it benefitted from his research legacy, his commitment to learning, and his willingness to effectively breach the 'science-management interface' in order to make his research relevant.

Fryer, J.K.* Columbia River Inter-Tribal Fish Commission. **Reflections on 35 years working with Okanagan Sockeye, the ONA, and Kim.** Over the past 35 years, Okanagan Sockeye Salmon have staged a remarkable recovery from lows of only a few thousand spawners to a peak of over 500,000 returning to Bonneville Dam. In the 1990s, few Canadians even knew Sockeye existed in the Okanagan, now the run is major news throughout the region, supporting tribal and recreational fisheries. Okanagan Sockeye are consistently the most abundant wild Columbia Basin salmon run; their range has been expanded, and habitat restored. Much of this turnaround can be attributed to the Okanagan Nation Alliance working Dr. Kim Hyatt and their unwillingness to let this run fade away, their determination, and vision. I have been fortunate over my career in that I have had the opportunity to observe, and participate, in this remarkable recovery and will share observations and stories about working with Kim and the ONA.

Wright, H.*, Benson, R., & Bussanich, R. Okanagan Nation Alliance. **Okanagan Nation Alliance's Okanagan Basin Sockeye Salmon Restoration Summary (1995-2021).** The Okanagan Basin was a major salmon tributary for the Columbia River. Salmon were essential to Syilx People in the Okanagan Territory for subsistence, culture, and commerce. Due to overharvest, dam construction, river channelization, and introductions of invasive species, salmon stocks in the Okanagan declined during the last century; salmon were extirpated from two of the three Okanagan Basin lakes. Sockeye restoration began in 1996 with an expert workshop; the outcome was to focus on Skaha Lake, directly downstream of Okanagan Lake. The Okanagan Nation Alliance (ONA), in partnership with the Federal and Provincial Governments and Washington State Public Utility Districts, implemented an Experimental Reintroduction of Sockeye into Skaha Lake in 2004. Fry are reared at the ONA owned kɬ cp̓ə̓lk̓ stim̓ Hatchery. A monitoring program contributes to the adaptive management process to ensure the aquatic ecosystem remains intact. Skaha and Osoyoos lakes now support self-sustaining Sockeye populations, and comprise 70-90% of the total Columbia Sockeye run. The restoration has expanded into Okanagan Lake, with on-going hatchery fry stocking and studies to address fish passage at Okanagan Dam, adult spawning locations, and survival.

McQueen, D.*, Hyatt, K., Ogden, A., Wright, H., Benson, R., Alex, K., Stockwell, M., & Pham, S. York University. **Age-structured interactions among Sockeye Salmon fry, kokanee, Mysis and their zooplankton prey in Skaha Lake, British Columbia.** In 2004, after an 85+ year absence, Sockeye Salmon were reintroduced into Skaha Lake. Prior to the introduction, fisheries managers were concerned that Sockeye fry might adversely affect kokanee through increased competition for zooplankton prey. Over 16 years (2005-20) we tested this hypothesis by introducing contrasting densities (0-2309 ha-1) of marked, hatchery-origin Sockeye fry, and comparing consumption by the pelagic planktivores (introduced Mysis,

kokanee and Sockeye) with zooplankton production. As the experiment progressed, density and survival of Sockeye and kokanee gradually increased, and rates of fish growth gradually decreased. Bioenergetics analysis showed that these two trends were associated with increased rates of prey consumption by Mysis and older kokanee. Consumption by Sockeye fry played almost no part in these events. Sockeye fry averaged 3% of annual zooplankton consumption, Lake Whitefish 3%, older kokanee 15% and Mysis 80%. It seems likely that enhanced Sockeye passage and spawning in the Okanagan River will soon replace the need for stocking, and Skaha Lake will again become a self-sustaining Sockeye Salmon nursery lake.

Fryer, J.K., Bussanich, R.*, Folks, S., Ogden, A., Stiff, H., & Challenger, W. Okanagan Nation Alliance. **Okanagan sockeye out of basin factors affecting adult and juvenile migration.** Okanagan River Sockeye Salmon sc'win, *Oncorhynchus nerka* (Okanagan Sockeye) are one of two remaining self-sustaining Sockeye Salmon populations in the Columbia River Basin. A key project of Dr. "Sockeye" Kim Hyatt, as lead DFO investigator, along with Dr. Jeff Fryer, and ONA biologists, developed a program using detection histories of smolts implanted with passive integrated transponder (PIT) tags between 2012 and 2019 to estimate survival and behavioral metrics during reintroduction efforts and changing environmental conditions over the monitoring period. The success of reintroduction efforts to increase spatial structure and diversity of Okanagan Sockeye is, therefore, critical to maintaining the population in years to come. The PIT smolt program continues to be a legacy project guide future work, including informing all aspects (hatchery, habitat, fish passage, and harvest) of the reintroduction experiment to the Okanagan (i.e., hatchery, habitat, fish passage, and harvest), as well as providing critical building a baseline information for an innovative full life cycle model being developed to assess the cumulative effects of water management, land use, fisheries activity, and climate change on Columbia River Sockeye Salmon.

Alex, K.* & Alexander, C.* Okanagan Nation Alliance, ESSA. **Dr. Kim Hyatt's role in the creation of the Okanagan Fish-Water Management Tool.** Natural variation, scientific complexity, competing objectives, staff (knowledge) turnover, and other multi-agency communication barriers are challenges faced by water managers who must decide how to allocate limited and variable water supplies. In the case of Okanagan Lake (British Columbia), water levels are managed to provide a balance for flooding, fisheries, urban/agricultural withdrawals and other interests. The Fish/Water Management Tool (FWMT) allows all levels of government and the Okanagan Nation to participate and agree on trade-offs to best meet socio-economic and environmental goals associated with water management at Okanagan Lake Dam. The FWMT decision support tool was masterminded by Dr. Kim Hyatt who led multi-entity teams in both its creation and development of related collaborative governance arrangements in the early 2000's. FWMT has been in operation ever since with benefits exceeding expectations. The core team who developed FWMT received both a BC Premier's Award for excellence in innovation, as well as the Murray A. Newman Award for Significant Achievement in Aquatic Conservation from the Vancouver Public Aquarium.

Selbie, D.* Fisheries and Oceans Canada. **Conservation and Management of Pacific Salmon Futures in an Era of Unprecedented Environmental Change: A tribute to Dr. Kim D. Hyatt.** We face the most profound period of environmental change in human experience, directly challenging the sustainability of Pacific salmon, supportive ecosystems, and human reliance. This is a delicate time, when societal

expectations meet the realities of resource statuses and freshwater and marine ecosystem transformations. Intricate Pacific salmon life histories are sensitive to environmental forcings, with numerous habitat interfaces inducing complex and interactive filters over space and time that shape salmon populations and permit fisheries. As climate change and interactive stresses on Pacific salmon evolve, however, so too will the preponderance of 'ecological surprises' inherent to fisheries, should salmon-ecosystem connections not be explicitly considered or remain poorly understood. The management of Pacific salmon will be increasingly challenged to meet societal, and thus policy and legislative expectations in this era of change, requiring targeted and integrated ecosystem monitoring and research, married with suitably precautionary approaches to fisheries, hallmarks of Dr. Hyatt's scientific vision and legacy.

Indigenous Management Systems

Armstrong, J.* & Benson, R.* Okanagan Nation Fisheries, University of British Columbia Okanagan. **Syilx Okanagan Nation Salmon Restoration: A Syilx Science Model.** A joint presentation for the Indigenous Fisheries on ONAF and TEK approach foundational to decision-making in the ONAF fisheries restoration work. The presentation will include an overview of the decades long work of planning and successful implementation of restoration of Okanagan sockeye and the more recent work of restoration of Okanagan Chinook, A focus on how Syilx TK research on Okanagan Chinook and results it produced in the ONAF approach. The presentation will summarize the process of Syilx TK and community process of informing the work as well as the process to develop Syilx specific approaches to the utilization of science innovations such as genetic and strontium tools following Syilx TK. The presentation will also present on tensions encountered in the determination of Chinook DU's in the Okanagan river system and the path forward.

Atlas, W.*, Ban, N., Moore, J.W., Tuohy, A., Greening, S., Reid, A.J., Morven, N., White, E., Housty, W.G., Housty, J., Service, C., Greba, L., Harrison, S., Sharpe, C., Butts, K., Shepert, W., Sweeney-Bergen, E., Macintyre, D., Sloat, M., & Connors, K. Wild Salmon Center. **Indigenous Systems of Management for Culturally and Ecologically Resilient Pacific Salmon (*Oncorhynchus spp.*) Fisheries.** Pacific Salmon (*Oncorhynchus spp.*) are at the center of social-ecological systems that have supported Indigenous Peoples around the North Pacific Rim since time immemorial. Through generations of interdependence with salmon, Indigenous Peoples developed sophisticated systems of management involving cultural and spiritual beliefs, and stewardship practices. Colonization radically altered these social-ecological systems, disrupting Indigenous management, consolidating authority within colonial governments, and moving most harvest into mixed-stock fisheries. We review Indigenous management of salmon, including selective fishing technologies, harvest practices, and governance grounded in multi-generational place-based knowledge. These systems and practices showcase pathways for sustained productivity and resilience in contemporary salmon fisheries. Contrasting Indigenous systems with contemporary management, we document vulnerabilities of colonial governance and harvest management that have contributed to declining salmon fisheries in many locations. We suggest that revitalizing traditional

systems of salmon management can improve prospects for sustainable fisheries and healthy fishing communities and identify opportunities for their resurgence.

Housty, W.G.* Heiltsuk Integrated Resource Management Department. **Traditional and ongoing Haíłzaqv salmon management: progress towards implementing Gv̓ı̓ḷas and ł̓áxvái in a contemporary context.**

Ballard, M.* University of Manitoba. **Dragging the Line: Reflections using 3-eyed seeing and voices of past, present, and future of Lake St. Martin.** Lake St. Martin has been repeatedly endured artificial flooding over the past sixty years. During the super flood of 2011, the Province of Manitoba declared a state of emergency, diverting water to Lake St. Martin causing overland flooding of the First Nation communities situated on the shores of Lake St. Martin. In 2011, an outlet channel was constructed on Lake St. Martin to divert the excess water to Lake Winnipeg. The Province is proposing another Outlet channel which will flow through Lake St. Martin. This talk will discuss 3-eyed seeing and voices of Lake St. Martin, and the aquatics Indigenous knowledge of Lake St. Martin. Data will be presented of what western science cannot decipher and First Nations knowledge regarding the lake and its "character". This talk also will explain how the knowledge of the lake is premised on Anishinaabe mowin that is based on natural law and how it is an important baseline monitor that is important for the lake.

Chegahno, J.*, Harpur, C.*, Dunlop, E.*, Lauzon, R.*, Chegahno, J.*, Redford, B.*, & Akiwenzie, C.* Saugeen Ojibway Nation (SON), Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry (NRF), Parks Canada. **Together with Giigoonyag: A two-eyed seeing approach for learning about Dikameg in Lake Huron.** Lake whitefish (Dikameg in Anishinaabemowin) populations have declined substantially in Lake Huron in recent years. Dikameg have been essential to the Saugeen Ojibway Nation's (SON's) diet, economy and culture for thousands of years, yet key gaps exist in the scientific understanding of many aspects of Dikameg ecology. Identifying causal factors of the species decline is a high priority. In response, SON in partnership with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry (NDMNRF) and Parks Canada have undertaken a community-based research initiative, known as Together with Giigoonyag (TWG). This presentation will explore how several research projects under this initiative contribute important information that can aid in lake-wide understanding, monitoring, and stewardship of SON's fishery. The TWG initiative aims to create a place for knowledge systems to interact with mutual respect and understanding, and this session's purpose is to share the resulting lessons with a broader audience.

Florea, A.* & Deslauriers, D. Institut des sciences de la mer de Rimouski-Université du Québec à Rimouski. **Biological characterization of Icelandic scallops (*Chlamys islandica*) and modeling of their predicted distribution based on local indigenous knowledge (Sanikiluarmiut Qaujimajatuqangit) in the Belcher Islands, Nunavut**. The Iceland scallop, Chlamys islandica, is a northern distributed bivalve that has been selected to potentially support a sustainable commercial fishery around the Belcher Islands to profit the Sanikiluaq community. These islands, situated in the South-East portion of Hudson Bay in Nunavut, are considered for the establishment of a Marine Protected Area (MPA) because of their very dynamic environment and diverse flora and fauna. This project aims at quantifying and qualifying C. islandica around the Belchers with morphological and physiological characteristics. In addition to this, we

are looking to predict the occurrence of this species with regards to environmental predictors using an ecological niche modelling approach. Our methods are mainly focused on integrating Inuit traditional knowledge into our model and co-producing our data collection along with Sanikiluarmiut Qaujimajatuqangit. Our objective is to create a dataset that will facilitate the development of a commercial fisheries that is in line with Fisheries and Oceans Canada requirements.

Pye, C.*, Bayse, S., Foley, P., Boaler, C., Kanagasabesan, T., Russell G., Jr., & Milbury, K. Fisheries and Marine Institute of Memorial University of Newfoundland. **Using adaptive management through community-based stewardship to investigate the presence of abandoned, lost, and discarded fishing gear (ALDFG) to protect Golden Cod in the Gilbert Bay Marine Protected Area (GB-MPA).** Abandoned, lost, and discarded fishing gear (ALDFG) is a worldwide environmental, economic, and social issue. This paper examines the magnitude of ALDFG in Gilbert Bay, Labrador. The Gilbert Bay Marine Protected Area (MPA) was created through community-based stewardship to protect a genetically unique and resident population of Atlantic cod (Gadus morhua). Expanding on community-lead initiatives, key knowledge holders (n = 14) of Gilbert Bay were interviewed to describe the collective understanding of ALDFG while identifying areas of concern. During retrieval, a total of 66 sea-based sites were investigated. Additionally, 19 land-based sites were identified during sea-based retrieval, with varying types and amounts of gear retrieved from 10 different sites. The removal of gear will act as a conservation measure for Gilbert Bay cod and will be analyzed by condition to identify potential economic opportunities for repurposing, recycling, or proper disposal of ALDFG, and provide solutions for proper end-of-life gear management.

Grant, S.* & Ward, J. Fisheries and Marine Institute of Memorial University of Newfoundland. **Strategic Multi-Year Fisheries Resource Assessment Project in the Arctic: Building Capacity of Northern Inshore Collaborative Research.** There is increasing pressure to utilize Canada's Arctic marine resources to minimize food insecurity through increased subsistence harvesting and where biomass/life-history/productive capacity information merits sustainable harvests, there is interest in commercial development. To obtain a greater understanding of marine fisheries resources in the Nunavut Settlement Area of Kinngait, Sanikiluaq, Igloolik, and Sanirajak, this 5-year research program introduces 1) the recently constructed RV Ludy Pudluk, a $2.6 million purpose built and innovative inshore fisheries research vessel (i.e. catamaran) owned by the Qikiqtaaluk Corporation, and 2) a novel science-Indigenous research partnership that will contribute to the success of the program and ability to extend research beyond the current scope. This presentation will summarize past studies that led to the current project, introduce 11 subprojects identified to date that Mitacs has approved funding for over $350,000, and positions that will be coming available at the graduate and post-doctoral level.

Zabudsky, S.*, Walsh, P., & Grant, S. Fisheries and Marine Institute of Memorial University of Newfoundland. **Video technology as a method to analyze populations of Cucumaria frondosa in the inshore environment of Nunavut, Canada.** The isolated location of communities in Nunavut makes food insecurity an ongoing concern. In the inshore environment, a potential fisheries resource has been identified; the orange footed sea cucumber (*Cucumaria frondosa*). Population information must be collected to determine sustainable harvest levels of an Indigenous-led commercial fishery supplying

Nunavut's country food markets. High-definition geo-referenced video footage of the seabed was collected in waters adjacent to Iqaluit, Kimmirut, Kinngait, and Sanikiluaq using towed video sled and drop camera surveys from community supplied vessels. Future surveys will include Igloolik and Sanirajak. Video footage is currently undergoing analysis for density and benthic community composition using a Canadian perspective grid developed for underwater imagery. Density estimates, community structure, and life-history will be used to determine ecologically sustainable harvest levels. The science-Indigenous research partnership demonstrated by this study will contribute to the success of future management systems and ability to extend research beyond the current scope.

Sylliboy, J.*, & Denny, S. Unama'ki Institute of Natural Resources. **UINR's Approach to Using Two-Eyed Seeing in Aquatic and Fishery Management.** Two Eyed Seeing is a concept coined by Elder Albert Marshall of Eskasoni. Albert tells us that two eyed seeing is about co-learning. It's about the opportunity to co-produce knowledge using the best of Western and Indigenous Knowledge.
In our experience, Two Eyed Seeing is a potential solution to many aquatic and fishery management issues. The integration of Mi'kmaq values of Mi'kmaw relationships to culturally significant species, preventing harm and waste, protecting water quality and habitats, and acting conservatively with the Western values of rigorous scientific methods and written transmission of knowledge are the foundation to Two Eyed Seeing. Our presentation will draw on our experience and projects with the Mi'kmaq, DFO, Parks Canada and Province of Nova Scotia to explain how UINR has been addressing management issues in aquatics and fisheries.

Creaser, L.* & Avery, T. Acadia University, Acadia First Nation. **Braiding knowledge systems with Etuaptmumk; initial conversations leading to continued communication and collaboration with Indigenous communities for Netukulimk in fish research**. Etuaptmumk – Mi'kmaq concept, coined by Elder/Dr. Albert Marshall, Eskasoni First Nation of Una'ma'ki in Mi'kma'ki (Cape Breton, NS). Etuaptmumk is viewing an overall subject in science with both Indigenous and Western knowledge system lenses. Through etuaptmumk solutions are developed based on both knowledge systems coming together for increased transparency and collaboration. To succeed, initiating and continuing conversations with appropriate respect and openness with Indigenous communities is important to braid knowledge in collaboration. Indigenous communities' in Mi'kma'ki fish for livelihood under treaty rights and practice Netukulimk. Netukulimk is comparable to minimum impact in a research footprint context in field research ethics. An analysis of previous fish research was conducted and interpreted regarding inclusion of Indigenous peoples. A comparable critique of knowledge systems used in past research was undertaken in reflection for future practice of inclusive research. Emphasis is on who, how, demographic awareness, and benefits of Indigenous collaboration to fish research.

Jacobs, C. University of Windsor & Walpole Island First Nation. **Making Space: Support of Indigenous-led Approaches to Fisheries Research, Management, Conservation, and Protection.** Through the spirit of reconciliation things are changing from the status quo in Canada and there is a lot to unlearn, relearn, and co-learn. This presentation focuses on insights from Bkejwanong Territory, otherwise known as Walpole Island First Nation, in southwestern Ontario that lives with nearly 80 of Canada's species at risk. Despite growing projects, partnerships, and collaborations, at a range of scales, there is need to make

space for Indigenous-led approaches to fisheries research, management, conservation, and protection. This talk aspires to initiate a broader network across Turtle Island leading to guidance on putting reconciliation into practice by bringing together Indigenous ways of knowing and science with the goal of achieving ecological sustainability.

Nolan, S., Jacobs, C.*, Donaldson, C., & Febria, C. University of Windsor. **Integrating storytelling into management strategies.** Storytelling is the perfect complement to research and management programs that seek to protect watersheds. Managing ecosystems also requires restoring a sense of place. While typical aims of success are quantitative targets/thresholds, we should also be paying attention to the human dimensions of watersheds. This presentation details the communications and storyteller initiatives of the Healthy Headwaters Lab at the University of Windsor, which focuses on translation ecology. Storytelling is a huge part of our culture – it's how we learn, share, and spread knowledge. When we know better, we do better, and increasing awareness and connection to the land and water inspires stewardship in the broader community. Collaborations with local communities highlights the significance of knowledge mobilization and transfer. Featuring insights from youth on preserving culture, community-based restoration guided by elders, and multi-dimensional investigations of endangered species habitat; we show how storytelling is an important tool in Indigenous and collaborative management strategies.

Hollinger, T.*, Stewart, R., Wilson, N., Nobis, R., Kowtiash, A., & Kowtiash, A. Lakehead University. **Biinjitiwaabik Zaaging Anishinaabek (BZA-Rocky Bay) Lake Nipigon Contaminants study: Reclaiming Lake Nipigon management through fish contaminants, water quality and sediment core analyses**. The community of Rocky Bay has long observed changes on the shores of Lake Nipigon. The Lake has long served as a vital resource and continues to support community commercial and subsistence fishing. With extensive resource development and extraction in the region, the community has long raised concerns about the health and overall management of the Lake Nipigon Basin. BZA has been working with Lakehead University over the past two years to assess fish contaminants (mercury and arsenic) as well as water quality and sediment in areas identified as culturally and economically important to the community. Concerns include contaminants from hydroelectric development, clear cutting, and mining. Commercial fishermen, Band Council members, biologists and researchers have partnered to assess the health of the lake. 7 bays and multiple river bays were sampled for fish contaminant levels and water quality to assess spatial trends in contaminants across The Lake's basin.

Connoy, J.* & Vamosi, S. University of Calgary. **Understanding salmon-ecosystem interactions at their very limit, as told by trees and Teslin Tlingit Council knowledge holders.** Pacific salmon function as major sources of sustenance and nutrients in moving from marine environments inland. In coastal systems, this has been demonstrated by positive relationships between salmon abundance and riparian tree growth, mediated by predators and scavengers fertilizing soil with salmon carcasses. We asked whether this occurs at the limit of Pacific salmon distribution, on the Teslin Tlingit Council (TTC) Traditional Territory in Southern Yukon. Tree growth chronologies were created for riparian sites and related to salmon escapement data from the Yukon and Teslin Rivers. Site growth chronologies were significantly and positively related to salmon escapement at three of four salmon-bearing sites. This

study demonstrates the ubiquity of the importance of salmon to all environments that they inhabit. Other roles of salmon in the study system and their population decline are currently being studied through Traditional Knowledge interviews with the TTC (delayed due to COVID).

Black, J., Carothers, C., Esquible, J., Woods, B.*, & Samuelson, J.* University of Alaska Fairbanks. **Indigenizing Salmon Science & Management: Knowledge and Reflections of Alaska Native Peoples.** Indigenizing Salmon Science and Management is centered on Indigenous cosmologies and methodologies to better understand the ways Alaska Native people steward salmon, incorporating values and providing ideas to improve current management practices and systems. Indigenous people have stewarded Alaska lands and waters for thousands of years, yet have been largely excluded from science and management systems that fail to advance Indigenous self-governance initiatives. We use a highly participatory approach facilitating circle dialogues and conducting semi-directed interviews multigenerational fishing families. Respect, reciprocity, responsibility, and relational accountability are some of our many guiding principles. This talk focuses on research conducted along the Yukon and Kuskokwim Rivers, with the guidance of local Tribes and Indigenous community members. Yup'ik and Athabascan values, knowledge, and stewardship practices are documented and shared. We also identify strengths and weaknesses of western management systems from the perspectives and experiences of Yup'ik and Athabascan people. Lastly, reflections on salmon, people and the future are shared to envision a more equitable and sustainable path forward for salmon and people in Alaska.

Black, J., Carothers, C., Westley, P., & Stern, C. University of Alaska Fairbanks. **Tamamta (All of Us) : Transforming Western and Indigenous Fisheries & Marine Sciences Together.** Motivated by deep inequities, Indigenous erasure, racism, and violence against Alaska Native peoples, Tribal sovereignty, Indigenous values, governance practices, and knowledge systems, the Tamamta program seeks to transform education, research, governance systems in Alaska and beyond. We envision a future where Indigenous Peoples and our/their knowledge and governance systems steward land, fish, and animal relations. We are supporting several cohorts of Alaska Native and Indigenous students to pursue their graduate degrees in western and Indigenous fisheries and marine sciences. We are working to decolonize and Indigenize our curriculum, programs, and institutions. We are hosting difficult dialogues, providing short courses, and cultural exchanges for state and federal partner agencies to join us in this transformation. In all of this, we center deep relational work based on reciprocity, respect, and redistribution. We will share our origin story, the work of our first year, and some opportunities and challenges met along the way.

Ogston, L.*, Rao, A.* & Hyland, H.* Tsleil-Waututh Nation. **Tsleil-Waututh Nation Indian Arm Creosote Pilings Removal, February 2021.** The project included the removal of 44 creosote piles and 5 cedar piles from 4 areas of Indian Arm totaling 28.25 metric tonnes taken for responsible disposal. Indian Arm is an area of importance to forage fish, salmon and traditional harvesting practices. Removal of creosote pilings from Indian Arm was identified by the TWN community, as the use of creosote causes contamination in water and sediments, has lethal effects on spawn, and contaminates harvested foods. There are over 100 pilings and other items from old logging operations in the area. Sediment analyses looked for PAHs leaching from these old pilings and showed localized sediment contamination around

several pilings tested. Work was completed in 3 days with the help of our partners and in-kind support, in an environmentally responsible way. Following this work, TWN observed herring spawning activity in Indian Arm to an extent not seen since the 1880's.

Fish Ecology: Communities to Ecosystems

McAllister, K.*, Andrew, D., Drake, R., & Power, M. University of Waterloo. **Round Goby (Neogobius melanostomus) impacts on benthic fish communities in two tributaries of the Great Lakes.** There is limited understanding of how Round Goby impacts small-bodied native benthic fishes within tributaries of the Laurentian Great Lakes. To address this knowledge gap, catch per unit area (CPUA) of Round Goby and darter species (family Percidae) from two Southwestern Ontario rivers were analyzed to assess relative abundance patterns along longitudinal tributary gradients. Round Goby CPUA was highest in habitats proximate to the Great Lakes but sharply declined after 18 and 14 km upstream from each lake in the Ausable River and Big Otter Creek, respectively. In both tributaries, sites with low CPUA of several darters coincided with high Round Goby CPUA, suggesting potential competition or displacement by Round Goby. The negative correlation between Round Goby and darter relative abundance was observed at greater spatial scales and longer post-invasion intervals than previous studies and provides insight into how Round Goby will affect native fish communities in other tributary ecosystems.

Boyachek, S.,* Reid, D., & Avery, T. Acadia University. **Invasive Chain pickerel in Kejimkujik National Park and National Historic Site: Spawning timing and effects on native fish assemblages.** Chain pickerel, Esox niger, is an invasive freshwater fish in Nova Scotia that was illegally introduced in the 1940s. Through natural movement and subsequent illegal introductions, Chain pickerel has spread across Nova Scotia, being recorded in 165 lakes, rivers, and ponds as of 2020. In 2018, Chain pickerel was first discovered in Kejimkujik National Park and National Historic Site (Kejimkujik). Spawning timing and the cascading effects of introductions of Chain pickerel on native fish assemblages is currently unknown. This study aims to characterize gonadal development using histological analyses and gonadosomatic index (GSI) to identify spawning periods. Further, through a comparative study of similar lakes that are invaded and invasive-free, the effects of invasion on native fish assemblages through monitoring and gut content analysis will be conducted. Our results will provide crucial insight on the life history and effects of Chain pickerel in Kejimkujik to inform management strategies.

Yeung, A.*, Li, A., Pearson, M., & Barrett, S. BC Ministry of Environment & Climate Change Strategy. **Old fish, new tricks: using large-scale fish presence-absence survey data to inform watershed assessment and management for the South Coast of British Columbia.** Standardized fish community indicators that reflect watershed conditions are challenging to develop at large geographical extents (e.g., ecoregion), due to limited data availability across space and time. It is largely untested whether fish richness metrics derived from presence-absence data can respond well to gradients from pristine to highly urbanized. Using fish records in government databases, we related 4 richness metrics (richness of native, sensitive, alien taxa, and assemblage-level sensitivity to disturbances) to landscape-scale attributes in pristine watersheds (< 3% impervious cover) of South Coast region. Based on such relationships, we compared the modelled and observed values of richness metrics, and generated the fish community index (FCI) for well-sampled impacted watersheds (≥ 3% impervious cover). FCI declined with increased urbanization,

particularly when watershed impervious cover exceeded 20%. Our study demonstrates the utility of presence-absence data in establishing baseline conditions for fish communities, and rapid, complementary bioassessment tools for watershed management.

Cormier, J.G.*, Curry, A., Linnansaari, T., O'Sullivan, A., Ogilvie, J., & Legleiter, C. Canadian Rivers Institute. **Remotely Sensed Riverscapes: Defining Relevant Aquatic Ecosystem Scales for Riverscape Hydraulics.** River health can be defined in terms of the assemblage, extent, and perseverance of aquatic habitats and measured through key variables such as temperature, depth, velocity, substrate, Reynolds, and Froude numbers. An appealing alternative means to measure, monitor, and model riverscapes (bathymetric and topographic surfaces combined) and their health is emerging yet is not readily utilized for land use planning by environmental managers. Using advanced geospatial analysis with remotely sensed data provides techniques for merging, coupling, and interpreting datasets which yields a level of detailed and insight previously not available. These advanced techniques produce models and surfaces at varying resolution, allowing for a holistic system assessment, considering geomorphic features at scale. The extracted data of the riverscape hydraulic parameters enables modelling and mapping of critically sensitive environments. Refinement in resolution of the key habitat variables allows for refinement in site characterization, but what scale do we meaningfully define the aquatic habitat? Accurately measuring and monitoring these habitat parameters is imperative for effective resource and wildlife management plans, at the macro and meso levels for freshwater habitats in changing climates and highly dynamic systems. Defining the morphology of the system, riparian and submerged, using these new technologies and techniques characterizes fluvial systems, providing detailed site maps, to monitor and manage their evolution. We can only manage what we measure. My research is to produce a meaningful way to define, map, and monitor aquatic habitat for conservation and environmental management practices by combining real world measurements, remotely sensed data, and computer-generated models.

Richardson, J.* & Becu, M. University of British Columbia. **Streams and lake deltas in a meta-ecosystem context.** Lake deltas form through the deposition of materials transported in from streams, linking these ecosystems. Inputs to lake deltas include organic and inorganic particles, as well as nutrients and DOM. Several teams have recognized the distinct zone these deltas provide, but there has been little quantification. However, there are additional hypotheses for why lake deltas might be unique littoral areas. We hope that highlighting the possible range of mechanisms, and their potential interactions, will focus future studies to consider the full suite of hypotheses. We also measured decomposition rates of leaf litter in lakes, ponds and streams to compare this ecosystem function across habitats. We found that decomposition rates and the numbers of shredding invertebrates were several times higher in streams than lakes, and probably not accounted for solely by fragmentation. We consider whether resource "security" (contingency) may be one explanation for such differences between ecosystem types.
Law, T.*, Fraser, D., & Peres-Neto, P. Concordia University. The context dependent nature of lake-fish communities. Prediction of lake-fish communities into the future requires an understanding of how mechanisms (e.g., environmental filtering, biotic interactions) shape communities. However, mechanisms that are important in certain environments may not be in others i.e., they are context dependent. Here, we asked: Do different environments select for different mechanisms? Using fish

association networks estimated with Markov random fields for over 700 lakes in Ontario, we tested if species association patterns among species, representing potential community assembly mechanisms, varied as a function of the environment. Our preliminary results show that the mean species-pair associations of a lake are predictable as a function of the environment and are correlated with patterns of beta diversity. Our results show that context-dependency is important for community diversity and can be used to improve predictions of future lake-fish communities through determining which mechanisms might be most important under specific environmental conditions.

Grimm, J., Miller-Saunders, K.M., Bateman, A.W., & Krkošek, M. University of Toronto. **Quantifying the spatial extent and elevated infection risk for microparasites originating from salmon farms**. Open pen aquaculture facilities used for domestic salmon in coastal British Columbia create spatially static, high-density host populations allowing infectious agents to proliferate. These conditions allow transmission both among aquaculture facilities and between domestic and wild salmon populations. Effective disease management is challenged by uncertainty in the salmon farms' relative contributions of infectious agents into the environment, especially for microparasites (bacteria, viruses, eukaryotes). Recent technological advances allow for screening of microparasites using high-throughput quantitative PCR methods, and recent research has detected high diversity and abundance for a suite of agents both within domestic fish and in environmental DNA adjacent to facilities. Here, I present a proposal to empirically characterize the dispersal of infectious agents originating from salmon farms and estimate the spatial extent of potential increased infection risk to wild salmon populations in proximity to farms.

Pearson, M.*, Rosenfeld, J., & Miners, J. Pearson Ecological. **Evidence of a sharp 10-year decline in Salish sucker abundance across the Canadian range.** Repeated, reach-scale capture-mark-recapture studies suggest that sharp declines in abundance of Salish sucker (*Catostomus cf. catostomus*; SARA Threatened) have occurred in multiple watersheds within the Canadian Range. Although infrequent monitoring of abundance and lack of ongoing monitoring of habitat conditions have impeded linking declines to particular events or causes, the weight of evidence suggests that reduced low flows, elevated summer water temperatures and extreme hypoxia driven by agricultural nutrient loading are responsible.

Cumulative Effects in Watersheds

Lapointe, N.W.R., Third, L.C., & Browne, D.R.* Canadian Wildlife Federation. **Cumulative effects of projects reviewed under Canada's 2012 Fisheries Act.** To manage thousands of projects a year, Fisheries and Oceans Canada implements a risk-based framework requiring authorization and offsetting for the highest risk projects. Projects considered lower risk proceed via letters of advice. Following changes to the Act in 2012, there were concerns about transparency and cumulative effects of low-risk projects. We used access to information requests to obtain documents and reviewed the department's 2012–2019 risk-based framework. Projects reviewed in Manitoba in 2016 were examined and the amount of permanent alteration and destruction approved without authorization was quantified (23,881 and 6,768 m2, respectively). The risk-based framework focused reviews and regulatory decisions on

project-by-project effects, rather than cumulative risks from multiple projects. Harm from lower risk projects was not tracked or offset, and is a significant source of cumulative effects to aquatic systems. New mechanisms are needed to manage such projects to achieve the conservation purpose of the Act.

Adams, M.*, Tulloch, V., Penn, B., Hemphill, J., Finn, R., Bourbonnais, M., DeRoy, B., Avery-Gomm, S., & Martin, T.G. University of British Columbia. **Looking ahead for salmon watersheds: an inclusive approach to predicting cumulative effects and their consequences for species health.** Pacific salmon populations are in decline. This decline is contributed to a myriad of pressures in both marine and freshwater environments across provincial, federal, and First Nation jurisdictions. Here, we provide a cross-realm cumulative effects assessment for multiple species in salmon watersheds and adjacent marine environments on the Central Coast of British Columbia. Working with Indigenous and scientific knowledge holders through an inclusive process, our work identifies past, present, and potential future pressures acting on salmon and other species, and the consequences that cumulative effects pose for population persistence of each species. Our approach was designed to inform the cross-realm management priorities and land and marine-use planning processes of the Kitasoo/Xai'xais, Nuxalk, and Wuikinuxv First Nations. We emerge with a comprehensive overview of threats facing salmon and other species across the region, as well as predictions of future consequences of cumulative effects under various development scenarios.

King, C.*, Fraser, J., (Nikal, D.*), Skeena Sustainability Assessment Forum Science and Technical Committee. Ministry of Forests, Lands, Natural Resource Operations, and Rural Development. **Collaborative Cumulative Effects Assessment and Monitoring for Fish and Fish Habitat in the Skeena Region.** The Skeena Sustainability Assessment Forum Environment Stewardship Initiative (SSAF ESI) is a collaborative partnership among ten Skeena First Nations and the Province of BC. Grounded in values of collaboration and guided by the Ownership, Control, Access, and Possession® principles on First Nations data governance, the SSAF ESI is leading the way in Skeena Region on cumulative effects assessment, environmental co-monitoring, development of trusted data, and management directives. Fish and Fish Habitat is one of the core values of the SSAF ESI. In 2021, the Forum released a comprehensive, landscape-level cumulative effects assessment report based on 20 indicators. Results are available for 2085 watersheds and are summarized by five broader watershed units for the region. The Forum has also completed three field seasons of data collection alongside exploration of various field-level monitoring protocols. The Forum has been recognized as a leader in collaborative monitoring, capacity building, and relationship building.

Finn, R.J.R.*, Chalifour, L., Gergel, S.E., Hinch, S.G., Scott, D.C., & Martin, T.G. University of British Columbia. **Using systematic conservation planning to inform restoration of freshwater habitat and connectivity for salmon.** Wild Pacific salmon support ecosystems, economies, and cultures. Today, they are at record lows and face multiple cumulative pressures. The loss and alienation of freshwater habitat is a key driver contributing to populations declines. Efforts to restore salmon habitat are hindered by lack of coordination throughout watersheds, scarce resources, and understanding where to invest to get the most benefit for wild salmon. We used spatially explicit estimates of restoration cost and benefit within a systematic conservation planning framework to prioritize the restoration of 669 barriers for 14

conservation units of salmon in the Lower Fraser River, BC. We contrast scenarios that maximize quantity of habitat with scenarios that emphasize quality across a range of budgets. We estimate approximately 75% of alienated habitat could be restored with an investment of $200 million, half this investment could restore 60%. Further, spatial shifts in priorities between scenarios reveal where additional restoration is needed.

Lilley, P.*, Pearson, M., Straker, D., & Azeez, L. Kerr Wood Leidal Associates Ltd. **Resilient Waters: Reconnecting salmon habitats isolated by flood infrastructure in the Lower Fraser River.** Over 150 pump stations, flood gates and dike crossings prevent or limit fish access from Fraser River to historically occupied tributaries and side channels between Hope and Vancouver. We undertook a rapid assessment to prioritize structures for upgrades to improve fish passage. Technical feasibility, stakeholder support, cost, and potential gains in habitat, particularly for juvenile Chinook were considered. Desktop analysis was used to reduce the full list to a 'long list' of 60. Based on a single field visit to these sites we constructed a short list of 25. We have partnered with First Nations, local government, and non-profit groups to further assess, prioritize, and develop these projects. seasonal fish use, water quality and habitat quality were collected during multiple field visits in 2021 and continue through 2023. In addition to the process, we discuss issues of recurring issues of technical feasibility, biological effectiveness and governance encountered.

Bucnahan, J.*, Hebert, A., Ramos-Espinoza, D. InStream Fisheries Research. **Seton River Fish and Fish Habitat Project: A Case Study in the Confounding Nature of Cumulative Effects**. Water Use Planning (WUP) monitors are designed to look at the effects of flow decisions on fish and their habitats, but rarely is a single stressor (i.e., discharge) solely responsible for changes to a population. Rather, changes are driven by the cumulative effect of all stressors present in the system. Seton River is presented as a case study to demonstrate the importance of considering cumulative effects on long-term monitoring studies. Constrained by multiple anthropogenic structures managed by different groups (e.g., dams, transportation infrastructure), Seton River is also the lowermost component in the Bridge Seton Hydroelectric Complex, so all upstream management decisions impact operations. As the WUP period draws to a close, we are faced with reconciling data that may not be fully explained by variables considered in the initial study design. Not considering cumulative effects at the start of the study may reduce the ability to confidently answer management questions.

Chen, E.*, Satterthwaite, W., Johnson, R., Phillis, C., Kormos, B., & Carlson, S. UC Berkeley. **Hatchery versus wild Chinook salmon life history and implications for fisheries and water in California.** A key assumption in Pacific salmon stock management is that hatchery fish are representative of their associated natural-origin counterparts. Data collected from hatchery fish are often used to inform monitoring and managing the combined population. We evaluated this assumption around the maturation and downstream migration schedules of endangered Sacramento winter-run Chinook salmon. We performed cohort reconstructions of the two sources using coded-wire tags recovered in hatchery fish and scales recovered and aged in natural-origin fish to inform spawning age structure and maturation. We analyzed the otolith microstructure and microchemistry of hatchery and natural-origin spawners to quantify freshwater habitat use and timing. Preliminary results comparing hatchery- and

natural-origin life history suggest hatchery fish have more homogenous outmigration and maturation behavior. Reduced variation in life history in hatchery fish can result in reduced stability and more amplified responses of hatchery fish to environmental conditions and events.

Atkinson, J.*, Murchy, K., Duguid, W., & Juanes, F. British Columbia Conservation Foundation, University of Victoria. A**ssessing the Influence of Anthropogenic (log booming) and Environmental Conditions on Adult Chinook Salmon Survival in Cowichan Bay, British Columbia.** In the past, the estuaries of Cowichan Bay provided a rich environment with habitat for a diverse array of species that were used and depended upon by generations of Cowichan Tribes members. Today, the harvest of the vast majority of these renewable resources is not conducted due to the industrialization within the estuarine environment. Log booms are known to impact estuarine health, but now, predation of adult Pacific salmon by pinnipeds utilizing log booms as haul-out/foraging platforms has been documented in estuaries and rivers along the East Coast of Vancouver Island. Even with the known negative impacts these activities have on estuaries, it is still common practice along the British Columbia coastline. This study aims to assess the impacts log booms in conjunction with environmental influences (i.e. droughts) have on terminal adult Chinook survival in Cowichan Bay, British Columbia, Canada.

Moulton, D.*, Hinch, S.G., Patterson, D., Miller-Saunders, K.M., Hendriks, B.J., Elmer, L., & Cooke, S.J. University of British Columbia. **Effects of multiple stressors on adult Fraser River sockeye salmon physiology and survival.** Adult Fraser River sockeye salmon (*Oncorhynchus nerka*) face multiple interacting stressors during the upriver spawning migration. These may include fisheries employing gear (e.g. gillnet) that commonly cause non-retention injuries, elevated water temperatures, and infection. To examine cumulative effects of these stressors, we conducted holding and tracking studies on experimentally entangled sockeye migrating under different thermal regimes and incorporated genomic analyses to examine physiological and infectious dynamics. Summer-run sockeye enduring mild entanglements but held at high temperature suffered high mortality. Late-run sockeye held at lower temperatures had considerably less mortality, despite more severe entanglement durations. Gillnet entanglement was associated with increased infectious burden and upregulation of wound healing, immune, and inflammatory genes. In the late-run sockeye tracking study, gillnet entanglement sharply reduced female survival. Results highlight the threat of elevated water temperature to survival, and indicate that gillnet entanglement affects multiple physiological pathways and causes elevated migration mortality for females.

Stenerson, S.D.*, Cook, J., Emmerton, C., Graham, M., Wyatt, F., Buendia-Fores, C., Nasr, M., & Vinebrooke, R.D. University of Alberta. **Cumulative impacts of multiple stressors on stream ecosystems: periphyton communities as bioindicators.** Future land management decisions regarding the preservation of stream ecosystems rely on ground-truthing of remote-sensing of the cumulative impacts of anthropogenic environmental michanges (i.e. stressors) at the watershed level. Algal biofilms, termed periphyton, have long been used as bioindicators of stream ecosystem health as they are highly responsive to environmental changes, occupying a vital link between water quality and higher trophic levels. We used periphyton to ground-truth geospatial models of human stressors of streams by conducting a three-year investigation of ~ 90 sites spanning tributaries along the North Saskatchewan

River Basin. Generalized linear models showed that inferred cumulative impacts of multiple human stressors at the catchment level stimulated periphyton production within streams. Those stressors most significantly influencing periphyton composition being agricultural land use and the amount of riparian cover. Taxonomic and functional shifts in periphyton communities were also in concordance with the inferred net effects of multiple stressors.

Fugère, V.*, St.-Pierre, A., Velghe, K., Rodríguez, M.A., Turgeon, K., Barrette, M-F., Gagné, S., Leclerc, V., Morissette, O., & Beisner, B. Université du Québec à Trois-Rivières. **Natural and anthropogenic drivers of brook trout, lake trout, and walleye abundance in Québec lakes.** Understanding the drivers of fish abundance in lakes is essential for the sustainable management of recreational fisheries in the face of ongoing environmental change. Using an extensive dataset of standardized gillnet surveys conducted by Québec's Ministère des Forêts, de la Faune et des Parcs, we explored the influence of climate, land use, lake connectivity, water quality, and lake morphometry on brook trout, lake trout, and walleye abundance across 664 Québec lakes. Fish data were combined with in situ physico-chemical measurements as well as information obtained through open geospatial datasets. Drivers of fish abundance were identified using additive models and random forest models. While additional predictors would be required to improve model accuracy, climate and lake morphometry had the strongest influence on the abundance of our three focal species. Given the importance of temperature-related variables emerging from these analyses, climate change may affect game fish abundance in Québec lakes.

Stuparyk, B.R.*, Stenerson, S., Van Mierlo, V., Lightbrown, J., Walz, M., Emmerton, C., Buendia-Fores, C., Wyatt, F., Nasr, M., Bhalia, M., Poesch, M., & Vinebrook, R.D. University of Alberta. **Natural versus anthropogenic drivers of lotic macroinvertebrate communities and their function across ecoregions.** Novel and extreme anthropogenic environmental changes (i.e. stressors) often override natural watershed processes that regulate river and stream ecosystems. Here, we demonstrate a comparative framework that integrates traditional taxonomic and trait-based functional approaches using stream macroinvertebrate communities as bioindicators of the natural and anthropogenic factors of ecosystem health at a macroecological scale. Preliminary findings suggest that agricultural land-use may exacerbate the impact of temperature, stream velocity, and fish abundance on macroinvertebrate communities regardless of ecoregion. This investigation will provide ground-truth estimates of the cumulative impacts of multiple stressors on stream ecosystems based on remote-sensing models, thereby improving predictive tools and informing regional natural resource managers of the health of numerous tributaries in the North Saskatchewan River watershed.

Becu, M.*, Richardson, J., & Michalski, T. University of British Columbia. **Lake deltas are hotspots along the shoreline that are impacted by upstream forestry disturbance.** Lake deltas (LDs) receive nutrient and energy subsidies from upstream habitats, and these inputs can support LD benthic production. Small lakes in coastal British Columbia often have inflow streams from areas with forest harvesting (FH), which is pervasive in this region. Although FH impacts can alter stream production, downstream impacts of FH are not largely considered within FH management. We aimed to determine (1) whether LDs are benthic hotspots along the lakeshore (LS), and (2) whether there are changes in LD communities in response to

upstream FH. We compared LD communities with upstream areas that were harvested (HLD) or relatively undisturbed (ULD), and LS sites not influenced by stream inflows. We found that while community structure was similar across sites, ULDs had higher biofilm and macroinvertebrate standing stocks (1.5 and 2 times higher, respectively) than HLDs and LS sites. These results advance our understanding of FH disturbance and stream-lake connectivity.

Theinpont, J.*, O'Hagan, C., Hoskin, G., & Korosi, J. York University. **Landscape changes and the implications for water quality in lakes of the rapidly warming Mackenzie Delta: a decadal perspective.** Permafrost is a defining feature of northern ecosystems and is vulnerable to degradation due to climate changes. In sloped terrain underlain by ice-rich permafrost, degradation can take the form of spectacular landslides called thaw slumps. Thaw slumps are commonly found on the margins of lakes and are known to alter the water and sediment chemistry of receiving waterbodies, and their flora and fauna. However, the duration and persistence of the impact to lakes is not known. As slumps regularly stabilize, the potential for lakes to recover following stabilization has not been previously studied. We will present the results of a decadal-scale analysis of water chemistry in the context of landscape changes as identified from high-resolution remotely sensed images of thaw slumps. This research focuses on an analysis of 66 lakes in the Mackenzie Delta region and provides new insights into the duration of retrogressive thaw slump disturbances on lake ecosystems.

Food Webs

Sora, K.J,*, Wabnitz, C.C.C., Steiner, N.J., SUmaila, U.R., Cheung, W.W.L., Niemi, A., Loseto, L.L., & Hoover, C.University of British Columbia. **Evaluation of the Beaufort Sea Shelf Structure and Function in Support of the Tarium Niryutait Marine Protected Area.** Climate change is threatening the effectiveness of the Tarium Niryutait Marine Protected Area (TNMPA) in conserving sensitive ecosystems. In this study, using the trophodynamic modelling platform Ecopath with Ecosim, we compared the status of the Beaufort Sea Shelf (BSS) ecosystem between the time periods 1970-1974 and 2008-2012 We compared the BSS against four other high latitude ecosystem models (Eastern Chukchi Sea, Barents Sea, Eastern Bering Sea, Gulf of Alaska). We find that the BSS has larger proportion of biomass from pelagic primary and secondary producers and lower level of production from higher trophic levels relative to the other ecosystems. Estimates of indices for BSS trophic structure, entropy, ascendency, and redundancy indicate temporal ecosystem stability. Although beluga whales – a focus of the TNMPA management plan – have low keystoneness, their prey groups play a substantial role in the ecosystem. Thus, the status of beluga whales represents important indicators for long-term ecosystem health.

Tremblay-Gagnon, F.*, Walkusz, W., Brown-Vuillemin, S., Shanes, K., Robert, D., & Deslauriers, D. Institut des sciences de la mer de Rimouski-Université du Québec à Rimouski. **Diet of Greenland Halibut (*Reinhardtius hippoglossoides*) in the Eastern Canadian Arctic and Labrador Sea, and the importance of the Northern Shrimp (*Pandalus borealis*)**. Greenland Halibut (*Reinhardtius hippoglossoides*) sustains one of the most lucrative fisheries in the Eastern Canadian Arctic and Labrador Sea. This species is also an

important player in food web connectivity and many ecological processes. Despite our current knowledge of the species, Greenland Halibut ecology in these areas remains poorly understood. The main goal of this study was to characterize the diet of Greenland Halibut collected in the Labrador Sea, Davis and Hudson Straits and investigate its predator-prey relationship with Northern Shrimp (*Pandalus borealis*), another commercially important species in Canada. Stomach contents analyzes were conducted on 1199 fish captured from 2018 to 2020. Distinct diets were observed in the three areas. The data shows a shift in the feeding strategies from shrimp dominated to fish dominated diets from 2018 to 2020. This work will help further elucidate the dynamics occurring between these two ecologically and commercially important species in Eastern Canada.

Tikka, K.* & Richardson, J. University of British Columbia. **Invertebrate mesopredator density-dependent intraspecific interactions and implications for benthic food webs and ecosystem functions.** In small streams of coastal British Columbia, the predatory stonefly larvae Calineuria californica can directly impact the prey community and indirectly cascade to alter leaf litter decomposition and periphyton biomass. However, the role of density-dependent interactions within this species are unknown. We determined the type and strength of interactions between C. californica individuals and assessed the impacts to food webs and ecosystem functions. We tested for density-dependent competitive interactions and the impact of that competition on prey communities and basal resources. Using laboratory microcosms, we measured the impact across a density gradient of 0 to 4 stoneflies per aquarium. Competition strength increased with density up to 3 stoneflies before lessening with 4. Competition resulted in higher than expected prey abundance that cascaded to impact basal resources. This demonstrates that density-dependent interactions cause unexpected outcomes and provides insight into how predator-predator interactions can regulate ecosystem function and impact community structure.

Rooney, N.*, Dalby, D., & Duivesteyn, R. University of Guelph. **Collecting benthic invertebrate stable baselines at appropriate depths could resolve incongruous fish stable isotope signatures.** Stable isotope (SI) signatures of benthic invertebrates are used to establish food web baseline values, an essential step in quantifying the degree of littoral-pelagic coupling (α) and trophic position of lacustrine consumers. In Lake Huron, δ13C signatures of ~20% of lake trout fall outside of end member pelagic (mussel) and littoral (mayfly) values, resulting in non-sensical α values (i.e. $\alpha>1$ or <0) and making the calculation of trophic position problematic. Here, we test the hypothesis that benthic invertebrate SI baseline values vary with depth of collection, and that this variation will explain the previously confounding results. The difference between littoral and pelagic SI values increased by ~50% from 1m to 3m collections depths, decreasing again until 6m where the difference was negligible compared to the 1m depth. Our results indicate that lake food web characteristics would be more accurately described if baseline values were collected from appropriate depths.

Pelletier, A.R., Bryshun, L., Villamarin, F., & Jardine, T.D. University of Saskatchewan. **Ecosystem Effects on Freshwater Food Web Structure: Implications for Mercury and Trace Element Dynamics.** Food web structure influences the environmental fate of trace elements and xenobiotics in aquatic ecosystems, with implications for wildlife and human health. For example, an ecosystem's maximum food chain

length describes the highest trophic position observed in that system, and chemical concentrations in aquatic organisms are closely related to trophic position via biomagnification and biodilution. Omnivory is also suspected to affect concentrations of biomagnifying and biodiluting chemicals in aquatic organisms because omnivory typically decreases an organism's trophic position. However, mechanisms affecting food chain length and omnivory in freshwater ecosystems remain poorly understood. A new theory suggests that total resource availability should control maximum food chain length and omnivory, but this theory lacks empirical data with which to test it. I investigate how resource availability affects food chain length and omnivory in freshwater ecosystems throughout western Canada and how these changes in food web structure affect trace element accumulation and magnification.

Kotowich, C.*, Rutko, R., Manzon, R., WIlson, J., & Somers, C. University of Regina. **Using compound specific isotope analysis to detect whitefish population structure near thermal pollution.** In Canada, 25% of electricity production results in aquatic thermal pollution. Increased temperatures near industrial sites alter fish behaviour and may negatively impact reproduction. The population structure of fish exposed and the potential loss of distinct local populations is unknown. Using compound specific isotope analysis (CSIA), we examined spawning-phase lake (Coregonus clupeaformis) and round whitefish (*Prosopium cylindraceum*) collected near the Bruce Power nuclear plant. Carbon and Nitrogen stable isotope values varied widely. We hypothesized that several populations from divergent food webs mix in thermally affected areas. Preliminary isotopic niche metrics and unsupervised clustering were used to compare thermally affected and non-affected areas. Niche overlap between areas ranged from 0% to 35% (lake) and 0% to 60% (round) providing support for divergent populations. However, when using unsupervised clustering on all isotopic values, two clusters representative of the two species, best described the data.

Heuvel, C.E.*, Zhao, Y-M., & Fisk, A.T. University of Windsor. **Influence of species movement on stable isotope analysis in freshwater fish.** Stable isotopes are a tool often used to describe relationships between organisms within aquatic food webs. However, our ability to derive these relationships is dependant on species remaining within the study area for the duration of the study as isotope signatures of different resources vary spatially. For species that migrate or forage over wide areas, sampling efforts must capture the entirety of the species movement range to make inferences about resource consumption. Here, we will determine basin-specific differences in energy sources of Lake Erie fish with varying mobility (migratory: walleye, *Sander vitreus*; non-migratory: yellow perch, *Perca flavescens*) using stable isotopes of carbon (δ13C), nitrogen (δ15N), and sulphur (δ34S). We expect non-migratory species (yellow perch) to reflect the isotope signatures of the basin they were caught in, and migratory individuals (walleye) to have isotope values that reflect their migration range, which can be estimated from telemetry papers

Jardine, T.D.*, Nyholt, K., Villamarin, F., Jacobi, C., Hawes, J.E., Campos-Silva, J., Srayko, S., & Magnusson, W. University of Saskatchewan. **Food web structure and mercury biomagnification in floodplain lakes of the Juruá River, Amazonas, Brazil.** Mercury (Hg) poses health risks for fish-eating consumers. Insufficient work on food web Hg has occurred in the tropics and fish consumption is high in regions such as the Amazonian Juruá River. We studied Hg concentrations in fishes from floodplain lakes to determine rates

of trophic magnification, assess if concentrations are high enough to impact humans eating fish, and examine seasonal differences. The average trophic magnification factor (increase per trophic level) was 6.6, well above the global average for freshwaters. This led to high concentrations (up to 17.6 mg/kg dry weight) in predatory pirarucu and piranha. 69% of samples had Hg concentrations above the recommended human consumption guidelines. Average concentrations were 42% higher in the dry season than the wet season, but differences varied by species. These observations point to Hg exposure for human populations here and in other tropical rainforest regions, even in the absence of local point sources.

Bergbusch, N.T., Graham, M.D., Hayes, N.M., Bledsoe, E., Finlay, K.*, & Leavitt, P.R. **University of Regina.** Daphnia feeding selectivity under a changing climate: Analyses of 22-years of zooplankton gut and water-column pigments in seven productive lakes. Climate change affects nutrient loading and algal growth, leading more prevalent cyanobacterial blooms in lakes around the world. This shift in the community of primary producers has unknown consequences on the diet and growth of secondary producers. Here, we analyzed Daphnia dietary preferences using 22 yr of biweekly analyses of phytoplankton pigments in digestive tracts and water column samples to calculate zooplankton diet selectivity in 7 lakes of the northern Great Plains. There were no observable changes in zooplankton community composition, but all major phytoplankton groups increased over the 22-year period. Overall, we observed increasing selectivity for cyanobacteria in Daphnia, with a corresponding decrease in consumption of diatoms both seasonally and over the time series, suggesting a functional response of Daphnia to increasing cyanobacteria. This work suggests that invertebrate populations may not be unduly impacted by climate induced changes in primary producer communities, including documented increases in toxic cyanobacteria.

Bansal, A.*, Zastepa, A., Davies, J-M., Vandergucht, D., & Hudson, J. Akaash University of Saskatchewan. **Impact of Cyanobacteria on Ecosystem Function: the pelagic phosphorus cycle.** Research concerning cyanobacteria has increasingly focused on the health implications and causal factors promoting cyanobacterial blooms. However, there is another important aspect of cyanobacterial blooms that has received less attention. Recent studies have provided indirect evidence that pelagic food web function is affected when cyanobacteria are abundant in lakes. This may be due to a combination of factors, such as their inedibility, poor food quality, or their production of cyanotoxins. With the use of a radiotracer, we measured pelagic phosphorus cycling in a variety of lakes from the Canadian Prairie Region and beyond (i.e., Lake Erie and Lake of the Woods). These lakes provided a broad range in cyanobacterial biomass (0 to 75% cyanobacterial biomass). Phosphate turnover, planktonic regeneration, and most important, planktonic food web turnover will be presented as a function of cyanobacterial biomass to determine if food webs dominated by cyanobacteria do indeed have reduced cycling efficiencies.

Martin, G., Fugère, V., St.Pierre, A., Rodríguez, M.A., Turgeon, K., Hout, Y., Walsh, D., & Beisner, B.* Université du Québec à Montréal. **Land use shapes multi-trophic alpha and beta diversity of Canadian lakes.** Aquatic communities consist of trophic guilds embedded in food webs with multiple interacting trophic levels, for which multi-trophic indices of diversity should provide deeper insight than do those estimated for individual trophic levels. We sampled bacterioplankton, phytoplankton, and zooplankton in

560 lakes across Canada as part of the NSERC Lake Pulse Network to evaluate predictors of diversity both within kingdoms and across taxa. Individual kingdoms showed varied responses to water chemistry and land use, while scaling up diversity indices to incorporate multi-trophic variation revealed a significant role for climate variables in structuring community diversity. While land use in the watershed occasionally had a significant direct effect on multi-taxa species diversity, it mostly appeared via indirect effects influencing local water chemistry. Our findings highlight how multi-trophic approaches may be beneficial for identifying general drivers of diversity across Canadian lakes, especially within a context of climate change.

Fisheries Science & Management

Melnychuk, M.*, Veneziano, A., Lees, S., Rasal, J., Koerner, L.M., Hair, P., Costalago, D., Hively, D., Jardim, E., & Longo, C. Marine Stewardship Council. **Eco-certification distinguishes sustainability status of assessed fish stocks.** Achieving Marine Stewardship Council (MSC) certification requires that targeted populations ('MSC stocks') are fished at sustainable levels. We expect that MSC stocks are more likely maintained at higher abundance relative to sustainability benchmarks compared to populations fished by non-certified fisheries ('non-MSC stocks'). We compared estimated biomass relative to biological reference points between MSC stocks and non-MSC stocks of wild-caught marine fish and invertebrates. On average, MSC stocks had greater relative biomass and were less frequently overfished than non-MSC stocks. The few MSC stocks observed to be recently overfished had previously entered the program based on scientific advice available at the time indicating they were fished sustainably. Subsequently, when revised stock assessments estimated biomass to be lower than previously thought, fisheries for those stocks were suspended from certification. Together, these results suggest that eco-certification is associated with a credible claim on stock status and provides a useful distinction from other seafood.

Czenze, A.* & Avery, T. Acadia University. **Assessing American Lobster (*Homarus americanus*) demographics in the offshore regions of lobster fishing areas 33 and 34 in Nova Scotia**. The lobster fishery is the most valuable fishery in Canada, representing over 40% of total seafood landings, with majority landings in lobster fishing areas (LFAs) 33 and 34 in the south shore region of Nova Scotia. Lobster landings have been steadily increasing in Canada since the 1980s and are projected to increase due to fewer predators and expanding suitable habitat. Within LFAs 33 and 34, lobster is caught both inshore and offshore, but these groups are poorly characterized by morphological characteristics. Each group may be influenced differently by climate driven habitat alterations. This study will characterize lobster morphometrics, population structure, and other metrics of population status in relation to habitat characteristics of depth, location, and temperature in LFAs 33 and 34 to determine if lobster population structure is dependent on local habitats, and further describe inshore and offshore fisheries. Experimental design and analysis will be presented for feedback and engagement.

Donovan, M.* & Bayse, S. Fisheries and Marine Institute of Memorial University of Newfoundland. **Can you hear me now? Snow crab (*Chionoecetes opilio*) auditory capacity and evidence for eavesdropping**.

Very little is known about crustacean hearing, despite their importance ecologically and economically. The snow crab (*Chionoecetes opilio*) is a large, commercially captured, valuable decapod crustacean. Snow crab were captured at night to prevent damage to sensory organs, brought to the Marine Institute and allowed to habituate for three weeks prior to testing. Hearing capacity was tested via an audiogram where individuals were tested in a mapped acoustic isolation chamber. Pure tones were played at 50 Hz, and 100 to 900 Hz frequencies at 100 Hz intervals. Crab responded to tones from 50 Hz to 600 Hz readily with some individuals responding to tones up to 900 Hz. Feeding sounds were recorded using a hydrophone and playback showed that crab spend significantly more time near a playing speaker than when the speaker is off. Further studies should examine if acoustics can be exploited for use in the fishery.

Steiner, R.*, Donovan, M., Walsh, P.J., Winger, P.D., Grant, S.M., & Bayse, S.M. Fisheries and Marine Institute of Memorial University of Newfoundland. **Testing new pots for the snow crab fishery to determine feasibility of new designs from a commercial perspective.** The snow crab (*Chionoecetes opilio*) fishery is one of the most lucrative fisheries in Newfoundland and Labrador and by assessing new pot designs we can find ways to maximize this fishery. A series of experiments were conducted in Conception Bay to investigate snow crab behaviour, pot saturation, and catch rate. Pots used in this study included, a short-cone pot, a side-entry pot, and a tarp-cone pot as the experimental treatments, and the traditional conical pots currently used in the fishery as the control. A behavioural study assessed time-to-capture of crab via collected video footage; a pot saturation study compared three fleets of pots set for different soak times - 1, 3, and 6 d, and a catch rate study compared the catch rates between experimental pots. By collecting a variety of different data, this study will be able to determine if these experimental pots can improve the snow crab fishery.

Frank, C.H.,* Steiner, R., Winger, P.D., & Bayse, S.M. Fisheries and Marine Institute of Memorial University of Newfoundland. **Using increasing brightness in glow-in-the-dark snow crab (*Chionoecetes opilio*) pots to better understand how light influences catch.** Luminescent-netting pots in the snow crab (*Chionoecetes opilio*) fishery is a promising new technology to increase CPUE (number of crab per pot). However, the reasons behind the increased catch remains largely unknown. Thus, to determine if increasing light has an effect, we tested four pot types in the commercial snow crab fishery in Newfoundland: pots with two, four, and six luminescent strands woven into the twine and traditional non-luminescent twine. When compared to the traditional, there was no significant difference observed for CPUE for two-strand pots (26.6 and 27.4), but both four- and six-strand pots were significantly higher (33.3 and 30.0). Size selectivity was variable for each experimental group when compared to the control. Though CPUE was higher for the four- and six-strand, CPUE was lower for the six-strand when compared to the four. In conclusion, CPUE did not continually increase with increased light, suggesting a potential maximum light threshold.

Krumsick. K.* & Pedersen, E. Concordia University. **Catch me if you Stan: Bayesian estimation of size-specific selectivity and size spectrum parameters from trawl data.** Selectivity, defined as the efficiency of specific fishing gear at harvesting fish species, is a key parameter in fishery biology known to vary with factors such as species, gear type, and water temperature. Requiring specialized research

designs to estimate, this difficult-to-measure parameter is often approximated from published literature. Our purpose was twofold: (a) determine the selectivity curve based on trawl data and (b) determine the resulting size spectrum parameters considering this selectivity curve. Assuming the two primary processes describing the shape of a species distribution in trawl data are the species-specific size spectrum and a selectivity curve, a Bayesian model was constructing using the rstan package in R to estimate size spectra and selectivity parameters. This model was then applied to 21 years of turbot (Reinhardtius hippoglossoides) survey data to determine size-specific catchabilities to Alfredo III gear and assess potential impacts of the expanding fishery on the turbot population productivity.

Clarke, S.H.*, McCracken, G.R., Humphries, S., Ruzzante, D.E., Grant, J.W.A., & Fraser, D.J. Concordia University. **Effects of experimental size-selective harvesting on effective population size in wild brook trout populations.** Sustainable fisheries management benefits from integrating demographic and genetic considerations into assessments, as both can affect harvest yields and population persistence. One important genetic measure is the effective population size, which can be used to predict future population viability and can be compared alongside the census size (Nc) to integrate genetic and demographic changes. We investigated harvest-induced changes in effective size in alpine brook trout populations, using Nb, a measure of effective size in a single breeding season. Nb and Nc were monitored over three years in three harvested populations and three controls. The Nc decreased 60.8% across all harvested populations, while fluctuating in control populations. There were no consistent changes in Nb, but we found evidence of genetic compensation in harvested populations, where density-dependent processes buffered decreases in Nb such that Nb/Nc increased. While effective size may be resilient in the short-term, it remains critical to monitor harvested populations.

Araya-Schmidt, T.*, Bayse, S.M., Winger, P.D., and Frank, C.H. Fisheries and Marine Institute of Memorial University of Newfoundland. **Using modified bottom trawls to tackle an emerging juvenile redfish (*Sebastes spp*.) bycatch problem in the offshore Northern shrimp (*Pandalus borealis*) fishery of eastern Canada.** Small mesh codends used in trawl fisheries to retain shrimp can also capture unwanted juvenile fish. In the offshore Northern shrimp (*Pandalus borealis*) bottom trawl fishery in eastern Canada, bycatch is minimized using a 22 mm bar spacing Nordmøre grid that sorts the catch while fishing. However, a recent rebound of juvenile redfish (*Sebastes spp.*), that can pass through the grid, has increased bycatch drastically. This study investigated the effectiveness of 17 and 15 mm bar spacing grids against the traditional 22 mm bar spacing grid using a twin-trawl (paired) configuration aboard a commercial fishing vessel. Juvenile redfish bycatch was significantly reduced by 27.7% and 23.6% for the 17 mm and 15 mm grids, respectively. The experimental grids resulted in no significant reduction in shrimp catch across all length classes. The overlap in width between species limits the overall sorting efficiency, leaving some redfish still vulnerable to capture.

Ngyuen, V.,*, Bayse, S.M., Cheng, Z., Winger, P.D., DeLouche, H., Kebede, G., & Legge, G. Fisheries and Marine Institute of Memorial University of Newfoundland. **An effective technique to reduce the capture of small fish in the redfish trawl fishery in Canada.** This study developed a full-scale shaking codend to reduce the capture of small fish in the redfish (*Sebastes spp.*) trawl fishery in the Gulf of St. Lawrence, Canada. We attached an elliptical-shaped piece of canvas to the back of a T90 codend, and its movement

and fishing characteristics were tested in a flume tank and field experiment compared to the T90 codend without canvas. In the flume tank test, the shaking codend had a higher amplitude ratio, period (1 revolution), and total acceleration than the T90 across all flow velocities. The field experiment showed that the shaking codend significantly reduced the capture of small redfish (< 22 cm) and has a better contact probability than the non-shaking T90 codend. Overall, the dynamics of the shaking codend were described and could be used as an effective technique to reduce the catch of small fish in the redfish and other trawl fisheries.

Ngyuyen, V.M., Young, N., Hinch, S.G., Pentz, B., Delle-Palme, C., Krueger, C., Vandergoot, C., & Cooke, S.J. Carleton University. **Bridging the gap between fisheries science and management: a reflection and synthesis on 5 + years of research using biotelemetry science as a case.** Telemetry technology has enabled researchers to electronically tag animals and track their movements in the wild. For aquatic ecosystems, this has opened the door to the underwater world and generation of novel information about various aquatic species, including important information for fisheries management and conservation. Telemetry technology, however, is costly and demonstration of conservation benefit is important. Our research group has conducted over 5 years of social science work to understand the interface between science and management using telemetry technology and fisheries management as a case. Using the knowledge-action framework and knowledge mobilization theory we have identified barriers, enablers, and future directions for research in this field.

Nyboer, E.A., Reid, A.J., Jeanson, A., & Cooke, S.J. Carleton University. **Identifying goals, challenges, and next steps in transdisciplinary fisheries research: perspectives and experiences from early-career researchers.** Fisheries are highly complex and tightly coupled social-ecological systems and are faced with multiple 'wicked' problems from sustainable resource management to climate change adaptation. Tackling such problems requires fisheries researchers to adopt transdisciplinary approaches that integrate perspectives across disciplines and knowledge systems. Despite widespread acceptance of such approaches, there are still limitations in personal and institutional capacity to carry out and support effective transdisciplinary research, and viewpoints of early career researchers (ECRs) are critical for promoting systemic change within the discipline. Here we present perspectives of ECRs from around the globe on goals, challenges, and future potential for transdisciplinary fisheries research in the Anthropocene.

Salmon in a Changing Climate

Turner, L.*, Ferguson, M., & Danzmann, R. University of Guelph. **Gene expression and physiological changes associated with high thermal tolerance in juvenile rainbow trout (Oncorhynchus mykiss).** Rainbow trout (*Oncorhynchus mykiss*) have been subjected to longer and more intense periods of heat stress with climate change, which has already begun to negatively impact salmonids. Thermal stress can trigger a range of metabolically expensive physiological changes, mediated by changes in gene expression, so the ability to survive new thermal regimes may depend on a fish's ability to increase

energy supply to match demand. We therefore subjected two strains of rainbow trout juveniles to an acute warming trial (0.8°C hour-1). RNA-seq on hepatic tissue and enzyme activities of key aerobic and anaerobic genes in the liver, gill and white muscle, alongside blood metabolites were analyzed in fish with the best and worst thermal tolerance (n = 8 each), compared to controls. Understanding short-term physiological and longer-term evolutionary responses to rising temperatures will be key to developing policy, and to mitigating the effects of climate change on fish species globally.

Hnytka, S.*, Rosenfeld, J. & Enders, E. Fisheries and Oceans Canada, University of British Columbia. **Local variation in Critical Thermal Maxima and agitation temperature in threatened Athabasca Rainbow Trout: implications for local acclimation of thermal tolerance.** Stream temperature is a key driver of physiological function in ectotherms, influencing metabolism, growth, reproduction and survival. Although stream warming is thought to have contributed to the recent decline of threatened Athabasca Rainbow Trout (*Oncorhynchus mykiss*) endemic to northeastern Alberta, their thermal sensitivity has not been formally studied. To assess whether Athabasca Rainbow Trout populations are capable of adapting to different stream temperatures by shifting their upper thermal tolerance, I performed stream-side Critical Thermal Maxima (CTmax; upper thermal tolerance) and agitation temperature (behavioural threshold for water temperature avoidance) experiments in 6 populations that differed in average water temperature. Stream-side physiology experiments demonstrate that CTmax is an adaptable plastic trait that increased with average stream temperature, whereas agitation temperature is fixed. This study should help define the critical habitat of Athabasca Rainbow Trout, and it's ability to adapt to changing temperatures.

Mayer, N.*, VanWert, J.*, Gauvin, K.B., Hendricks, B.J., Eliason, E., & Hinch, S.G. University of British Columbia. **Life stage- and sex-specific variability in the upper thermal tolerance of stream-spawning Kokanee salmon (*Oncorhynchus nerka*).** Fish vulnerability to rising temperatures is a product of three factors: thermal tolerance, thermal exposure, and adaptive capacity. Pacific salmon are especially vulnerable given their narrow optimal temperature ranges, exposure to high temperatures during rearing and migration periods, and limited capacity to extend upper thermal tolerance. We assessed for the first time, the critical temperature for aerobic scope and Critical Thermal Maximum (CTmax) of juvenile and adult Kokanee salmon - a landlocked form of sockeye salmon. At 24℃, mortalities approached 50% and 58% in juvenile and adult fish respectively. Adult males appear less resilient than females at 24℃, accounting for 86% of premature mortalities. CTmax was highest in 22℃ treatment groups for juveniles (29.27℃∓0.15) and adults (30.43℃ ∓1.35℃). Acclimation to 24℃ did not lead to an increase in CTmax, supporting the theory that plasticity in upper thermal tolerance can only be extended through acclimation up to a certain threshold.

Ivanova, S.V.*, Fish, A.T., & Johnson, T.B. University of Windsor. **Observed versus assumed thermal occupancy in bioenergetics models for freshwater predators.** Species bioenergetics models can be used to estimate predation pressure on lower trophic levels and thus, are an important tool for ecosystem and species management. Most bioenergetics models assume thermal occupancy based on the species' optimum temperatures and not empirical data. However, many fish occupy temperatures above or below their optimums that could bias bioenergetics predictions. In this study, acoustic telemetry and

pop-off archival tags were deployed on lake trout (*Salvelinus namaycush*) and Chinook salmon (*Oncorhynchus tshawytscha*) in Lake Ontario between 2016 and 2019 to obtain in-situ year-round temperature observations to contrast bioenergetic predictions based on assumed and empirical data and quantify the effect on growth and consumption estimates. Results for both species showed that the use of assumed thermal occupancy produced positive and negative biases in estimated growth, proportion of maximum consumption and thus, estimates of life-time consumption by the species. Such bias carries implications for the management of fish stocks and thus, for ecosystem integrity in the face of continuing climate change.

Smith, T.*, Rosenfeld, J., Hunt, B.P.V., St. Pierre, K., Chartrand, S., Naman, S., & Mussett, K. University of British Columbia. **Turbulence mediates microhabitat selection by juvenile drift-foraging steelhead.** Turbulence may be particularly important for salmonids that drift-feed in flowing water. Yet the influence of turbulence and other complex hydraulics on in situ habitat selection of these fishes is poorly understood. Hydraulic conditions at the focal point and in the prey interception range of juvenile steelhead were compared to nearby vacant locations that had similar depth and velocity. Locations where fish were observed had lower turbulence intensity, a more confined range of turbulent fluid motions, and more consistent increases in velocity throughout their prey interception range compared to locations where fish were not observed. Lower variance in velocity gradients and turbulent fluid motion at focal positions suggest that fish select microhabitats that minimize their energetic cost of swimming and turbulence that may interfere with prey capture success. Such measurements can inform the fine-scale processes driving microhabitat selection, adaptive differentiation, and habitat capacity in stream environments, allowing for their improved conservation and restoration.

Traynor, E.*, Hasler, C, & DePasquale, S. University of Winnipeg. **Effects of acute carbon dioxide exposure on juvenile salmonids.** There is evidence that some freshwater ecosystems are experiencing a rise in carbon dioxide (CO2). The risks that high CO2 poses for freshwater fishes is unknown and important to understand as fish are economically and ecologically valuable. The objective of this study was to determine if CO2 effects occur in multiple species of salmonids and, if high CO2 influences growth rate, escape response, lateralization movements, and swimming. Juvenile Salvelinus alpinus, Oncorhynchus mykiss, and Salvelinus fontinalis were used. Growth rates across species were significantly reduced in the high CO2 treatment. No significant differences were observed in escape responses or lateralization. Swimming performance was only found to vary between species and not due to exposure to high CO2. By using multiple related species, the information learned will be more relevant ecologically and will also help industry quantify the effects of high CO2.

Niese, A.* & Rogers, S. University of Calgary. **The effect of early life rearing conditions on later life outcomes in coho salmon (*Oncorhynchus kisutch*).** Anthropogenic environmental change continues to impact fish habitat in complex and interacting ways (e.g., logging can influence substrate composition and temperature). How fish will react to these interacting factors and the fitness consequences remains largely unknown. Here we examine the impact of temperature and substrate as a metric for habitat quality on the development of coho salmon (*Oncorhynchus kisutch*). We reared two populations of coho salmon from the west coast of Vancouver Island in three ecologically relevant temperatures and

substrate types in complete factoral design using a common garden approach. Hatch success and heat shock protein gene expression were measured to determine the direct effect of early life rearing environment. Multiple phenotypes related to fitness (growth rate, body condition, and total body lipid content), as well as thermal tolerance window were analyzed to determine the impact of substrate and/or temperature on coho salmon.

Chavarie, L.*, Honkanen, H.M., Newton, M., Lilly, J.M., Greetham, H.R., & Adams, C.E. Norwegian University of Life Sciences. **The benefits of merging passive and active tracking approaches: new insights into riverine migration by salmonid smolts.** The process of smolting is a critical phase in the life-cycle of anadromous salmonids and it has been associated with substantial rates of mortality. Survival during freshwater and marine migration is known to have population level effects, thus an understanding of the patterns of mortality has the potential to yield important insights into population bottlenecks. Despite important advancements in tracking techniques, the specifics of mortality events in anadromous salmonids during their initial migration to sea remains somewhat elusive. Here, we develop a framework combining spatial and temporal detections of smolt riverine migration from two tracking techniques, which enable inferences to be made about mortality locations, causes, and rates. We embed this framework into a fine-scale behaviour study of migration and social structure. Overall, by estimating migration loss and its variability, our study framework should help to guide management actions to mitigate the widespread population declines these species are currently facing.

Scott, D.C.*, Chalifour, L., MacDuffee, M., Baum, J.K., Beacham, T., Rondeau, E., & Hinch, S.G. University of British Columbia. **Potential factors influencing variation in early growth rates of juvenile Chinook salmon in the Fraser River, B.C**. We studied juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Fraser River estuary over five years (2016-2020) to understand variation in estuary use between two major populations of ocean-type Chinook. The timing of migration to the estuary did not significantly vary between years despite significant variation in climatic conditions. Significant variation in fork lengths occurred between years, with the smallest individuals occurring in 2017 in both populations and the largest in 2019. Fork lengths showed a statistically significant relationship with regional climate variables but not spawner abundance which also varied significantly across this period. The largest individuals occurred in years with relatively warm winter and spring conditions, and the smallest individuals in a year with a particularly cold winter and average spawner abundance. As climate change is resulting in milder winters it may result in increased early growth for these ocean-type individuals and potentially explain increases in productivity of the South Thompson population in recent decades.

Wilson, S.* & Moore, J.W. Simon Fraser University. **Changing outmigration phenology and phenological mismatch in juvenile salmon.** Climate change may be shifting the timing of animal migrations and their prey availability at different rates and it is unclear how this may impact survival (i.e., the match/mismatch hypothesis). For example, juvenile salmon migrate from freshwater to the ocean and rely upon seasonally abundant marine prey. Yet climate change may be altering juvenile salmon migration timing, possibly increasing the frequency of mismatches with prey. We examined outmigration timing of 66 populations of six species of Pacific salmon ranging from Oregon to Alaska. Magnitude of shifts in outmigration timing varied between species and across populations. In a focal population, we

then examined how timing of marine prey availability relative to migration timing of juvenile steelhead trout influenced ocean survival and found that when prey availability peaked later, survival was lower. Differing rates of phenological change across species and populations may result in more phenological mismatches which could impact salmon survival.

Ryan, R.E., Ruhi, A., Grantham, T., & Carlson, S.M. University of California Berkeley. **Habitat heterogeneity reduces variation in population dynamics of an endangered salmon complex at the southern edge of its range.** Increasing climatic variability threatens endangered Coho Salmon (*Oncorhynchus kisutch*), especially at the southern edge of the range; however, diverse habitats within a watershed have the potential to buffer the impacts of environmental variability on a population. Using long-term monitoring data from the Lagunitas Creek watershed in Marin County, California, and time series models, we explore how subpopulations of juvenile Coho Salmon across a heterogeneous watershed respond differently to environmental extremes. Preliminary results show that the effect of precipitation during critical rearing months on juvenile salmon changed depending on the stream, as did the amount of stochasticity experienced by a subpopulation. These findings suggest that even at the small watershed scale, diverse stream habitats drive different responses by salmon to climatic conditions, which can be important for stock stability.

Sloat, M.* , Reeves, G., & Christiansen, K. Wild Salmon Center. **Salmon spawning habitat response to wood loss and increased flooding in Southeast Alaska.** We estimate the influence of instream wood on Pacific salmon spawning habitat under contemporary and projected increases in mean annual flood magnitudes expected with climate-change in >800 southeast Alaskan watersheds. We used synthetic stream networks and field data to determine basin-scale spawning gravel availability under six combinations of flood magnitude and wood occurrence. Our simulations suggest that streambed coarsening as the result of wood loss from rivers could have a much greater effect on salmon spawning habitat availability than would increases in mean annual flood magnitudes of up to 30%. Our analysis provides a useful basin-scale perspective on the potential impact of wood loss (or benefit of wood restoration) for salmon spawning gravel availability relative to the effects of climate-induced increases in flood disturbance in southeast Alaska.

Knight, K., Cooke, S.J., & Lapointe, N.W.R. (Twardek, W.M.*) Carleton University. **Understanding Chinook salmon migrations through the upper Yukon River: A collaborative research approach.** Upper Yukon River Chinook Salmon (upstream of Whitehorse, YT) once supported the subsistence harvest of a few hundred families, but today, their populations have dwindled such that only a few hundred salmon return each year to spawn. To better understand the factors limiting the recovery of the upper Yukon River Chinook Salmon, a collaborative research project was undertaken from 2017-2020 involving First Nation and Federal governments, local industry, and NGOs, with Canadian Wildlife Federation as the project coordinator. Here, we focus on the collaborative aspects of this project, and the contributions of these groups to each stage of the research process including experimental design, fieldwork, and interpretation of results. We highlight the benefits and challenges of this collaborative approach, outlining how these partnerships affected research outcomes. It is our hope that the example presented

here will provide a useful case study for those seeking to engage in collaborative community-based research.

Godwin, S.*, Kuparainen, A., & Hutchings, J. Dalhousie University. **Effects of sea lice on salmon in the era of climate change.** Infectious disease can be a key driver of fish population dynamics, but whether and how climate change will influence disease impacts remains unclear. We performed an experiment in which we tested the temperature-dependent effects on Atlantic salmon (*Salmo salar*) of sea lice (*Lepeophtheirus salmonis*) – a parasite that can depress the productivity of wild-salmon populations and the profits of the salmon-farming industry. We explored sea-louse impacts on their hosts across a range of temperatures (10, 13, 16, 19, and 22 °C) and infestation levels (zero, 'low', and 'high' infestation). We found that the effects of sea lice on the growth rate, condition, and survival of juvenile Atlantic salmon all worsen with increasing temperature. Our results provide a rare empirical example of how climate change may influence the impacts of marine disease for an imperilled fish species. These findings underscore the importance of considering climate-driven changes to disease impacts in fish populations.

Farrell, T.*, Zhang, Y., Polinski, M.P., Morrison, P., Brauner, C.J., & Garver, K. University of British Columbia. **Piscine orthoreovirus in salmon in British Columbia: risk vs consequences.** The measured physiological consequences of deliberately injecting concentrated BC-strain PRV into juvenile sockeye and Atlantic salmon were incompatible with previous suggestions of sub-lethal cardio-respiratory impacts. A peak PCR response developed 4-6 weeks post-injection and PRV infection at or beyond that seen in wild and farmed salmon persisted without mortality and a maintained body condition. Our time-matched comparison with sham-injected salmon considered their routine and maximum respiratory performance and hypoxic performance, using well-established respirometry techniques for individual fish. While blood hemoglobin concentration and hematocrit were modestly reduced at week 4 post-infection in sockeye and at weeks 1 and 9 in Atlantics, these changes were not sustained at week 9 in sockeye or at week 18 in Atlantics. Routine metabolic rate, maximum metabolic rate and hypoxia tolerance of PRV-infected sockeye and Atlantics were not significantly different from time-matched controls, with one exception. MMR was actually higher in infected Atlantics at week 10.

Teffer, A.K.*, Miller, K.M., Connors, B., Ming, T., Kaukinen, K., Bass, A.L., Bateman, A., Hunt, B.P.V., Patterson, D., & Neville, C. University of British Columbia, Fisheries and Oceans Canada. **Pathogens associated with sockeye salmon declines.** Pathogens are known to impact the health and survival of wild fishes. However, fitness outcomes of individual infections have yet to be scaled up to population level. Population-level pathogen impacts should be detectable as a negative association between pathogen metrics (prevalence, load, composite) and host population productivity or body condition. We integrated long-term multi-pathogen survey data from Fraser River sockeye salmon into a Bayesian multilevel modeling approach that included temperature and competition cofactors. Thousands of Fraser River sockeye salmon smolts were genetically screened for dozens of pathogens over ten years to calculate pathogen metrics per population; these data were correlated with host productivity and condition during this period. Our results identified several marine and freshwater pathogens with evidence to support a negative association with host survival and/or condition. These pathogens could

pose an increasing threat to wild salmon as the environment in which host relationships were formed continues to shift.

Elmer, L.K.*, Bass, A.L., Johnston, S.D., Teffer, A.K., Kelly, L.A., Miller, K.M., Cooke, S.J., & Hinch, S.G. University of British Columbia. **Genetic biomarkers demonstrate that migratory thermal refuges benefit adult sockeye salmon during upriver migration.** We investigated changes in gene expression and infectious agent profiles for a population of wild, Fraser River sockeye salmon (*Oncorhynchus nerka*) during lake passage associated with the final 40 km of their 400 km upriver spawning migration. This is the first individual-based study to investigate changes in gene- and infectious agent profiles during adult salmon migrations. We sampled fish prior to starting lake migration and again on spawning grounds, surveying genes predictive of immune response, wound healing, temperature stress, viral disease, and mortality. We found a downregulation of genes associated with thermal stress once arriving on spawning grounds supporting the fact that migrants benefit from using thermal refugia (the hypolimnion) during lake passage. We also found evidence that cooler water selection during lake migration occurred in fish with higher infection burdens, suggesting that thermal refuges may be important for reducing some negative impacts of infection.

Muchy, K.*, Duguid, W., Atkinson, J., & Juanes, F. University of Victoria. **Behavioral responses of Chinook salmon to shipping noise in Cowichan Bay, British Columbia.** The increase in human-generated noise over the last 60 years has led to concerns regarding the impacts shipping noise has on marine species. Research shows marine mammals demonstrate changes in their behavior near ships, but no work has been done on the impacts to salmon. An array of acoustic receivers and underwater hydrophones were deployed in Cowichan Bay, British Columbia, Canada, to begin to understand any potential changes in behavior as salmon encounter shipping noise. Adult Chinook salmon were captured and acoustically tagged with tags that had depth and acceleration sensors. Behavior parameters from all detections of tagged salmon were modeled against environmental conditions to begin to understand general movement and behavior of Chinook salmon. Then underwater sound pressure levels were calculated for the minute prior to each detection and were added to the model. Data collected from this study will aid in understanding the behavioral patterns of Chinook salmon.

Rechisky, E.L.*, Brosnan, I., Berejikian, B., Moore, M., Porter, A., Freshwater, C., Mucrhy, K.A., Atkinson, J., Duguid, W., Pellett, K., Drenner, S.M., Juanes, F., King, J., Hinch, S.G., & Welch, D. Kintama Research Services. **Review of acoustic tagging studies shows little evidence for dinner bell effect for Pacific salmon and steelhead.** Acoustic telemetry has become a common tool for tracking salmonids in western North America in areas where marine mammals, particularly pinnipeds, are abundant. The dinner bell effect, the ability of a marine mammal to learn to associate tag transmissions with prey and thereby increase predation rates of tagged populations, was previously demonstrated and has raised concerns for biologists studying salmon survival. To further assess this effect, we collated results from Pacific salmon and steelhead acoustic tracking studies that also included an ancillary tracking method (e.g., double tagging) that allowed us to independently measure survival. We found that survival of acoustic-tagged fish was generally not reduced or was inconclusive compared to their untagged counterparts. We consider how tag programming characteristics, as well as tagging location, fish life

stage, and migration speed could potentially lead to increased predation of acoustic-tagged fish in areas where pinnipeds overlap.

Hague, M.*, Wong, S., & Michielsens, C. Pacific Salmon Commission. **Stay calm and think pink: Assessing Fraser River pink salmon in a time of change.** One of the mandates of the bilateral Pacific Salmon Commission is to provide scientific advice to inform pre-season planning and in-season management of pink salmon returns to the Fraser River, British Columbia. Recent changes in the magnitude and variability of migration characteristics, biology, and productivity of Fraser River pink salmon have reduced the effectiveness of traditionally applied stock assessment tools. Concurrently, decreases in pink, and co-migrating sockeye salmon, returns have increased pressure on biologists to produce earlier, and more accurate, in-season run size assessments. We discuss some of the main shifts in pink salmon behaviour, the impact on stock assessment, and how biologists and managers also need to adapt alongside the salmon. Even with improved understanding of the key environmental and biological covariates driving the changes in the Fraser River pink salmon run, it will remain challenging to provide accurate predictions of run size and timing to inform in-season management decisions.

Fish Physiology

Tipku, T.*, Treberg, J., & Rennie, M. Lakehead University. **Field assessment of Fish Stress in Boreal Ecosystems using a Point of Care device.** Technologies for the rapid assessment of stress in fish can provide an important tool to resource managers, particularly in the face of sudden and unexpected environmental impacts. At the IISD Experimental Lakes Area, we used the i-STAT Point-of-Care device to assess stress in spawning lake trout (*Salvelinus namaycush*) across a stress gradient induced by various capture and handling methods. Blood was collected across five lakes during spawning in October 2020. We found that blood glucose, lactate, hematocrit, hemoglobin, and sodium all varied across the gradient of stress applied to fish. Additionally, sex was a significant additive factor in our analyses, where lactate, hemoglobin, and hematocrit were all significantly higher in males than in females across lakes. The duration of time between hooking and sampling for angled lake trout had a significant positive effect on glucose, hemoglobin, and hematocrit.

Pleizier, N.*, Algera, D., Nelson, C., Rost-Komiya, B., Cooke, S.J., & Brauner, C.J. University of British Columbia. **Factors affecting gas bubble trauma in fish.** Hydroelectric dams can generate total dissolved gas (TDG) supersaturation, which can cause harmful bubble growth in the tissues of aquatic animals, known as gas bubble trauma (GBT). We conducted a meta-analysis of the relationships between TDG and GBT in fish, and identified depth, dissolved oxygen, temperature, body size, and species as important factors. Depth is known to have a protective effect against GBT, but the empirical relationship has not been investigated. We conducted an experiment to determine the relationship between depth, TDG, and GBT in rainbow trout. We concluded that 47 cm of depth compensated for 4.1% (±1.3% SE) TDG supersaturation. Conversely, locomotion is thought to promote GBT. We found no significant relationship between locomotion and the progression of GBT. We also investigated whether fish can avoid harmful

TDG supersaturation. We were unable to detect a significant difference in the duration spent in TDG supersaturated water compared to air-equilibrated water.

St. Louis, B., Frank, C., Love, O., Warriner, T., & Semeniuk, C.* University of Windsor. **The effects of probiotic therapy on stress coping styles of triploid juvenile farmed Chinook salmon.** Triploid fish (3N) used in aquaculture exhibit immune, behavioural, and physiological drawbacks which reduce their condition and survival. We examined the effects of probiotic treatment on behavioural- and stress-related traits in triploid fish with the goal of increasing fish yield. Chinook salmon (*Oncorhynchus tshawytscha*) crosses were designed so that family eggs were split into 2N or 3N treatments. As alevins, fish were reared on probiotic or regular feed within each ploidy. Juveniles were tested eight months postfertilization and behaviourally assayed, then terminally sampled for plasma cortisol concentrations. 3N fish exhibited marginally increased activity and neophobia, and showed reduced behavioural stress-induced cortisol concentrations. Probiotics increased boldness and exploration behaviours in all fish. Finally, we observed interaction effects between physiology and behaviour, and physiology and probiotics on mass. Findings from this study can contribute to increasing yield in finfish aquaculture production by increasing favourable behaviours and reduced stressor responsiveness, resulting in increased growth.

Olson, E.* & Rogers, S. University of Calgary, Fisheries and Oceans Canada. **The effect of early hatchery rearing environments on female coho salmon reproductive investment.** Management of Pacific salmon stocks within critically important watersheds of First Nations territories include programs that raise fish in hatcheries for enhancement. Yet, the long-term consequences of variation during rearing in captive environments remains largely unknown. Reproductive investment in salmonids is responsive to environmental variation and can have consequences for recruitment and offspring survival. We hypothesize that fecundity may be increased by hatchery rearing environments, as it is determined by early life cycle growth rates. Egg size and quality should decrease in trade-off with increasing fecundity. To address this, we quantified reproductive investment metrics in N=170 adult female coho salmon (*Oncorhynchus kisutch*) reared in standard versus enriched hatchery treatments in a Vancouver Island, BC hatchery and the adjacent wild source population. We will discuss variation in fecundity, egg size and egg quality (water, fat, and protein content) between experimental groups while controlling for factors such as body size.

Howell, B.E.*, Stewart, E.M.C., Frasca, V.R., Wilson, C.C., & Raby, G.D. Trent University. **Capture of spawning Brook Trout by electrofishing does not impair embryo survival.** Electrofishing is widely used to capture fish in freshwater systems. Fisheries assessment and fish culture activities that occur during spawning do so in the absence of meaningful base evidence regarding the effects of electrofishing on fish reproduction. In this laboratory experiment, we assessed whether electrofishing adult brook trout Salvelinus fontinalis affected embryo survival. We used two genetically distinct strains of Brook Trout to do so. Both strains and sexes of fish were exposed to pulsed direct current electrofishing in a factorial design, after which their incubating offspring were monitored for survival to eyed-egg, alevin, and fry stages. We did not detect any effects of our electrofishing treatment, or interactions with the sex or strain of the fish exposed to electrofishing, suggesting electrofishing did not negatively impact gamete

viability. Our results support the use of responsible electrofishing to collect spawning salmonids for the purpose of gamete collection for hatchery rearing.

Deslauriers, D.* Institut des sciences de la mer de Rimouski-Université du Québec à Rimouski. **Unconventional and innovative energy budget development for a broad range of aquatic species.** Several environmental conditions can affect an individual's physiology and behaviour, which in turn can have repercussions at the population level. However, in most cases, eco-physiological information on the species of interest is lacking and needs to be developed. The physiological response of individuals can be described through the development of bioenergetics models, which balance the energy requirements for growth and reproduction with the energy that is gathered through consumption. Bioenergetics models are regulated by the size of the organism and the environmental conditions, such as temperature. In this presentation, I will demonstrate how the development of ecologically-, biologically-, and physiologically-relevant bioenergetics models can lead to simulations of fish growth under dynamic or altered environments. Combining sclerochronology and in situ respirometry, this innovative approach can provide powerful insight into the significant impacts fish can have on their environment, and how the environmental conditions can shape energetic responses at the population level.

Ritchie, E.*, Raby, G.D., & Brownscombe, J. Trent University. **Calibration of accelerometer transmitters for estimation of field metabolic rates in a sexually dimorphic fish.** In the face of climate change, it is important for fisheries managers to understand how changes in water temperature may impact growth and recruitment of fish. Remotely measuring bioenergetic parameters in the field, like metabolic rate, allows researchers to model species-specific responses to future environmental changes. We investigated the metabolic performance of adult walleye (*Sander vitreus*) across a range of temperatures using accelerometer transmitters and a swim tunnel respirometer to be able to remotely estimate field metabolic rates in the wild. We used a mixture of hatchery-reared and wild-caught fish (both sexes), surgically implanted accelerometer transmitters, and swam fish at a range of temperatures (9-22C) and water speeds (4-8cm/s) with a standard Ucrit protocol, while measuring oxygen consumption rate. These data will help determine whether metabolism affects growth in ways that are sex-specific or temperature dependent and help uncover the bioenergetic causes and consequences of sexual size dimorphism in walleye.

Earhart, M.*, Blanchard, T., Strowbridge, N., Morrison, P., Penman, R., McMaster, C., Baker, D., Brauner, C.J., & Schulte, P. University of British Columbia. **How hot is too hot? Physiological consequences of rearing white sturgeon at relevant Nechako River temperatures.** White sturgeon (*Acipenser transmontanus*) are endangered throughout the Nechako river system in British Columbia. The rapid decline in larval and juvenile fish in this population is likely caused by many factors, including increasing temperatures from climate change. Therefore, it is crucial to understand how current and future river temperatures affect sturgeon thermal phenotypes and survival at vulnerable early life stages. We reared Nechako white sturgeon embryos at four different temperatures (13°C, 15°C, 18°C, or 21°C) from shortly following fertilization to expulsion of their yolk-plugs. Additionally, sturgeon were subjected to heatwaves in the lab that simulated those occurring in the river in 2021. Survival, growth, metabolism, thermal, and hypoxia tolerance were assessed at multiple timepoints and were affected by rearing

temperature and heatwave exposure (P<0.001). Results demonstrate the effects of increasing river temperatures on phenotypic development in this endangered population.

Climate Extremes & Change in Aquatic Systems

Stewart, E.*, Wilson, C., & Raby, G.D. Trent University. **Field-based critical thermal maximum (CTmax) demonstrates intraspecific variation and plasticity in thermal tolerance of a stream salmonid.** Understanding the drivers of intraspecific variation in thermal tolerance of salmonids is increasingly important in the age of climate change. Brook trout are under threat in their native range because of several stressors including warming. In southern Ontario they are limited to streams where temperatures can vary widely and temperature extremes are increasingly likely to occur. Brook trout thermal tolerance has been studied for decades, though we lack data on if and how genetically-isolated populations vary. CTmax depicts upper thermal tolerance, but has come into question as a methodology given that CTmax values within a species often vary due to different warming rates and acclimation temperatures. We quantified in situ CTmax for 19 populations of stream-resident brook trout across Ontario to investigate intraspecific variation of thermal tolerance using a standardized, repeatable approach that included quantifying acclimation. Our study demonstrates brook trout resiliency to climate change related warming and extreme events.

Middleton, E.*, Gilbert, M., & Speers-Roesch,B. University of New Brunswick Saint John. **The metabolic impacts of environmental variability associated with winter conditions in a temperate char (*Salvelinus fontinalis*).** Cold and reduced food availability can make winter physiologically challenging for fishes. Cold-adapted species, including many salmonids, thrive at low temperatures and often attempt to remain active and feeding. However, variation in winter conditions may alter the energy expenditure of such species, impacting their overwintering success. We characterized the behavioural response of brook char (*Salvelinus fontinalis*) to cold, finding that while spontaneous activity did decline, they remained active and feeding during acute cooling (14°C to 2°C) and subsequent acclimation to 2°C. Next, we fed (0.5% body weight day-1) or starved brook char and acclimated them to 2°C or 8°C for 90 days. Brook char markedly decreased resting metabolic rate during starvation, exhibited strong thermal compensation at 2°C, and conserved their aerobic capacity regardless of temperature or feeding regime. These results suggest that brook char are physiologically flexible in a manner that may facilitate survival in warmer, less predictable winters.

Middleton, K.*, Speers-Roesch, B., & Kieffer, J. University of New Brunswick Saint John. **The effects of cold on activity and feeding in Atlantic and shortnose sturgeon.** Northern fishes experience challenging environmental conditions over winter including frigid temperatures that slow physiological processes (e.g. swimming activity) and poor food availability that constrain energy supply. Atlantic and shortnose sturgeon co-exist in the Saint John River basin in New Brunswick, but have divergent overwintering strategies. Whether these strategies are associated with divergent effects of cold on physiological and behavioural processes is unknown. Thus, we examined the effects of acute cooling (15-2°C at 1.5°C

day-1) and prolonged (3 weeks) cold exposure (2°C) on feeding and activity. During acute cooling both species decreased food consumption and activity. The Q10 temperature coefficients suggest that shortnose sturgeon are less sensitive to acute cooling and have a greater capacity for cold acclimation. The acclimation potential and thermal sensitivities of feeding and activity in Atlantic and shortnose sturgeon suggest that these species have distinct responses to cold that may be associated with their divergent overwintering strategies.

Firth, B.L.*, Craig, P.M., Drake, A.R., & Power, M. University of Waterloo. **Seasonal, environmental, and individual effects on hypoxia tolerance of threatened eastern sand darter (*Ammocrypta pellucida*).** Metabolic rate and hypoxia tolerance are highly variable in relatively stable environments. Thus, understanding the variability of these metrics in wild populations is critical for understanding adaptive potential and determining local extinction risk as a result of climate induced increases in temperature and hypoxia. In this study we assessed field metabolic rate (FMR) and hypoxia tolerance of Eastern Sand Darter (*Ammocrypta pellucida*), a threatened species in Canada. Trials were conducted stream-side from June - October 2019 to encompass a range of ambient water temperatures (10-25C). Temperature significantly positively affected hypoxia tolerance metrics but not FMR. Temperature alone explained very little of the variance in all three metrics, but environmental and fish-specific factors helped explain more of the residual variation. Variation in FMR significantly increased with temperature while variation in hypoxia did not. Overall, the results provide information to assess habitat suitability and demonstrate the importance of variation for conservation.

Czich, A.*, Shackell, N., Stanley, R., den Heyer, C., & Avery, T. Acadia University. **Recent and projected climate-change induced expansion of Atlantic halibut in the Northwest Atlantic.** With the influence of climate change on marine systems expanding, consideration of climate adaptation will be essential for the next generation of fisheries management. An exponential increase in Atlantic halibut Hippoglossus hippoglossus landings over the past decade has coincided with decadal warming. We explored spatio-temporal trends of thermal habitat availability and growing degree days (index of growing season) and whether increased abundance is linked to changing habitat conditions and how trends may continue with future warming from two emissions scenarios. Between 1990 and 2018, available thermal habitat increased 17% and growing degree days increased 9.83°C·Days across the region. With warming, spatial distribution is projected to increase up to 20% in the north and decline by 5% in the south by 2085. We present a strong logical basis to predict how climate change will influence Atlantic halibut distribution, providing stronger justification for fisheries managers to adopt adaptive management practices in a changing marine climate.

Mac Rae, D.*, Sunday, J., & Pedersen, E. Concordia University. **Quantifying dispersal functional diversity in Atlantic marine communities.** To understand and predict how regional diversity changes under directed environmental pressure, there needs to be more focus on monitoring community-level dynamics. Using dispersal traits as a metric of functional diversity can provide information on ecosystem function and services, as dispersal connects individuals to ecosystems and allows for ecological complexity. It is hypothesized that variation in dispersal capability among species can play a key role in increasing the stability and resilience of a community through maintaining asynchronous population

dynamics. The objective of this study is to quantify dispersal trait variation in marine Atlantic communities, and investigate how it varies spatially. Dispersal-linked traits, ie. adult length and PLD, can be measured and used in functional trait space. Spatiotemporal patterns of dispersal variation can then be checked for correlation with community stability and resilience. Identifying if dispersal variation enhances ecological resilience will provide insight into the importance of preserving functional diversity.

Engler, A.*, Fraser, D., & Peres-Neto, P. Concordia University. **Different traits influence fish community structure differently: changes in assembly mechanisms across large scale environmental gradients.** Determining how community level trait variation interacts with environmental conditions has become a key approach for uncovering the mechanisms underlying community assembly and for understanding communities' potential responses to future disturbances. We applied a functional-ecology approach across more than 700 lake-fish communities from the Ontario Broadscale Monitoring Program. Two assembly mechanisms are expected to produce opposite functional trait patterns . Environmental filtering should produce higher functional redundancy within communities by selecting species with specific sets of traits. Conversely, competition should lead to low functional redundancy within communities through competitive exclusion. The choice of traits was critical to interpret functional redundancy patterns: Northern lakes, species were similar in their temperature tolerance and dissimilar in their diet traits. The opposite pattern was observed for southern communities. When traits are pooled together, no latitudinal pattern was detected. Overall, stronger signal of environmental filtering and competition were detected in boreal lakes than in temperate lakes.

Rimas, R.*, Webb, J., Jensen, S., Leavitt, P., & Finlay, K. University of Regina. **Characterizing greenhouse gas fluxes from desiccating small agricultural reservoirs in the northern Great Plains.** Small constructed agricultural reservoirs in the northern Great Plains are ephemeral aquatic systems that process allochthonous and autochthonous carbon (C) at high rates. In southern Saskatchewan, the regional climate is experiencing increasingly extreme hydrological and thermal conditions, with desiccation being the worst-case scenario for both agricultural practices and C cycling. In the summer months of 2019 - 2021, water quality metrics, sediment/soil conditions and CO2, CH4, and N20 fluxes were measured along a transect from open water to upland soil. Using generalized additive models (GAMs), we found increasing CO2 and decreasing CH4 efflux from exposed sediment in desiccating conditions. As depth decreased over the course of a summer, water quality declined and open water N2O influx increased, indicating changes to N cycling in the reservoirs. This work will provide a valuable understanding of negative and positive feedback mechanisms between water GHG fluxes and a changing climate.

Imtiazy, M.N.* & Hudson, J. University of Saskatchewan. **Influence of hydrological flow on dissolved organic matter properties in a river-reservoir on the Canadian prairies.** The effects of increasing number of reservoirs worldwide on global carbon cycles are significant. However, little is known of the effect on dissolved organic matter (DOM) properties in semi-arid temperate regions. DOM properties in a multi-purpose river-reservoir on the Canadian prairies (i.e., Lake Diefenbaker) were investigated under varying flow conditions from 2011-2018. DOC concentrations did not increase significantly with increasing inflows despite greater allochthonous loading (linear mixed-effect modeling, $p= 0.12$), whereas DON concentration had a negative relationship with inflow rate ($p< 0.0001$). In spring and early

summer, allochthonous DOM dominated the reservoir due to greater allochthonous loading from the South Saskatchewan River. However, in the fall, autochthonous DOM contributions made up a greater proportion of DOM due to reduced loading and increased autochthonous production in the reservoir during summer. These patterns may have important implications for drinking water, light penetration, and contaminant cycling in reservoirs in temperate, semi-arid climates.

Taskovic, M.*, Tank, S., & Lanoil, B. University of Alberta. **Assessing microbial functional responses to permafrost thaw slump activity on the Peel Plateau, NT.** In the Peel Plateau region (Northwest Territories), climate-driven thaw of permafrost and the evolution of mass-wasting features known as retrogressive thaw slumps mobilize modern soils and previously frozen materials, delivering vast quantities of sediments, solutes, and associated organic carbon to aquatic systems. Microbial communities play a critical functional role in aquatic systems, driving biogeochemical cycles (carbon, nutrients) and food web processes alike. We assessed how thaw-slump activity changes water quality conditions in streams and measured microbial respiration (CO2 production) to examine how the influx of permafrost thaw materials influences the functional capacity for microbial communities to break down labile to recalcitrant carbon substrates. Thus far, preliminary results meet expectations such that shifts in biogeochemistry in slump-affected streams elicit a response in carbon processing. Amidst a warming and evolving Arctic, this research will provide fundamental information towards understanding the role of aquatic microorganisms in the carbon cycle, and potential ecological implications.

Lapins, D.*, Vermaire, J., Chetelat, J., & Smol, J. Carleton University. **Environmental change in Yellowknife Bay, Northwest Territories, over the last two centuries inferred through diatom paleolimnological analysis.** Great Slave Lake is one of the largest subarctic lakes in the world and the deepest lake in Canada. The duration and strength of thermal stratification is increasing in many subarctic lakes across the northern hemisphere, but little information is available for larger and deeper systems such as Great Slave Lake. This thesis uses paleolimnological techniques to investigate ecological changes occurring in Yellowknife Bay, Great Slave Lake, over approximately the last two centuries based on diatom and Chla analysis of a dated sediment core. The results of this thesis showed a sharp increase in the relative abundance of the smaller planktonic Discostella stelligera from <10% to ~25% diatoms and a decline in heavier *Aulacoseira sp*. These data suggest that over the last ~two centuries thermal stratification is increasing in Yellowknife Bay with potentially important ecological consequences for this large subarctic lake.

Drapeau, H.*, Tank, S., Cavaco, M., Serbu, J., St. Louis, V., & Bhatia, M. University of Alberta. **Organic carbon and microbial dynamics across glacierized watersheds in the Canadian Rockies.** Mountain glacial systems are undergoing rapid climate change leading to increased water fluxes from these catchments, with concomitant export of sediment and organic carbon. Glacial organic carbon represents an aged, but potentially bioavailable carbon pool that is compositionally distinct from other catchment sources. Despite this, the composition of riverine organic carbon from glacial headwaters to downstream reaches, and its role in structuring microbial communities has yet to be characterized in the Canadian Rockies. Over three summers (2019-2021) samples were collected monthly from glacially-fed rivers in Banff and Jasper National Parks. Preliminary results show temporal trends in microbial

community composition and dissolved organic matter (DOM) absorbance spectra and age, tied to seasonally-evolving water sources. Carbon isotopes and DOM fluorescence will also be incorporated into this study to provide an integrated understanding of the age, source, lability, and biological processing of organic carbon exported from Rocky Mountain glaciers.

Sudlow, K.*, Madsen, F., & Vinebrooke, R. University of Alberta. **Impacts of receding glaciers on the ecosystem functioning of alpine streams in Alberta.** Rapid deglaciation is altering the unique abiotic conditions and biodiversity of glacially fed alpine streams while the functional consequences for downstream communities remain knowledge gaps in mountain limnology. We quantified taxonomic and trait-based functional shifts in algal and macroinvertebrate communities as related to environmental variables along a deglacierization gradient consisting of 14 streams in Banff and Jasper National Parks. Deglacierization (i.e. reduced glacial discharge and less turbidity) appears to stimulate species diversity and trait-based shifts towards larger body-size and increased resource competition based on multivariate community analyses. Our preliminary findings suggest that shrinking glaciers will increase the productive capacities of certain mountain stream ecosystems.

Aquatic Habitat Restoration & Partnerships

Alex, K.* & Armstrong, J.* Okanagan Nation Alliance, University of British Columbia Okanagan. **Restoring Our River: Restoring Our Responsibility.** With the guidance and vision from syilx elders and community, the Okanagan River Restoration Initiative (ORRI) has completed 14 projects. The projects on the Okanagan River mainstem span 20 years, restoring river dynamics, spawning areas, rearing habitats, and floodplain re-engagement. The community partnership with En'owkin Centre is one example of focus on how the Cottonwood Riparian, and the k'əmcnitkʷ projects, are aligned with the plant restoration utilizing both TEK and and species at risk work of ECOmmunity projects at the Locatee lands with an emphasis on how such collaborations and partnering are vital to salmon habitat. We have learned much from these projects to drive the next phases of work and have seen many benefits to date.

Szekeres, P.*, Schonewille, B., & Tobler, P. EDI Environmental Dynamics Inc. **For the love of Salmon: Stories of collaboration between Yukon First Nations and a biological consulting company.** The Yukon is home to 14 First Nations, 11 of which are self-governing. During recent declines and challenges to various fish stocks, First Nations have taken on critical lead roles in the stewardship, restoration, and rehabilitation of these culturally vital fish stocks and habitats. EDI Environmental Dynamics Inc. (EDI) has had the privilege of collaborating with many First Nations in the Yukon and providing technical support for numerous First Nation-led planning, research, and restoration projects. For example, there have been concerted efforts across several traditional territories and watersheds to better understand the life history of the imperiled—and culturally critical—Yukon River Chinook salmon, which travel as far as 3,000 km to reach their spawning grounds. This presentation will highlight some collaborations on First Nation-led studies and projects, and how culturally appropriate methods have positively interfaced with Western science to complete successful projects and inform local management, knowledge, and restoration.

Mussett, K.*, Stirling, K.*, Duncan, J., & Reid, A. University of British Columbia. **Weaving Together Ways of Knowing: A Lower Fraser River Case Study in Decolonizing Aquatic Ecology.** Fish and fish habitats in the Lower Fraser River watershed are increasingly at risk of population decline and degradation, respectively, due to the ongoing and interactive effects of industrial development, infectious diseases, climate change, contaminants, and poor management. Through partnerships with six of the Lower Fraser First Nations and the First Nations Fisheries Legacy Fund, this work aims to co-create a framework for fish habitat health assessment by weaving together ways of knowing, interacting in intentional relational processes, and co-creating ethical space. Co-development of this framework began with and continues through ongoing community workshops based in discussion of aquatic health and water relationality, alongside both riparian and eDNA-based field and lab work. Early results of this collaborative project have seen not only the formation of trusting relationships between Indigenous and non-Indigenous participants, but also effective models for weaving together ways of knowing, and patterns in riparian variables that align with community evaluations of watershed health.

Sarchuk, J.*, Walsh, M.*, Nordquist, D., Holmes, D., Harris, S., Lund, B., Holmes, C., & Ashley, K. Ministry of Environment & Climate Change Strategy, Adams Lake Indian Band. **Incorporating Western Science into Indigenous Management of Sqlelten7úwi̓, Sockeye Salmon, (in Secwepemctsín; *Oncorhynchus nerka*) Restoration.** Adams Lake Indian Band (ALIB) is leading a salmon restoration project on Adams Lake to address the degradation of lake rearing habitat and to restore the Upper Adams early summer run Sockeye (Sqlelten7úwi̓ in Secwepemctsín; *Oncorhynchus nerka*). Adams Lake suffered from anthropogenic oligotrophication caused by the collapse of this Sockeye run. Historically, the Upper Adams River supported over 1 million sockeye which was valued for food, social, ceremonial and trade purposes. The lake restoration involves the addition of limiting nutrients, nitrogen and phosphorus, to increase phytoplankton and zooplankton production, and lead to increased fry/smolt growth and survival. This is a 4-year project with baseline data collection completed in 2020 and nutrient restoration/monitoring from 2021-2023. Monitoring by the ALIB is undertaken to examine ecosystem response and allow for adaptive management. This innovative approach combines the strengths of Secwepemc Indigenous knowledge and Western science.

Harris, S.L.*, Sarchuk, J.A., Vainionpaa, H.E., Johner, D., & Weir, T. BC Ministry of Environment and Climate Change Strategy. **It takes a village: Restoring ecosystem productivity and habitat connectivity in the Alouette Watershed to conserve a rare ecotype of *O. nerka*.** Dam construction on Alouette Lake had profound impacts on the aquatic environment including loss of habitat connectivity for anadromous species, diminished productivity in an aging reservoir, and the loss of marine derived nutrients. The anadromous form of Oncorhynchus nerka in Alouette Reservoir are considered extinct however a resident population of Kokanee had persisted at low levels providing an opportunity to restore anadromy in the Alouette Watershed. The Province of BC, BC Hydro, Katzie First Nation and the Alouette River Management Society partnered to restore ecosystem productivity and establish habitat connectivity. We used nutrient restoration to restore the resident population of Kokanee which provided smolts to re-establish the anadromous life history form. To re-establish habitat connectivity an experimental spring water release was used to support smolt migration in combination with a fall trap and truck

program. This presentation highlights how restoration was achieved by a multi-project and multi-partner approach.

McLeod, A.* Cows and Fish-Alberta Riparian Habitat Management Society. **Working together to recover native trout in Alberta; a case study on the Alberta Native Trout Collaborative.** Headwater streams of the Eastern Slopes are the last stronghold for Alberta's threatened Native Trout but with cumulative pressures, including recreation, grazing, and industry, it can be overwhelming to know where to focus recovery efforts. The Alberta Riparian Habitat Management Society (Cows and Fish) works with watershed groups, land users and managers to help mitigate human pressures on aquatic habitats. In recognition of the need to work together to tackle this complex issue, Cows and Fish joined the Alberta Native Trout Collaborative (NTC) in 2019. The NTC is a group of organizations, partnering to support native trout recovery in Alberta through coordination of resources and effort, watershed prioritization, habitat restoration, and monitoring. Bringing together a diversity of data, skillsets, and stakeholders, the NTC has developed new tools to prioritize and mobilize. Moving from analysis to action, engaging Albertans on the issues facing Native Trout has not been without its challenges.

O'Shaughnessy, K. & Ambrose, N.* Cows and Fish-Alberta Riparian Habitat Management Society. **Putting Beavers to Work for Watershed Resiliency and Restoration in Alberta – Collaboration, Community Engagement and Co-existence.** Since 2012, the Alberta Riparian Habitat Management Society (Cows and Fish) has partnered with the Miistakis Institute and multiple partners to improve awareness and tools for beaver co-existence among Albertans. Our collaborative, Putting Beavers to Work for Watershed Resiliency and Restoration provides a platform to share knowledge and expertise from other jurisdictions, and build on our individual partner strengths. Our goal is to create opportunities for scientifically informed and community-based solutions to beaver management. Through hands-on training for practitioners, policy recommendations, presentations and beaver extension materials, we share the benefits of beavers for improved water quality, fish habitat, increased watershed resiliency and restoration of aquatic and riparian landscapes. We showcase and help implement practical co-existence tools (e.g., culvert protectors, pond-levellers etc.) to tackle common beaver-caused challenges. This presentation will highlight lessons learned as our collaborative has evolved, as well as what we have achieved so far.

Ambrose, N.* Cows and Fish-Alberta Riparian Habitat Management Society. **How Can Cows and Fish Co-exist? Converting Good Intentions into Effective Conservation Programs – Lessons Learned from 30 years of Cows and Fish Program Delivery**. Since 1992 Cows and Fish embarked on a journey to address a need, and do things differently: to find a way to integrate land uses and riparian health together. That journey focussed on partnering with landowners and local watershed community groups to create long-lasting outcomes in a way that had not be done before. It included thousands of outreach activities and riparian health inventories, hundreds of partnerships, plus several external program evaluations. Partnering with landowners and local groups has been more effective at increasing knowledge and influencing management with certain approaches than others. Understanding human behaviour and motivations, not focussing just on fish, wildlife or water, is key. This presentation will share lessons learned from 30 years of evaluations and experience to help natural resource professionals consider how

to effectively partner to be most impactful with landowners, communities and land managers, benefiting land and water, aquatic or terrestrial ecosystems.

Keeshig, K.*, Jacobs, C., Febria, C., & Donaldson, C. Great Lakes Institute for Environmental Research. **Exploring Holistic, Community-based Solutions for Aquatic Habitat Restoration.** How can research institutions support community capacity building in Indigenous communities? Can we build resiliency into restoration projects by connecting to multiple sustainability goals (i.e., economic, cultural, environmental, social)? How does utilizing Indigenous Knowledge Systems change the way we frame and respond to ecological issues? How does embedding ourselves within ecosystems affect the way we approach solutions? We explore these questions and more as we share where we are in our journey of partnership building, community engagement and exploring community-led aquatic habitat restoration. This session centres around a partnership between a Freshwater Research Lab and First Nation community and what can happen when you really start listening. We discuss our process of re-framing conventional approaches to restoration and move into a discussion of challenges, barriers and what our group believes is needed to continue moving forward.

Sylliboy, J.* & Denny, S. Unama'ki Institute of Natural Resources. **Two-eyed Seeing as an Approach to Collaboration.** The foundation of Two-Eyed Seeing rests on principles of collaboration, co-learning, and the co-production of knowledge. Building on the foundation of Mi'kmaq values of equality, equity, and Netukulimk, and the principles of Two-Eyed Seeing, UINR developed Partnership Tenets that are meant to help provide guidance on how to collaborate effectively. Two Eyed Seeing is a concept coined by Elder Albert Marshall of Eskasoni. Albert tells us that two eyed seeing is about co-learning. It's about the opportunity to co-produce knowledge using the best of Western and Indigenous Knowledge. Our presentation will draw on our experience in multi-partnership habitat restoration projects such as the Bras d'Or Lake Lobster Reef Ball project and the Habitat Restoration Planning, Implementation and Collaboration in Four Nova Scotia Watersheds of the Southern Gulf of St. Lawrence Rivers Priority Area project to explain how UINR has been addressing partnership and collaboration successes and frustrations.

Restoration of Freshwater Ecosystems

Reid, J.* Carleton University, Canadian Centre for Evidence-Based Conservation. **A Toolbox for the Freshwater Biodiversity Crisis.** Globally, we are currently experiencing a freshwater biodiversity crisis. There is an urgent need to rethink aquatic ecosystem management and to equip practitioners with the evidence needed to make well-informed decisions. Resource constraints and accessibility issues limit the ability of practitioners to make full-use of existing literature that should guide evidence-based approaches to conservation. We describe a toolbox intended to i) introduce two questionnaire-based appraisal tools that can be used to assess the reliability and relevancy of evidence syntheses to users, and ii) demonstrate the utility of these tools in a case study regarding freshwater management actions in Canada. We assembled, summarized, and appraised 259 evidence syntheses, yet results indicate there is

need for more rigorous conduct and clearer recommendations. We anticipate this novel approach of summarized and scored evidence syntheses, alongside interactive appraisal tools, will serve as a model for engaging and empowering practitioners in other regions beyond Canada.

Little, C.* & Wik, A. Simon Fraser University. **Does restoration targeting salmon habitat influence ecosystem function in urban streams?** Those who care about freshwater ecosystems sometimes lament that there are no freshwater pandas. But in the Pacific Northwest, salmon may serve a similar role as umbrella species for the conservation of biodiversity and ecosystems. We examined whether stream restoration projects designed to improve Pacific salmon returns were also effective in restoring ecosystem function. Specifically, we deployed cotton strips in 29 stream reaches in the metropolitan Vancouver area to disentangle the effects of environmental characteristics, human development, and restoration on organic matter processing, a key ecosystem function at the base of freshwater food webs. We found that restoration did have moderate effects on organic matter processing rates, but that multivariate habitat characteristics and the amount of impervious surface surrounding a stream reach were more important. Our results suggest that while channel restoration may improve physical habitat and salmon passage, threats to ecosystem health are more challenging to solve.

Wood, J.*, Connors, K., & Holmes, G. Minnow Environmental Inc. **Hazeltine Creek Habitat Remediation Following Mount Polley TSF Breach.** The Tailings Storage Facility perimeter embankment failure at Mount Polley Mine in 2014 released 25 million cubic metres of tailings and dam material that substantially altered fish habitat in Hazeltine Creek. From 2015 to 2018, a fish fence restricted access to upper Hazeltine Creek, a key spawning and rearing area for Polley Lake rainbow trout, while channel remediation works were underway which were focused on re-establishing trout spawning and rearing habitat. Monitoring since 2018 indicates that the remediated habitat meets trout life history requirements. Productivity is sufficient to support trout and, in some cases the remediated areas have recovered to a reference area condition and have remained stable across three years. Fry abundance in 2018 was consistent with pre-mining estimates but has decreased due to low recruitment when Hazeltine Creek was inaccessible. However, the majority of trout hatched in 2018 are anticipated to spawn for the first time in 2022.

Vinebrooke, R.*, Stubaryk, B., Parker, B., & Schindler, D. University of Alberta. **Restoration of fishless alpine lakes following introductions of invasive sportfish in Banff National Park.** Once inspired as an undergraduate student reading Charles Elton's book entitled Ecology of Invasions by Animals and Plants, David Schindler would later conduct whole-ecosystem studies into the restoration of fishless alpine lakes stocked with invasive sportfish. He used active and passive restoration strategies such as aerial reintroduction of extirpated keystone species, gill-net fish removals, and natural fish decline. We compared the effectiveness of these restoration strategies based on the taxonomic and trait-based functional trajectories of zooplankton communities in each of these lakes. Our findings revealed the recovery rates to be similar across the lakes despite differences in how they were restored to a fishless state. Contrasting trajectories during periods of invasion and restoration highlighted the presence of hysteresis. Although taxonomic and trait-based trajectories closely tracked each other over time, the

latter displayed far less variance, highlighting the functional redundancy that existed within these recovering species-poor alpine communities.

van Poorten, B.*, MacKenzie, C., Neufeld, K., Peterson, L., & Reilly, J. Simon Fraser University. **Can non-native cutthroat trout affect bull trout recovery?** Establishing recovery targets and understanding threats to the population are key to population recovery. One common threat to species recovery is the introduction and expansion of non-native species, yet determining the threat of introduced species involves understanding interspecific interactions. In this talk, we evaluate recovery targets for bull trout in Pinto Lake, Alberta. Historically, bull trout were the only fish species in this headwater system, with access from downstream blocked by a waterfall. Overfishing into the 1980s led to a complete fishery closure in 1989. However, introduced cutthroat trout were discovered in 1993, which seemed to hinder bull trout recovery, which was surprising since these species coexist in other systems. We use existing monitoring data to reconstruct these populations and evaluate interspecific interaction mechanisms to determine how cutthroat affect bull trout. Results are used to establish updated bull trout recovery targets given the novel threat posed by cutthroat trout.

Vainionpaa, H.*, Sarchuk, J., Harris, S., Weir, T., & Johner, D. BC Ministry of Environment and Climate Change Strategy. **An innovative nutrient restoration and biomanipulation experiment in Wahleach, a montane hydroelectric reservoir in British Columbia.** Wahleach Reservoir was created in 1953 for hydroelectric power production with the damming of a small montane lake. By 1993 the recreational fishery had collapsed; Rainbow Trout (*Oncorhynchus mykiss*) were stunted, while Kokanee (*O. nerka*) were extirpated. This coincided with trophic depression in the aging reservoir and food competition with illegally introduced Threespine Stickleback (*Gasterosteus aculeatus*). In partnership with BC Hydro and the local cabin association, nutrient restoration coupled with biomanipulation of the food web through fish stocking has stimulated phytoplankton and zooplankton production and ultimately restored the fishery. Initially, Kokanee were stocked to establish a self-sustaining population, while Cutthroat Trout (*O. clarkii*) are added annually to maintain top-down control on the Threespine Stickleback population. Our results show we have achieved our objective of restoring historical populations of Kokanee and Rainbow Trout in Wahleach. Critical to attaining our projects objectives are strong partnerships with the hydroelectric agency and local stakeholders.

Bassett, M.*, Schindler, E., & Weir, T. BC Ministry of Forests, Lands, Natural Resources and Operations. **Nutrient additions to compensate for hydroelectric impacts to restore productivity in a lake and a reservoir in the interior of British Columbia.** Kootenay Lake and Arrow Lakes Reservoir have been influenced by several anthropogenic stressors, one of which is the construction of upstream hydroelectric impoundments. These impoundments caused nutrient retention leading to oligotrophication of both systems and declines in kokanee salmon. To address this, nitrogen and phosphorus have been added to restore pelagic productivity and improve food conditions for kokanee salmon in this large-scale restoration project. Kokanee are the primary food source for piscivorous rainbow trout and bull trout and are considered keystone species of the ecosystem. Results show the varying response in trophic levels from phytoplankton, zooplankton, mysid shrimp (an introduced exotic crustacean) and kokanee. The program is delivered by BC ministry staff, contractors and First Nations.

Funding comes from the Fish and Wildlife Compensation Program, Columbia Power and Bonneville Power Administration, and through a trans boundary relationship with the Kootenai Tribe of Idaho.

Posters

Nagao, T.L.*, Cook, J., Graham, M.D., Loewen, C.J.G., & Vinebrooke, R.D. University of Alberta. **Environmental drivers of phytoplankton communities in the Canadian Rockies under a changing climate.** Phytoplankton communities are some of the earliest responders to ecosystem stress resulting from global change. Our survey of ~100 lakes along a climatic gradient aimed to determine the key explanatory variables of phytoplankton beta diversity using multivariate analyses of morphological and taxonomically diagnostic pigments. Preliminary ordinations suggest that glacial coverage, TP, lake depth, underwater light availability, and barren sedimentary bedrock best predict shifts in community composition. Concordance testing will demonstrate the level of agreement between morphological versus pigment-based analyses, which will assist in guiding future studies in this area. Our findings will also help identify potential future functional (e.g., productivity) and service (e.g., potable water) trajectories of these lake ecosystems in a rapidly changing world.

Mercer, B.* & Vinebrook, R.D. University of Alberta. **Disentangling potential antagonistic effects of removal of introduced sportfish and higher temperatures on ecological recovery in mountain streams.** Mountain lakes and streams are subjected to a range of novel and extreme anthropogenic environmental changes (i.e., stressors), such as invasive sportfish and higher temperatures linked to global warming. While most studies have focused on the cumulative ecological impacts of stressors, a key knowledge gap remains concerning recovery responses to the removal of these stressors. The goal of our research is to explore how macroinvertebrate and periphyton communities respond to the removal of non-native sportfish under ambient versus elevated water temperatures using experimental montane stream mesocosms. Based on co-tolerance theory, we predict that higher water temperatures dampen the recovery response of benthic communities by suppressing thermally intolerant species that would otherwise experience release from fish predation. The anticipated significance of our findings lies in demonstrating to natural resource managers the extent to which the removal of invasive sportfish may achieve ecological recovery in mountain streams under a rapidly changing climate.

Groves, V.* & Brown, G.E. Concordia University. **The effect of temperature and predation risk on learning in Trinidadian guppies**. Prey rely on many information sources to learn the identity of novel predators. The availability of information, however, can be shaped by anthropogenic disruptions like climate change, resulting in an ecological trap whereby individuals make choices that are maladaptive to their survival. This can include energetically costly responses to irrelevant cues or failing to respond to legitimate threats causing death. We explored the combined impact of temperature and predation risk

on the learning abilities of Trinidadian guppies (*Poecilia reticulata*). Guppies underwent background exposure to temperature and predation risk before being conditioned to recognize a novel cue as a threat, and then tested for a learned response. Preliminary results suggest that predation risk and increased temperature affect the ability of guppies to learn to recognize a novel threat. Understanding how prey will cope with these threats contributes to a broader understanding of how climate change will impact animal behavior and biodiversity.

Gilbert, M.*, Harris, L., Malley, B., Hollins, J., Middleton, E., Hussey, N., Moore, J-S, Speers-Roesch, B. University of New Brunswick. **Behavioural and physiological overwintering strategies in Earth's most northerly distributed anadromous fish, the Arctic char.** Many Arctic fishes, including Arctic char (*Salvelinus alpinus*), spend most of their lives under extreme winter conditions with frigid temperatures and limited food. Adult anadromous Arctic char feed in marine habitats during summer, but then return freshwater to avoid freezing over winter where they often cease feeding (~10mth/yr). To assess the impacts of these prolonged winters, we examined the seasonality of activity, organ somatic indices and tissue composition in anadromous char in Nunavut's Kitikmeot region. Arctic char activity nearly ceased over winter and markedly decreased digestive organ masses while conserving heart mass. We simulated these overwintering conditions in the laboratory and found that prolonged fasting resulted in similar changes in organ masses and a substantial reduction in resting metabolic rate. These results suggest that activity suppression and selective tissue atrophy during fasting are likely crucial energy conservation strategies used by Arctic char to facilitate their extraordinary feast and famine lifestyle.

James, S., Levings, C., Juanes, F., Moore, J.W., & Pearsall, I. Pacific Salmon Foundation. **A synthesis of historical and current salmon diets across estuary types in British Columbia.** As stressors on salmon populations become more pervasive it is important we investigate cumulative impacts on salmon. Estuaries are important rearing grounds for Pacific salmon where foraging conditions can influence growth and subsequent survival. What we know about the foraging ecology of salmon in estuaries comes from a mix of peer-reviewed and gray literature and is mostly unassimilated. Our goal is to synthesize existing knowledge of salmon diets in estuaries across British Columbia as well as key data on estuary characteristics (i.e. type, watershed, disturbance) through the creation of an open-access database. Where data allow for comparisons across studies, we will investigate the relationships between estuary characteristics and juvenile salmon diets. This open-access database will evolve with future studies and will allow for assessments of estuary health, analyses of cumulative impacts, and utility of the database as both a scientific reference and tool.

Kanigan, A., Hinch, S.G., Furey, N., & Lotto, A.G. University of British Columbia. **Living in a world of feast and famine: Bull trout movements and feeding ecology in relation to salmon-derived subsidies.** Pacific salmon (*Oncorhynchus spp.*) migrations and spawning events can represent important but brief feeding opportunities for many consumers. Thus, consumers may possess behavioural and physiological adaptations that facilitate the exploitation of those food resources. Using complimentary acoustic telemetry and diet studies, we describe the movement patterns and feeding ecology of adult bull trout (*Salvelinus confluentus*) in relation to the timing of sockeye salmon (*O. nerka*) spawning and the out-migration of sockeye salmon smolts in the Chilko Lake system, British Columbia. Telemetry revealed

that some bull trout moved over considerable distances (>100 km, annually) and that a portion of bull trout returned to the lake outlet in consecutive years during sockeye spawning and the smolt out-migration. Such behaviour may allow bull trout to maximize exploitation of sockeye salmon, which potentially account for a substantial proportion of their annual diet. Preliminary results of the bull trout diet study will also be presented.

Butler, N.A.*, Eliason, E.J., Lotto, A.G., & Hinch, S.G. University of British Columbia. **Assessing effects of acclimation temperature on thermal tolerance of stream-type juvenile Chinook salmon under climate change scenarios.** We evaluated thermal tolerance in Chinook fry and parr using three approaches. Fish were acclimated for two weeks at temperatures spanning present and expected future summer levels (15°C, 18°C, 20°C, 24°C). Using fish from each acclimation temperature, we measured: 1) endurance swimming (Eswim), where swimming fish were exposed to increasing speeds at each temperature, 2) critical thermal maxima (stationary) (CTmax stat) where water was heated (0.3°C/min) in a stationary tank, and 3) critical thermal maxima (swimming) (CTmax swim) where water was heated (1°C/30min) while fish swimming at a fixed speed. Fish acclimated to higher temperatures generally exhibited higher thermal tolerance, based on CTmax stat and CTmax swim trials, though fry exhibited a greater sensitivity to increased temperatures. However, swim performance impairment was greater at the 24°C acclimation treatment for both CTmax swim and Eswim trials in parr and fry, indicating an upper thermal limit with differing responses between life stages.

Dextrase, A.*, Patterson, D.A., & Martins, E.G. University of Northern British Columbia. **Thermal Preference and Behavioural Thermoregulation of Adult Sockeye Salmon in Babine Lake** This research investigates the thermal preference of adult migrating sockeye salmon and how effectively they regulate their body temperature while passing through Babine Lake. Twenty-one salmon were caught in the Babine River in 2021, tagged externally and internally with temperature loggers, and subjected to a 24hr thermal preference shuttle box test. Sixty other salmon were tagged with a radio transmitter and temperature logger and released to continue their migration. Median thermal preference was 14.01°C and weakly, positively associated with river temperature at capture, fat content, and size at tagging. Temperature loggers were recovered from 24 of the radio tagged salmon post-spawn, and the median temperature they selected while migrating through Babine Lake was 10.73°C. Future analysis will focus on incorporating thermal preference estimates and selected temperatures to estimate how effectively sockeye regulated their body temperatures in Babine Lake, and investigate if this impacted their spawning success.

Moore, E.* University of British Columbia Okanagan . **Hydroclimatic effects on the run timing of kokanee salmon and the impacts of future climate change and forest disturbance in Peachland Creek, British Columbia.** Kokanee salmon (*Oncorhynchus nerka*) are a non-anadromous ecotype of sockeye salmon and are therefore extremely sensitive to freshwater habitat changes. Peachland Creek has been identified as a key watershed in the Okanagan basin due to its very high innate capacity to produce healthy kokanee populations. However, initial analysis of historical data shows that the timing and duration of annual kokanee spawning events have varied greatly over time for unknown reasons. The objectives of this research are to: (1) determine how hydroclimatic variables, such as water temperature,

streamflow, air temperature, and peak snow water equivalent (SWE), have influenced the timing and duration of kokanee spawning events over the past 30 years in Peachland Creek, and (2) forecast how potential climate and land management scenarios may impact these relationships in the future through changes in hydroclimatic variables.

Andersen, A.*, Martin, T., & Hunt, B.P.V. University of British Columbia. **Vulnerability assessment for juvenile sockeye salmon using biological indicators**. The early marine phase is important for salmon survival of their first marine winter, and influences overall salmon returns. Determining the relationships between environmental drivers (e.g. temperature) and biological indicators (e.g. fish condition metrics) can provide key insights into how changing ocean conditions impact juvenile salmon. This can inform a climate change vulnerability assessment, using environmental drivers and biological indicators as exposure and sensitivity components, respectively. Using quantitative data on biological indicators collected in the Discovery Islands, and knowledge of environmental drivers impacting salmon elicited from experts, we will present a framework for a juvenile sockeye salmon vulnerability assessment based on guidelines set by the Intergovernmental Panel on Climate Change. Development of such a vulnerability assessment offers a much-needed tool that can enable incorporation of early marine life experience into management and conservation decisions.

Kuzmenko, Y.*, Hunt, B.P.V., Egorova, Y., Spesivy, T., & Pakhomov, E.A. University of British Columbia. **Evidence of size and growth rates selectivity in Sockeye salmon post early marine stage**. Shapes of growth rates curves during the early marine period of life were build based on the chemical and microstructural analysis of the juvenile salmon otoliths collected at the time of outmigration. Similar juvenile growth curves were built from the otoliths collected at the spawning area for the same cohorts of sockeye fish. Comparison of the curves points on the size and growth selectivity during the post early marine stage of Fraser River sockeye life.

Balfour, T.* & Martins, E. University of Northern British Columbia. **Effects of release size and location on the early survival of chinook salmon (*Oncorhynchus tshawytscha*) on the west coast of Vancouver Island**. Population abundances of Chinook salmon (*Oncorhynchus tshawytscha*) are heavily influenced by survival at early life stages. Our project used PIT tags to evaluate the relationships between length of freshwater migration, family group, body size and timing of out-migration on survival of 5000 hatchery-origin Chinook salmon released in the Toquaht River on the West Coast of Vancouver Island. Releases were done on three separate dates and during each release fish were split evenly between three different locations within the watershed. Two antennae in the lower river detected tagged fish as they entered the estuary. Detection's were analyzed using an integrated model of travel time and capture-recapture. Freshwater residency time between release and detection ranged from 0.8-60 days (avg. 15.26). Preliminary analysis indicates survival may be higher for fish released in a lake, mid-watershed, in late June. Weight and length did not appear to influence survival. The results will identify hatchery release strategies that increase freshwater survival and potentially increase return rates of hatchery-origin Chinook.

Badger, A*., & Demers, E. Vancouver Island University. **Habitat use and movement of coastal cutthroat trout in relation to changing flow dynamics in a small Vancouver Island stream**. The ecological value of small, urban streams and their capacity to support populations of vulnerable fishes is becoming increasingly recognized. However, the natural hydrologic dynamics of urban watersheds are often heavily altered as a result of anthropogenic interference. This study used Passive Integrated Transponder (PIT) technology to assess the movement behaviour and preference of instream habitat types of coastal cutthroat trout Oncorhynchus clarkii clarkii in relation to stream flow conditions in an upper reach of Shelly Creek, a small tributary to the Englishman River in Parksville, BC. Fifty-two cutthroat trout (≥ 70 mm fork length) were PIT tagged and monitored from June 2021 to February 2022 using a mobile antenna and stationary instream array. Preliminary results indicate trout were confined to isolated pools during summer low flows (≤ 0.0004 m3/s), and substantial movements (≥ 20 m) were not observed until flows reached 0.0515 m3/s in late October.

Lingard, S.*, Hinch, S.G., Bass, A., & Cook, K.University of British Columbia. **Assessing residence duration in sub-yearling Chinook Salmon in a fjord estuary using micro (V3) acoustic transmitters.** Estuary habitat restoration is commonly undertaken as a conservation initiative for Chinook Salmon; however, planning effective restoration requires intimate knowledge of species and life-stage specific ecology and behaviour. Using newly developed miniaturized transmitters (Innovasea V3), we monitored movement ecology of wild sub-yearling (n = 46) Chinook Salmon in a fjord estuary undergoing restoration. Fish implanted with transmitters ranged in size from 67 to 90 mm. Using time-to-event analysis we obtained a median residence duration of 11.2 days. This research provides the first direct measure of estuary residence duration in sub-yearling salmon. These insights can be used to guide selection of habitat-based conservation actions.

Reid, J.* Carleton University. **Habitat Use and Movement Patterns for Muskellunge in an Urbanized Environment**. River ecosystems are experiencing cumulative stressors including wide-scale fragmentation from urbanization and agricultural activities. In a time of rapid transformations to riverine and riparian habitat, it is important to study the habitat use and movement of aquatic species. In Ottawa, the Jock River is experiencing current and future wide-scale housing development and agricultural practices that may threaten water and habitat quality. Despite being situated in a heavily populated urban center, this river supports a diverse and unique fishery, including a self-sustaining population of the apex predator species Muskellunge (*Esox masquinongy*). To determine the year-round movements and key habitat areas of Muskellunge, including their use of previously restored areas, I will use acoustic telemetry to track fish movement in the Jock River. Given the ongoing global biodiversity crisis, it is important to be proactive with Muskellunge management so that resource-managers can adopt evidence-based approaches for balancing anthropogenic activities and ecosystem health.

Pallard, J*. & Poesch, M. University of Alberta. **Effects of non-native salmonids on Bull Trout in Alberta's foothills.** Bull Trout require cold, complex, and connected habitat, and are vulnerable to the invasion of non-native species and the effects of climate change. Despite their vulnerability and the Saskatchewan – Nelson River population's status as threatened under COSEWIC, there is little research on the effects and interactions of two non-native salmonids, Brook Trout (*Salvelinus fontinalis*) and Brown Trout (Salmo

trutta), with Bull Trout in Alberta. We conducted electrofishing and habitat surveys in 13 headwater streams in the North Saskatchewan and Red Deer River watersheds from 2020-2021. Our research utilizes stable isotope analysis and multi-species occupancy modelling to assess the effects of Brook Trout and Brown Trout on the diet and habitat use of Bull Trout in the North Saskatchewan and Red Deer River watersheds.

Mushet, G.R.*, Blanchfield, P.J., Higgins, S.N., Paterson, M.J., & Rennie, M.D. Queen's University. **Ecosystem indicators to track natural variability in fish productivity in a small boreal lake.** Amendments to Canada's Fisheries Act in 2019 re-established the need to understand linkages between changes in fish habitat and fish productivity. Recent work has also identified both: (1) understanding impacts of climate change on water quality, and; (2) identifying effective metrics for quantifying the impacts of stressors on fish habitat as priority research areas in Canadian freshwaters. To identify relationships between fish habitat and productivity, we leverage three decades of fish community data (size-spectrum, abundance, and body condition for trophic guilds ranging from littoral prey fish to piscivorous lake trout), lower foodweb, and physicochemical data from a long-term reference lake at IISD-ELA. Initial findings indicate that the size spectrum of the prey fish community may capture seasonal variation in the productivity of this trophic guild. This project highlights strong correlates of fish productivity that are cost-effective ecosystem indicators, informing fish habitat monitoring programs across Canada.

Hirsch, E.*, Gantner, N., Spendlow, I., Walters, C., & Martins, E.G. University of Northern British Columbia. **Oxy-thermal habitat use of Burbot (*Lota lota*) in Fraser Lake, British Columbia, Canada**. Burbot is an important harvest species in northern British Columbia for First Nations and recreational angling communities. In the Omineca Region, current burbot fisheries regulations such as daily quotas, lake-specific closures, and gear restrictions largely come from dated studies with limited evaluation of environment. As lakes continue to warm rapidly, benthic species experience increased water temperatures and reduced dissolved oxygen, potentially causing stress and reducing available habitat. We investigated burbot's oxy-thermal habitat use in Fraser Lake through acoustic telemetry monitoring. We compared realized oxy-thermal habitat use to preferred oxy-thermal environment using the "shuttlebox" system. Preliminary results indicate that burbot occupied warmer water but not significantly deeper sites over the summer months. Further results will characterize effective use of the preferred oxy-thermal habitat, to be incorporated into regional fishery management plans.

Gartshore, D.* & Rennie, M.D. Lakehead University. **Using bioenergetics modelling to evaluate the impacts of Bythotrephes on the growth of young-of-year walleye.** Invasive species are a major threat to ecosystem structure and function. For example, Bythotrephes longimanus (*Bythotrephes hereafter*) have had significant impacts on invaded ecosystems such as decreasing zooplankton density and biomass, and are capable of outcompeting zooplanktivorous fishes. Young of year (YOY) walleye (*Stizostedion vitreum*) are zooplanktivorous initially, and have recently been shown to display reduced growth in Bythotrephes-invaded lakes. We evaluated the impacts of Bythotrephes invasion on YOY walleye using a bioenergetics model, to compare growth differences with and without Bythotrephes based on differences in zooplankton abundance and community assemblage reported in the literature. Preliminary results support field observations elsewhere of reduced larval walleye growth in the presence of

Bythotrephes. Since growth is ultimately linked to reproduction, recruitment, and production, understanding the impacts of Bythotrephes on walleye growth rates is essential to support adaptive management.

Kneale, A.J., Glowa, S.*, Enders, E.C., Ghamry, H., & Watkinson, D.A. Fisheries and Oceans Canada. **Standard operating procedure for an unmanned aerial vehicle (UAV) in riverine ecology.** Remote sensing has been applied to a variety of ecological studies, including assessing and monitoring fish habitat. However, little information is published about data collection methods required to perform such complex habitat studies. An unmanned aerial vehicle (UAV) was deployed to capture 2D photogrammetry flights of two river reaches in Southern Manitoba. The flights were conducted under different environmental conditions and flight settings to determine how these variables can effect the data collection process as well as the accuracy and precision of data collected. Structure-from-motion software was used to process the images and develop a digital elevation model (DEM) and an orthomosaic image for each flight. A standard operating procedure was produced to inform future UAV-based ecological studies in rivers on what methods are the most efficient and result in the most accurate DEM and orthomosaic image.

Eissenhauer, F.*, Linnansaari, T., Hill, C.R., Pratt, T., Curry, R.A., & Harrison, P. University of New Brunswick. **A mark-recapture approach to estimate the annual numbers of American eel elvers (*Anguilla rostrata*) arriving at a dam in a large river.** American eel populations have declined throughout their geographical range. Threats include habitat fragmentation by barriers that prevent eels from moving between the sea and freshwater. Mactaquac Dam is the lowest dam on the Saint John | Wolostoq river and is impassable for elvers (juvenile eels). Nonetheless, every year large numbers of elvers congregate below the dam. In 2021 we initiated a mark-recapture study to assess the size and age structure of the arriving population. We marked 5000 elvers with visible implant elastomer tags and collected otoliths from 120 individuals. Data from the first season suggests a high number of elvers in their second freshwater year recruiting to the dam. Annual data will be used to develop a method for future population estimates based on an index of abundance. This will allow a long-term assessment of population trends and provide insights in the impact of the hydropower dam on elver recruitment.

Zubick, P.*, Sherker, Z., Lapointe, N., Maloney, D., & Hinch, S.G. University of British Columbia. **A compliance audit of culvert barrier remediations in the Interior Fraser River Watershed.** Culverts often become barriers to upstream fish movements. Culvert remediation efforts involve low-cost retrofits, placing weirs downstream and adding baffles into the structure, or replacing the culvert with open bottom structures. However, there has been limited investigation of how these remediations perform through time. Therefore, we conducted a compliance audit and compared 38 remediated culverts in British Columbia with stream crossing construction regulations and guidelines. Preliminary results from 12 sites found that only 1 remediation complied with stream constriction regulations. The remaining sites had a constriction ratio > 1 based on culvert width and the average bankful width 100m upstream and downstream of the culvert. According to a fish passage assessment, 50% of the remediated sites are barriers or potential barriers to fish movement. These preliminary results suggest that non-compliance

with stream crossing regulations can cause remediated culverts to degrade and become a fish passage barrier again.

Kussin-Bordo, N.S.*, Hinch, S.G., & Asadian, Y. University of British Columbia. **Effects of log storage in the Fraser River estuary on water quality and shoreline habitat**. Estuarine storage of timber in large floating rafts termed 'log booms' is a common activity in British Columbia. In the Fraser River, booms cover large areas of the estuary and lower reaches, yet there has been very little research into the effects of log storage on aquatic habitats. We compared sediment compaction, vegetation, and benthic invertebrate biomass and diversity among active log storage sites (n= 10), historic sites (n=12), and reference sites (n=10). We found pH levels were significantly lower at ~10cm above substrate at active log sites compared to control sites. We also found significantly higher temperature at control sites compared to active. We found lower levels of dissolved oxygen and pH when comparing site status. Active sites were more likely to experience soil compaction, and have less aquatic macrophytes, likely as a result of the booms 'grounding' onto the benthos. Dipteran abundance was significantly higher at control sites compared to active sites. Haplotaxida abundance however was significantly higher at active sites compared to control sites. Our findings suggest that log grounding is the main contributor to changes in habitat where logs are stored and should be the focus of managers within the estuary.

Miner, M.*, Speller, C., & Hunt, B.P.V. University of British Columbia. .**"Lax Kwil Dziidz: The Place That Squirts" - Harmful Algal Blooms, Ancient DNA, and Gitga'at Shellfish Mariculture at Clamstown.** The Gitga'at First Nation have managed a sustainable and ecologically complex bivalve fishery at Lax Kwil Dziidz (Clamstown, Fin Island, British Columbia) for thousands of years. In recent years, biotoxin monitoring has identified elevated levels of saxitoxin in butter clams at Clamstown, leading to the closure of the fishery. These phycotoxins, produced by the harmful algal bloom (HAB) dinoflagellate *Alexandrium catenella*, bioaccumulate in filter-feeding marine organisms where they pose a public health risk to humans. In this poster we present the conceptual framework for an ongoing two-part research project. First, modern butter clam (*Saxidomus gigantea*) shells will be collected from sites across a gradient of HAB intensity. Environmental DNA associated with *A. catenella* will be amplified from these shells, quantified, and compared to biotoxin data. Second, this same method will then be applied to archaeological shells from Clamstown in an attempt to quantify the relative abundance of Alexandrium in the past.

Donovan, M.*, Grant, S., Walsh, P., Zabudsky, S., & Steiner, R. Fisheries and Marine Institute of Memorial University of Newfoundland. **Incorporation of Western science and traditional knowledge in Nunavut with community engagement**. Food security is a persistent issue in rural communities of Canada's arctic and many communities rely heavily on locally harvested marine species. Combining Western science with traditional Inuit knowledge allows communities and fisheries managers to more effectively manage resources and potential to create small scale fisheries. We have worked with Inuit in several communities to increase the understanding of local resources. Community members provided vessels as research platforms for deployment of baited pots, small dredges, and drop camera systems. Inuit research partners shared traditional knowledge openly and eagerly and were excited to share their experiences with other community members each day upon returning to land. Familiar foods like

scallops, urchins, shrimp, whelk, toad crab, and sea cucumber were captured or viewed by video. Future goals of this project include individual communities collecting data on catch and performing camera surveys to assist in management of local fisheries resources.

Jung, N.*, Edwards, J., Picco, C., & Reid, A. University of British Columbia. **What If Nuu-chah-nulth Worldviews Shaped Our Views of Rockfish Stewardship?** The Nuu-chah-nulth Nations have sustained their people through a rockfish fishery for thousands of years, but within just decades colonial legislation and fisheries have put rockfish, people, and the worldviews underlying Nuu-chah-nulth fisheries in positions of crises. In partnership with Ha'oom Fisheries Society (an organization that supports five Nuu-chah-nulth Nations in exercising their commercial fishing rights, while caring for fish populations and habitats), we look to assess recent temporal trends in rockfish size and age at spatial scales relevant to the Nuu-chah-nulth Nations and their stewardship planning process. Such assessments can be crucial: If rockfish size and age structures are becoming truncated, this is an early warning signal of reduced recovery potential due to the disappearance of the largest, most fecund fishes. In doing this collaborative work, we analyze the Pacific Halibut Management Association's (PHMA) longline survey data, and consider how visions of sustainable and just rockfish stewardship can engage Nuu-chah-nulth worldviews and Indigenous resurgence.

Nguyen, V.*, Bayse, S., Einarsson, H.A., & Ingólfsson , O.A. Fisheries and Marine Institute of Memorial University of Newfoundland, Marine and Freshwater Research Institute, Norwegian Institute of Marine Research. **Herding behavior of fish at different locations of the trawl mouth**. This study used fish escape location underneath a bottom trawl to infer fish herding behavior at the trawl mouth (trawl opening). Three collecting bags (center (bosom) and wings (port and starboard)) were mounted behind the groundgear, underneath the trawl, to determine the catch-at-length of species that escaped capture by passing below the trawl. Thus, fish escape location could be used to infer fish response behaviour, herding behaviour, and swimming capacity at the trawl mouth. For Atlantic cod (Gadus morhua) and haddock (Melanogrammus aeglefinus), small fish (< 28 and < 14 cm, respectively) were more likely to escape at the center of the trawl, and larger fish at the wings. Other demersal species, e.g. flatfish and monkfish (Lophius piscatorius), showed more variation with species-specific results. Generally, results reflected differences between fish swimming capacity and species' association to the sea bottom.

Araya-Schmidt, T.*, Bayse, S.M., Winger, P.D., & Santos, M.R. Fisheries and Marine Institute of Memorial University of Newfoundland. **Underwater observations of a Northern shrimp (*Pandalus borealis*) bottom trawl to address an emerging juvenile redfish (*Sebastes spp.*) bycatch issue**. A recent rebound of juvenile redfish (Sebastes spp.) in areas where the Northern shrimp (Pandalus borealis) bottom trawl fishery in eastern Canada occurs has been challenging industry to maintain bycatch of this species within acceptable levels. Using self-contained underwater cameras and red lights, this study investigated the behaviour of redfish and shrimp in a bottom trawl Nordmøre grid and in an escape panel after the grid section to explore solutions on how to behaviourally reduce juvenile redfish bycatch and increase shrimp catches. Qualitative observations indicated that considerable amounts of shrimp escaped through the Nordmøre grid outlet, redfish were prone to swim upwards when approaching the grid, and the escape panel after the Nordmøre grid exhibited good potential, as many redfish were seen exiting the trawl

through the opening. Undergoing generalized linear models and behavioural trees analyses will provide statistical evidence to aid in the solution to reduce juvenile redfish bycatch.

Zabudsky, S.*, Walsh, P., & Grant, S. Fisheries and Marine Institute of Memorial University of Newfoundland. **Northern deep-sea fish communities: A comparison using camera surveys and stationary fishing gears**. Seabed research requires accurate, low-impact assessment methods to avoid damage to sensitive benthic ecosystems. In collaboration with Indigenous research partners, novel high-definition video of the seabed was collected over a 24km linear distance from the deep-sea environment (885-1369m) of the Davis Strait using a towed video sled. Stationary baited pots equipped with video camera systems were also deployed. Towed video footage is being analyzed using a modified Canadian perspective grid developed for deep-sea imagery to assess benthic finfish density, community composition, and associations with vertical structure (e.g., living and non-living). Finfish density estimates are being compared to catch data in stationary fishing gears (i.e., gillnets and baited pots) collected on the same grounds as the video data. Video and capture data are expected to provide conclusions regarding capture efficiency and analysis of behaviour is expected to explain differences in catchability of various fish species in stationary fishing gears.

Frank, C.*, Steiner, R., Bayse, S., & Biton, P-P. Fisheries and Marine Institute of Memorial University of Newfoundland. **Can I get a light? Underwater light performance of glow-in-the-dark pots designed for the Newfoundland snow crab (*Chionoecetes opilio*) fishery**. Recent studies have shown that there is promise in using new luminescent-netting pots to increase catch rates within the Newfoundland snow crab (*Chionoecetes opilio*) fishery. However, there have been no studies analyzing the peak brightness and spectral curve of this new technology. Using spectrophotometry, we measured the brightness and decay of three treatment groups: two strands of luminescent twine woven into pots, four-stranded pots, and six-stranded pots. The brightest treatment, six-stranded pots, emit 150 Mq s-1 cm-2 of light, peaking at a 523 nm wavelength. Four- and two-stranded pots emit 82 and 35 Mq s-1 cm-2, respectively. Light decay is initially rapid, falling over 50% in the first five minutes, following a traditional radiation decay curve. Although light from the pots is initially brighter than natural light sources in the deep ocean, when accounting for decay, even the brightest pots are dimmer than some bioluminescent animals after one hour.

Steiner, R.*, Hiscock, W., Grant, S.M., & Hasler, C.T. Fisheries and Marine Institute of Memorial University of Newfoundland. **Use of large plastic collars to decrease the capture of non-legal snow crab (*Chionoecetes opilio*) in the Nova Scotia pot fishery**. Pot modifications are used as a method to mitigate capture of non-legal snow crab (*Chionoecetes opilio*) in the Canadian fishery. This study investigated plastic collars of different sizes (12, 18, and 24 cm) to determine whether they would reduce capture of non-legal crab. The study design included each plastic collar tested with a traditional pot, a traditional pot as a control, and a small mesh pot that was used to determine the snow crab size distribution in the area fished. An absolute selectivity approach was used to determine size selectivity of crabs caught in each pot. With an increase in collar size, there was a decrease in size selectivity, with the 24 cm collar reducing the capture of crab in all size classes. Overall, the plastic collars acted as a deterrent to both non-legal and legal-sized snow crab catches, thus not a feasible option from a commercial perspective.

Navarroli, G.*, Mullen, E., Kroeker, D., Kitch, I., & Hasler, C.T. University of Winnipeg. **Recreational angling effects on Manitoban lake trout populations**. Lake trout (*Salvelinus namaycush*) is a prized trophy fish among recreational anglers throughout Manitoba, yet they have been understudied in the province for several decades. Recreational angling is the most common form of fishing lake trout, but the long-term effects of this practice remain unknown on Manitoban lake trout populations. Gillnetting index programs were conducted in several Manitoban lakes across a latitudinal gradient to assess the recreational angling effects on lake trout populations. Biometric data such as: length, weight, sex, gonad weight, liver weight, diet, and otoliths were collected from lake trout. Preliminary results indicate southern lakes consistently have fewer and smaller lake trout than northern lakes, which could be related to higher fishing pressure. Based on results of this study, additional rules and regulations may be needed to address the current state of lake trout fisheries in southern Manitoban lakes.

Nemeczek, C.*, MacMillan, J., Van Wyngaarden, M., & Ruzzante, D.E. Dalhousie University. **Genome wide patterns of structure and diversity among nine small brook trout populations in Nova Scotia: The role of genetic drift vs. local adaptation examined with low-coverage whole genome sequencing (lcWGS)**. Understanding the relative roles played by local adaptation and genetic drift in small, isolated populations, where low genetic diversity is expected and responses to environmental changes are unpredictable, is fundamental for robust conservation and management strategies. Accordingly, we conducted low-coverage whole genome sequencing of N≈192 brook trout (*Salvelinus fontinalis*) collected in June 2021 from nine small coastal streams in Nova Scotia. Individuals were sequenced at ~3x depth using paired-end sequencing on the Illumina NovaSeq and genotype likelihoods calculated with ANGSD. We report on genome-wide patterns of genetic structure and diversity and identify genomic regions of interest with a potential role in local adaptation to environmental variables (e.g., geomorphology, temperature, flow.). We aim to identify genomic regions of interest using genome scans and genotype-environment association analyses with stream specific temperature and water flow data alongside other environmental data.

Konstantinov, N.*, Ferguson, M., & Danzmann, R. University of Guelph. **Genetic architecture of variation in growth-related traits in rainbow trout (*Oncorhynchus mykiss*) chronically exposed to warmer water temperatures**. Aquaculture-reared fish like rainbow trout are vulnerable to stress caused by increased water temperatures from climate change, which can negatively impact many economically important traits such as feeding rate and growth. Producing fish with increased thermal tolerance by selectively breeding fish with genetic markers associated with increased growth is a potential solution to mitigating these effects. Our objective was to characterize the genetic architecture of growth-related traits as indicators of whole animal performance in rainbow trout chronically exposed to increased temperature. By genotyping each individual fish using a 57k SNP chip , we identified SNPs associated with variation in growth-related traits as indicators of superior performance of rainbow trout gradually exposed to heightened temperatures over 10 weeks. SNPs identified may be used to further our understanding of thermal tolerance in rainbow trout and may be used for commercial breeding programs through marker assisted breeding.

Jain, S.*, Lara-Jacobo, L., & Simmons, D. Ontario Tech University. **Refining Adverse Outcome Pathways Using Japanese Medaka Embryos (Oryzias Latipes) Exposed to 2,3,7,8-Tetrachlorodibenzodioxin (TCDD)**. Adverse outcome pathways (AOPs) are a collaborative framework that categorizes the impact of chemicals from the molecular to the ecosystem level. This research aims to refine two existing AOPs (21 and 150) that are initiated by dioxins binding to the Aryl hydrocarbon receptor (AhR), resulting in altered cardiovascular development in a multitude of organisms. Medaka embryos were exposed to 0.001, 0.01, 0.1, 1, and 10 ppb of TCDD for 1 hour at 4 hours post-fertilization. When embryonic development is adversely impacted by dioxins, there are gene and protein expression differences, which were detected by non-targeted proteomics and qPCR. These were linked to higher-level adverse effects observed as heart rate impairment and severity of pericardial edema. Our results indicate the lack of one key event and instead offers a new link that combines the two AOPs into one. Refining AOPs will improve our ability to respond to chemical contaminants of concern.

Rix, C.*, Hannan, N., & Gray, D.K. Wilfrid Laurier University. **Potential Impacts of Road Dust on Zooplankton Communities in Arctic Lakes.** Gravel roads alter the surrounding environment in a myriad of ways that can influence surface-water flow, sedimentation runoff, and the delivery of dust and debris to nearby lakes. These changes have the potential to influence water quality and zooplankton communities in roadside lakes. I will count and identify zooplankton samples from nine different lakes in the Boreal region in the Northwest Territories that fall into three distance categories from the Dempster Highway (0-300m, 300-600m, 600-900m). I will analyse the resulting dataset using ANOVAs and PERMANOVAs to examine differences in richness, abundance, and species composition among lake categories. Based on the results of recent studies, I hypothesize that: 1) higher calcium levels due to road dust deposition will lead to increased abundance of zooplankton that require high calcium levels; and 2) higher conductivity levels near the road will cause increases in abundance but decreases in diversity and evenness of communities.

Gao, V.*, Gray, D., & Kheyrollah Pour, H. Wilfrid Laurier University. **Gravel Road Runoff in an Arctic Environment: An Assessment of the Impact on Macroinvertebrates in Roadside Lakes.** Gravel roads can be a major source of pollution to their surrounding environment. Road dust can alter water quality, which could negatively impact macroinvertebrates in roadside lakes. I will examine: 1) If road dust runoff from unpaved highways affects macroinvertebrates in Arctic lakes; and 2) If different types of roadside vegetation (boreal vs. tundra) could influence the severity of these impacts. I will survey macroinvertebrates in 18 lakes adjacent to the Inuvik-Tuktoyaktuk Highway (ITH) in the Northwest Territories and measure rates of dust deposition for each lake. To complement my field sampling, I will utilize remote sensing to determine if lake productivity or turbidity has changed since the construction of the ITH was finished in 2017. I hypothesize that changes in water quality will alter the macroinvertebrate composition, and boreal vegetation will act as a better barrier than tundra shrubs for water quality protection.

Nelligan, C.*, Benoit, N., Dove, a., & Howell, E.T. Minnow Environmental Inc. **Nearshore-offshore integration of trace metals in surface waters of the Laurentian Great Lakes**. The Great Lakes basin has a unique history of metals contamination from industrial and atmospheric sources. Environment and

Climate Change Canada and the Ontario Ministry of the Environment, Conservation and Parks have monitored trace-metals in the surface waters of the Canadian Great Lakes since 2003 using an ultra-clean, low-level method for trace metals analysis. Using this robust dataset, we describe the current state of trace metals in lakes Superior, Huron, Erie, and Ontario. Specifically, we aim to (1) identify areas with elevated metal concentrations (i.e., "hot-spots"), (2) assess temporal trends in areas of interest, and (3) assess differences among lakes, nearshore and offshore areas, as well as among areas representative of ambient conditions and areas chosen to capture watershed or anthropogenic stressors. The last assessment of trace metals in the Great Lakes was conducted in the late-1990s and thus, this investigation provides a current summary of trace-metal concentrations thirty-years later.

Bourdages, M.P.T.*, Provencher, J.F., Hurtubise, J., Jardine, A.M., & Vermaire, J.C. Carleton University. **Characterization of microplastics in surface water from the Yellowknife River and Yellowknife Bay, Northwest Territories.** Microplastics are pervasive and persistent in the environment, however, understanding the sources, distribution, and fate of microplastics within freshwater systems requires further investigation. Recent studies have identified microplastics in Arctic marine environments, but little is known about the presence of microplastics in Arctic freshwater systems. Circumpolar rivers input large amounts of water to the Arctic Ocean, and could be important transport pathways for microplastics. This study characterizes microplastic concentration and composition in surface waters around Yellowknife, NT, to assess the amount of microplastics transported into Great Slave Lake. In July 2021, samples were collected using a 300 µm Manta trawl (20-minutes per sample) from the Yellowknife River (n = 10), Yellowknife Back Bay (n = 10), and Yellowknife Bay (n = 10) with guidance and support from the North Slave Métis Alliance. Higher concentrations of microplastics are expected in the samples from Yellowknife Bay than upstream from the Yellowknife River.

Langenfeld, D.*, Rochman, C., & Paterson, M. University of Manitoba. **Response of a freshwater zooplankton community to microplastics in an in-lake mesocosm experiment.** Microplastics (plastic particles <5mm) are globally ubiquitous contaminants and there is currently no scientific consensus on their toxicity in natural environments, especially freshwater. The objective of my research was to assess the potential effects of microplastics on a natural freshwater zooplankton community in a large scale in-lake mesocosm experiment that was conducted in summer 2021 at the International Institute for Sustainable Development Experiment Lakes Area (IISD-ELA) in northwestern Ontario. A mixture of three types of microplastic fragments (PE, PET, PS) were added to 10m diameter x 2m deep mesocosms in an experimental lake (Lake 378) using a regression design (0, 6, 24, 100, 414, 1710, 7071, 29,240 particles/L). Preliminary data indicate that zooplankton abundance increased after 5 weeks with higher microplastic concentrations. After 10 weeks, no significant differences in zooplankton abundance were observed.

Klasios, N.*, Flores Ruiz, I., Posacka, A., & Tseng, M. University of British Columbia. **First insights into microplastic contamination in sub-surface water and zooplankton in British Columbia lakes**. In British Columbia (BC), lakes are ecologically, economically, recreationally, and culturally important to many, yet little is known about the extent of microplastic pollution in these freshwater ecosystems. We investigated microplastic pollution by sampling sub-surface water and zooplankton from eight lakes

spanning BC, six of which are part of the province's Lake Monitoring Network. We report characterizations and concentrations, evaluate differences between lakes, and investigate if differences are driven by environmental or human-impact parameters in or nearby our sites. Our research is the first to report microplastic contamination in multiple lakes in BC and, by sampling water and zooplankton, it provides further insight into the fraction of microplastics entering the food web. The data collected can be used to inform future experiments that aim to evaluate environmentally relevant exposure scenarios and by stakeholders to assess the state of microplastic contamination and subsequent ecological risks.

Veneruzzo, C.V.*, Bucci, K., Langenfeld, D., McNamee, R., Rennie, M.D, Rochman, C.M., Paterson, M.J. Lakehead University. **Effects of microplastics on Yellow Perch (*Perca flavescens*) metabolic rates**. Microplastics (MP) are a complex emerging contaminant as they are beginning to be found in most freshwater ecosystems around the world. Their complexity stems from their potential to harm aquatic organisms both physically, from blockages or lacerations, and chemically due to leachates of chemical additives within the plastic itself, or from existing environmental contaminants that sorb to MP particulates. During an eleven-week mesocosm study at IISD-ELA, we exposed yellow perch to a variety of MP concentrations and measured their metabolic rates using respirometry. Preliminary results show a potential decrease in maximum metabolic rate (MMR) and aerobic scope (AS) at the highest concentration (29,240 particles/L). Conversely, there appears to be no change in standard metabolic rate (SMR). This suggests that MP have the potential to impact the maximum aerobic potential of freshwater fish which inherently lowers their overall fitness.

Anderson, A.*, Blanchfield, P., & Fisk, A. University of Windsor. **Influence of habitat on littoral food web energy sources in a freshwater lake**. Stable isotope analysis, widely used in aquatic research, can depict feeding relationships and energy transfer through an ecosystem. A founding principle of stable isotope ecology is that d13C values vary between littoral and pelagic habitats in lakes, but whether these values vary across littoral habitat types has not been widely examined. The application of d34S, relatively uncharted in freshwater systems, has been proven to compliment d13C. Here we assessed macroinvertebrate, zooplankton, mussel, and fish communities at three distinct littoral habitat types in a large oligotrophic lake to distinguish any within lake spatial variability in species composition or isotopic signatures. Sample collections show forage fishes yellow perch (*Perca flavescens*) and pumpkinseed (*Lepomis gibbosus*), along with mayfly nymphs and freshwater mussels (*Elliptio spp.*) were consistently observed across all habitats. Results from this study will aid in determining whether habitat-specific spatial sampling is necessary when using stable isotopes in lake food web studies.

O'Connor, R.*, McCann, K., Rooney, N., & McMeans, B. University of Guelph. **The Role of Across Scale Portfolio Effects in Stabilizing a Lower Trophic Level Metacommunity**. Biological structures (e.g., life history, trophic, and spatial structure) play an integral role in mediating diversity stability relationships in aquatic food webs. Portfolio effects represent stabilizing structures within food webs that act to reduce variability at aggregate scales, whether that is within local communities (species PE), across metapopulations (spatial PE) or across communities (cross-community, species X spatial PE). Here, we harness a long-term data set from a zooplankton metacommunity in a large temperature lake to investigate the relationships between stability, diversity, and asynchrony across organizational scales. We

found that asynchronous cross-community dynamics contribute a significant amount to stabilizing the metacommunity and reducing overall variability, while more synchronous dynamics within local communities and across metapopulations contribute relatively little to stabilization. We briefly investigate the role of global changes (e.g., climate warming, invasive species) and find that they are eroding portfolio effects by increasing synchronous dynamics across scales.

Fedus, A.*, Paterson, M., & Rennie, M. Lakehead University. **Effects of macrophyte removal on lower trophic levels in a small, shallow lake.** Aquatic macrophyte removal can reduce environmental heterogeneity, causing changes in biodiversity and community composition of plankton species, and potentially impacting higher trophic levels. This study aimed to determine changes in community composition and biomass of zooplankton and phytoplankton from a whole-lake macrophyte removal experiment conducted at Lake 191 of the Experimental Lakes Area from 1994-2003. Approximately 50% of macrophytes were removed from the littoral zone of the lake from 1996-1998. Correspondence analyses were conducted for both plankton populations in Lake 191 and three reference lakes. Preliminary results from this analysis show decreases in annual biomass of zooplankton in 1996-1997, followed by dramatic increases in 1998-1999. In 2000-2001, annual biomasses return to pre-removal levels. Reference lakes demonstrated no similar trends over time. Further studies will integrate these findings with those of the fish communities in Lake 191 to determine the effects of macrophyte removal on the whole ecosystem.

Jan, A., Guannico, G.*, Arismendi, I., & Flitcroft, R. Oregon State University. **The use of habitat models to assess non-native trout threats to native Cyprinids in Himalayan rivers.** Biological invasions are one of the major threats to biodiversity worldwide. Many regions in Africa, Asia and South America have scarce primary biodiversity data and limited habitat surveys. However, these regions support the highest fish biodiversity on earth and current trends on species introductions call for more conservation efforts. Ecological Niche Models can be a first useful step in providing baseline information on current and future distributions of native and invasive species in such regions. We present a case study of Rainbow Trout introduction in the Indus Basin in South Asia. To ensure equity of access to our methodology, we used open-source software and freely available data (hydro-climatic, geophysical, and network) as predictor variables. We discuss the challenges of modelling invasive species and provide new insights from data exploration in multivariate niche space. We argue that niche space exploration of data can reveal additional insights that can guide model parameterization.