ISE-FP 2024 SCHEDULE OVERVIEW

ISE-FP Quebec 2024 SCHEDULE OVERVIEW					
Workshop venue: INRS, 490 de la Couronne, Québec, Qc, G1K 9A9, Canada					
Sunday may. 5	Conference venue: Hôtel le Concorde, 1225 Cr du Général de Montcalm, Québec, QC G1R 4W6, Canada				
Timeslot	Speaker ready room (3rd floor)				
9:00-16:30	Workshop: INRS				
15:00-18:00	Kiosque installation: Concorde				
18:00- 20:00	Ice-Breaker and Registration desk open – Foyer in Level 3 Concorde				

Monday may. 6

Timeslot	Speaker ready room (3rd floor)				
6:30-8:00	Breakfast served at Level 2 Jean-Paul Lemieux				
	Suzor-Côté Ballroom 1	Krieghoff Ballroom 2	Borduas Ballroom 3	Leduc-Fortin	Pilot
7:00-8:00	Registration desk open – Foyer				
8:00-10:30	Opening Ceremony, Plenary 1: Steve Cook and Plenary 2: Marianne Bachand				
10:30-11:15	Break	Break	Break	Break	Break
11:15-12:30	Session 1: Hydropeaking ecological impacts (5 slots)	Session 2: Recent advances in fish tracking techniques (5 slots)	Session 3: Environmental flows (5 slots)	Session 4: Optimizing fishway designs (5 slots)	Session 5: Habitat restoration (5 slots)
12:30-13:45	Lunch served at Level 2 Jean-Paul Lemieux				
13:45-15:30	Session 6: Fish protection at dams (7 slots)	Session 7: Tracking fish migrations (7 slots)	Session 8: Habitat connectivity at high flows (7 slots)	Session 9: Sustainable hydropower (7 slots)	Session 10: Advances in numerical methods 1 (7 slots)
15:30-16:00	Break	Break	Break	Break	Break
16:00-17:45	Session 11: Recent development in fish screening techniques (7 slots)	Session 12: Selective fish passage (7 slots)	Session 13: Hydrodynamics in fishway designs 1 (7 slots)	Session 14: Vegetation in ecohydraulics: Wetlands and coastal areas (7 slots)	Session 15: Fish passage: opportunities for funding and collaboration 1 (7 slots)
17:45-18:45	Posters session and kiosques – Foyer				

Tuesday may. 7

Timeslot	Speaker ready room (3rd floor)				
7:00-8:30	Breakfast served at Level 2 Jean-Paul Lemieux				
	Suzor-Côté Ballroom 1	Krieghoff Ballroom 2	Borduas Ballroom 3	Leduc-Fortin	Pilot
8:30-9:30	Plenary 3: Carole-Anne Gillis				
9:30-10:15	Break	Break	Break	Break	Break
10:15-12:15	Session 16: Understanding and managing aquatic habitats (8 slots)	Session 17: Environmental flows and aquatic organisms (8 slots)	Session 18: Integrating fish behavior in fish passage and exclusion (8 slots)	Session 19: Man-made & natural barriers (8 slots)	Session 20: Fish passage: opportunities for funding and collaboration 2 (8 slots)
12:15-13:45	Lunch served at Level 2 Jean-Paul Lemieux				
13:45-15:30	Session 21: Insights on thermal habitat (7 slots)	Session 22: Safe downstream passage (7 slots)	Session 23: Hydrodynamics in fishway designs 2 (7 slots)	Session 24: Eel migrations in regulated rivers (7 slots)	Session 25: IAHR
15:30-16:00	Break	Break	Break	Break	Break
16:00-17:45	Session 26: Restoring aquatic connectivity (7 slots)	Session 27: Advances in numerical methods 2 (7 slots)	Session 28: Vegetation in ecohydraulics (7 slots)	Session 29: Restoring aquatic organism passage (7 slots)	Session 30: TBD
17:45-18:45	ISE Business Meeting	Fish Passage SC meeting (meet in Foyer)			

Wednesday may. 8

Timeslot	Speaker ready room (3rd floor)				
7:00-8:30	Breakfast served at Level 2 Jean-Paul Lemieux				
	Suzor-Côté Ballroom 1	Krieghoff Ballroom 2	Borduas Ballroom 3	Leduc-Fortin	Pilot
8:30-9:30	Plenary 4: Theodore Castro Santos				
9:30-10:15	Break	Break	Break	Break	Break
10:15-12:15	Session 31: Working across the riverscape (8 slots)	Session 32: Innovative fish passage designs (8 slots)	Session 33: Fishway monitoring & evaluation 1 (8 slots)	Session 34: Fish locomotion in unsteady flow (8 slots)	Session 35: Modelling aquatic habitats (8 slots)
12:15-12:45	Get bagged lunch (Level 2 Jean-Paul Lemieux) and find where your tour leave from (Lobby)				
12:45~(16:00-17:00)	Visits and activities				
17:00-18:00	Free time				
19:00-22:30	Banquet (bar open at 18:00)				

Timeslot	Speaker ready room (3rd floor)				
7:00-8:30	Breakfast served at Level 2 Jean-Paul Lemieux				
	Suzor-Côté Ballroom 1	Krieghoff Ballroom 2	Borduas Ballroom 3	Leduc-Fortin	Pilot
8:30-10:30	Session 36: Aquatic habitat modelling and management (8 slots)			Session 37: Optimizing fishway designs (8 slots)	Session 38: Aquatic Habitat quality (8 slots)
10:30-11:00	Break	Break	Break	Break	Break
11:00-12:15	Session 39: Fishway monitoring & evaluation 2 (5 slots)			Session 40: Agricultural & urban habitats stream restoration (5 slots)	Session 41: Hydropeaking ecological impacts (5 slots)

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May 5 (Sunday) Room/hours	
INRS	
9:00-16:30	Dam removal
9:00-16:30	Nature-like fishway design
9:00-16:00	PIT-tag
10:00-16:00	DYI Electronics
12:30-16:30	EcoEnet
13:00-16:00	MesoHABSIM
Concorde	
17:30-19:30	**Registration desk - Foyer**
18:00-20:00	**Ice-Breaker - Foyer**

May 6 (Monday) Room/hours		
6:30-8:00	**Breakfast served at Level 2 Jean-Paul Lemieux**	
7:00-8:00	**Registration desk - Foyer**	
8:15-10:30	**Opening Ceremony - Ballrooms** **Plenary 1. Steve Cooke: Can ecohydraulics help to address the freshwater biodiversity crisis?** **Plenary 2. Marianne Bachand: Dealing with a flood of data by modelling the ecosystem response to water regulations in Canada's large water bodies**	
10:30-11:15	**Break - Foyer**	
Suzor-Côté Ballroom 1 **May 6**	**Session 1: Hydropeaking ecological impacts**	**Chairs: Davide Vanzo**
11:15	Hervé CAPRA	Quantifying the impacts of hydropeaking on fish stranding and habitat selection INRAE herve.capra@inrae.fr Clarisse Judes, INRAE, UR RiverLy, Lyon-Villeurbanne, France, EDF R&D LNHE - Laboratoire National d'Hydraulique et Environnement, Chatou, France, HYNES team (INRAE-EDF) E&D), Chatou, France; Flora Insulaire, EDF R&D LNHE - Laboratoire National d'Hydraulique et Environnement, Chatou, France; Véronique Gouraud, EDF R&D LNHE - Laboratoire National d'Hydraulique et Environnement, Chatou, France, HYNES team (INRAE-EDF E&D), Chatou, France; Agnes Barillier, EDF CIH, Savoie Technolac, La Motte Servolex, France; Amael Paillex, ECOTEC Environment SA, Geneva, Switzerland; Hervé Pella, INRAE, UR RiverLy, Lyon-Villeurbanne, France; Franck Cattanéo, HEPIA – University of Applied Sciences and Arts Western Switzerland, Jussy, Switzerland; Nicolas Lamouroux, INRAE, UR RiverLy, Lyon-Villeurbanne, France Hydropeaking induce rapid artificial flow variations, highly variable velocities, drift and stranding risks for aquatic organisms. In the context of a regulated river

		with quasi-natural shorelines, the Ain River, France, our goal was to identify how the combination of hydropeak characteristics and river morphology could influence fish stranding and microhabitat selection. We used an extensive dataset of fish stranding observations collected over three years in spring at 48 stations along a 50 km-long river reach. We aimed to characterize stranding events and their associated fish assemblages, and to identify the spatial and temporal determinants of stranding. We described each decreasing event after which stranding observations were conducted and the history preceding the decreasing event. We found that the occurrence of morphological microstructures of the riverbed, mainly scour pools, was the main factor explaining fish stranding. Low flow ranges (low peak flow, low base flow) occurring after periods without hydropeaks induced mainly “salmonid” and “super-stranding” events, while other flow ranges induced regular stranding events. Salmonids were particularly subject to stranding at the beginning of the sampling period. To weight the relative effects of past and present hydraulic conditions on microhabitat selection, we combined extensive fish sampling in 1180 microhabitats (507 sampled by electrofishing, 673 by snorkeling) at various discharge rates. We also used a calibrated 2D hydrodynamic model for identifying microhabitats dewatering (drying during > 10h) or with high-velocity conditions (> 1.3 m s-1 during > 10h). Fish responses were different between a “bank” guild selecting dewatering microhabitats and a “midstream” guild avoiding them. Contrarily to invertebrates, selection of present hydraulics by fish was similar to that observed in rivers without hydropeaking. Overall, past hydraulics influenced microhabitat selection, with stronger effects of dewatering than of velocities. However, high past velocities forced fish to move."
11:30	Joël Ronald Wittmann	Validation of the Fish Escaping Routes Model to Quantify Fish Stranding Risk in Rapid Flow Alteration Benjamin Berger, Kraftwerke Oberhasli AG, Matthias Meyer; Kraftwerke Oberhasli AG, Davide Vanzo, ETH Zurich; Steffen Schweizer, Kraftwerke Oberhasli AG; Roman Stocker, ETH Zurich; Luiz G. M. Silva, ETH Zurich Rapidly changing flow conditions in rivers endanger aquatic organisms. Especially the early life-stages of fish may struggle to follow the associated spatial shift in habitat, potentially leading to stranding or drift. The Fish Escaping Routes (FiER) modelling tool quantifies stranding and drifting risk in rapid flow alteration. FiER identifies areas of increased risk and aggregates them on the reach scale using the Weighted Habitat Loss (WHL) indicator. The WHL indicator ranges from 0 (no risk) to 1 (high risk). In this study FiER is validated to quantify stranding risk. The validation uses data from 39 stranding experiments conducted under controlled settings in an Alpine river in Switzerland. In each experiment 50 wild brown trout larvae (18–52mm) were released and acclimatized to a confined cage. After acclimatization, flow was reduced at vertical ramping rates of 0.02 – 4.18 cm/min, drying most of the cage area. The individuals’ stranding location and total number of stranded larvae are used to validate FiER. During the validation three different levels of detail are assessed. On the first level, FiER’s ability to quantify stranding risk at the reach scale is tested by comparing observed stranding rates to the computed WHL indicator. The strength of the correlation between WHL and observed stranding rates is used to evaluate model performance. The second level computes the distances from the initial shoreline of observed and modelled stranding locations. Comparing the distributions of the computed distances assesses how well FiER predicts stranding in 1D. On the third level, FiER’s ability to predict stranding in 2D is evaluated by computing the spatial correlation between the observed and modelled stranding locations. The validated FiER model allows refinement of population models by providing information on losses; localizing drift entry and stranding; and evaluating impacts of alterations to flow regime and morphology on recruitment.
11:45	Bryan Bozeman	The ecological effects of sub-daily flow variability on riverine fishes: a systematic review Oak Ridge National Laboratory bozemanbb@ornl.gov Paul Matson (Oak Ridge National Laboratory); Brenda Pracheil (Pacific Northwest National Laboratory) The contribution of renewable energy to the global energy portfolio is increasing. The flexibility of hydropower to support increased integration of intermittent renewable energy production such as solar and wind makes it an attractive option for power producers responding to grid demands for electricity on a short timescale. Operating hydropower dams to respond to real-time energy market

		conditions can result in rapid and abnormal fluctuations in downstream flow, called hydropeaking. Hydropeaking alters the timing, magnitude, and rate of change of natural flow regimes by decoupling seasonal climate and flow patterns and rapidly changing river discharge via pulses of water from upstream reservoirs. Consequently, hydropeaking can affect wetted width, temperature, habitat quality and availability, and other biotic and abiotic river characteristics downstream of hydropower facilities. In this systematic review, we summarize and synthesize the growing body of literature on the ecological effects of sub-daily flow variability on riverine fishes associated with hydroelectric power production. Specifically, we characterize the magnitude and direction of the suite of reported impacts of hydropeaking on fish and the techniques and metrics used to assess these impacts. We also identify research opportunities to address knowledge gaps and explore emergent dynamics. Findings from this review will help illuminate the generality of hydropeaking impacts on fish and inform hydropower operation strategies that balance flexible hydropower production with downstream ecosystem integrity.
12:00	Mónica Basilio Hazas	Hydropeaking indicators for groundwater systems Technical University of Munich monica.basilio@tum.de Giorgia Marcolini, Technical University of Munich; Barbara Wohlmuth, Technical University of Munich; Gabriele Chiogna, Technical University of Munich Hydropeaking indicators are commonly used to evaluate the impacts of hydropower production in the downstream river and the riverine ecosystem, and their application has been helpful in the development and evaluation of mitigation strategies. While the indicators are often based on the characteristics of the river stage and discharge fluctuations, surface water-groundwater (SW-GW) interactions have received less attention. However, aquifers should also be considered when assessing the impacts of hydropeaking. On the one hand, hydropeaking propagates into the groundwater at different spatio-temporal scales; on the other, fluctuations in the groundwater can have consequences for the critical zone, and for mixing processes in the subsurface, including at the interface between the saturated and the unsaturated zone. In this work, we propose four different metrics to assess the impacts of hydropeaking in the groundwater. For this, we consider field data of an alpine aquifer traversed by two regulated rivers. We analyse groundwater head time series employing wavelet techniques and apply the proposed indicators to classify the stress level in the aquifer at each monitoring well as weak, moderate and high. Our results provide experimental evidence of the propagation of hydropeaking on groundwater bodies, and highlight the need to include aquifers in the ecohydrological analysis of hydropeaking. We expect that in the future, the proposed indicators can be related to biogeochemical processes in the aquifer and serve as a proxy to quantify the impacts of hydropeaking in aquifer ecosystems.
12:15	Philippe Baran	Assessing morphoecological impacts due to hydropeaking in the Rhone-Mediterranean and Corsica river basins ECOGEA philippe.bara@ecogea.fr Terrier Benoit, Agence de l'eau Rhône-Méditerranée Corse; Malavoi Jean-René, Agence de l'eau Rhône-Méditerranée Corse In 2017, a project was carried out to assess the morphoecological risks due to hydropeaking on the Rhone-Mediterranean and Corsica river basins. The results highlighted that 570km out of the 1230km of the rivers that were studied exhibit severe morphoecological risks. A sequential approach has since been developed to quantify and rank the actual impacts due to hydropeaking, to set up mitigation objectives and to recommend the appropriate mitigation measures. We propose to describe the first stage of this approach, which aims to quantify and rank the morphoecological impacts using the causal chain. 5 categories of morphoecological impacts have been identified: • The impacts of substrate mobility with a focus on the mobility of substrate on spawning sites used by lithophilic fish; • The impacts on habitat taking into account the areas of habitat suitable for the various stages of fish life cycle • The impacts on the variations of this habitat • The impacts related to dewatering and rewatering processes (spawning sites and trapping and standing of fish) • The impacts of on fish passages

		For each category of impacts, several descriptors and quantification methods are proposed. Those methods are essentially based on coupling the hydraulic modelling of study sites and the preferenda of various stages of fish life cycle. An analysis of the impact severity has been developed using threshold values for the descriptors. The approach combines the intensity of hydropeaks (maximum peak flow, amplitude, gradient, duration) and the frequency of the event in relation to a given period corresponding to the biological cycle of fish species. Matrixes to assess the severity of impacts are provided as well as a synthetic analysis to help rank the impacts. This sequential approach aims to identify the morphoecological impacts of hydropeaking, to rank them and then to define and implement the most efficient mitigation measures.
Krieghoff Ballroom 2 May 6	**Session 2: Recent advances in fish tracking techniques**	**Chairs: Adrian Jordaan**
11:15	Jean-Francois Senecal	Observation of Sturgeons Habitat Use in relation to Ecohydrological Features and Ship Cooccurrences ISFORT-UQO senecal.jean-francois.3@courrier.uqam.ca Clément Chion ISFORT-UQO; Angélique Dupuch ISFORT-UQO; Dominic Lagrois ISFORT-UQO; Marc Mingelbier MELCCFP Atlantic Sturgeons (*Acipenser oxyrinchus*) habitat use is known to be influenced by biological factors (e.g. season, age) and ecohydrological ones (e.g. water temperature, current speed, substrate). However, how these factors influence fine-scale habitat use with and without the disturbance brought by anthropogenic sound is currently unknown. Previous research has shown that heavy industrial activity such as dredging does not prevent or hinder migration to spawning area, but shorter-term negative effects on daily habitat use could still be possible with less intensive or shorter duration disturbances. We investigated how merchant ship transit in the St-Lawrence river might influence fine scale habitat use in comparison to when there are no such ship-fish cooccurrences using an extensive telemetry network. Our results show that sturgeons cease their activity for longer periods of time following ship transits than when there are no cooccurrences. Higher than expected signal loss of the telemetry signals could happen even when ships were several km from the sturgeons locations. We show that this signal loss is not due to interference from incoming ship noise. We also present sturgeons fine scale habitat use in relation to ecohydrological features with and without ship cooccurrence.
11:30	Ianina Kopecki	A novel method to calculate 2D acoustic telemetry tracks: application example in high noise environment ianina@kopecki.net Pieterjan Verhelst, Research Institute for Nature and Forest (INBO), Brussels, Belgium; Jelger Elings, University Ghent, Ghent, Belgium; Ine Pauwels, Research Institute for Nature and Forest (INBO), Brussels, Belgium The advances in telemetry nowadays allow to position fish at a high spatio-temporal accuracy when detection stations are placed in a grid (i.e., 2D telemetry). Yet, the high spatial accuracy needed when studying animal behaviour at such fine-scale temporal resolutions is not always reached. Most available post-processing software for acoustic telemetry can be expensive or even black boxes. In addition, the accuracy of determining fish positions is not always expressed in meters, but rather in a complicated metric which makes interpretation difficult. In this work we demonstrate the results of a new intuitive algorithm for processing 2D acoustic telemetry data. We illustrate the algorithm with a case study using five hydrophones placed near the outflow of a small hydropower station. Position accuracy estimations were verified with GPS test tracks. To eliminate a priori impossible transmitter positions in the dry areas, the potential area is restricted to a wetted surface of a river. After time synchronization of all hydrophones, transmitter positions are found by iterating over grid cells covering the study area. The true position of a transmitter is determined using the time-of-arrival (TOA) of a detection on at least three hydrophones. The method enables the estimation of transmitter locations with an accuracy comparable to that of the commercial InnovaSea system (VPS: Vemco Positioning System), but with fewer outliers as the algorithm is bounded by river edges. We show that the performance of the receiver array decreases rapidly as the transmitter moves outside the enclosing receiver polygon. The accuracy is

		given in meters, thus allowing to filter the obtained positions individually based on specific study requirements. Therefore, we think this method will benefit many fish ecologists in their analysis of 2D telemetry networks.
11:45	Véronique Dubos	Oviduct tags and fine-scale acoustic telemetry can reveal timing, location and behavior of spawning in two Arctic salmonids Université Laval veronique.dubos.1@ulaval.ca Les N. Harris, Fisheries and Oceans Canada; Richard Ekpakohak, Elder and Cambridge Bay Resident; Brendan K. Malley, Fisheries and Oceans Canada Matthew J.H. Gilbert, University of Alaska; Nathan B. Furey, University of New Hampshire; Jean-Sébastien Moore, Université Laval Understanding the reproductive ecology of fish is central to the management of their populations, but can be challenging, particularly in remote locations. This is the case for Arctic char (*Salvelinus alpinus*) and lake trout (*Salvelinus namaycush*) in Arctic regions, where they are important subsistence species for Inuit communities. To study spatiotemporal aspects of spawning in Arctic char and lake trout in two lakes near Ikaluktutiak (Cambridge Bay, Nunavut, Canada), we used arrays of acoustic receivers (VPS, Vemco positioning system) to track fish equipped with acoustic transmitters inserted in fish oviducts in conjunction with conventional abdominal tags. Six of the oviduct tags were shed during inferred spawning time and allowed to locate spawning sites and characterize their depths. Lake trout spawned a month earlier than Arctic char and the spawning timing of both species could be related to variation in water temperature and hatching date. Pairing the oviduct tags with abdominal tags highlighted that anadromous Arctic char remained close to their spawning site for months during egg incubation, a behaviour not yet documented for this species. The similarity in behavior also allowed us to infer the spawning location of some anadromous Arctic char equipped with abdominal tags, but not implanted with oviduct tags. The inferred spawning lake trout showed no protective behaviour towards the eggs post-spawning. Using oviduct tags in combination with abdominal tags opens the way to applications in the conservation and protection of spawning grounds for fish species whose reproduction sites and timing are not well understood, and this is especially the case in geographic locations where direct observations are logistically difficult.
12:00	Daniel Deng	Next-Generation Miniature Transmitter Development for Fish Passage Monitoring Pacific Northwest National Laboratory zhiqun.deng@pnnl.gov Huidong Li , Pacific Northwest National Laboratory; Jun Lu, Pacific Northwest National Laboratory; Bingbin Wu, Pacific Northwest National Laboratory; Jayson J Martinez, Pacific Northwest National Laboratory; Jie Xiao, Pacific Northwest National Laboratory; Robert P Mueller, Pacific Northwest National Laboratory; Katherine A Deters, Pacific Northwest National Laboratory; Stephanie A Liss Larson, Pacific Northwest National Laboratory American shad (*Alosa sapidissima*) is a migratory fish native to a large range across the East Coast of the US. In many rivers where shad are present, they must pass upstream and downstream of hydropower facilities multiple times to complete their life cycle. American shad are an economically valuable fishery, but their populations have been declining throughout their historic range. More than 100 US hydropower facilities with a total capacity of >4 GW will have expiring Federal Energy Regulatory Commission (FERC) licenses over the next 10 years and are within the native range of American shad. As a part of the FERC hydropower license process, fish passage and mitigation measures for American shad will be routinely and rigorously reviewed by federal agencies and stakeholders. PNNL developed a revolutionary acoustic transmitter that can be used to study the behavior and survival of sensitive species such as juvenile American shad to inform hydropower mitigation and species management. It is 8.0 mm in length and 2.0 mm in diameter, weighs 0.05 gram in air and 0.025 gram in water, and lasts about 30 days if it transmits every five seconds. We are also evaluating the feasibility of applying this technology to study delta smelt in collaboration with University of California at Davis and ICF International. The ability to implant acoustic transmitters and track the movements of species and life stages of fish that have never been studied before at this level of detail would greatly advance our understanding of fish migration timing and behaviors, habitat use, fishway use and performance, and survival rates at hydropower

		facilities – resulting in more informed management decisions regarding new and existing hydroelectric facilities and better designs of new hydropower systems that minimize or avoid environmental impacts.
12:15	Daniel Deng	Lab-on-a-Fish Pacific Northwest National Laboratory Brett Pflugrath, Pacific Northwest National Laboratory; Wonseop Hwang, Pacific Northwest National Laboratory; Huidong Li, Pacific Northwest National Laboratory; Jayson Martinez, Pacific Northwest National Laboratory; Daniel Deng, Pacific Northwest National Laboratory Biotelemetry tag - a recording or transmitting tags to collect and information of fish physiology, physics or environmental parameters - is an emerging technology that provides an unprecedented capability into biological processes and leads to otherwise unattainable discoveries. Current biotelemetry tags are constrained to limited types of measurands all integrated on the single device as well as relatively large dimension and weight. We report the first-ever biotelemetry tag (Lab-on-a-Fish) that can measures in situ simultaneously the electrocardiogram and electromyogram, the two dominant physiological parameters of the fish in literature as well as its behavior (motion sensor) and environmental parameters (temperature, pressure, and magnetic sensor) with a weight of only 2.4 g and a dimension of 5.5 mm × 6.5 mm × 33 mm. The developed working prototype is capable of transmitting the collected and on-board processed data in real-time as well as storing the raw data using on-board Flash memory for locations that are challenging for acoustic communications or for complex post data processing. Because the Lab-on-a-Fish can provide the 3D locations of the tagged animal, the proposed device can also act as an autonomous mobile sensor package that can associate sensor readings with specific river locations. The tag's ability to store and transmit historical sensor data on both environmental parameters and the tagged animals' bioactivity will provide valuable information for studying fish behavior and accelerating hydropower deployment.
Borduas Ballroom 3 May 6	**Session 3: Environmental flows**	**Chairs: Francisco Martinez Capel**
11:15	Mathieu Roy	Integrated Social Economic Environmental (ISEE) system to evaluate flood mitigation measures: A Case study of the Lake Champlain - Richelieu River basin. Environment and Climate Change Canada mathieu.roy@ec.gc.ca Mathieu L. Roy, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Marianne Bachand, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Antoine Maranda, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Rémi Gosselin, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Dominic Thériault, Hydrodynamic and Ecohydraulic Section, Environment and climate Change Canada; Gabriel Poirier, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Olivier Champoux, Hydrodynamic and Ecohydraulic Section, Environment and climate change Canada; Nicolas Fortin, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Mouna Doghri, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Marie-France Julien, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Khalid Oubennaceur, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada; Jean Morin, Hydrodynamic and Ecohydraulic Section, Environment and Climate Change Canada The ISEE system is an integrated modeling framework designed to address complex water resource management problems involving concurrent socio-economic and environmental objectives. The ISEE system incorporates basin-scale water balance inputs, hydrodynamic simulation datasets, and a high-precision digital elevation model to simulate flooding and estimate the spatio-temporal impacts of changes in the water level regime. Impacts are quantified using a selection of performance indicators based on the relationship between variations in different physical variables (e.g. water level) and relevant interests. The ISEE system was applied to the Lake Champlain – Richelieu River transboundary basin to evaluate different flood mitigation measures. Impacts of

		changes to the water level regime were estimated by comparing flood mitigation scenarios to a baseline over a 93-year period. Simulations showed that a mitigation measure combining a submerged weir and a selective excavation at a control reach of the Richelieu River provided the greatest flood damage reduction, while having minor positive environmental impacts. Specifically, performance indicators assessing impacts on the residential, commercial, industrial, and agricultural sectors indicate a 36% reduction in economic damage. In addition, this alternative could provide, among other things, more suitable depths for northern pike spawning and migratory waterfowl, could be beneficial to the viability of muskrat winter huts, and could tend to improve optimal nesting habitat for the least bittern, a small and endangered heron. Furthermore, this flood mitigation alternative could result in a slight landward shift in the distribution of wetland classes in the Upper Richelieu River, with an increase in marsh and swamp areas. This case study demonstrates the effectiveness of this integrated modeling approach in highlighting socio-economic and environmental trade-offs and providing clear guidance to decision makers, stakeholders and the general public in evaluating water management policies.
11:30	André St-Hilaire	Environmental flows in Québec: Planning the next research priorities andre.st-hilaire@inrs.ca Laureline Berthot UQAM; Marie Laroque UQAM; Habiba Ferchichi INRS The Québec Department of Environment and Fight Against Climate Change has the responsibility to regulate water withdrawals in Québec. Over the course of the last decade, a considerable effort has been made to improve the province's accounting of those water withdrawals. At the same time, research conducted in southern Québec has shown that hydrological approaches for environmental flow (e-flow) determination in the province need to be regionally adapted if they are to be used. Additional information on wetted perimeters and river temperature have also shown to be useful to define minimum flow requirements. An initiative is underway in Québec to rethink guidelines and possibly regulations related to e-flows. A five year project is in its planning phase. Recent research results and a path forward will be presented.
11:45	Martina Bussettini	Implementation of ecological flows in Europe Istituto Superiore per la Protezione e la Ricerca Ambientale martina.bussettini@isprambiente.it Paolo Vezza, Politecnico di Torino; Wouter Van De Bund, European Commission Joint Research Center The EU Water Framework Directive (WFD) provides a framework to protect and sustainably use European water bodies and to mitigate the effects of drought and floods. The WFD dictates that all European water bodies achieve good ecological status, through integrated, sustainable, inclusive and adaptive six-year River Basin management planning. The first review of the River Basin Management Plans concluded that water withdrawals and abstraction were a major cause for EU rivers failing to reach good ecological status and more effort is needed to implement of measures to restore more natural flow regimes in EU rivers. In 2014, the European Commission and Member States (MS) issued a Technical guidance clarifying the key concepts and requirements for implementation. The guidance also included an overview of the existing approaches of ecological flows (e-flows) in Europe in terms of coverage and methodologies in use. A compilation of case studies demonstrated a lack of consistency in the methodologies used. Hydrological methods and, within those, minimum flow approaches were found to be most common. In the last decade, considerable progress was made at the EU level to get a common understanding of the role of hydromorphological processes in sustaining ecosystems and the provision of their services. The interplay of sediments and water in shaping riverine habitat was also better recognized and accounted for in river basin planning. Therefore, after almost ten years, a new survey was carried out to evaluate progresses in the e-flows implementation and whether or how EU MS had enhanced their methodological approaches. The survey touched upon several aspects and scales of e-flows implementation and resulted in a comprehensive review of the current state-of-the-art. In this paper, we illustrate the results of this review and the progress made, followed by conclusions are made on how to complete the transition to actual ecological flows implementation.

12:00	Yangwen Jia	Quantifying Impacts of Groundwater Exploitation on Baseflows and Environmental Flows of the Weihe River Using the WEP-L Model State Key Laboratory of Simulation and Regulation of Water Cycle in River Basin, China Institute of Water Resources and Hydropower Research (IWHR) jiayw@iwhr.com Cunwen Niu, State Key Laboratory of Simulation and Regulation of Water Cycle in River Basin, China Institute of Water Resources and Hydropower Research (IWHR); Chunfeng Hao, State Key Laboratory of Simulation and Regulation of Water Cycle in River Basin, China Institute of Water Resources and Hydropower Research (IWHR); Dongdong Wang, Department of Water Resources, China Institute of Water Resources and Hydropower Research (IWHR) Quantifying impacts of intensive groundwater exploitation on river baseflows is vital to the determination of river environmental flows in water-stressed river basins in the anthropocence due to possible changes of discharge and recharge relationships between groundwater and river water. In addition, the present relationship between groundwater and river water is not suitable to adopt for the determination of river environmental flows due to the requirement of groundwater overexploitation treatment for the restoration of groundwater functions. To quantify the interactions between groundwater and river water under various groundwater exploitation scenarios, a physically-based hydrological model may be adopted. In this study, the Weihe River Basin (135000 km2), the first-level subbasin of the Yellow River Basin in China, is selected as a case study area. Intensive groundwater exploitation in plain area (around 2.5 billion m3/a in recent years, accounting for 76% of groundwater resources) and overexploitation in some local areas caused the baseflow reduction of the Weihe river. The WEP-L (water and energy transfer processes in large river basins) model, a physically-based distributed hydrological model is developed and validated by observed river flows and groundwater levels, and then applied to quantify the interactions between groundwater and river water under various groundwater exploitation scenarios in the Weihe River Basin in the past 40 years (1980-2019). The study reveals: (1) the baseflow discharge of groundwater into the Weihe river was decreased with some fluctuation in the past 40 years under the combined impacts of precipitation variation and increasing groundwater exploitation; (2) the environmental flow at the downstream Huaxian section with the implementation of local groundwater overexploitation treatment (balancing groundwater exploitation and recharge) is 17% larger than the result based on the present status of groundwater exploitation; (3) the sensitive factors of groundwater discharge into river are identified as groundwater exploitation, precipitation and surface water irrigation. Some suggestions are put forwarded to enhance the environmental flow management and groundwater restoration in the study area.
12:15	Claudio Consuegra-Martinez	Practical study of environmental low determination for the Guayabero River and Quebrada La Reserva located in the AMEM, Colombia Lasalle NHC cmartinez@lasallenhc.com The Área de Manejo Especial de La Macarena (AMEM) in Colombia, is a rich territory of natural resources formed by four national parks, three Integrated Management Districts for natural resources, a hand of forest reserves, first nation territories and other lands of environmental importance. In this practical study, the environmental flow of two watercourses located in the AMEM, Quebrada La Reserva and Guayabero River, were calculated using two approaches: hydrological (IDEAM and flow-duration curve indices) and hydraulic (wetted perimeter). For the Guayabero River, the IDEAM method, which represents a fixed percentage of minimum monthly flow, was calculated using mean flow data of two hydrometric stations. The flow data was likewise used to compute a flow-duration curve to establish the 50 %, 90 % and 95 % percentiles and hence determine the environmental flow. Lastly, the information of the hydrometric stations (flow, water levels and cross sections) was used to calculate the environmental flow using the weted perimeter method. In the case of the Quebrada La Reserva, which is a tributary of the Guayabero River, the same hydrological methods (IDEAM and flow-duration curve indices) were used by means of a flow transfer supported by a morphometric watershed characterization of 5 watercourses. For the weted perimeter method, 2 km of bathymetric data were used to estimate the environmental flow using a 1D HEC-RAS numerical model. With the environmental flow estimations, some considerations are given on what should be the drivers when establishing flow

		requirements from a conservative, protective, aesthetic, normative, water need or water quality perspective.
Leduc-Fortin May 6	**Session 4: Optimizing fishway designs**	**Chairs: Marc Mingelbier**
11:15	Sylvie Tomanova	Macroroughness block ramp: an efficient solution to reduce the impact of weirs on fish circulation Office français de la biodiversité sylvie.tomanova@ofb.gouv.fr Sylvie Tomanova, Pôle R&D écohydraulique, Office français de la biodiversité ; Dominique Courret, Pôle R&D écohydraulique, Office français de la biodiversité; Sylvain Richard, Pôle R&D écohydraulique, Office français de la biodiversité; Olivier Mercier, Pôle R&D écohydraulique, Office français de la biodiversité; Axel Guillemin, Pôle R&D écohydraulique; Mathilde Labedan, Pôle R&D écohydraulique; Pierre Sagnes, Pôle R&D écohydraulique, Office français de la biodiversité Macroroughness ramps (with a rough bed and protruding blocks evenly distributed in staggered rows) are nature-like fish passes offering a wide range of flow conditions, and can be efficient devices to mitigate the impact of weirs on fish movements in regulated rivers. Their efficiency in situ has however not been demonstrated until now for holobiotic fish community. Using Passive Integrated Transponder (PIT) telemetry of 963 individuals belonging to 13 fish species, we conducted a two-year study on a macroroughness ramp in order to: 1) quantify its attraction efficiency (Ef), passage Ef and overall Ef, along with passage times; and 2) assess the influence of species, fish size and environmental conditions (river discharge and temperature) on these efficiency estimates. In total, 11 from 13 tagged species were detected downstream of the dam equipped with the ramp, and none was blocked in its upstream progression. Depending on the analytical approach, the ramp attraction Ef ranged between 65.5 – 52.9%, the ramp passage Ef between 81.8 - 77% and the overall Ef between 53.6 – 41.6%. Fish with a total length of between 70 and 451 mm crossed the ramp, in a generally short time. In comparison with available efficiency results on other fish passage devices, the studied macroroughness ramp ranks among the most efficient ones and reduces efficiently the impact of weirs on fish circulation. Our study also allowed to better assess the timing and migration rate of different freshwater fish species, poorly documented until now.
11:30	Martin Hunt	Redesign and Rehabilitation of Fish Passage Systems of the Churchill Weir Manitoba Hydro mhunt@hydro.mb.ca The Churchill weir is a rockfill control structure located at Mosquito Point, approximately 10 km upstream of the Town of Churchill, Manitoba, Canada. It was commissioned as a part of Churchill River Water Level Enhancement Project to revitalize the river area upstream of Churchill, thereby improving accessibility to the river above the weir, enhancing fish habitat, and ensuring a potable water supply for the town of Churchill. The original design of the Churchill Weir incorporated two rock ramp fishways. One near the center of the wide V-notch portion of the weir and a second located within a bridge crossing on a side channel of the river within the non-overflow section of the weir. The fishways were designed to facilitate the upstream fish passage with Lake Cisco, juvenile Whitefish, and Northern Pike as the target species. Since its construction the condition of the weir has deteriorated as a result of reoccurring ice damage and high flows. In particular the record spring 2017 flood caused significant damage to the weir and necessitated the rehabilitation, redesign, and reconstruction of major portions of the weir and the entirety of both fishways. This presentation will provide an overview of the assessment and redesign of the Churchill Weir fish passage systems. For the mainstem fishway two dimensional hydraulic modeling was used to assess connectivity under low flows and determine the feasibility of utilizing the existing west side breaches to establish a new permanent naturalized fishway through the breaches. For the Goose Creek Fishway Bridge two dimensional hydraulic models were used to design the replacement structure and confirm suitable fish passage conditions while at the same time protecting the structure from the extreme ice conditions of the Churchill River.
11:45	Arif Wibowo	Improving fishway design through comprehensive biodiversity survey, a case study on irrigation weir at the Cibareno River, Java, Indonesia National Research and Innovation Agency

		wibowo@daad-alumni.de Kurniawan, Research Center for Conservation of Marine and Inland Water Resources; Satoshi Nagai, Japan Fisheries Research and Education Agency Lee J. Baumgartner, Gulbali Institute for Agriculture, Water and Environment; Meaghan L. Rourke, New South Wales Department of Primary Industries The contribution of renewable energy to the global energy portfolio is increasing. The flexibility of hydropower to support increased integration of intermittent renewable energy production such as solar and wind makes it an attractive option for power producers responding to grid demands for electricity on a short timescale. Operating hydropower dams to respond to real-time energy market conditions can result in rapid and abnormal fluctuations in downstream flow, called hydropeaking. Hydropeaking alters the timing, magnitude, and rate of change of natural flow regimes by decoupling seasonal climate and flow patterns and rapidly changing river discharge via pulses of water from upstream reservoirs. Consequently, hydropeaking can affect wetted width, temperature, habitat quality and availability, and other biotic and abiotic river characteristics downstream of hydropower facilities. In this systematic review, we summarize and synthesize the growing body of literature on the ecological effects of sub-daily flow variability on riverine fishes associated with hydroelectric power production. Specifically, we characterize the magnitude and direction of the suite of reported impacts of hydropeaking on fish and the techniques and metrics used to assess these impacts. We also identify research opportunities to address knowledge gaps and explore emergent dynamics. Findings from this review will help illuminate the generality of hydropeaking impacts on fish and inform hydropower operation strategies that balance flexible hydropower production with downstream ecosystem integrity.
12:00	Marq Redeker	How to best serve Sturgeon Steve? Design of fishways at the Iron Gate Dams on the River Danube using fish telemetry and CFD modeling
Pilot May 6	**Session 5: Habitat restoration**	**Chairs: Eva Enders**
11:15	Line Sundt-Hansen	Cross-disciplinary approach to assess bottlenecks for ecological condition of fish and aquatic invertebrates and recreation in a regulated river Norwegian Institute for Nature Research line.sundt-hansen@nina.no Torbjørn Forseth, Norwegian Institute of Nature Research; Frode Fossøy, Norwegian Institute of Nature Research; Markus Majaneva (NINA), Norwegian Institute of Nature Research; Terje Bongaard, Norwegian Institute of Nature Research; Ingerid Julie Hagen, Norwegian Institute of Nature Research; Berit Köhler B., Norwegian Institute of Nature Research; Rolf Sivertsgård , Norwegian Institute of Nature Research; Helge Skoglund, NORCE; Håkon Sundt, NTNU/Sintef Energy We expand the environmental design concept, originally developed for salmon in regulated rivers, to include other fish species, invertebrates and recreational activities. This inland river is heavily influence by hydropower, characterized by 32 weirs on a 33 km stretch. A cross-disciplinary approach was taken to investigate hydrological and morphological bottlenecks impacting both the ecosystem and recreational use of River Nea, using expertise in hydrology, ecology, genetics and social science. To assess the condition of the brown trout population, the effective number of spawning fish was calculated based on genetic analyses of juvenile trout. The invertebrates were analysed by taxonomy experts, metabarcoding and eDNA. Recreational use of river Nea was analysed using different user groups assessing aesthetic conditions related to weirs. Analysis of all data showed that the bottlenecks for brown trout and aquatic invertebrates are linked to both hydrological and habitat-related conditions. The weirs are barriers for migration and gene flow for the brown trout population, causing a fragmented and inbred population. where both the nearby lake and the river Nea are important to fulfill their life cycle. For aquatic invertebrates, the slow flowing areas created by weirs have a different community composition than the more river-like areas, and a reduced number of species overall. Thus, the multiple weirs in combination with reduced water flow because of hydro-power regulation, has had a negative impact on the ecosystem. However, people use the river and the pools created by the weirs for recreational purposes such as swimming, fishing and canoeing and is thus valuable. However, when provided information on the impact on the ecological impact of weirs, they are more positive to modifications or of weirs. To improve ecological conditions in the river we suggest removal and modifications of weirs with the aim of increasing connectivity, reestablish migration routes and reestablish unused spawning areas.

11:30	Joachim Pander	The contribution of nature-like fish passes to fish diversity and the restoration of riverine habitats Technical University of Munich joachim.pander@tum.de Juergen Geist, Technical University of Munich Dams and weirs lead to fragmentation and degradation of riverine habitats and hinder fish to freely move along riverscapes. To antagonize this loss of connectivity, fish passes were implemented to allow fish to bypass the obstacles. Fish pass designs range from rather technical solutions to nature-like construction schemes (NLF) that mimic natural rivers, yet the roles of such NLF beyond their function as migration corridor, e.g., as habitat, are poorly understood. We assessed typical NLF in the Danube catchment regarding their roles as fish habitats by electrofishing and larvae drift-nets. These data were linked to important abiotic characteristics such as water depth, current speed, substrate composition, deadwood, temperature, pH, O2, electric conductivity, and the availability of pools, riffles, runs, spawning grounds and juvenile habitats. The results clearly revealed that NLF provide important aquatic habitat for almost all life stages of riverine fish. This was particularly true for shallow habitats less than 100cm deep that are key for completion of critical life stages in riverine species, but scarce in dammed rivers across the Danube-catchment in Bavaria. Consequently, NLF had a high fish species diversity including threatened *Chondrostoma nasus*, *Barbus barbus*, *Thymallus thymallus* and *Hucho Hucho*. Depending on construction features, NLF also provided habitat for limnophilic species such as *Rhodeus amarus* or *Misgurnus fossilis* if they were connected to pond-like structures with low flow current. In conclusion, this study highlights that besides their function for fish migration, the habitat functions of NLF also need to be considered. This not only holds true for critical life stages of riverine fish, since innovative designs can largely contribute to overall fish diversity and restoration success.
11:45	Christin Kannen	Influence of the use of natural material on morphodynamics around instream structure on the example of a Triangular Pier Karlsruhe Institute of Technology Christin.Kannen@kit.edu Frank Seidel; Karlsruhe Institute of Technology; Mário J. Franca; Karlsruhe Institute of Technology Formerly, hydraulic structures in rivers had to fulfill mainly an engineering function such as foundation for bridges, maintaining a sufficient water level in navigation channels (e.g., groyne fields), fish passages at weirs and sluices. Those structures are typically made of engineering materials such as concrete, steel and big stones. With the shift of philosophy of river engineering towards ecosystem engineering the urge to use natural materials for instream structures arose in the last decades. Engineering structures made of natural materials have fundamentally different hydraulic properties in comparison with those made of classical engineering materials such as a concrete pier. This study investigates the influence of edge design, surface roughness and porosity on the morphology around instream structures on the example of a Triangular pier. Laboratory experiments with movable bed in clear-water scour conditions showed that the surface roughness is neglectable for morphodynamics. The edge design is relevant for emergent structures, where smooth edges lead to a reduction of 20 % of scour depth. The highest influence on morphodynamics is the porosity of the structure. Already with a Solid Volume Fraction of 0.77 the scour depth reduces by 51 %. This implies that habitat functions of e.g., a deep pool habitat cannot be fulfilled anymore. The study concludes with recommendations for the use of natural material for the implementation of instream structures that can be used by practitioners.
12:00	Abul Baki	Habitat complexity metrics around instream boulders in support of river restoration Clarkson University abaki@clarkson.edu Naima Reggad, Clarkson University; Amir Golpira, Northwest Hydraulic Consultants; Haitham Ghamry, Fisheries and Oceans Canada; Chris Katopodis, Katopodis Ecohydraulics Ltd. Instream boulder placement is an effective way to restore degraded streams and enhance fish habitat quality and availability by creating heterogeneous flow

		conditions. This work hypothesized that boulder placement (e.g., rock-ramp arrangement) in a stream enhances instream hydraulic complexity and hence habitat quality. This experimental study aims to evaluate the influence of boulder placement in rock-ramp arrangements on mean and turbulent-based habitat complexity metrics, such as kinetic energy gradient, modified recirculation, turbulent kinetic energy, turbulent energy dissipation rate, integral length scale, and near-bed Reynolds shear stress for multiple boulder concentrations and flow events. Based on the studied metrics, boulder placement with the highest boulder concentration ($\lambda = 8.3\%$) resulted in the greatest habitat hydraulic complexity. A set of relationships of moderate strength was proposed to predict the metrics in reaches with boulders by having information about only boulder concentration, habitat characteristic size, and reach-averaged flow characteristics. The findings offer insights into the implications of these metrics for fish habitat availability. The results of this study may help stream restoration projects that employ boulder placement techniques by providing a better understanding of interactions between boulders, hydraulic complexity, and instream habitat quality.
12:30-13:45	**Jean-Paul Lemieux**	**LUNCH (on-site)**
Suzor-Côté Ballroom 1 **May 6**	**Session 6: Fish protection at dams**	**Chairs: Sterling Watson**
13:45	John Nestler	Optimizing a Novel Fish Protection System at a Pumped-Storage Hydropower Dam Using Failure Mode and Effects Analysis Fisheries and Environmental Services john.m.nestler@gmail.com Mark A. Weiland, Four Peaks Environmental Science & Data Solutions Pumped-storage hydropower dams use reversible pump-turbines instead of conventional turbines. During periods of low power demand pump-turbines buy relatively cheap electricity to pump water from a lower reservoir to recharge an upper storage reservoir. During periods of high-power demand, when power revenues are also high, pump-turbines produce electricity like conventional turbines. Pumpback operation can cause significant fish entrainment mortality when downstream fish abundance is high and water is drawn into the pump-turbines at velocities exceeding fish swim speeds. We conducted multi-year, baseline studies before installation of four pump-turbine at the Richard B. Russell Dam on the middle Savannah River, between Georgia and South Carolina, USA. We used traditional fishery sampling gear (e.g., different kinds and scales of nets and mobile hydroacoustics sampling) to describe fish species and distributions to inform design of an initial fish protection system. Once the pump-turbines became operational, we used Failure Mode and Effects Analysis (FMEA: engineering tool to identify where and how a process fails and the effects of the failure) of data from recovery netting and fixed-aspect hydroacoustic monitoring to spot fish entrainment peaks caused by failure of the fish protection system. We identified the cause of each fish entrainment peak and then iteratively improved the fish protection system until no further peaks were encountered. The optimized fish protection system integrated behavioral (acoustic- and light-based) and structural (wedge-wire veneer screens attached to the trash racks) measures with physical alterations of the tailrace channel to modify hydraulic approach conditions. Operational restrictions further reduced entrainment during periods of maximum fish activity. Ten years of follow-up fixed-aspect hydroacoustics monitoring confirmed that high fish entrainment events encountered during initial entrainment monitoring were eliminated. We show that pumped storage operation with minimal impacts is possible even when fish are abundant if effective fish protection measures can be adopted.
14:00	John Burnett	An International Trend Toward Increased Fish Protection at Water Intakes and Diversions Intake Screens, Inc. jburnett@isi-screens.com Russell Berry, IV, Intake Screens, Inc. Water intakes and diversions are located throughout the developed world where water is abstracted for municipal water, irrigation, power generation, and other industrial purposes. These abstractions have the potential to impact early life stage through adult fish through the processes of entrainment and impingement. Recent regulatory focus on these impacts throughout the United States and internationally has led to the construction of fish protection screen system with aperture sizes as small as 0.5-mm to protect small fish eggs and larvae. This

		presentation will provide an overview of this regulatory landscape and how fish protection can be achieved through use of small aperture, low water velocity screen systems. Projects from the United States, United Kingdom, Australia and New Zealand will be discussed.
14:15	Blane Bellerud	Protocol for Estimating Downstream Survival of Diadromous Fishes at Hydroelectric Facilities NOAA Fisheries blane.bellerud@noaa.gov Bjorn Lake, NOAA Fisheries; Jeff Murphy, NOAA Fisheries; Nick Anderson, NOAA Fisheries; Melissa Jundt, NOAA Fisheries NOAA Fisheries is responsible for the stewardship of our Nation's marine fishery resources including the protection and passage of diadromous fish species during their downstream migration in freshwater habitats. Diadromous fish must complete migrations between freshwater and marine habitats to fulfill their life cycle. Safe, timely, and effective downstream passage at hydroelectric facilities is imperative to sustaining a viable commercial and recreational fishery in the U.S. The Federal Energy Regulatory Commission is obligated under the Federal Power Act and National Environmental Policy Act to consider the impacts of non-federal hydroelectric projects on diadromous fish species. Hydroelectric projects pose a significant risk to successful downstream migration by causing migratory delay, increased predation, and injury/mortality during passage. During the last century, our understanding of downstream passage and protection at hydroelectric projects has increased substantially (Pflugrath et al. 2020). While NOAA Fisheries provides comments and recommendations to the Commission for assessing the effects of hydroelectric projects on migratory fish species during the licensing process, no formal protocol or best practices document has been developed that informs study designs and incorporates lessons learned. A protocol allows for consistency of methods across projects and a more accurate quantification of project effects which leads to better outcomes for our trust species and a more sustainable hydropower industry (Algera et al. 2020). The intent of this protocol is to describe the steps necessary to adequately examine project effects on downstream passage of fish. The goal for this protocol is two-fold: (1) the development of best practices for downstream survival and passage studies that the hydroelectric industry can follow during licensing, and (2) creation of standard procedures that the Commission can use to screen study plans and findings to inform additional information requests from project proponents.
14:30	Anita Moldenhauer	(Electrified) curved bar racks for safe downstream fish passage – a promising solution to improve protection and guidance for a wide range of fish species Eidgenössische Technische Hochschule Zürich moldenhauer@vaw.baug.ethz.ch Oliver M. Selz, Swiss Federal Office for the Environment; Ismail Albayrak, Laboratory of Hydraulics, Hydrology and Glaciology; Robert M. Boes, Laboratory of Hydraulics, Hydrology and Glaciology Fish guidance structures with vertical curved bars and an adjacent bypass system represent a promising technical solution for the protection and guidance of downstream moving fish at water intakes. These "foil-shaped Curved-Bar Rack Bypass Systems" (f-CBR-BS) function as a mechanical behavioural barrier with a large bar spacing. Turbulences are created upstream of the bars leading to an avoidance reaction of approaching fish. High fish protection efficiencies (FPE) between 80 and 100 % were shown in previous laboratory tests of CBR with a clear bar spacing sb = 50 mm and an approach flow velocity of U0 = 0.5 m/s for several cyprinid species and salmon (*Salmo salar*). However, FPEs for Brown trout (Salmo trutta) were considerably lower. The present study systematically investigated an f-CBR-BS with live-fish tests of brown trout for sb = 25 mm and 50 mm and U0 = 0.15, 0.3 and 0.6 m/s. Additionally, electrification of the rack was tested. The electric field was generated by using the rack as a cathode and either placing anodes downstream or placing an anode along the flume bottom. Without electrification, the FPE was low at 43% for sb = 50 mm and U0 = 0.6 m/s, but significantly higher at 70% for sb = 25 mm. Electrification combined with sb = 50 mm significantly improved the FPE up to 76% depending on the approach flow velocity. Electrification combined with sb = 25 mm led to very good FPEs up to 100%. The present contribution will give an overview of the reactions of brown trout to combined hydraulic and electric cues at electrified bar racks. Recommendations for suitable bar spacings and type of electrification for

		f-CBR intended to guide fish to a safe bypass route will be given based on the present and previous studies on several fish species.
14:45	Joachim Bretzel	Impingement susceptibility and approach velocity responses of freshwater fish and crustacean species at a wedge-wire protection screen Charles Sturt University jbretzel@csu.edu.au Katherine Doyle, Charles Sturt University; Craig Boys, NSW Department of Primary Industries; An Vi Vu, Charles Sturt University; Robyn Watts, Charles Sturt University; Claudio Galbusera, Independent; Lee J. Baumgartner, Charles Sturt University Fish protection screens are increasingly applied to prevent fish from being removed from waterways at water diversions and intakes. Appropriate water velocities around the screen are crucial for its functionality and to avoid fish impingement. To determine suitable velocity ranges, 17 fish and two crustacean species were observed in front of a 3 mm mesh wedge-wire screen panel in a specialized flume, simulating fish screen encounters at approach velocities ranging from 0 to 0.3 m/s. Species-specific impingement susceptibility, detachment ability, and entrainment were analyzed. Velocities ≤ 0.1 m/s effectively reduced impingement and are likely suitable to protect a wide range of fish across different life stages and habitats. Higher approach velocities were considered too high for most tested fish species and resulted in impingement. Species-specific behavior played a crucial role in screen encounters and should be considered when designing screens globally to protect aquatic biota.
15 :00	Christian Haas	Protecting fish with a non linear electric field - electrical barriers as an effective measure for fish guidance at hydraulic structures I Am Hydro christian.haas@iamhydro.com Philip Thumser, I am Hydro Mathias Meyer, Kraftwerke Oberhasli AG (KWO), Department of Ecology Sabina Ziola, Prokom Systems S.A. The operation of hydraulic power plants (HPPs) and related structures necessitates innovative approaches to protect aquatic biota, particularly fish. For this purpose, electric barriers employing non-linear electric fields have proven to be an efficient and effective solution. These systems can come in a variety of setup options making them a valuable tool for local fish protection. The barriers manipulate fish behavior through non-uniform electric fields, guiding them away from hazardous zones such as turbines and intake structures, and into safe bypasses or fishways without causing harm. This study focuses on the implementation and monitoring of such electric barriers, detailing their operational mechanisms and the technologies used for monitoring and assessment. The study will provide insights on echosounder and sonar camera results as well as comparative analyses with other fish protection methods, like physical barriers and sensory deterrents, illustrate the benefits and potential limitations of electric barriers. Especially within deterring fish from entering a dead end towards a HPP and moving migratory fish towards a fish pass the NEPTUN system has been proofed to work reliable and effective. Detailed performance metrics from installations at different global sites, including case studies from Europe, North, and South America, are discussed. Results on effectiveness on various sites show results between 90.5% - 100 % fish protection. Specific case studies, such as an implementation of a NEPTUN System during the flushing of a storage lake in Switzerland, and evaluations of systems at a HPP and a water intake in Poland will be presented showing different applications and their monitoring results.
Krieghoff Ballroom 2 May 6	**Session 7: Tracking fish migrations**	**Chairs: Val Ouellet**
13:45	François Martignac	A toolbox to assess the spatio-temporal dynamics of Atlantic salmon recolonization after dam removal on the Sélune River (Normandy, France) INRAE francois.martignac@inrae.fr Emilien Lasne, DECOD (Dynamics and sustainability of ecosystems, from source to ocean), INRAE, Institut Agro, IFREMER, Rennes, France; François Martignac, DECOD (Dynamics and sustainability of ecosystems, from source to

		ocean), INRAE, Rennes, France; Erwan Quemere, DECOD (Dynamics and sustainability of ecosystems, from source to ocean), INRAE, Rennes, France Morgan Druet, U3E (Unité Expérimentale d'Ecologie et d'Ecotoxicologie Aquatiques), INRAE, OFB, Rennes, France ; Julien Tremblay, U3E (Unité Expérimentale d'Ecologie et d'Ecotoxicologie Aquatiques), INRAE, OFB, Rennes, France ; Guillaume Evanno, DECOD (Dynamics and sustainability of ecosystems, from source to ocean), INRAE, Institut Agro, IFREMER, Rennes, France; Laura Soissons, DECOD (Dynamics and sustainability of ecosystems, from source to ocean), INRAE, Institut Agro, IFREMER, Rennes, France; Laurent Beaulaton, Pole MIAME, Management of diadromous fish in their environment, OFB, INRAE, UPPA, Institut Agro, Rennes, France France; Jean-Marc Roussel, DECOD (Dynamics and sustainability of ecosystems, from source to ocean), INRAE, Institut Agro, IFREMER, Rennes, France The removal of the last impassable 16m high dam in the Sélune river (Normandy, France) in 2022 was the starting point for the recolonization of the upstream part of the catchment by diadromous fish species. A third of the watershed, which represents around 1 000 km of flowing habitats, is now accessible to these species, including the iconic Atlantic salmon, after a century's absence. Historical documents and the presence of ruins of former fisheries upstream attest for its wide distribution and abundance from the Middle Age to the 20th century. Here, we present the toolbox that has been designed as part of the Sélune scientific program to track the dynamics of Atlantic salmon recolonization. To do that, we combine traditional and modern approaches such as telemetric tracking of spawners, counts of redds, electrofishing of juveniles' habitats, eDNA and, in parallel, a long-term and continuous acoustic camera monitoring survey, which started 10 years ago. Fish tissues are also collected to further study the demography and population genetics of salmons in this area. In our presentation, we will focus on the first evidence of upstream colonisation by salmon individuals few weeks after dam removal, and proofs of reproduction in the following winter 2022-2023. We will also discuss other benefits of dam removal, including thermal regime and habitat quality in the river, to show how connectivity improvement may contribute to mitigate adverse effects of climate change on Atlantic salmon populations.
14:00	Armin Peter	Downstream migration of Atlantic salmon (Salmo salar) smolts in the Aare and Rhine Rivers in Switzerland FishConsulting GmbH apeter@fishconsulting.ch Lisa Wilmsmeier and Nils Schoelzel Atlantic salmon inhabited rivers of the Rhine River catchment in Switzerland. However due to the distinct fragmentation of the rivers, salmon populations collapsed in the year 1930. For more than 40 years, substantial efforts have been carried out for the restoration of salmon in Switzerland. Upstream migration infrastructure, habitat restoration and the reconnection of many tributaries were carried out. Switzerland also participates in an international European program for the restoration of the salmon in the Rhine River: for example, in recent years many suitable tributaries were stocked with young salmon reared in hatcheries. However, no systematic monitoring was undertaken to assess the success and emigration from stocked tributaries into the main stem Aare and Rhine Rivers. Two radio telemetry studies were carried out (Aare River in 2022, Rhine River in 2023). Salmon smolts were tagged with radio transmitters (0.3 and 0.57 g) and tracked with fixed stations during the emigration from rearing streams into the Aare and Rhine River. Numbers of emigrating smolts and migration distances in the Aare and Rhine River were analyzed. Time of the emigration, migration speed and success/survival were evaluated for two different groups: for semi-wild and for hatchery salmon. In the Aare River salmon were tracked to the confluence of the Rhine River. River discharge and temperature were important factors determining the emigration of salmon smolts from the tributaries. We observed distinct differences in the migration behavior and survival of the two groups. However, individuals of both groups migrated mainly at night. Results will be discussed in the context of optimizing future stocking activities and improvement of downstream migration infrastructure.
~~14:15~~	~~Mark Yeldham~~	~~Severn Unlocked? The response of two anadromous fishes to catchment-scale barrier mitigation in the River Severn revealed using acoustic telemetry~~ Bournemouth University, University of Hull myeldham@bournemouth.ac.uk

		J Robert Britton, Bournemouth University; Charles Crundwell, Environment Agency; Peter Davies, Bournemouth University, University of Hull; Jamie R Dodd, University of Hull; Chris Grzesiok, Environment Agency; Andrew D Nunn, University of Hull; Randolph Velterop, Natural England; Jonathan D Bolland, University of Hull Programmes to remove or mitigate riverine barriers are increasingly used to improve the passage rates of migratory fishes in lowland rivers, enabling individual fish to range more freely over larger areas of river. In the impounded lower River Severn basin, western Britain, a programme of weir modifications ("Unlocking the Severn"), including fish pass construction, was completed in 2022. The result is that anadromous twaite shad Alosa fallax and sea lamprey Petromyzon marinus can now potentially more easily access spawning areas in the middle and upper catchment. Using acoustic telemetry between 2018 and 2023, we tracked the spawning migrations of 353 iteroparous shad for up to three consecutive years, and 128 semelparous sea lampreys for single years, to assess the effect of this reconnection on the spawning migrations of these threatened species. In the presence of the weir modifications, individuals of both species were able to pass weirs at lower flows than pre-modification, and more easily reach upstream spawning areas. However, the proportion of the species moving upstream of these weirs remains low, especially for shad at weirs mitigated with fish passes, despite relatively high numbers of fish in river reaches immediately downstream. While both species can now move more freely through the river than prior to re-connection, their initial responses to this improved access to upstream spawning areas remains limited due to the relatively low proportions of individuals currently passing through these novel structures. However, with virgin shad more likely than repeat spawners to pass the most downstream fish pass, this suggests the potential for the recolonisation of upstream spawning habitat by shad that are not homing to previously utilised downstream spawning habitat.
14:30	Olivia Simmons	The influence of hydraulic conditions on Atlantic salmon swimming behaviour at a hydropower dam Norwegian Institute for Nature Research olivia.simmons@nina.no David Aldvén, Vattenfall R&D; Torbjørn Forseth, Norwegian Institute for Nature Research; Patrik Andreasson, Vattenfall R&D; Stephanie Mueller, Vattenfall R&D; Olle Calles, Karlstad University; Ana T. Silva, Norwegian Institute for Nature Research Renewable energy production is increasingly important for the world to transition to a green economy. Hydropower is a critical form of renewable energy but can have negative consequences on migratory river species. One such species, the Atlantic salmon, Salmo salar, is known to be negatively affected by hydropower production during its migration. For example, dams create barriers that impede or hinder salmon migration. Some life stages of salmon are relatively well-studied, with much known about downstream-migrating juveniles and upstream-migrating adults. However, very little is known about the downstream-migrating post-spawner adults (hereafter 'kelts'), an important life stage with great conservation value. Baseline knowledge about how kelts interact with different hydraulic conditions, which is crucial for developing efficient methods to help kelts bypass dams, is limited. Thus, the aim of this work is to gather baseline information about how kelts interact with different hydraulic conditions. To do so, tracking data was collected from forty-eight kelts in the River Orkla, Norway, upstream of a hydropower dam. This tracking data was coupled with hydraulic data simulated using computational fluid dynamics model. We assessed various characteristics of kelt swimming behaviour, including swimming depth preferences, swimming speeds, and the swimming direction of the fish. We also assessed passage efficiency of the kelts at the dam. These results are a first assessment of kelt swimming behaviour directly related to the hydraulic conditions present at a hydropower plant. As such, they should be insightful to those interested in the interaction between hydraulics and fish behaviour, downstream passage solutions, and river management.
14:45	Katrina Cook	Should I Stay or Should I Go? Advance and Retreat Movements of Migratory Bull Trout at the Site C Dam Fishway InStream Fisheries Research Katrina@instream.net Ted Castro Santos, United States Geological Survey; Dani Ramos-Espinoza, InStream Fisheries Research; Nich Burnett, BC Hydro

		Some Peace River Bull Trout undergo spawning migrations that necessitate passing the Site C Dam. Site C is currently being constructed in northeastern British Columbia and features a weir-orifice fishway to provide fish passage during river diversion. Using data from an extensive radio and PIT telemetry array, we analyzed the movements of tagged Bull Trout on the approach to and within the weir-orifice fishway. Key research questions guiding our modeling include understanding possible barriers to passage (i.e., at approach, entry, or passage, or within the fishway), how attraction flows can be modified to encourage passage, and the role of other covarying environmental factors. We developed a competing risks time-to-event (TTE) modeling framework to explore how environmental factors, including attraction flows, affect rates of approach to, entry into, and passage of the fishway across three years of operations. Since dam construction began, hundreds of fish have been radio-tagged and thousands PIT-tagged, contributing to a robust dataset including thousands of attempts (i.e., individual fishway entries). While our research focusses on five target species, here we present model results from fluvial Bull Trout given interest in this migratory species and knowledge of spawning grounds upstream of the dam. River discharge and attraction flows were commonly associated with upstream (advance into fishway) and downstream movement (retreat from fishway). However, exploring the unique behaviours driving model results, assessing random effects distributions, and model comparison across species highlight nuances to these findings. These distinct facets guide discussions regarding trade-offs of fishway operational strategies.
15:00	Céline Le Pichon	The recovery of extinct Allis shad (Alosa alosa) in the navigated Seine River: what are the best routes for spawning migrations? INRAE celine.lepichon@inrae.fr Céline Le Pichon, Université Paris-Saclay, INRAE, HYCAR; Armand Michelot, Université Paris-Saclay, INRAE, HYCAR; Frédérique Bau, INRAE, UR EABX; Evelyne Talès, Université Paris-Saclay, INRAE, UR HYCAR; Sébastien Grall, Fish migration association SEINORMIGR; Eric Rochard, INRAE, UR EABX The human-impacted Seine basin (France) has seen the extinction of diadromous fish over the last two centuries but has recently witnessed the return of some of these species, notably the allis shad (Alosa alosa). In this historically navigated river, the existing anthropogenic structures can impede or facilitate the upstream spawning migration of this species. The ability of migrants to negotiate complex barriers (dam, lock, fish pass) is unknown on this recolonizing river. Individual behavior was studied during the spawning migrations of 19 allis shad, using acoustic telemetry in a fragmented stretch of the Seine River, between the most downstream dam and Paris (185 km, 5 navigation dams). No intra-gastric tagged individuals (captured in the first fish pass located 165 km from the sea) has interrupted their upstream migration and 17 have recovered quickly, allowing for trajectory analysis. Specifically, we tested for individual variability in open-reach groundspeed, waiting time and transit time at barriers, downstream fallback movements and passage routes. Open-river reach movements were quite similar from the moment fish were released and throughout the five navigation reaches (1-5 km.h-1). Waiting time below navigation dams account for 30 to 95% of total time trajectories with a high individual variation in passage times. At the first barrier encountered by fish migrating upstream, 45km after release, 75% of individuals crossed it and 30% made 1 to 5 downstream fallback movements before crossing it. Navigation barriers have limited upstream migration, with only 15% of individuals reaching Paris, but a further 15% have chosen the Oise River, a tributary known as a historic spawning route. Multinomial models have indicated that barriers crossing is favoured by good oxygen conditions and the daytime period. The main passage routes are locks (90%) or secondary fishways, indicating a low level of functionality for vertical slot fishways (conception and management).
15:15	Mikel Cherbero	Environmental cues and phenological variations in spawning migration of Allis shad (Alosa alosa) INRAE mikel.cherbero@inrae.fr Céline Le Pichon, INRAE; Eric De Oliveira, EDF LNHE Anadromous fish have to adjust their migration timing to meet favorable environmental conditions for reproduction when they arrive at the spawning grounds. This is especially the case for semelparous species, such as the Allis

		shad (Alosa alosa), an endangered species distributed along the Atlantic coast of Western Europe. To study the environmental cues and phenological variations in spawning migration of Allis shad, we gathered data from commercial fisheries or video-counting stations located on the estuary or lower reaches of 10 French rivers. These rivers vary in terms of geographical position, watershed surface and shad population dynamics. Annual indicators of the onset and duration of the migration period were extracted, over 11 to 33 years for each river (1986-2022 period). The relation between phenological indicators and seasonal descriptors of coastal, estuarine and river environmental conditions, as well as shad abundance, were analysed. Temporal trends for phenological indicators and environmental descriptors were quantified on the rivers with the longest datasets. Overall, water temperature and secondarily flow conditions are the key triggers of migration phenology. On contrary, the abundance of spawners has less effect. Significant trends towards earlier migration have been detected for five rivers among the six with the longest datasets. Range of these trends are site dependent and correlated to the evolution of water temperatures. Comparing rivers, migration tends to start in earlier environmental conditions on rivers where the distance to spawning grounds is greater. This study is the first step in a comprehensive analysis of the factors affecting migration phenology and spawning grounds accessibility for Allis shad along the French Atlantic coast.
Borduas Ballroom 3 **May 6**	**Session 8: Habitat connectivity at high flows**	**Chairs: Mathias Collins**
13:45	Paul Demuth	Flood refugia availability in a locally widened river reach ETH Zurich demuth@vaw.baug.ethz.ch Liz Brandenburger, Hunziker, Zarn & Partner AG; Mahmoud O. M. Awadallah, ETH Zurich; David F. Vetsch, ETH Zurich; Robert M. Boes, ETH Zurich; Volker Weitbrecht, ETH Zurich Human impacts on river systems not only changed stream characteristics like flow regime and channel geometry but also affected the availability, connectivity, and variability of habitats. These human activities have disrupted naturally occurring fluvial processes, leading to a loss of intricate and periodically changing habitat mosaics. Therefore, the physical restoration of such habitat characteristics is a primary goal of numerous river restoration projects. Different approaches to evaluate restoration projects mainly focus on flow depth, velocity, and grain size distribution. In most cases the analysis focusses on habitat availability representing average discharge conditions since biological data (e.g. preference curves) are almost exclusively available for this state. However, for resilient river habitats, it is necessary to consider the availability of flood refugia, a habitat that can mitigate the effect of disturbance events for specific organisms. In our study we focus on the presence of flood refugia, by evaluating the development of a river widening on the Emme River at Altisberg. The locally widened reach is compared with the channelized river reach prior to its restoration. Measured terrain elevations at different cross-sections from the channelized state and a digital elevation model based on drone surveys from the widened reach are transferred into two different 2D hydrodynamic models. Various discharges ranging from a 2-year flood event to a 5-year flood event were simulated to gather data on hydraulic conditions such as flow depth, flow velocity, and bed-shear stress. The results show that refugia for the target species brown trout is almost non-existent during flood events in the channelized reach in comparison to the widened river reach, potentially impacting the resilience of the species. The floodplain within the widened river reach serves as a flood refugia for mobile aquatic organisms in case of high shear stresses with intense bed load in the main channel.
14:00	Brian Wardman	Enhancing Habitat and Reducing Flood Risk Northwest Hydraulic Consultants bwardman@nhcweb.com Greater Sacramento California is located at the confluence of the American and Sacramento Rivers and is one of the most at-risk regions in America for catastrophic flooding. Both rivers provide critical habitat to endangered anadromous salmonids, and the American River is also designated as a Wild and Scenic River. Recent upgrades to the flood control system are reducing the risk of levee failure due to erosion. One of these upgrades includes a 2 km long project called Site 2-3. The site is located where highly erodible sand and silt deposits from historic gold mining in the American River watershed had

		deposited in the late 1800s and early 1900s. The deposits resulted in steep banks and elevated floodplain that limited floodplain habitat and accessibility, while constraining the river. The Site 2-3 design excavated over 190,000 cubic-meters of material from the bankline. The resulting bank profile reduces water levels during peak flow events reducing the risk of overtopping. The excavation includes planting benches at elevations where natural riparian vegetation which had been limited by the artificially high floodplain should now flourish. The combination of vegetation and flatter bank slopes will limit the likelihood of bank erosion, while buried rock tie-backs limit erosion extents if erosion were to initiate to prevent erosion from reaching the levee. The design provides improvements to ecology of the site by allowing more frequent inundation and access to shallow floodplain habitats to rearing juvenile salmonid, improving recreational access with flatter bank lines, and providing some natural erosion to occur intermittently along the channel. The project met U.S. Army Corps of Engineers risk assessments and provides an example of engineering with nature to provide multi-benefit projects within high flood risk environments.
14:15	Dan Gibson-Reinemer	Flooding allows rapid long-distance movements by native and invasive fish species in the Mississippi River United States Geological Survey dgibson-reinemer@usgs.gov Mark Fritts, United States Fish and Wildlife Service; Cody Henderson, United States Fish and Wildlife Service; Katie Lieder, United States Fish and Wildlife Service; Doug Appel, United States Geological Survey; Amanda Milde, United States Geological Survey; Marybeth Brey, United States Geological Survey; Andrea Fritts, United States Geological Survey Dams on large rivers have disrupted natural flow regimes and profoundly affected patterns of fish movement, which has harmed fishes in large rivers. In the upper Mississippi River, a series of 29 lock and dam structures control water levels and flow to facilitate commercial vessel traffic. Dams vary in the degree to which they regulate flow, with some dams commonly entering open river conditions while a few dams are infrequently in open river condition. Understanding how native and invasive fishes move through the navigation dams on the upper Mississippi River is critical to help managers conserve native species and control invasive species. We used a large-scale acoustic telemetry network spanning over 600 river km to examine the movement of over 300 bigheaded carp and over 50 American Paddlefish from 2022 to 2023. In 2022, an unusually low-water year, movements by all species tended to be shorter and appeared to be constrained by a lack of open-river conditions at key dams. In contrast, during flooding in 2023 that created open-river conditions at dams, Paddlefish and bigheaded carp rapidly moved more than 200 km upstream. We discuss the implications of these rapid movements during flood conditions in the context of invasive carp population dynamics and restoration of natural movement patterns for Paddlefish.
14:30	Jonathan Bolland	A global perspective on fish passage and protection at flood-relief pumping stations University of Hull j.bolland@hull.ac.uk Craig Boys,New South Wales Department of Primary Industries, Australia David Buysse and Ine Pauwels, Research Institute for Nature and Forest; Paul Franklin, National Institute of Water & Atmospheric Research; Shams Galib,University of Rajshahi, Bangladesh; Jeroen Huisman, Van Hall Larenstein Applied Sciences University / Wageningen University; Stephanie Lingard, University of British Columbia; Martyn Lucas, Durham University Josh Norman, University of Hull; Dan Straker, Resilient Waters Falko Wagner, Institute of Aquatic Ecology and Fish Biology Jena; Ros Wright, Environment Agency Flood-relief pumping stations lift river water to a higher downstream elevation (against gravity) for river level management and to reclaim land (in combination with embankments / levees / dikes) for agriculture and urban development. The future requirement for pumping stations will increase with climate change, sea level rise and population growth in lowland areas. Pump operation is sporadic, depending on rainfall and upstream water levels. When inactive, they are barriers to fish movement in both directions. However, when operational they can entrain, injure, and kill fish. For example, catadromous anguillid eels, which are of conservation concern globally, are particularly vulnerable when they emigrate

		from lowland rivers to spawn at sea. On the west coast of North America, these structures limit both the upstream passage of spawning adult anadromous Pacific salmon and trout (genus Oncorhynchus) and can kill entrained kelts and juveniles during their seaward migration. In Bangladesh, siluriform catfishes that enter flood control areas can be subsequently entrained in pumps. Non-migratory fishes are also at risk, especially during pump start-up and extreme flood-relief operations. Given the necessity of pumping stations now and in the future, coupled with the disproportionally severe impacts on lowland river ecosystems and aquatic biodiversity, they warrant special attention by conservation practitioners. However, managing the impact of flood-relief pumping stations receives less global attention when compared to other anthropogenic infrastructure such as hydropower or water abstractions for consumptive use. For the first time, we have quantified the prevalence of flood-relief pumping stations and the impact on fish globally. Comparisons are made to pump stations for irrigation purposes, and the cultural, legislative and policy drivers for fish passage and protection are also explored. The paper concludes by considering priorities for future research to strike a balance between safe and timely fish passage and societal flood protection needs.
14:45	Zachary Sherker	Fish and Floods: Floodgate and culvert remediations to improve salmon access to critical juvenile rearing habitat The University of British Columbia sherkerz@mac.com Patrick Zubick; Cole Martin; Arthur Bass; Dan Straker; Scott G. Hinch Pacific salmon are currently barred from thousands of kilometers of spawning and rearing habitat in British Columbia by ill-fitting culvert barriers and improperly functioning floodgates. Culverts were initially installed to rapidly transport water past instream infrastructures (e.g. road crossings), but over time have degraded to form one of the most numerous barriers to fish movement globally. Floodgates can remain closed for weeks to months at a time, blocking access to thousands of kilometers of invaluable floodplain habitat. Failed culverts and floodgates have culminated into an intricate, and poorly quantified, network of barriers to fish in B.C., with the strongest impact being felt by obligatory migrators such as potadromous and anadromous salmonids. To address this pervasive form of freshwater habitat fragmentation, tens of millions of dollars have been spent to remediate barrier sites and reopen otherwise viable stream and floodplain habitats. However, very little monitoring has been done to assess the effectiveness and longevity of these remediations for improving fish movements. To evaluate the efficacy of various culvert remediation strategies, I assessed fish passage at 40 culvert remediation sites that employed an array of barrier mitigation techniques (e.g. installation of baffles, rock weirs, fishways, culvert removal and replacement with open bottom structures) by comparing fish community structure and abundance upstream and downstream 10-15 years post-remediation. I have also been using innovative PIT technologies to monitor juvenile coho and Chinook passage into overwintering habitat upstream of a remediated (self-regulating) floodgate, compared to an un-remediated site and a control site nearby, to fine tune the self-regulated gate and better match opening operations with fish movements. This research will provide critical effectiveness monitoring to inform future barrier remediations efforts and ensure maximal benefits to salmon populations.
15:00	Patrick Holzapfel	An energy-based approach to quantify habitat connectivity between functional fish habitats considering steady-state hydrodynamic flow fields in fluvial ecosystems BOKU - University of Natural Resources and Life Sciences patrick.holzapfel@boku.ac.at Daniel Wildt, AFRY Austria GmbH; Christoph Hauer, BOKU - University of Natural Resources and Life Sciences Fluvial ecosystems are characterized by spatial heterogeneity and temporal variability. Furthermore, they can be described as dynamic mosaics of interconnected patches of physical conditions or biological communities. However, successfully completing a fish's life cycle requires access to different physical habitats during various life stages, often referred to as functional habitat units (FHUs). Thus, spatial heterogeneity and connections between habitat patches are critical for fulfilling this requirement. Nevertheless, modeling concepts addressing habitat connectivity or spatial interactions between patches or FHUs have rarely been applied in ecohydraulics. However, in the presented work, a Python-based algorithm was developed which is capable of mapping all possible pathways between a “starting patch” (e.g., spawning habitat) and all

		available “target patches” (e.g., rearing habitats) within a 2d-depth-averaged-hydrodynamic flow field. FHUs or patches are classified and localized using a common PHABSIM approach. Furthermore, depending on the swimming performance of the investigated fish species and fish length, it is determined whether a path is used for further connectivity analyses by applying dimensionless fatigue curves to the modeled flow field. For all remaining paths, the energy is calculated as the time integral of the power required for swimming at a relative velocity through a fluid velocity field. We then calculate a Habitat Connectivity Index for the analyzed starting patch by dividing the Weighted Usable Area of each individual target patch by the median energy cost of all feasible paths leading to that patch. As a final step, we sum up all individual Habitat Connectivity Indices and assign the total value to the starting patch for evaluation as the overall Habitat Connectivity Index. The novel concept was successfully tested in two morphologically differing river sections within the Gail River in Austria.
15:15	Megan DiNicola	High Flows Dictate Subadult Freshwater Mussel Suitable Habitat Patterns In an Engineered River Utah State University A02315573@usu.edu Freshwater mussels were once common in the southern and eastern United States, but habitat degradation and shifting climates have greatly reduced their numbers and in some cases extirpated them from these waterways. Freshwater mussels are unique in that they do not attach themselves to stable features and only burrow into the riverbed for protection, meaning their preferred suitable habitat is heavily reliant on stable sediments. As a result, mussel habitat is very patchy across rivers, making it difficult to predict presence, populations and estimate appropriate reintroduction locations. This is especially true for subadult mussels, which are small and hard to detect during routine surveys. To address this challenge, we have developed a framework for assessing subadult mussel habitat suitability that integrates flume experiments, an intensive field study, 2D hydraulic modeling and a statistical streamflow analysis. Starting at the smallest scale, the flume study provides incipient motion thresholds for the mussels in various sediment types. Stepping up in scale, the field study provides sediment and morphology characteristics that affect mussel habitat stability at specific sites along a river corridor. Next, the 2D model provides site and river segment-wide velocity and shear stress outputs, while the river flow analysis provides a likelihood of habitat-altering flows over time based on historic records and future climate predictions. The framework is applied to an urban, restored reach in the San Antonio River, Texas, USA, where the local river authority is actively working towards reintroducing freshwater mussels into the river. The results from this study will provide river managers with tools to assess reintroduction locations and to inform future restoration projects with subadult freshwater mussel suitable habitat requirements in mind.
Leduc-Fortin May 6	**Session 9: Sustainable hydropower**	**Chairs: Hervé Capra**
13:45	Atle Harby	Environmental design of hydropower regulated rivers SINTEF Energy Research atle.harby@sintef.no Line Sundt-Hansen, Norwegian Institute for Nature Research Planning, building and operation of hydropower must include considerations of technical, economic, environmental and social aspects in order to meet sustainability criteria. To address the environmental needs in a regulated river, we have developed the environmental design methodology. The method has previously been developed for only one species, Atlantic salmon, and it has been applied to several regulated rivers with hydropower and important salmon stocks. We are now developing similar methods for other species, activities and services. The objective is to improve licensing, operation and mitigation measures in regulated rivers with hydropower to meet sustainability requirements. We have defined a number of species, activities and services it is important to consider reaching sustainability in Norwegian rivers, adapted to the local conditions: the aquatic species salmon, trout, char, grayling, eel, river mussels, dune tiger beetle and benthic macroinvertebrates; the activities kayaking, swimming, fishing and aesthetics, the special nature type river delta as well as the services flood control, water supply and flexibility and energy services to the grid. The first step is to establish a diagnosis on how hydro-morphological factors that are impacted by hydropower and river regulation. Key indicators for each species, activity and service about how they are impacted by

		alterations in hydro-morphology are defined and assessed. Typical indicators are changes in low flow and floods, water-covered area, water depth, water velocities, sediments, substrate, water temperature, water vegetation, riparian vegetation and the presence of barriers. Metrics to assess key indicators are developed for each species, activity and service to be able to identify effects and bottlenecks. We are also relating potential mitigation measures to improve conditions for species, activities and services, leading towards a more sustainable operation of hydropower regulated rivers.
14:00	Ana T. Silva	Atlantic salmon (Salmo salar) conservation and sustainable Hydropower in Norway: downstream passage solutions Norwegian Institute for Nature Research ana.silva@nina.no Torbjørn Forseth, Norwegian Institute for Nature Research; Ismail Albayrak, Laboratory of Hydraulics, Hydrology and Glaciology; Olivia M. Simmons, Norwegian Institute for Nature Research; Kamal Pandey, Laboratory of Hydraulics, Hydrology and Glaciology; David Vetsch, Laboratory of Hydraulics, Hydrology and Glaciology; Bjørn Winther Solemslie, Norwegian Institute for Nature Research; Robert Boes, Laboratory of Hydraulics, Hydrology and Glaciology; Olle Calles, Karlstad University; Patrik Andreasson, Vattenfall Research and Development, Älvkarleby Laboratory; Stephanie Müller,Vattenfall Research and Development, Älvkarleby Laboratory; Henrik Baktoft, National Institute of Aquatic Resources, Technical University of Denmark; David Aldvén,Vattenfall Research and Development, Älvkarleby Laboratory The management and conservation of salmonids populations in Norway have become increasingly critical in the face of growing anthropogenic pressures and climate change impacts. Norway, as a major hydropower producer, often has its rivers fragmented by hydropower plants (HPP), which significantly affect aquatic biodiversity. Migratory species such as Atlantic salmon are highly impacted by the presence of HPP. Due to their ecological, economical, and social importance this species is often served as lead species for conservation efforts. In Norway several studies have investigated the behaviour of Atlantic salmon in the presence of HPP. This knowledge is crucial for developing solutions that prioritize the safe and efficient migration of this species ultimately increasing survival rates and safeguarding the ecological health of its populations. While solutions for upstream migration have been well-researched, little information exist on downstream migration of Atlantic salmon. The Safepass, FishFence, FishPath, and Kelt2Sea, herein presented, are among the international initiatives in Norway addressing this issue. These projects were affiliated with or received funding from the HydroCen center, a Norwegian centre dedicated to innovative research on environmentally friendly energy. These efforts are integral to the sustainable management of salmonids in Norway, aligning with the ongoing development of sustainable hydropower sources.
14:15	Daniel Hayes	Ecohydraulic studies in the context of a hydropower project in Uzbekistan, Central Asia University of Natural Resources and Life Sciences, Vienna daniel.hayes@boku.ac.at Pieterjan Verhelst, Research Institute for Nature and Forest; Matthias Schneider, SJE Ecohydraulic Engineering GmbH; Erkin Karimov, Tashkent State Agrarian University; Johan Coeck, Research Institute for Nature and Forest; Iana Kopecki, SJE Ecohydraulic Engineering GmbH; Bakhtiyor Karimov, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers; Tobias Hägele, SJE Ecohydraulic Engineering GmbH;Otabek Omonov, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers; Stefan Schmutz. University of Natural Resources and Life Sciences; Bernhard Zeiringer, University of Natural Resources and Life Sciences Central Asia's relatively pristine mountain rivers support diverse habitats and species. However, the demand for hydropower in these regions threatens the aquatic ecosystems. Notably, knowledge of the region's fish fauna and their ecological requirements is scarce. Therefore, the sustainable development of hydropower necessitates a deep understanding of organism-flow interactions, including habitat and migration studies for environmental flow assessments and fish passage designs. Here, we conducted an impact assessment of a small diversion hydropower plant developed within the Horizon 2020 project 'Hydro4U'. This assessment included applying advanced ecological tools and data collection to preserve fish habitats and migration routes. This study focuses

		on the snow trout (*Schizothorax eurystomus*), a migratory species whose genus is widespread in Central Asia. We conducted microhabitat analyses and employed a fuzzy rule-based habitat modeling approach combined with QField-based mesohabitat mapping using smartphones. Moreover, we conducted a one-year radio telemetry study to observe snow trout movement and migration patterns. The outcomes served to prescribe seasonal environmental flow scenarios and designs for connectivity restoration measures. Further post-implementation assessments are planned. This study provides an example of an ecohydraulics-based sustainability assessment of Central Asian hydropower projects, which can potentially be applied worldwide.
14:30	Frédéric Burton	Aménagement d'une frayère en eau vive en aval du barrage de Saint-Timothée (fleuve Saint-Laurent) Englobe corp. frederic.burton@englobecorp.com Marc Gendron, Englobe corp ; Patricia Johnston, Hydro-Québec ; Mathieu Gendreau, Englobe corp. Le projet de réfection de la digue de la centrale des Cèdres située sur le fleuve Saint-Laurent, a nécessité plusieurs mesures de compensation pour les pertes d'habitat du poisson, dont l'aménagement d'une frayère en eau vive d'une superficie d'environ 8 000 m^2 en aval de l'écumoire du barrage de Saint-Timothée. Cet aménagement, construit à l'automne 2021, est une rivière artificielle formée à l'aide d'un épi de 285 m de longueur, permettant d'isoler le cours d'eau provenant de l'écumoire, du bassin principal en aval du barrage. Le débit provenant de l'écumoire est de 15 m^3/s. Avant les travaux, le bief aval de l'écumoire était formé principalement de roche mère et de blocs sur une longueur d'environ 100 m avant de rejoindre le bassin en aval du barrage. Des modélisations hydrauliques ont permis d'optimiser le design de l'aménagement pour calibrer la dimension de l'enrochement de l'épi afin de supporter les vitesses de courant provenant de l'évacuateur de Saint-Timothée situé à proximité, ainsi que pour obtenir dans la rivière artificielle, des profondeurs et des vitesses de courant adéquates pour la fraie en eau vive des poissons du secteur. Les critères visés sont des profondeurs de 0,2 à 2,5 m et des vitesses de courant de 0,2 à 1,5 m/s, sur une longueur d'environ 320 m et une largeur variant entre 20 et 50 m. Du substrat de fraie de différentes tailles et des ilots rocheux ont été ajoutés sur toute la longueur de l'aménagement afin de créer une grande diversité d'habitat et de favoriser la reproduction de plusieurs espèces de poissons. Un suivi de la frayère au printemps 2023 a montré une forte utilisation par les poissons, notamment le doré jaune, le meunier noir, le chevalier rouge, le chevalier blanc, le chevalier jaune, le naseux des rapides et le fouille-roche zébré.
14:45	Marie-Pierre Gosselin	Hydropower related hydromorphological alterations in freshwater pearl mussel (*Margaritifera margaritifera*) rivers: impacts, knowledge gaps and potential mitigation measures. Norwegian Institute for Nature Research marie-pierre.gosselin@nina.no Jo H. Halleraker, Norwegian University of Science and Technology; Jon H. Magerøy, Norwegian Institute for Nature Research (NINA); Bjørn Mejdell Larsen, Norwegian Institute for Nature; Knut Alfredsen, Norwegian University of Science and Technology The freshwater pearl mussel (FPM) (Margaritifera margaritifera) is listed on the IUCN red list for endangered species as 'endangered'. Its populations have been declining throughout its range due to human pressures on river ecosystems. It is an umbrella species and, as such, an excellent bioindicator. Norway represents a stronghold for the species and about 25 % of the remaining populations in Europe are located there. However, a third of the historically known populations of FPM in Norway have disappeared and 75% of the remaining populations are today not viable. Norway is also Europe's largest hydropower producer and the 7th largest in the world. Out of the 419 rivers with freshwater pearl mussels in Norway, a large number are impacted by hydropower. Among the most widespread measures implemented to mitigate hydromorphological alterations is the release of fixed minimum flow. Although requirements for variations between summer and winter e-flow release have become more common in recent hydropower licenses, ecosystem-based measures, such hydropeaking mitigation with thresholds or flushing flows are rarer. Although a lot of studies have focused on the requirements and effects of minimum flows for fish, very little is known as to the flow and related hydromorphological requirements of freshwater pearl mussels. Addressing this knowledge gap is critical for the protection of this

		long-lived species that can reach up to 250 years of age in favorable rivers, even more so in the context of multiple pressures like climate change and increased demand for flexible hydropower production. We present an overview of the management challenges in Norway. This includes assessment of the relationship between the intensity of hydropower impacts and the status of freshwater pearl mussel populations, as well as possible suitable mitigation and management measures specially targeted for this species.
15:00	Joe Rathbun	Dams and Clams; Dam Removals and Freshwater Mussel Relocations rathbunj@sbcglobal.net Elle Gulotty, Michigan Department of Natural Resources; Kesiree O'Brien, Michigan Department of Natural Resources Freshwater mussels are one of the most imperiled groups of animals in the world, and reservoirs can host large populations; 1 million or more in large reservoirs. Reservoir drawdowns (RRDs), for whatever purpose, and dam removals can seriously impact mussels in the reservoir and downstream of the dam site. The State of Michigan has recently written a protocol for rescuing and relocating mussels in the course of RRDs. It discusses planning and executing a mussel rescue and relocation; search, rescue and handling techniques; relocation techniques; and post-RRD monitoring. Historical research on this topic and selected case studies will also be discussed, as well as recommendations for assessing sediment transport issues in downstream river reaches (not included in the protocol).
15:15	Véronique Gouraud	Method to identify effective hydropeaking mitigation measures: lessons learnt from site studies EDF R&D LNHE - Laboratoire National d'Hydraulique et Environnement, Chatou veronique.gouraud@edf.fr Agnès Barillier, EDF CIH – Center for Hydropower Engineering; Leah Bêche, EDF CIH – Center for Hydropower Engineering "Hydropeaking generates rapid flow variations that impact organisms (stranding, dewatering of spawning grounds, drift...) and their habitats. The French hydroelectric fleet is characterized by a wide variety of facilities located on rivers with a large diversity of hydrological and sedimentary regimes. The nature and degree of hydropeaking impacts are site-specific, with habitat disturbance varying in severity depending on other existing pressures and local site conditions. Reducing the negative ecological effects of hydropeaking must therefore take all of these factors into account, while preserving as far as possible hydropower's ability to produce carbon-free energy and facilitate the integration of variable energies into the electricity grid. To help identify effective hydropeaking mitigation measures tailored to the specific characteristics of each site, we have developed a method divided into different phases: i) a diagnostic phase to assess the impacts caused by hydropeaking, taking into account the impacts of other pressures; ii) a ""mitigation assessment"" phase to identify appropriate mitigation measures, to predict their expected effects and assess the technical feasibility of their implementation; iii) a ""cost-effectiveness assessment"" phase to compare the expected ecological benefits of the selected mitigation measures with the economic costs; iv) a ""monitoring phase"" with ecological monitoring before and after the implementation of mitigation measures. Lessons learned from site studies, where diagnosis and mitigation were implemented, were summarized to highlight the key points to be observed when identifying effective mitigation measures. We emphasized the importance of i) considering the ecological context in which they occur, ii) conducting a systemic analysis on a case-by-case basis to determine the relative importance of hydropower impacts compared to other pressures and to identify potential external limiting factors, iii) integrating this analysis within a forward-looking approach that also considers climate change, the evolution of multi-purpose water use and electricity grid requirements.
Pilot **May 6**	**Session 10: Advances in numerical methods 1**	**Chairs: André St-Hilaire**
13:45	Mulugeta Genanu Kebede	Remote Sensing-based River Discharge Estimation for a Small River Flowing Over the High Mountain Regions of the Tibetan Plateau Addis Ababa University mule.genanu@gmail.com

		Lei Wang; Xiuping Li; Zhidan Hu River discharge, as one of the most essential climate variables, plays a vital role in the water cycle. Small-scale headwater catchments including high-mountain regions of Tibetan Plateau (TP) Rivers are mostly ungauged. Satellite technology shows its potential to fill this gap with high correlation of satellite-derived effective river width and corresponding in-situ gauged discharge. This study is innovative in estimating daily river discharge using modified Manning equation (Model 1), Bjerklie et al. (2003) equation (Model 2), and Rating curve approach (Model 3) by combining river surface hydraulic variables directly derived from remote sensing datasets with other variables indirectly derived from empirical equations, which greatly contributes to the improvement of river flow measurement information especially over small rivers of TP. We extracted the effective width from Landsat image and flow depth via hydraulic geometry approach. All the input parameters directly or indirectly derived from remote sensing were combined and substituted into the fundamental flow equations/models to estimate discharges of Lhasa River. The validation of all three models' results against the in-situ discharge measurements shows a strong correlation (the Nash–Sutcliffe efficiency coefficient (NSE) and the coefficient of determination (R2) values ≥ 0.993), indicating the potentiality of the models in accurately estimating daily river discharges. Trends of an overestimation of discharge by Model 1 and underestimation by Model 2 are observed. The discharge estimation by using Model 3 outperforms Model 1 and Model 2 due to the uncertainties associated with estimation of input parameters in the other two models. Generally, our discharge estimation methodology performs well and shows a superior result as compared with previously developed multivariate empirical equations and its application for other places globally can be the focus of upcoming studies. Keywords: River discharge estimation, remote sensing, effective width, hydraulic relationship, Tibetan Plateau
14:00	Melina Sattelmeier	Analyzing Relative Influences of Pumped-Storage Hydroelectricity Operations and Reservoir Characteristics on Hydraulic Conditions Luleå University of Technology melina.sattelmeier@ltu.se Anders G. Andersson[1]; J. Gunnar I. Hellström[1]; T. Staffan Lundström[1] [1]Luleå University of Technology, Department of Engineering Sciences and Mathematics, Fluid and Experimental Mechanics Pumped-storage hydroelectricity (PSH) currently marks a preeminent position in the global landscape of energy storage technologies. Current efforts to increase the share of renewable energies give rise to a growing interest in the exploration of energy storage, including PSH. This is also true for Sweden, which, historically, has had little experience with the deployment of PSH. Given that the environmental impacts of PSH facilities are highly site-specific, new studies are needed, to show how PSH can be integrated into Swedish premises. Concerns are raised especially in terms of the disruption of local ecosystems and effects on water quality parameters such as temperature levels. Therefore, this study assesses the influence that reservoir characteristics have on environmentally relevant hydraulic conditions (e.g., thermal stratification) in reservoirs that are connected to a PSH facility. Simultaneously, it highlights the potential challenges that should be considered when extrapolating findings between reservoirs in different topographic and climatic contexts. This is done by adapting a 3D hydrodynamic model of a generic PSH facility according to different reservoir characteristics and pumping scenarios. Future studies are needed to extend the findings by other parameters as turbidity, nutrient concentration, or oxygen saturation. This study further constitutes the foundation for subsequent ecohydraulic studies, which quantify the ecological impacts of temperature alterations.
~~14:15~~	~~Marcela Politano~~	~~Numerical investigations of supersaturated water transport downstream of a hydropower plant in Norway~~ US Army corps of engineers (USACE) marcela.s.politano@erdc.dren.mil S. Das, University of Iowa; J. Martin, University of Iowa; J. Mafra, Sinop Energia; L. Beche, Centre d'Ingénierie Hydraulique; E. Florentin, Centre d'Ingénierie Hydraulique

		Elevated total dissolved gas (TDG) poses a significant threat to aquatic organisms, potentially leading to gas bubble disease (GBD). The severity of GBD depends on various factors, including the fish species, age, supersaturation levels, and exposure duration. In the past, fish exhibiting GBD symptoms have been observed on the Teles Pires River in Brazil during spillway releases. Gas supersaturation occurs by the dissolution of air bubbles carried deep into the tailrace by plunging spillway jets. Currently, TDG uptake in Sinop Dam is mitigated by gradual changes in spillway gates. While this approach has been effective to avoid GBD, it precludes the use of an immediate spill if such action was required. To further reduce the risk of supersaturation and enhance dam operation flexibility, spillway flow deflectors that redirect the plunging flow horizontally are proposed. This study presents a numerical analysis based on the open-source code OpenFOAM to assess the design of spillway deflectors at Sinop Dam. The model assumes three phases: air, liquid and bubbles in the liquid phase. The solver includes the dissolution of bubbles and an air entrainment model specifically developed by one of the authors for spillway operations. Two numerical models were developed: a sectional model encompassing one and a half spillway bays and a tailrace model covering the entire spillway, powerhouse and one kilometer downstream of the dam. The model was validated against pressure measurements obtained in a 1:100 reduced-scale hydraulic model for the 10- and 100-years flood event, as well as TDG field data collected in the tailrace. The model was used to determine the deflector length and location at the spillway face, aiming to minimize bubble transport to depths where dissolution is enhanced. Numerical details, criteria for deflector design and predicted TDG with and without the designed deflector will be presented and discussed.
14:30	Dominic Lagrois	Effects of ecohydraulic properties on acoustic propagation in the fresh waters of the St. Lawrence River, Canada Université du Québec en Outaouais dominic.lagrois.1@ulaval.ca Irène T. Roca, Université du Québec en Outaouais; Marc Mingelbier, Ministère de l'Environnement, de la Lutte contre les Changements Climatiques, de la Faune et des Parcs (MELCCFP); Jean-François Sénécal, Université du Québec en Outaouais; Clément Chion, Université du Québec en Outaouais Lac Saint-Pierre (LSP), the largest fluvial lake in the St. Lawrence River, is recognized as a World Biosphere Reserve due to its abundant biodiversity. Some 90 species of freshwater fish have been recorded, including 20 species at risk exposed to acoustic pollution from anthropogenic activity. Commercial traffic reports 4,800 transits per year via the navigation channel. The high summer season sees an abundance of fishermen and recreational boats altering the acoustic environment. Finally, the presence of undetonated shells on the south shore of the lake requires a series of controlled on-site explosions for safety reasons. The shockwave generated by the detonation of explosive devices poses a threat to the habitat of the aquatic fauna. This ecological context together with the unique topographical and hydrodynamic properties of LSP require an in-depth study of anthropogenic noise sources and their propagation in the underwater environment. The freshwater lake consists of a vast flood plain, with an average depth of ~3 m, separated from east to west by an artificial navigation channel ~300 m wide and ≥11.3 m deep. Freshwater is supplied by several tributaries with highly variable water quality, resulting in horizontal stratification of conductivity, temperature, and turbidity. The dominant substrate is fine (silt and clay), becoming coarser near the channel (gravel, pebble, and rock). The shallow portion is seasonally covered by vegetation, sensitive to turbidity and highly variable in density. This work presents the computational and numerical steps developed to model the acoustic propagation and attenuation in the waters of LSP from acoustic sources of known spectral signature. Impacts of varying ecohydraulic properties (e.g., water temperature, depth of the water column, vegetation cover from one season to another) on the acoustic footprint left by anthropogenic sources will be discussed.
14:45	Anders Andersson	Hydraulic modelling of seasonal flow variations in regulated Nordic rivers Luleå University of Technology anders.g.andersson@ltu.se Lovisa M. Sjöstedt, Luleå University of Technology; J. Gunnar I. Hellström, Luleå University of Technology

		The world is currently undergoing an unprecedented transformation aimed at shifting society towards renewable energy sources. This profound change necessitates the integration of sustainable hydropower systems, which are crucial for balancing the growing influx of intermittent energy sources such as solar- and wind power. Notably, the Northern parts of Sweden and Finland boast some of the largest rivers in Fennoscandia, making this region a significant hub for hydropower installations. Climate change is anticipated to bring about increased temperature and precipitation with greater magnitude and variability in the Nordic region, changing the seasonal availability of water and amplifying the occurrences of floods and droughts, thereby impacting crucial sectors such as hydropower, forestry, fishery, and agriculture. Simultaneously, the region faces challenges related to wintertime flow conditions, such as ice formation, freezing-, and break-up times, which all influence hydropower operations and local environmental conditions in regulated Nordic rivers. Addressing these complexities requires a holistic approach that safeguards public interests while fostering sustainable energy solutions. As part of this holistic approach, two-dimensional modelling of river flow was here utilized on two reaches in highly regulated and environmentally significant Finnish and Swedish rivers. The seasonal discharge dynamics in the river reaches and its impact on river biodiversity (here mostly focused on fish) was investigated using the hydraulic models for current operating schemes. Time-series of water depths, water temperatures and depth-averaged velocities were produced for relevant flows in different seasonal stages and the results were analyzed in terms of e.g., suitable habitat and stranding risk for target species. Possible future flow scenarios will also be simulated using the same hydraulic models and the results will be compared with the current-day conditions to pinpoint conceivable future issues and evaluate possible environmental measures.
15:00	Mohammad Golestani Eraghi	Impact of rainfall spatio-temporal variability on rainfall-runoff and flood modelling in the Selke catchment Magdeburg-Stendal University of Applied Sciences (Hochschule Magdeburg-Stendal) m.golestani.e@gmail.com Daniel Bachmann; Shahin Khosh Bin Ghomash Rainfall variability is an important component that impacts the hydrological response of catchments and has significant implications for water resources management, flood forecasting, and catastrophe risk reduction. The Selke catchment, which is found in the northern part of Germany, is a region that is particularly susceptible to the effects of the variability of rainfall as a result of its high amounts of precipitation and its complicated topography. This master's thesis investigates the impact of spatial and temporal rainfall variability on rainfall-runoff and flood modeling in the Selke catchment. Hydrological data from the Selke catchment are evaluated using a combination of numerical and modeling techniques. The study discovered that the relationship between rainfall patterns and runoff in the Selke catchment is complex and that including Spatio-temporal variability in rainfall is important for precise flood forecasting in the catchment. Quantum Geographical Information System-QGIS software was used for data preparation, whereas ProMaIDes® software and its QGIS plug-in were used for all modeling processes. The software packages Paraview® and R Studio were utilized for data processing and visualization. The study also indicated that changes in land use, model resolution, elevation aggregation, and catchment division significantly impacted the dynamics of rainfall-runoff and flooding. This study's findings provide valuable insights into the hydrological processes of the Selke catchment and will aid in the development of more effective management methods for minimizing the danger of floods and other hydrological hazards in the region. Incorporating spatial-temporal variability in rainfall and other factors, such as land use changes, model resolution, elevation aggregation, and catchment division, into flood forecasting models can improve the accuracy of flood predictions in the Selke catchment and similar regions, according to the conclusion of the thesis.
15:15	Mariana Acosta	Non Darcy Turbulent Flow in Porous Media Study Universidad Nacional de Colombia, sede Manizales macostap@unal.edu.co Philippe Chang, Universidad Nacional de Colombia, sede Manizales Darcy’s law for flow in porous media has been applied effectively to groundwater flow applications considering laminar and irrotational flow

		hypothesis and permeability as a proportionality constant. In such context induced shear can effectively be quantified. On the other hand, the Forchheimer and Brinkmann equation have been inferred from the Navier Stokes equations and further developed based on empirical studies to explore other flow conditions notably turbulent flow in porous media. Such equations have been associated to what is called the pre and post Darcy flow theories that are represented by strongly nonlinear convective terms found in the linear momentum equations. The shear stress that may be induced by such turbulent flow conditions has not been examined extensively mainly because such flow conditions can seldom be observed in natural flows. In the Andeans mountains intense precipitation have caused numerous and repeated landslides. The present study examines turbulent flow conditions that is induced by intense and prolonged precipitation and consequent ground infiltration as a cause for slope instability and collapse. Firstly, the shear stress associated with the Forchheimer and Brinkmann equations are examined highlighting its theoretical implication. Additionally, a case study is examined comparing numerical results with current model limitations and hypothesis on flow characteristics. Simulation: By carrying out studies, it is expected to measure the Reynolds number and verify if its possible that in de porous media the effect of rain can generate a turbulent flow within it. The objective of the project is to study the existing equations mentioned above and observe if they are applicable to the theory initially proposed, it is expected to carry out laboratory experimentation to know the behavior of the flow in the porous medium. Additionally, it is necessary to vary the intensity of the flow to know what intensity of precipitation is necessary to cause turbulent flow in the slope and to apply the theory in new study cases.
15:30-16:00	**Break - Foyer**	
Suzor-Côté Ballroom 1 **May 6**	**Session 11: Recent development in fish screening techniques**	**Chairs: Andrew Goodwin**
16:00	Stefan Hoerner	Towards a reliable and validated toolbox to replace live fish tests for the assessment of injury and mortality during downstream passage Université Grenoble-Alpes, CNRS, Otto von Guericke University Magdeburg stefan.hoerner@univ-grenoble-alpes.fr Wolf Iring Kösters, Otto von Guericke University Magdeburg, Tallinn University of Technology; Shokoofeh Abbaszadeh, Otto von Guericke University Magdeburg; Falko Wagner, Institute of Aquatic Ecology and Fish Biology; Jeffrey Andrew Tuhtan, Tallinn University of Technology Live fish tests remain as the most common method to evaluate the risk of injury or mortality during turbine and pump passages. Considering sites at which the risk of injury and mortality can be reasonably assumed to be either too high or negligible, a multi-stage method using passive sensors and numerical models is proposed as an alternative to replace live fish tests. Three alternative approaches are available to replace live fish tests which have already been applied in both lab and field studies: (1) analytical and statistical blade strike models based on hydraulic machinery geometry, flow conditions and fish kinematics, (2) Computational Fluid Dynamics (CFD) approaches coupled with models to account for the passage of fish and (3) sensor systems which record at a minimum, the total pressure and linear acceleration during passage. Blade strike models have been applied for several decades and are well-studied and continuously improved. Case-specific validation studies however show good agreement as well as high uncertainty. CFD studies are limited to well-documented sites and still await to be validated using field data collected from live fish tests. Sensor systems can provide reliable assessments of barotrauma risk due to pressure changes, but only when biological reference data are available. Estimating the risk of collision-related events using passive sensors remains challenging due to the substantial differences between the physical properties of the sensor body and that of live fish. To address knowledge gaps related to collision-related injury and mortality, current sensor technologies were analyzed and a laboratory strike system was developed to investigate blade impact events under controlled conditions. Finally, we provide insight into how and why existing approaches are prone to fail to accurately assess blade impact events and propose an alternative type of sensors.
16:15	Aljon Salalila	Development of the Sensor Fish Suites for Hydropower and Marine Hydrokinetic Technologies

		Pacific Northwest National Laboratory aljon.salalila@pnnl.gov Lu, Jun; Martinez, Jayson J; Hou, Hongfei; Li, Huidong; Deng, Zhiqun Marine and hydrokinetic (MHK) technology, aimed at harnessing energy from ocean waves, tides, and river currents, holds promise as a dependable energy source. However, persistent uncertainties surround the environmental risks associated with MHK technologies, including interactions with marine life, habitat alterations, underwater noise, and electromagnetic fields. Thus, investigating the environmental impacts of emerging MHK technologies is imperative. To support the FERC licensing process, federal agencies and stakeholders must consistently and rigorously review hydropower facilities and commercial-scale MHK projects. Pacific Northwest National Laboratory has developed an autonomous Sensor Fish technology, providing in-situ measurements of three-dimensional (3D) linear accelerations, 3D rotational velocities, 3D orientation, pressure, and temperature at a sampling frequency of 2048 Hz. It is also equipped with an automatic floatation system and a built-in radio-frequency transmitter for recovery. This research introduces new form factors with added capabilities to the original Sensor Fish to characterize various complex hydraulic structures previously challenging to study. These additions include the Sensor Fish Mini, a miniaturized version in a spherical form, for evaluating fish passage conditions and assessing physical stressors in small hydraulic structures. The Flexible Sensor Eel (FSE) and Flexible Sensor Shad (FSS) assist in characterizing static and dynamic blade strike testing for hydro turbines to determine blade shapes and sizes. Finally, the Marine Sensor Fish (MSF), equipped with an acoustic transmitter for 3D localization and a conductivity sensor for CTD measurements, enables the study of new MHK technologies. This research discusses the design, application, and deployment results of these new Sensor Fish form factors. The ability to assess and monitor stressors associated with both existing hydropower facilities and new MHK technologies using Sensor Fish technology will allow for more informed management decisions and optimized designs to minimize or mitigate their environmental impacts.
16:30	Eric De Oliveira	Fish species recognition based on morphological and swimming pattern on acoustic videos EDF R&D eric.de-oliveira@edf.fr Azénor Le Quinio, EDF R&D; Alexandre Girard, EDF R&D; François Martignac, INRAE; Eric De Oliveira, EDF R&D Acoustic cameras are increasingly used in monitoring studies of diadromous fish populations as they present many advantages. They allow us to continuously monitor fish without any handling, at higher range than optical devices and with low dependency to environmental conditions, such as water turbidity. However, the high amount of data recorded by the camera makes their analysis very time consuming for the operators. Developing an automatic method to detect, count and identify fish from those data is a key issue to fully exploit the acoustic cameras' capacities. Many characteristics that help to identify fish species (color, shape, tails…) are not apparent on acoustic camera data because of the nature and resolution of the recorded videos. The image processing pipeline developed in this study is designed to handle the high amount of video, by filtering the short video clips of interest and by then detecting, tracking, and extracting images of the object to identify. First, the global shape of the fish is analyzed by a morphological analysis that retrieved multiple information using image processing tools. Then, the fish body deformation along the movement is characterized. Implementing a deformation model which is gradually deformed according to the contours of the fish echo area is applied for all successive images of the same fish. The deformation from one detection to the other is analyzed using signal processing tools to improve fish species distinguishment, thanks to repeating and discriminant patterns. A study case on four different species illustrates the performance of the method and the dependency to recording characteristics (resolution in pixels, distance to the camera, fish size).
16:45	Helmut Mader	The development of an AI-based automated 24/7/365 fish monitoring system KÖR GmbH & BOKU Vienna helmut.mader@fischaufstieg.at Sabine Käfer, VERBUND Hydro Power GmbH; Sabrina Mai, VERBUND AG; Magdalena Hutze, VERBUND AG; Stefan Laudemann, paiqo GmbH; Timo Klerx, paiqo GmbH

		As part of the construction of the fish ladder at the Feistritz power plant with 160 enature multi-structure slots, a fish monitoring research station was installed. The fish movement through the fish ladder is recorded using 2D and 3D video cameras. The recordings are stored in the VERBUND cloud and processed automatically. For the evaluation of the videos, experiments were carried out on the influence of the image sharpness and image size of the recorded objects, the white balance using black/white/grey dots and the water turbidity based on the diffusion of the structure of reference points. The optimized video recordings of the moving objects are evaluated in a pre-trained binary MobileNet classifier according to object type (fish/no fish) and the relevant video areas are extracted for further analysis of the fish species and fish length. The accuracy of differentiation between fish and no fish objects reached > 95%. The length of the fish is determined using the 3D camera images. The further determination of fish species and fish length is carried out using newly developed and trained AI models. An InceptionV3 architecture was used to distinguish 16 classes, 15 lead species and 1 collection class for all other species. The accuracy of the models was evaluated at 90-95% for most species. Certain species pairs are difficult to distinguish with a single generalized network. These contribute significantly more to the overall error than other pairs. Therefore, a hierarchical classification system was developed to improve classification accuracy. The results of the automated 24/7/365 fish species and fish length determination will be presented at the conference.
17:00	Pedro Romero-Gomez	Combining Sensor- and Simulation-based Assessments of Fish Passage through Hydro Turbines ANDRITZ Hydro pedro.romero-gomez@andritz.com Z. Daniel Deng, Pacific Northwest National Laboratory; Rudolf Peyreder, Research and Development, ANDRITZ Hydro GmbH; Lee Baumgartner, Gulbali Institute, Charles Sturt University The demands for demonstrating enhanced fish passage conditions through hydro turbines have spurred the development of techniques based on computer modelling and simulations, laboratory experimentation and field deployments. In general, such techniques quantify key fish-relevant hydraulic magnitudes and link them with the consequential likelihood of survival based on biological response models. For hydropower plant operators and turbine design engineers, assessments based on flow simulations and fish trajectory tracking are affordable and provide 3D details of flow phenomena influencing the investigated stressors. Richer flow information can assist in developing more effective countermeasures. Most simulation-based studies of fish passage, however, lack validation because it is difficult to consolidate knowledge from diverse fields of expertise in the same passage evaluation project. The present contribution summarizes the implementation of both simulation- and data-based hydraulic stressor assessments in four different evaluation projects. First, a feasibility study of Sensor Fish Mini deployed through a Kaplan-type turbine in a commercial test rig validated the calculated outcomes from CFD/streamline simulations. Second, a full Sensor Fish Mini deployment was conducted through a Francis-type turbine to corroborate the outcomes from simulations of the tested operating points. Third, a comparative study of two low-head Kaplan turbines (one conventional and the other designed on fish passage enhancement principles) is summarized and last, the characterization of a very large Kaplan-type turbine with both simulations and measurements is presented. We focus on describing the features of the modelling approach in detail, as well as its benefits and advantages. Furthermore, we highlight the challenges and opportunities that still exist for improving the prediction accuracy of fish-relevant hydraulics. A more complete understanding by turbine engineers about the effects of turbine hydraulics on fish passage survivability will lead to faster and more effective development of environmentally enhanced technologies with minimum impact on natural resources.
17:15	Philippe Hamel	Investigation of computational fluid dynamics and autonomous device methods to estimate fish mortality in a hydroelectric turbine University of New Brunswick philippe.hamel@unb.ca Hydroelectric dams are an important source of renewable power, but they create major barriers to fish migration [1] [2]. The 55 m tall Mactaquac Dam is located 17 km upstream of Fredericton, NB on the Saint John/Wolastoq River (SJWR)

		and generates approximately 12% of the province's electricity [3]. Fish migrating downstream must travel through its 6.7 m diameter Kaplan-type turbines [4], which kill or injure an unknown proportion of fish travelling through them [5]. The Atlantic salmon and American eel populations in the SJWR are classified as endangered and special concern (threatened), respectively, and are of high economic, ecological, and cultural value [6] [7]. The decline of both species has been attributed in part to the damming of many rivers of the Atlantic drainage basin [6] [7]. In the fall of 2020, a team of University of New Brunswick (UNB) researchers, which included myself, started investigating the plight of fish as they pass through turbine #1 of the Mactaquac Dam by using submersible pressure and acceleration sensors (Sensor Fish). The devices indicated high, sudden pressure drops and accelerations in excess of 100 g, but were limited in their ability to gather appropriate data to assess injury and mortality mechanisms or flow conditions inside the turbine. This study makes use of computational methods, specifically computational fluid dynamics (CFD) and the Biological Performance Assessment (BioPA) developed by the Pacific Northwest National Laboratory, to further investigate fish mortality in turbine #1 of the Mactaquac Dam. Reducing mortality of these species at the Mactaquac Dam would contribute towards increasing their population in the SJWR. Improving our understanding of the mechanisms responsible for causing mortality or injury to fish across a range of operating flows could allow modifications in flow regime during fish migratory periods to reduce the risk of mortality during turbine passage.
17:30	Jeffrey Tuhtan	Smart Fish Counter Software for the Automated Monitoring of Fish Species and Body Length Tallinn University of Technology jetuht@taltech.ee Elizaveta Dubronvinskaya, Tallinn University of Technology; Aleksandr Ivanov, Tallinn University of Technology; Alexandra Kolosova, Tallinn University of Technology; Lizaveta Miasayedava, Tallinn University of Technology; Vishwajeet Pattanaik, Tallinn University of Technology; Jürgen Soom, Tallinn University of Technology; Bernd Mockenhaupt, German Federal Institute of Hydrology; Nicole Scheifhacken, German Federal Institute of Hydrology; Cornelia Schütz, German Federal Institute of Hydrology; Christian Haas, I AM HYDRO GmbH; Philipp Thumser, I AM HYDRO GmbH Multi-stage computer vision systems increase the accuracy and processing speed of underwater fish counter videos and reduce the costs of human evaluators, enabling the possibility of automated monitoring activity at a lower cost. In this work, we present a camera-agnostic computer vision system capable of rapidly pre-selecting video segments with and without fish, classifying individual fish by species and estimating their total body length in 5 cm size classes. A novel aspect of this work is the comparison of fish size class estimates between multiple human raters, which indicates that on average, the individual biases of human estimates cancel each other out over a total body length range of 5 to 60 cm. Furthermore, we provide key insights and suggestions for improving the performance of species classification considering the presence of biofilm, adverse lighting conditions, variable frame rates and different image resolutions. We also showcase the necessity for image augmentation, including the use of stable diffusion models to generate synthetic images of fish species for which little archived video material is available. We present how advances in low-powered, 5V embedded computing hardware have substantial potential for real-time software applications which run continuously in the field, opening new possibilities for the automated hourly reporting of fish species and their size classes. The smart fish counter project is planned for release in 2025 to the ecohydraulics community as a series of open source modules, providing powerful new software tools for the automated processing of camera trap or continuous video monitoring data of freshwater fish in typical river environments.
Krieghoff Ballroom 2 **May 6**	**Session 12: Selective fish passage**	**Chairs: Jessica Stanton**
16:00	Daniel Zielinski	Exploration of the science supporting selective connectivity at fish migration barriers Great Lakes Fishery Commission dzielinski@glfc.org

		Reid Swanson, Great Lakes Fishery Commission; Andrew Muir, Great Lakes Fishery Commission Addressing the tension between improving aquatic connectivity for fishery restoration versus using dams and barriers for invasive species management (the connectivity conundrum) is one of the greatest global issues facing fishery managers. Selective connectivity, where organism movement is selective in terms of taxa and potentially individuals based on restoration or conservation goals, presents a potential solution to this connectivity conundrum. The Great Lakes Fishery Commission and its partners are developing an approach to selective fish passage that integrates fish ecology and biology with engineering at FishPass. The FishPass project will replace the last of four legacy barriers on the Boardman (Ottaway) River, Traverse City, Michigan, with an improved barrier and adaptable fishway designed to develop and test tools to selectively pass desirable fish while blocking and/or removing undesirable fish, like the invasive sea lamprey. The process used to select and configure fish sorting tools will follow an eco-engineering approach inspired by material recycling and emphasizes automation and the integration of multiple technologies that target sortable phenological, morphological, behavioral, and physiological attributes of fish. Herein, we will provide an overview of FishPass including ongoing research supporting selective fish passage in the Laurentian Great Lakes.
16:15	Mahmoud Abdelbaky	Comparative swimming performance of Brook Trout, White Sucker, and Sea Lampreys in a baffled channel Université de Sherbrooke abdm1802@usherbrooke.ca Mahmoud Abdelbaky, Université de Sherbrooke; Dencil Mathew, Université de Sherbrooke; Elsa Goerig; Université de Sherbrooke, USGS, Harvard University; Jay Lacey, Université de Sherbrooke; Theodore Castro-Santos, USGS Sea Lamprey are considered an invasive species in the Great Lakes Basin and a wide variety of methods, such as barriers and lampricides, are used to control their population. Barriers can be detrimental to native fish populations and alternative methods inducing selective passage are being investigated. Turbulence inducing baffled channels are a promising option as ray-finned fish are thought to have superior ability to navigate fast, turbulent flows, by comparison to lampreys, which lack paired fins. This comparative study is the first to investigate the swimming behavior and ability of brook trout, white suckers, and sea lampreys through baffled channels. We measured entry rate and ascent distances in an experimental flume lined with attachment-inhibiting substrate, under varying flow speed and four baffle configurations, taking into account the effect of environmental and biological covariates. Surprisingly, the study defied expectations as brook trout displayed reduced swimming performance when water velocities exceeded 1.5 m/s. In contrast, suckers and lampreys exhibited remarkable motivation to enter the flume and adaptability, navigating water velocities up to 2.5 m/s under specific baffle configurations. Turbulence induced by the baffles appeared to limit upstream progression of fish under certain conditions. These findings provide valuable insights to design selective fish passages in the Great Lakes area.
16:30	Dencil Mathew	Baffle designs to improve selective passage in sea lamprey barriers Université de Sherbrooke dencil.mathew@usherbrooke.ca Mahmoud Abdelbaky, Université de Sherbrooke; Jason Duguay, Université de Sherbrooke; Elsa Goerig, Harvard University; Jay Lacey, Université de Sherbrooke; Theodore Castro-Santos, United States Geological Survey Invasive sea lampreys (Petromyzon marinus) pose a significant threat to native fish populations in North America. This study introduces an innovative strategy to enhance selective fish passage at sea lamprey barriers by disrupting their ability to rest on surfaces and subjecting them to varying velocities and turbulence gradients. Bed-mounted roughness elements, including perforated and grooved baffles, are strategically employed to achieve this goal which also offer advantages for native fish passage by providing low-velocity pathways and sheltering zones. Computational fluid dynamics (CFD) is used to model and compare various baffle configurations, identifying flow characteristics such as turbulent kinetic energy, Reynolds stresses, and recirculation zones. Results from CFD analysis are used to understand fish locomotion, which was observed during the lab experiments. The modeling is performed using OpenFOAM with

		the volume of fluid method to capture the free surface. These results are validated using acoustic Doppler velocimeter measurements obtained from one of the baffle configurations. This study underscores the advantages and limitations of employing both ADV measurements and OpenFOAM CFD simulations. The obtained results contribute to improving baffle designs to create a successful selective barrier.
16:45	Kassandra Reynolds	Hydraulic and hydrologic characteristics of effective sea lamprey barriers University of Minnesota - Twin Cities reyno906@umn.edu Daniel P. Zielinski, Great Lakes Fishery Commission; Miki Hondzo, University of Minnesota; Vaughan Voller, University of Minnesota A network of 494 lowermost barriers on tributaries of the Laurentian Great Lakes prevent invasive sea lamprey from accessing upstream spawning habitat. Most of the lowermost barriers are low-head dams that are designed to maintain a minimum vertical separation of 45 cm between the barrier crest and the downstream water level. Many barriers are unable to maintain the design criteria for all flows, yet still effectively prevent sea lamprey passage. The fact that some barriers continue to block sea lamprey passage even when inundated (i.e., the downstream water level rises above the barrier crest) suggests other hydraulic conditions near the barrier may limit passage. However, little is known about the in situ hydraulic conditions downstream of these barriers. We hypothesize that barrier efficacy is partially dependent on variations in stream hydrology and downstream hydraulic characteristics related to velocity and turbulence. To test this hypothesis, we conducted a physical modeling laboratory study of four sea lamprey barriers of varying historical efficacies. Acoustic-Doppler Velocimeter (ADV) and particle image velocimetry (PIV) visualization data were collected to provide a robust quantification of turbulence characteristics. In this presentation we will summarize trends in the hydrologic and hydraulic conditions associated with effective and ineffective barriers. An improved understanding of how existing barriers block sea lamprey movement will aid in the design of future effective sea lamprey barriers.
17:00	David Smith	Assessing Invasive Carp Response to Three-Dimensional Geometric Structures with Known Hydrodynamic Flow Patterns US Army Engineer Research and Development Center david.l.smith@erdc.dren.mil Avery Schemmel and Marcela Politano, USACE Invasive carp pose a significant threat to native species and ecosystems in the Mississippi River Basin. Carp and other rheotactic species are known to respond to strong hydrodynamic stimuli such as flow separation and recirculation. Understanding a species' preference for favorable and unfavorable hydrodynamic conditions may provide insight into improving existing attractant or deterrence technologies. Further, investigating alternative flow control mechanisms that do not require external resources or extensive infrastructure (CO2, electric barriers, bubble curtains, acoustics) can provide a passive and cost-effective strategy to improving or delaying fish navigation. This study aims to assess invasive carp response to hydrodynamic flow patterns generated by a series of 4ft tall half-cylinders with a diameter of 3ft. Velocity data is collected with an acoustic doppler velocimeter (ADV) mounted above the straight section of a semi-circular hydraulic flume for flow speeds of 0.82 ft/s (25 cm/s) and 1.48 ft/s (45 cm/s) and a water depth of 3ft. Top-mounted cameras record fish position as they navigate upstream toward the structures. Additionally, a computational fluid dynamics (CFD) model of the flume is developed using open-source code OpenFOAM, and the model is validated using collected data. Fish tracks are post-processed from video data, and fish positions are compared against the CFD model. Results suggest fish are actively avoiding vortices shed from the half-cylinders, proving to show promise as a flow control method. Additional studies are ongoing for other three-dimensional structures including a NACA 0015 airfoil and a slotted wall to investigate other unique flow patterns which might affect fish navigation.
17:15	Avery Schemmel	Assessing Zebra Mussel Impact on Fishway Efficiency: McNary Lock & Dam Case Study US Army Engineer Research and Development Center avery.j.schemmel@erdc.dren.mil David Smith and Marcela Politano

		The Columbia River Basin faces a significant threat from the potential invasion of zebra mussels, notorious for their ability to attach to various substrates, including fishway structures. The construction of fishways in the basin has proven effective in restoring aquatic connectivity. However, extensive mussel colonization within the fishways might affect fish passage by altering flow dynamics or creating physical barriers. The objective of this study is to assess the potential of zebra mussels to attach to fishway surfaces and form colonies in the McNary Lock and Dam fishway. The study also evaluates the effect impact of this infestation on the fishway's efficiency. According to the literature, mussel habitat suitability includes factors such as water velocity and depth, Froude number, velocity/depth ratio, shear stress and shear stress ratio. A computational fluid dynamic (CFD) model of the entire McNary fish ladder was developed using the open-source code OpenFOAM. Mesh quality is critical to obtain a reliable solution. The numerical grid was refined near the free surface and all solid surfaces to properly capture the free surface location and shear stress. Simulation results for the 5-year average flowrate were in agreement with measured head over each weir. Regions susceptible to mussel infestation were identified, and a new numerical model considering mussel presence was developed. The model assumed that 25% of aggregates could reach a maximum vertical depth of 657 mm, and the remaining 75% form a monolayer with a minimum vertical depth of 21.9 mm. Velocity profiles, vorticity and shear stress, both with and without mussel, provided insights into the infestation's impact on the fishway efficiency. Specific details on mesh construction, model setup and numerical results will be presented and discussed.
17:30	Ambroise Percheron	Rehabilitation of the Davis Diversion Intake: A novel environmental solution apercheron@kgsgroup.com The Davis Diversion was built in 1939 by the *Prairie Farm Rehabilitation Administration* (PFRA) near the Town of Maple Creek in Southwestern Saskatchewan. The main purpose of this canal is to divert unregulated flow, particularly spring run-off, from Davis Creek to Belanger Creek and then to Cypress Lake. The original diversion system included an old timber weir to control water levels in the creek and a concrete headgate structure at the inlet of the diversion canal. The Davis Creek is home to several fish species including the Plains sucker, which is listed as a "Threatened" species under the Species at Risk Act (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In the past, several fish species including the Plains sucker, have been reported to be stranded in the Davis Diversion canal during operation. The death of fish due to canal operations made the original diversion system non-compliant with the Federal Fisheries Act and Federal SARA. In 2020, WSA retained KGS Group to complete a conceptual level study of potential fish exclusion measures while accounting for the local hydrology, hydraulics, operational requirements, constructability and environmental constraints. Following the completion of the conceptual study, construction of a new weir featured with a Coanda Screen was selected as the preferred option, as it fulfilled the project objectives and addressed the need for decommissioning of the aging timber weir and concrete headgate. KGS Group completed the detailed design of the new weir and Coanda screen, which also included a new rock ramp fishway to re-establish hydraulic connectivity and bi-directional fish passage in the creek. The construction of the Coanda fish exclusion screen is a first in Saskatchewan. This project provided a novel solution to an environmental problem involving stranding of federally protected fish species, while addressing the need for decommissioning and renewal of the aging infrastructure. Construction was completed in the winter 2022/2023, with the first successful operation of the new system in the spring 2023.
Borduas Ballroom 3 **May 6**	**Session 13: Hydrodynamics in fishway designs 1**	**Chairs: Bryan Sojkowski**
16:00	Lucas Stiles	3D CFD Modeling – A Cornerstone of the Fish Passage Design Process Kleinschmidt Associates Lucas.Stiles@KleinschmidtGroup.com Jesse Waldrip, Kleinschmidt Associates All over the world fish find man-made structures impeding their migratory pathways, impacting their life cycle, and ultimately challenging their survival. In many countries, the owners of hydroelectric dams are required to provide passage of migratory fish over, around, or through their hydroelectric stations.

		One of the technologies that has become a foundational tool in the fish passage design process is 3-Dimensional (3D) Computational Fluid Dynamic (CFD) modeling. CFD modeling can be instrumental in analyzing the flow field and hydraulic conditions in and around hydroelectric stations, assessing fish passage facilities built to mitigate their environmental impact, and determining passage facilities ability to meet standard engineering design criteria identified by regulatory agencies and other professional and academic experts. Providing attractive and effective hydraulic conditions at fish passage facilities is instrumental for achieving successful passage of migratory fish species. This presentation will provide a high-level overview of 3D CFD modeling technologies and will focus on the benefits of using 3D CFD modeling in the fish passage design process. This presentation will identify some of the common questions and challenges that can be resolved through the use of 3D CFD modeling and will also provide a number of case studies highlighting some specific real-world applications of 3D CFD modeling in the planning and design of both upstream and downstream fish passage facilities. We will review how 3D CFD modeling can be used to analyze far-field attraction (ability of fish to sense the presence of a route of passage in the larger field of flow as they approach a dam), near-field attraction (ability of fish to successfully enter a fishway), and the internal hydraulics of a fishway (detailed analysis of the conveyance flow and attraction flow through the hydraulic pathways within fishway structures).
16:15	Robin Andersson	Simplifying Faunapassage Outlet Positioning: A Hydraulic Approach Luleå University of Technology robin.andersson@ltu.se There are a broad number of publications within the area of faunapassages, a thorough review can be found in (Silva, et.al. 2017). There are no established ""global"" objective goals or perfomance criteria to determine which conditions that are actually favourable for faunapassages. This leads to problems when assessing existing faunapassages from an existing framework. Although the performance of faunapassages i largely dependent on the context, i.e. where they are positioned. There is a need to find common denominators concerning faunapassages. When performing studies or simulations for planning faunapassages the investigations can become extensive, since every facility is planned according to the context of location and the resulting solutions are indiviualized. Many existing facilities are also very remote, which is problematic when performing field measurements as heavy equipment may have to be transported to the site. The goal of this study is to develop a method for determining the optimal location for a fish passage exit based on the mean flow (momentum) characteristics. I.e., Estimating to which extent the fish passage flow will effect the mean flow in relation to the turbine outlet. This will enable relatively simple methods of evaluation in the field with easy to bring equipment, such as hand-held velocimeters or drones with specific equipment. The methodology evaluated here will be used as a basis for a set of field measurements on specific faunapassages in Sweden, which have been deemed to work either good or bad.
16:30	Sebastian Schwindt	Fish passage and flood safety: multi-model perspectives Institute for Modelling Hydraulic and Environmental Systems (IWS), University of Stuttgart sebastian.schwindt@iws.uni-stuttgart.de Federica Scolari, IWS; Stefan Haun, IWS; Silke Wieprecht, IWS In the hydro-environment, infrastructure tends to collide with ecosystem functions. Concrete structures, like dams, are necessary elements to protect and power our society, but they represent rigid frontiers for ecological agents. For instance, dams enable hydropower generation and regulation of floods or droughts, but no fish can cross a dam. Acknowledging this well-known problem, fish passage structures are being built worldwide, but with varying efficiency. Ideally, artificial near-natural morphodynamic channels enable fish migration, rest, and reproduction. However, practical constraints sometimes necessitate space-efficient fish pass layouts. Spatial efficiency, achieved with concrete-lined vertical slot passes, creates bottlenecks for fish due to fast-flowing constrictions and high-turbulence pools. Numerous guidelines exist for the careful design of such high flow-energy environments for fish passage, but often with too generalized instructions, such as cross-section averaged flow velocity limits for target fish species. Thus, more precise modeling in three dimensions (3d) is required to assess and improve suitable hydrodynamic conditions for target fish species. 3d modeling can be achieved numerically or in a lab flume where

		complex flow fields can be assessed with computer vision tools or modern measurement devices. Additionally, a 3d model can serve to evaluate flood safety in the vicinity of critical infrastructure. This study examines a case in an urban environment surrounded by a city highway, metro station, and high-voltage transmission line, where fish passage and flood safety are strict design requirements. To verify hydraulic conditions at average flows and flood safety for a 100-year event, a 1:3-scale physical lab flume and multiple types of numerical models were built. Every model provided new insights and highlighted critical design aspects. The conclusions of this study substantiate a comprehensive synopsis of the competencies of particular modeling concepts for simulating a technical fish pass.
16:45	Philipp Werner	Experimental analysis of climate change influenced flows on an adapted vertical slot pass University of Applied Sciences philipp.werner@h-da.de Nicole Saenger, Darmstadt University of Applied Sciences, Faculty of Civil- and Environmental Engineering, Hydraulic Laboratory, Germany Climate-driven environmental change is predicted to accelerate over the coming decades (Davis et al. 2020). Generally, rising atmospheric CO2 concentration affects runoff and stream flows (Skinner et al. 2017). According to Lange et al. (2020), it increases temperatures and changes precipitation and runoff patterns, greater variability in temperature, flows, and water levels, and increases in the frequency of extreme events. Interacting with climate change are also non-climatic hazards such as habitat loss, a shift of habitats, fragmentation, water abstraction, and nutrient enrichment (Tanneberger et al. 2017; Ojanen and Minkkinen 2020; Page and Baird 2016). Those changes impact the functionality of vertical slot passes and thus the connectivity of aquatic ecosystems. In the first experiment, the influence of anthropogenic climate change was detected. This was identified by increasing and decreasing the flow according to future flow scenarios. The results showed an impact on the maximal velocity and energy dissipation, which are with the water level the controlling parameters inside the pools of the vertical slot pass. Now, in a second experiment, the vertical slot pass will be adapted. The adaptations will be geometrical obstacles that are placed strategically inside the pool. The same flows as the first experiments will be introduced. The measurements are, as the first experiment, compared with the policy (DWA M-509). The goal is to meet the given threshold, which specifies a functionality. The comparison will give an overview of how high the adaptability of vertical slot passes is. To conclude, this paper will focus on the adaptability of vertical slot passes following the effects of anthropogenic climate change on flows. To finish, this paper will give an overview of the data that was gathered during the experiments and will reflect on how to adapt vertical slot passes to be resilient in a changing world.
17:00	Haitao Liu	A study on the connection mode of fish upstream passage in the dam downstream water reducing reach of hydropower station China institute of water resources and hydropower research htliou@163.com Guangning Li, China institute of water resources and hydropower research; Shuangke Sun, China institute of water resources and hydropower research; Tiegang Zheng, China institute of water resources and hydropower research The Yao-jia-ping hydropower station is planned to be built on the Qing-jiang River in Hubei province, China. The high arch dam of the hydropower station has disrupted the connectivity of the river, so it is necessary to build fish elevators and fishways to help the migratory fish swim upstream. However, the tail water flow during the power plant operation is significantly reduced compared to the natural flow of the river, resulting in a series laborious sections of high flow velocity and low water depth in the river channel within 10km downstream of the dam, that make it difficult for migratory fish to reach the upstream collection and transportation area through the sections. This article focuses on the main operating conditions of the power plants and uses mathematical models to analyze the changes in flow velocity and water depth along the water reducing river section, and determines the mainly 6 laborious river sections according to the cruise swimming speed of local migratory fish. The drop of these section is 2-39m, and the bottom slope is 2.7-8.7%. In response to this issue, the idea of constructing a simulated natural fishway along the riverbank was proposed, which involves excavating a channel along one side of the riverbank beach, using pebbles to construct the pool room to form a

		simulated natural fishway, reducing the flow velocity to the local fish cruise swimming speed. The concept of equivalent roughness of natural fishway is proposed based on the arrangement of pebbles, which is convenient for the mathematical model analysis. Through a mathematical model of water flow, the layout plan of the natural fishway is optimized, and the diversion ratio between the main channel and the fishway is reasonably adjusted, to ensure the continuous and effective low velocity fish passage can be formed in the river channel during the operation of the power station. The river regulation plan has been adopted by the design.
17:15	Damien Calluaud	Vertical double slot fishways flow: influence of geometry, slope and discharge Institut Pprime, CNRS-Université de Poitiers-ISAE Ensma damien.calluaud@univ-poitiers.fr A.F. Lejeune, Institut Pprime, CNRS-Université de Poitiers-ISAE Ensma, Pôle R&D écohydraulique, OFB-IMFT-PPRIME; P. Sagne, Office Français de la Biodiversité, Pôle R&D écohydraulique, OFB-IMFT-PPRIME; S. Richard, Office Français de la Biodiversité, Pôle R&D écohydraulique, OFB-IMFT-PPRIME; G. Pineau, Institut Pprime, CNRS-Université de Poitiers-ISAE Ensma, Pôle R&D écohydraulique, OFB-IMFT-PPRIME; L. David, Institut Pprime, CNRS-Université de Poitiers-ISAE Ensma, Pôle R&D écohydraulique, OFB-IMFT-PPRIME Hydraulic conditions in Vertical Double Slot Fishways (VDSF) are less studied than in Vertical single Slot Fishways (VSF) and have not undergone the same development in order to optimize flow characteristics respect to fish swimming abilities and behaviour. Therefore, flow features inside VDSF pools are poorly known and their current design criteria are based on those of VSF, without any reliable study validating this approach. Here, a parametric study is presented based on laboratory measurements, carried out on a scale model of a VDSF, and numerical simulations . Velocity measurements were performed using Acoustic Doppler Velocimetry and Particle Image Velocimetry. Water levels, measured with ultrasonic probes, were used to complete the experimental data set. These data, supplemented by Large Eddy Simulation and Volume Of Fluid numerical simulations, were used to carry out a parametric study comparison. Six parameters were tested: the slope (4, 5 and 7.5%), the scaled flow rate (4.8, 5.6 and 7.0), the ratio between pool length and slot width (9, 11.1 and 13), the ratio between pool width and slot width (8.89, 12 and 15) and the slot width (50, 75 and 100 mm). The influences of those parameters on the turbulent flow features and on the hydraulic and kinematic quantities were quantified, enabling a hydraulic optimization in the design of VDSF. Specific attention was devoted to analysing the maps showing potential ‘kinematic difficulties’ and favourable zones for the upstream migration of fish using this type of fishway.
17:30	Vincent Autier	Designing Technical Upstream Fishways Capable of Adjusting to Changing Environmental Conditions McMillen, Inc. autier@mcmillen.com Obsolete dams which have exceeded their design life and no longer serve their primary purpose are often forgotten, creating impassable barriers which disrupt the natural function of the river and impact the equilibrium of a fragile ecosystem. There is a renewed consensus that in such cases, dam removal is the ideal way to provide connectivity and fish passage. When dam removal is not feasible or when new dams are being built, the next best thing is to provide fish passage with adjustability. This paper covers the need to design technical upstream fishways capable of adjusting to changing conditions. Changing conditions may be environmental and influenced by climate change, such as different water quality, temperature, or flow rates. Changing conditions may also be stakeholder imposed, such as the need to increase efficiency to a greater range of species, increase operation window, and/or increase the low and high tailwater elevations. Addressing these changes may prove difficult with a concrete structure that offers minute flexibility. This paper argues that the flexibility for adaptive management should be built into the design with consideration for unexpected changes. It examines a case study to demonstrate the planning, construction, and operation of two upstream fishways, one temporary and one permanent, as part of the construction of a third hydroelectric dam on the Peace River in northeast British Columbia, Canada (Site C Clean Energy Project). The presentation focuses on lessons learned from the temporary facility and how they informed the design and construction of the permanent facility.
Leduc-Fortin May 6	**Session 14: Vegetation in ecohydraulics:**	**Chairs: Valérie Tremblay**

	Wetlands and coastal areas	
16:00	Jacob Stolle	Seasonal change in wave attenuation through Canadian saltmarshes INRS jacob.stolle@inrs.ca Ganga Caldera INRS; Enda Murphy NRC; Paul Knox NRC; Damien Pham Van Bang ÉTS Nature-based Solutions (NbS) for coastal protection have been recognized by international and national bodies as sustainable, economical, and eco-friendly alternatives to conventional grey structures, particularly considering the long-term impacts of climate change. NbS to mitigate coastal flood and erosion risks can take a variety of forms depending on the coastal environment and design objectives. Living shorelines, which incorporate natural elements such as saltmarshes, can provide flood and erosion risk management benefits while delivering multiple co-benefits, such as improved biodiversity and carbon storage. However, there are a range of roadblocks that limited their implementation including a limited long-term monitoring of their performance in the Canadian climate. The primary objective of this study is to analyze the evolution of the performance of newly planted saltmarsh vegetation under wave action. The experiments were performed in the large-scale wave flume (120 m × 5 m × 5 m) at the Institut national de la recherche scientifique (INRS). An idealized marsh profile consisted of a 1:10 slope to a 60 m marsh platform (1:100 slope) was constructed from a well-graded fine sand. A 30 m marsh consisting of three native Canadian East Coast species (Sporobolus alterniflorus, Sporobolus pumilus, Sporobolus michauxianus) planted in 10 m sections with an inter-plant spacing of 0.15 m. A series of wave tests using a range of wave heights (0.10 – 0.25 m), wave periods (2 and 4 s), and water depths (2.5 m and 2.75 m) were performed over a three-month period. Throughout the experiments, important biomechanical properties (biomass, height, and stiffness) were monitored to see how they evolved through time. The experiments showed that the plant biomass contributed to the attenuation of wave energy. The results of these experiments will enable practitioners to better understand the seasonal performance of newly installed living shorelines.
16:15	Dominic Thériault	AI-Powered Modeling for Assessing the impact of changing water levels on Great Lakes Coastal Wetlands Environment and Climate Change Canada (ECCC) dominic.theriault@ec.gc.ca Marianne Bachand, ECCC; Jean Morin, ECCC; Rémi Gosselin, ECCC; Caroline Sévigny, ECCC; Antoine Maranda, ECCC Great Lakes coastal wetlands are invaluable ecosystems, supporting native biodiversity and providing essential ecosystem services, such as nutrient capture, carbon storage, and erosion reduction. Nevertheless, these dynamic ecosystems are facing concerning declines in coverage and biodiversity due to several factors, including human development, drainage, invasive species, and changing water levels. Given the strong influence of water level fluctuations on coastal wetlands, employing decision-making tools to assess their impacts on wetland distribution and biodiversity is essential. The Coastal Wetland Response Model (CWRM), a supervised machine learning model, predicts the annual spatio-temporal distribution of coastal wetlands according to different water-level time series. It combines machine learning techniques with a rule-based framework to guarantee that inter-annual successions of wetland classes adhere to their respective tolerance thresholds. It utilizes hydro-period variables which represent the magnitude and variability of water depth (period, amplitude of fluctuations, percent of time flooded, maximum, minimum, mean water depth) and topographic features (slope and curvature). The model classifies wetland types into broad categories, including submerged aquatic vegetation, emergent marshes, wet meadows, and swamps. Validation and calibration involve extensive data from multiple sources, covering several years, such as quadrat samples, photo-interpretation maps, and remote sensing data in more than 70 different wetland sites surrounding Lake Ontario. The CWRM has been applied in different projects and water bodies and achieved an overall accuracy greater than 75%. This powerful model facilitates the comparison of different water level scenarios, offering valuable insights to inform policies and guide decision-makers. Its application in the Great Lakes Protection Initiative has been crucial in predicting the spatio-temporal distribution of wetlands in the context of climate change. Furthermore, the CWRM maintains its significant role within the Great

		Lakes Adaptive Management project, actively contributing to the reassessment of Lake Ontario's regulation plan.
16:30	Antoine Maranda	Machine Learning Elevation Correction Model for Coastal Wetlands in the Laurentian Great Lakes. Environnement et Changement climatique Canada (ECCC) antoine.maranda@ec.gc.ca Dominic Thériault, Environnement et Changement climatique; Marianne Bachand, Environnement et Changement climatique; Jean Morin, Environnement et Changement climatique Accurate characterization of elevation is critical to better understand coastal wetland behaviour under different water level scenarios and such characterization is generally achieved through high-definition Digital Terrain Models (DTM). Albeit the increasing availability of high precision airborne LIDAR surveys, creation of accurate LIDAR-derived DTMs in coastal wetlands still represents a major challenge for two reasons: (1) The inability of laser pulse to penetrate dense vegetation canopy and (2) laser pulse reflectance on water surface. To tackle this challenge, an elevation correction technique in coastal wetlands, based on elevation values and Normalized Difference Vegetation Index (NDVI), was applied in previous studies with convincing results. Although, the models developed are site specific and rely on ground truth points and high accuracy multispectral imagery, which makes it unrealistic to apply on all coastal wetlands over a vast area such as the Laurentian Great Lakes. I this context, we developed a broader approach where a unique elevation correction model, also based on elevation and NDVI values, can be applied to all coastal wetlands in the Laurentian Great Lakes. This model based on machine-learning Random Forest algorithm, was built using 3844 ground truth points coming from 29 coastal wetlands in Lake Ontario with NDVI values coming from 10m-resolution Sentinel 2 images. Over 100 folds, 20 sites were randomly selected for training and 9 sites kept for validation and testing with average error reduction of 40% (17cm). To verify broader applicability, the model was also tested on 11 coastal wetlands (2594 ground truth points) from Detroit River, Lake Erie and Lake St. Clair with average error reduction of 36% (19cm). Such results suggest that our approach can be used to develop a model improving elevation accuracy in coastal wetlands DTMs that is applicable over a vast area of interest such as the Laurentian Great Lakes.
16:45	Rémi Gosselin	Extracting local physical variables for wetlands response modelling from large-scale climatic predictions of the Great Lakes ECCC remi.gosselin@ec.gc.ca Rémi Gosselin; Caroline Sévigny; Mouna Doghri; Olivier Champoux; Jean Morin Coastal wetlands in the Great Lakes are areas of rich biodiversity that play a vital role for local ecosystems, by providing services like nutrient capture, wildlife habitat, carbon storage, flood mitigation or coastal erosion control. Their vitality is greatly influenced by local water level fluctuations. Regulated systems like the Great Lakes are regularly reviewed for their efficiency. Predicting water levels across the system is invaluable for their management. Climate change models, and past weather reanalysis, are both based on global weather models that provide large-scale variables, such as regional winds and precipitations that are used to estimate the average water levels with hydrological models. By incorporating various physical processes, such as the various wind effects or the impact of discharge values on flow velocities and river slopes, it is possible to recreate time-series of important physical variables at different locations all over the system. This enrichment of the global model results with local variations greatly improves the dataset used for wetland response modeling. While technically feasible and applicable here, a transient-based hydrodynamic modeling approach requires very high computational resources and limits the number of simulation runs possible. Thus, a scenario-based approach has been developed to address this concern. The method recreates time-series using interpolation between the different scenarios, each representing various equilibrium states under different conditions. These scenarios are computed using a 2D hydrodynamic model and the results shows an error on water levels in the range of +/- 5 cm for the Great Lakes. Even though a few specific transient phenomena cannot be captured using this method, such as seiches or tidal waves propagation, this approach proves to be an efficient and powerful method for recreating time-series with relatively short temporal scales and fine spatial

		resolutions, down to the wetland scales. The data generated serves as inputs for complex wetland modeling such as the Coastal Wetland Response Model (CWRM).
17:00	Graham Hill	Restoring coastal ecosystems, rematriating landscapes, and contributing to coastal resilience NHC ghill@nhcweb.com Caitlin Pierzchalski, Comox Valley Project Watershed; Krissy Brown, K'ómoks First Nation The Courtenay River and the upstream Puntledge and Tsolum rivers serve as critical salmon migration corridors, supporting the recently listed East Vancouver Island Chinook salmon runs. The K'ómoks Estuary, where these rivers meet tidewater, is highly productive and ecologically significant, ranking among the top ten estuaries in Southwestern BC. Kus-kus-sum (KKS) is a partnership project between Project Watershed, the K'ómoks First Nation (KFN), and the City of Courtenay to restore a former industrial sawmill site in the heart of the K'ómoks Estuary. The project's objectives are ecological and cultural restoration; reconciliation; and, climate change mitigation and adaptation. The project aims to restore 4 hectares of tidal marsh and riparian forest, and to rematriate the land back the KFN. The original sawmill, constructed in the 1940s, was permanently decommissioned in 2004. Following its closure, site reclamation efforts were initiated to remove contaminated materials, resulting in the issuance of a provincial Certificate of Compliance. Project Watershed began exploring the purchase of the site for restoration in 2015. Extensive fundraising ensued, leading to the successful acquisition of the site, followed by the development of an environmental restoration plan. This plan focuses on natural biodiversity, intertidal wetland restoration, off-channel habitat creation, tidal marsh zones, and riparian tidal forest restoration. Additionally, it addresses climate change impacts through flood attenuation, sea level rise adaptation, and carbon sequestration, while reinstating cultural and traditional uses for the KFN community. Restoration activities started in 2020, involving utility disconnection, infrastructure removal, and excavation. By 2023, bulk excavation, grading, and site vegetation were underway. This presentation explores the cultural context, project history, land acquisition, engineering, and construction progress, highlighting the ecological restoration processes and ongoing monitoring efforts. Kus-kus-sum stands as a testament to collaborative efforts in restoring coastal ecosystems, preserving cultural heritage, and building resilience in the face of environmental challenges.
17:15	Samantha Chan	Utilizing Drone Imagery to Predict Coastal Protection Provided by Vegetation Massachusetts Institute of Technology samchan2@mit.edu Heidi Nepf, MIT; Megan Terrell, Waquoit Bay National Estuarine Research Reserve Coastal vegetation can provide protection to the coastline through its root structures, which reduce soil erosion, and its stem structures, which dissipate wave energy. The drag a plant induces could be used to quantify the amount of coastal protection that is provided. This study combined field measurements and drone surveys to develop methods for quantifying vegetation drag, focusing on Spartina alterniflora, a smooth cordgrass native to the study site: Waquoit Bay National Estuarine Research Reserve. The drag of a single plant is proportional to frontal area. The drag per bed area is proportional to the drag of a single plant and the number of stems per bed area. This study collected plant samples over the growing season to generate allometric relationships between tiller height and individual plant biomass and frontal area, which provides a way to translate remotely-sensed measures of biomass into stem count and frontal area per bed area. The frontal area was measured through digital imaging of individual plants. The elastic modulus of the stem was also measured using an Instron testing machine. Several vegetation metrics, such as Normalized Difference Vegetation Index (NDVI), were considered. Using sixteen 1m x 1m test plots, vegetation metrics extracted from drone multispectral imagery were compared to measured stem count and estimated biomass. Stem count was estimated using a 0.25m x 0.25m quadrat. The study compared two different years and three time points within a growing season [August 2022; June, August, October 2023]. In addition, at three plots the stem count was manually altered by cutting out 50% and 100% of the plants.

Pilot **May 6**	**Session 15: Fish passage: opportunities for funding and collaboration 1**	**Chairs: Michelle Lennox**
16:00	Nick Anderson	Barriers to Fish Passage and Historic Investments under the Bipartisan Infrastructure Law NOAA Fisheries Nick.anderson@noaa.gov Melanie Harris, NOAA Fisheries; Alex McOwen, NOAA Fisheries; Bjorn Lake, NOAA Fisheries
16:15	Gillian O'Doherty	Fish Passage and Habitat Connectivity: Federal Highway Administration Federal Highway Administration gillian.odoherty@dot.gov Joe Krolak, Federal Highway Administration The National Culvert Removal, Replacement, and Restoration Grant Program (Culvert Aquatic Organism Passage (AOP) Program) is an annual competitive grant program administered by the Federal Highway Administration and established by the Bipartisan Infrastructure Law (BIL). Grants are awarded to eligible entities for projects that replace, remove, and repair culverts or weirs that meaningfully improve or restore fish passage and habitat connectivity for anadromous fish, while also reducing road flood risk and ensuring connectivity for human communities. In its first year, the Culvert AOP Program provided funding to 59 tribal, state, and local governments to advance 169 projects nationwide. This presentation will describe the funding opportunity, discuss the collaborative approach used to establish and implement the program, and highlight fish passage projects funded through this program.
16:30	Arianna Ramirez	Fish Passage and Habitat Connectivity: U.S. Fish and Wildlife Service U.S. Fish and Wildlife Service arianna_ramirez@fws.gov The U.S. Fish and Wildlife Service's National Fish Passage Program (NFPP) works with local communities on a voluntary basis to restore rivers and conserve our nation's aquatic resources by removing or bypassing barriers. The Bipartisan Infrastructure Law (BIL) provided $200 million to the program over five years to restore fish and wildlife passage by removing in-stream barriers and providing technical assistance to partners. This presentation will highlight the NFPP as a partner-driven model for collaborative, impactful, fish passage funding through both BIL and base funding. It will also highlight some of the initiatives FWS has undertaken to advance interagency collaboration on fish passage, including the Federal Interagency Fish Passage Task Force and Fish Passage Portal.
16:45	Brian Kelder	Fish Passage and Habitat Connectivity: National Marine Fisheries Service NOAA brian.kelder@noaa.gov NOAA Fisheries' Restoration Center works to reopen migratory pathways and restore access to healthy habitat for fish. These efforts help recover threatened and endangered migratory fish and support the sustainability of commercial and recreational fisheries. Under the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA), the Restoration Center is the steward of the fish passage and tribal fish passage grant programs to support in-stream barrier removal projects and restore access to healthy habitat for fish nationwide. In their first year, these programs funded 39 fish passage projects across the United States. This presentation will describe the focus of the funding opportunity; discuss the Restoration Center's engagement with a diverse range of community groups, including Tribes; and highlight fish passage projects funded through this program.
17:00	Nancy Munn	Restoration of climate-smart fish passage as a tool in species recovery in the Pacific Northwest National Marine Fisheries Service nancy.munn@noaa.gov 28 species of Pacific salmon and steelhead were listed as threatened or endangered under the Endangered Species Act in the 1990s and early 2000s.

		Since that time, with few exceptions, the status of these species has remained static or declined. A primary cause for decline is blocked access to historical habitat by high head dams but also by thousands of culverts that were installed decades before the needs of fish were fully understood. Even culverts that passed all life stages of salmon at one time have become barriers over time due to changes in the landscape and stream flows resulting from development, fire, logging, and climate change. Recent advances in NOAA's fish passage criteria support structures that are more resilient to changes in the landscape, and provide fish passage long into the future. The criteria support moving fish into cold water of headwater streams that provide the climate resilience needed for species persistence. I will showcase two examples of restoration projects that NOAA is funding in cooperation with Trout Unlimited and the Tulalip Tribe to improve fish passage and support species recovery: Enloe Dam and 16 barrier removal projects in the Snohomish River watershed (Tulalip Tribe). Enloe Dam on the Similkameen River (a tributary to the Columbia River) has blocked fish passage for 100 years. Its removal would open access to cold water habitat, improve tribal fishing opportunities, and reduce the risk of flooding. The projects on the Snohomish River remove or replace culverts with structures designed to withstand climate change. They will restore connectivity to more than 32 miles of habitat in priority streams for the recovery of salmon. Presentation as part of Panel Session: Fish Passage and Habitat Connectivity - Opportunities for Funding and Collaboration
17:15	James Turek	Scaling-Up Community-Based Fish Passage Restoration through the Bipartisan Infrastructure Law and Inflation Reduction Act: Successes and Challenges in Southern New England NOAA Restoration Center james.g.turek@noaa.gov Eric Hutchins, NOAA Restoration Center; Brian Kolder, NOAA Restoration Center; Danielle Perry, NOAA Restoration Center NOAA Fisheries' Office of Habitat Conservation (OHC) has been providing funds and technical assistance for fish passage restoration through our community-based and natural resource damage restoration programs since 1996. We have worked diligently with our partners on 64 dam removals, in addition to 58 technical and nature-like fishway and culvert replacement projects in southern New England watersheds. The enactment of BIL/IRA legislation has infused unprecedented funding levels and stimulated both a greater number and scaling-up of new and ongoing fish passage restoration projects. The OHC and its many Greater Atlantic Region (GARFO) partners are underway with this vitally important scaled-up approach that includes both dam removals which have been priority targets for decades, as well as hydro dam decommissioning and removals that are now a reality with the significant NOAA funds available. We are gaining invaluable, but challenging experiences in successfully advancing implementation of these projects. NOAA's 2023 Atlantic Coast-wide River Herring Habitat Conservation Plan and our comprehensive plans for the Connecticut and Merrimack River watersheds are serving as guidance, along with our partners' input in prioritizing fish passage restoration and fulfilling the goals of the BIL/IRA that include increased climate resilience and economic vitality to local communities, particularly tribes and underserved communities. Our presentation discusses exemplary case studies for ongoing projects in southern New England, addressing various constraints and challenges with the projects, and solutions that can be valuable to future efforts in the GARFO and elsewhere.
17:30	Dana McCoskey	Working with the Water Power Technologies Office to advance fish passage science and technologies US Department of Energy, Water Power Technologies Office dana.mccoskey@ee.doe.gov An overview of fish passage and protection research and development supported by the U.S. Department of Energy's Water Power Technologies Office's (WPTO) Hydropower Program will be shared to highlight science and technology innovations. WPTO's funding mechanisms will be outlined to clarify pathways for industry, small businesses, agencies, non-governmental organizations, universities, tribes, and others to get involved as partners and performers. A summary of feedback WPTO has received on fish passage and aquatic resources protection from hydropower community stakeholders at Environmental and Industry Summits and with the reimaging of the 2023

		reimaging of the Hydropower Vision Roadmap will be provided to illustrate research key needs of the sector relevant to technology innovation and resource protections.
17:45-18:45	**Poster session and kiosques – Foyer (see list after the program)**	

May 7 (Tuesday) Room/hours		
7:00-8:30	**Breakfast served at Level 2 Jean-Paul Lemieux**	
7:30-8:30	At breakfast, find the AFS-BES/ASCE-EWRI Joint Committee on Fisheries Engineering and Science's table for the an informal recruitment meeting	
7:00-8:15	**Registration desk – Foyer** **If you have not registered yet after this time, please do so in the secretariat room or find a member of the organizing committee (green name tag) to help!**	
8:30-9:30	**Intro - Ballrooms** **Plenary 3: Carole-Anne Gillis: Carole-Anne Gillis: A Western scientist in Gespe'gewa'gi – An unlearning journey**	
9:30-10:15	**Break - Foyer**	
Suzor-Côté Ballroom 1 **May 7**	**Session 16: Understanding and managing aquatic habitats**	**Chairs: Francine Mejia**
10:15	Gregory Pasternack	Near-Census Evaluation of Anadromous Salmonid Cover Types In A Regulated Gravel River University of California at Davis gpast@ucdavis.edu Maurice D Ledoyen, University of California at Davis The availability and distribution of suitable physical cover features are important ecological variables influencing the presence, abundance, and behavior of organisms. In riverine ecosystems, salmonids prioritize various cover features at all life stages, such as streamwood, aquatic vegetation, riparian shrubs, and large bed elements (LBEs, constituting boulders and bedrock ~ >0.5 m dia.). Physical cover is especially critical for juvenile salmonids, providing a predation buffer, hydraulic and thermal refugia, visual isolation, and increased foraging opportunities. The purpose of this study was to map diverse cover types in unprecedented detail, analyze their spatial and statistical attributes, and then evaluate their habitat roles for fry and juvenile size classes of rearing Chinook salmon (Oncorhynchus tshawytscha) and rainbow trout (O. mykiss). The study mapped, modeled, and evaluated ~ 37.1 km of the lower Yuba River (California, USA) at submeter resolution. Cover data was generated from topo-bathymetric data and 2-cm resolution aerial imagery by expert-based object mapping and automated object extraction workflows. New expert-based cover HSCs were developed in this study. Spatially based aggregate cover availability statistics were generated for each discharge, hydrologic zone, geomorphic reach, and river landform. Ecohydraulic model outputs provided a more comprehensive analysis of discharge-based preferred habitat availability, especially including new findings about flood refugia. Finally, observed cover objects were used to train a Random Forest machine learning algorithm to predict the locations of each type solely on the basis of meter-resolution bare-Earth terrain metrics.
10:30	Mathias Chabal	Predicting bed material size along Atlantic salmon rivers from LiDAR data INRS-ETE mathias.chabal@inrs.ca Charles Gignac, INRS, CGQ; Claudine Boyer, INRS; André St-Hilaire, INRS; Jean-Nicolas Bujold, MELCCFP; Normand Bergeron, INRS Riverbed granulometry is one of the key variables for Atlantic salmon (Salmo salar) habitat. Although the field method for measuring this variable is relatively simple to perform locally, it becomes extremely time-consuming when applied to the entire course of a river. Remote sensing methods have been proposed to estimate bed material size from topographic and hydrological data (Buffington et al. 2004, Gorman et al. 2011, Snyder et al. 2012). We predicted bed material size using 1) the method of Buffington et al. (2004) based on flow competence at bankfull discharge and 2) the method of Gorman et al. (2011) using an empirical

		relationship between unit stream power at bankfull discharge and bed material size measured in the field. A digital elevation model of the channel bed and channel margins was produced by combining Orthophotos (30 cm resolution), discharge data, and water surface slope information extracted from raw Lidar data were used to produce channel bathymetry from the Hydraulically Assisted Bathymetry method of Fonstad & Marcus (2005). HEC-RAS hydraulic simulation were conducted at bankfull along the entire length of the river. Field data were collected to measure the median diameter of the granulometry (D50) on 5 Québec (Canada) rivers (Matane, Trinité, Sainte-Marguerite-Nord-Est, York and Les Escoumins) for a total of 118 sites for the calibration and the validation of the models. The presentation will compare the results obtained by the two models, according to the type of channel geomorphic units and the methods used to arrive at these results.
10:45	Simon Joly-Naud	Formation and persistence of cool-water zones in Atlantic salmon river pools INRS-ETE Simon.joly-naud@inrs.ca Normand Bergeron, INRS-ETE; Isabelle Laurion, INRS-ETE When river temperature exceeds the optimal thermal range of Atlantic salmon, large aggregations of adults are observed at the bottom of specific river pools, suggesting they thermoregulate in cool-water zones (CWZ). Although CWZs are thought to originate from groundwater or hyporheic influxes, their formation and persistence is still poorly documented. In summer 2022-2023, we monitored the vertical thermal structure of 24 pools from eight Atlantic salmon rivers (Qc, Canada). Pools were selected to cover a broad range of bed morphology and flow turbulence. Each pool was instrumented for a period of 72h to 4 months with a mooring comprised of 10-12 thermographs distributed vertically. Surprisingly, vertical temperature differences (ΔT) of at least 0.2oC were identified in all surveyed pools: 2 (8%) were linked to groundwater inflow, 8 (34%) to hyporheic flow resurgence, and 14 (58%) to another mechanism causing the daily formation and breakdown of CWZs. We suggest that these diurnal CWZs are linked to the diel cycle of water temperature and density, with nighttime (cooler and denser) water sinking to the bottom of the pool and daytime (warmer and more buoyant) water floating atop of the cool bottom water. The suggestion is supported by the statistically significant effect of diel water temperature amplitude on the maximum daily ΔT of these CWZs. Groundwater produced the largest (max 2.7°C) and most persistent ΔT. Hyporheic flow generated smaller (max 1.5°C) and less persistent ΔT. Diurnal ΔT were generally small (0.2-1.5°C) but in the detectable range of salmon. The three formative mechanisms are significantly dependent on flow stability preventing the mixing of cool water. The diurnal formation of cool-water zones in river pools is an understudied process that could play an important role for the conservation of salmon in the current context of river warming.
11:00	Yaqi Luo	Response of macroinvertebrate communities to the environmental patterns in highland river networks Tsinghua University luoyq16@163.com The Yarlung Tsangpo Basin (YTB), situated in the Tibetan Plateau (TP) and renowned as the world's highest river basin, possesses oligotrophic and hypometabolic ecosystems that are vulnerable to both anthropogenic and natural disturbances. The unique fluvial processes of YTB's rivers, influenced by the TP's uplift, are believed to influence geographic patterns, consequently altering the dynamics of this highland river ecosystem. However, there is a gap in our understanding of the diversity, structural, functional and trophic characteristics of biotic communities in response to the environmental patterns within YTB's river networks. In this study, we investigated the main stream of the Yarlung Tsangpo River (YTR) and its tributary, the Nyang River (NR), by sampling macroinvertebrates and measuring a variety of environmental variables. Through hierarchical clustering, three biotopes, primarily characterized by their substrates, were identified, i.e., the biotopes paved by the boulders (Bb), cobbles (Bc), and gravels (Bg). The YTR was found to contain all three biotope types, whereas the NR featured only Bb and Bc. The results indicated significant ($p < 0.05$) differences in the diversity, taxonomic composition, and biomass of macroinvertebrate communities across biotopes. Notably, Bc exhibited the highest levels of macroinvertebrate abundance, richness, and biomass, while Bg displayed the lowest. In addition, grain size, flow velocity, and dissolved oxygen were recognized by the redundancy and correlation analyses as the three most important environmental variables influencing the macroinvertebrate communities in predictable patterns. This study enhances our understanding of

		characteristics of biotic communities in terms of the diversity, taxonomic composition, functional traits and trophic interactions, and provides insights into what of and how does the environmental patterns influence these characteristics in highland rivers. This study further underscores the need for future research to comprehensively understand the fluvial and biotic processes in this unique highland river system.
11:15	Francesca Padoan	On the generality of the Habitat Suitability Indexes of brown trout (Salmo trutta L.) in relation to ecohydraulic variables EPFL - PL-LCH francesca.padoan@epfl.ch Giulio Calvani, PL-LCH – EPFL; Giovanni de Cesare, PL-LCH – EPFL; Paolo Perona, PL-LCH – EPFL The decline in biodiversity within freshwater ecosystems is a pressing issue influenced by pollution levels, colonization by invasive species all exacerbated by ongoing changes in environmental conditions. River restoration works and activities aimed at safeguarding freshwater species, e.g., like the brown trout (Salmo trutta L.), have today been introduced in worldwide river management agendas. The design and the positive outcomes of the proposed restoration measures on river ecomorphology are usually evaluated based on some empirical indicators. One of the most popular quantitative tools used by aquatic ecologists, river scientists, and engineers is the Habitat Suitability Index (HSI). The HSI considers multiple environmental factors, including flow velocity, water depth, and substrate type, to evaluate the suitability of a specific river-reach for the well-being of brown trout. Although such curves present differences related to their original geographical location and other spurious factors of variability, they also show a certain degree of similarity and common dependence on flow discharge. To this regard, an impellent question concerns the degree of similarity of such curves for a particular species as far as ecohydraulic variables are concerned. In this work, we build on an extensive literature review aimed at conceptualize a method to unify and compare HSI measured in different worldwide locations, authors, etc. for the same species, i.e. the brown trout. We concentrate on the role that ecohydraulic variables, notably water depth, velocity, temperature and substrate have on the HSI. These variables represent indirectly the environmental signature of the habitat, and understanding their degree of universality for the same species would help understanding species resistance and resilience to changing conditions.
11:30	José Lorduy	Habitat suitability index of the Bocachico (Prochilodus magdalenae; Steindachner 1879) in the Bajo Sinú large swamp and Betancí swamp, Córdoba, by the implementation of a hydrodynamic and water quality model. University of Cordoba jlorduygonzalez67@correo.unicordoba.edu.co Karol Edith Vellojin Muñoz The growing concern for the environmental conservation of wetlands has led to more research on their management. In this study, the EFDC+ Explorer model was implemented to determine the spatial distribution of suitable areas for the Bocachico (Prochilodus magdalenae) in the Betancí swamp and in the Bajo Sinú large swamp, Córdoba, Colombia. The model was calibrated with data measured in the field and used to simulate the habitat suitability index HSI with respect to five variables that constitute the habitat preferences of the species and influence its growth and development. The results showed that, in the dry season, 9% of the Betancí swamp extension presents acceptable suitability conditions, the remaining 91% occupies the medium category and only 1.8% of the swamp extension gets worse in the rainy season. In the Bajo Sinú large swamp, 17% of the area is considered as low suitability, 82.78% as medium and the remaining area as acceptable, which deteriorates by 18.9% in the rainy season. In both wetlands, the variables with the highest influence on the HSI were ammonia nitrogen, water velocity and water depth. The study concludes that the EFDC+ model is an effective tool for assessing habitat suitability for the Bocachico in the Betancí and Bajo Sinú swamps it was also determined that the combination of hydrodynamic variables is useful for an initial assessment, but the use of both physical and chemical variables play an important role in defining habitat preferences.

11:45	Maxime Brousseau	Concilier la nature et le développement : Gestion innovante des barrages de castors pour la préservation de l'habitat de la tortue mouchetée Centre d'enseignement et de recherche en foresterie (CERFO) mbrousseau@cerfo.qc.ca Maxime Brousseau, CERFO; Samuel Rosner, CERFO; François Groulx, Fluvio; Jean Fink, Habitats Fauniques JNF Par la construction de barrage, le castor (*Castor canadensis*) façonne son environnement de manière radicale. Reconnu comme étant un ingénieur de l'écosystème, il influence les processus hydrologiques en créant des zones humides qui filtrent l'eau, recharge les nappes phréatiques, régule le débit des cours d'eau et crée des habitats propices à une grande variété de plantes et d'animaux. Bien que généralement bénéfique sur le plan écologique, les barrages de castors peuvent représenter un risque pour les infrastructures humaines et la sécurité publique. Il est donc impératif de développer des façons de concilier les avantages et les enjeux que représentent les barrages de castors surtout dans un contexte d'incertitude lié aux changements climatiques. Dans le cadre d'un projet de maintien de l'habitat de la tortue mouchetée (*Emydoidea blandingii*), une espèce étant désignée menacée au Québec et au Canada, le Centre d'enseignement et de recherche en foresterie (CERFO) a procédé à l'installation de plus d'une vingtaine de systèmes de contrôle du niveau de l'eau. L'objectif de ce dispositif est de réduire les risques d'inondation et permettre le maintien de l'habitat de la tortue mouchetée. En collaboration avec Fluvio et Habitats Fauniques JNF, les processus hydrauliques en jeu ont été documenter afin d'optimiser l'efficacité de ce dispositif de cohabitation. Ce projet s'inscrit dans un contexte moderne plus large qui vise à trouver des moyens de conciliation permettant la cohabitation avec le castor. En effet, d'autres méthodes d'aménagement ont le potentiel de répondre à divers enjeux, notamment pour assurer la continuité longitudinale des cours d'eau, établir des refuges thermiques pour différentes espèces de poisson et même favoriser la captation du carbone. En somme, ce projet s'inscrit comme un exemple prometteur d'une approche permettant de préserver la biodiversité tout en tenant compte des impacts engendrés par le castor.
12:00	Jonathan Czuba	Effects of dam hydropeaking on juvenile freshwater mussel settling Virginia Tech jon.czuba@gmail.com Fatemeh Shacheri, Virginia Tech (first author); Sumaiya Sumaiya, Virginia Tech; Jonathan Czuba, Virginia Tech Freshwater mussel populations have been declining at an alarming rate around the world. We investigated whether changing flow conditions, as they affect juvenile freshwater mussel settling, could be a potential causative factor for this decline in the Dan River, North Carolina, USA. We deployed two uplooking velocity sensors on the riverbed between May and November 2019: one where mussels reside and another where they do not. From this data, we calculated shear velocity, which is a measure of the turbulence that acts to lift particles into suspension and acts against particle settling. We determined that a shear velocity <0.66 cm/s would be required to settle relatively large and dense juvenile mussels onto the riverbed; however, the lowest shear velocity we measured was 0.9 cm/s. Additionally, we estimated that juvenile freshwater mussels as large as 280-510 µm could always be suspended and not be able to settle onto the riverbed at these two locations. Therefore, the flow during May-November 2019 was high enough to prohibit recruitment of juvenile freshwater mussels at the sensor locations. Furthermore, we hypothesized that low-flow peaks in the streamflow hydrograph, not related to rainfall, would be prevalent in the Dan River due to upstream dam operations and result in higher low flows during periods of low mussel recruitment. Our major finding was that low-flow periods, which are decreasing, are important for mussel recruitment and these low flows are being disrupted by dam releases, which are occurring more frequently, that together are correlated with a decrease in the mussel populations in the Dan River.

Krieghoff Ballroom 2 **May 7**	**Session 17: Environmental flows and aquatic organisms**	**Chairs: TBD**
10:15	Mathias Collins	Historical occurrence and predictions for environmental streamflows important for diadromous fish NOAA Fisheries mathias.collins@noaa.gov Geological Survey New England Water Science Center, Augusta Valerie Ouellet, Integrated Statistics contractor for NOAA's Northeast Fisheries Science Center, Orono Environmental streamflows" refer to the magnitude, frequency, duration, and seasonal timing of streamflows needed to sustain freshwater and estuarine ecosystems. The U.S. Geological Survey (USGS) and NOAA Fisheries are collaborating to analyze historical trends in selected annual, monthly, and seasonal environmental streamflows at hundreds of USGS gages across the conterminous United States and model these streamflows for thousands of ungaged stream reaches. We are analyzing relatively natural basins and watersheds with substantial human influence on streamflows. We are also investigating relations between environmental streamflows and atmosphere-ocean climate variability patterns. A unique component of the project is a focus on streamflows important for diadromous fish. To identify these flows, we consulted with NOAA scientists, fish passage engineers, and managers in the Northeast, Southeast, Northwest, and Southwest regions as well as other regional diadromous fish experts. All groups identified seasonal metrics of high and low flows as their primary concern, however the seasonal windows are region-specific. In this presentation we will describe the project design, our regional consultation process, each region's identified flows and seasonal periods important for diadromous fish, and any available preliminary results.
10:30	Bruno Mendonca	Brook trout (Salvelinus fontinalis) as a model anadromous species to evaluate water withdrawal effects in a groundwater-driven coastal watershed. University of Prince Edward Island bmendonca@upei.ca Michael Van Den Heuvel; Andre, St-Hilaire This research emphasizes the essential role of biological validation when formulating Environmental Flows guidelines. It centers on a small-scale watershed (Coles-creek), part of the North River, in Prince Edward Island (Canada). This watershed is primarily influenced by groundwater inflow and subjected to water abstraction pressures, resulting in low flow and elevated temperatures. The study spans eight years, from 2016 to 2023, encompassing the monitoring of pre- and post-water pumping periods. A comparative analysis was conducted between different sections of the same stream and with a paired reference stream unaffected by water abstraction, in which we examined the impact on local brook trout (Salvenilus fontinalis) populations. During this research, a pronounced reduction in summer stream flow was observed, surpassing recognized low flow thresholds (70% of median flow, or 70Q50, and 65% of median flow, or 65Q50) for water abstraction. Temperature consistently exceeded the optimal growth thresholds for the brook trout, eventually reaching levels of potential physiological stress. A substantial reduction in the length of the brook trout Young of the Year (YOY) coincided with the years 2020 and 2022, the lowest summer flows observed here. This evidence of potential stress was attributed to low flow and elevated temperature conditions. Despite these findings, no direct correlation was established between the local brook trout population's density or biomass and low flow conditions. Thus, at this stage, the seasonality effect should be considered since the complete growth period of brook trout may influence the observed YOY growth trends. It is also essential to recognize the potential influence of other direct and indirect stress factors associated with low flow and high temperatures, including stream habitat loss, diminished stream productivity, land use impacts, and broader-scale climate change effects.
10:45	Robert Milhous	Beneficial Use of Water for Environmental Needs

		Retired US Geological Survey rtm80526@yahoo.com In water resources management there is a need to quantify water used for different purposes such as irrigation, municipal, and industrial. There is also a need to quantity water used for environmental purposes and to show the use is a benefical use. Quantifying water for the ecosystem is different from the usual quantification of water use because the traditional uses are diversions – use for the aquatic ecosystem is an instream use. Another difference is that the aquatic ecosystem adjusts to changes in the streamflows. In some places there is a right given to the ecosystem similar to rights for diversion; in these situations the water used for the ecosystem is the same as the water right. In situations where a right has not been established the environmental water use could be quantified using the same approach as would be used to establish the water right. There are four approaches that might be used: 1) use the streamflow hydrograph to allocated a portion of the water to the aquatic ecosystem, 2) use characteristics of the 'natural' hydrograph and allocate water with an objective of preserving its characteristics and form but at a different discharge, 3) use an analysis of the channel to determine a flow that results in widths and depths appropriate for a specific aquatic ecosystem, and 4) use an analysis of the relation between the streamflows and the physical habitat. In this paper information for the Clark's Fort Yellowstone River in Montana, Virgin River in Utah, and Cache la Poudre in Colorado USA are use to illustrate each of the methods. It is difficult to show beneficial use based on the stream flow hydrograph or the hydraulic characteristics alone. By adding habitat to the determination of environmental needs it is much easier to show beneficial use.
11:00	Luiz G. M. Silva	A novel methodology to study the effect of environmental flow conditions on early life stage Salmonids ETH-Zürich lumartins@ethz.ch Tina Dubach - ETH-Zürich; Andris Wyss - ETH-Zürich; Ismail Albayrak - ETH-Zürich In Switzerland, restoring river connectivity is of utmost importance to meet the goals set by the Swiss Water Protection Act. To achieve that, the country set an ambitious goal of providing effective fish passage for more than 700 hydropower plants until 2030. This goal provides a unique opportunity to learn and adapt strategies and decisions based on acquired knowledge as the design, implementation, and monitoring of fish passages advance. We used a dataset of over 20,000 pit-tagged fish to quantify passage efficiency at eight hydropower plants in the Upper Rhine River, including the Limmat, Aare and Rhine Rivers. We calculated findability (number of fish that entered the fish passage) and passage efficiency and determined the passage and transit time for different species. The findability varied between 68 and 8%, decreasing at larger dams located in the Rhein, while absolute passage efficiency varied between 38 and 80%. The attraction flow ratio calculated for the studied sites showed a range of 0.3 to 4% of the competing flows in the tailrace. Therefore, attraction and entrance conditions can be improved for larger river systems, such as the Rhine River, but the dataset analysed did not allow for disentangling these two components. Passage efficiency was similar among fishways (e.g., vertical slot and nature-like), but transit times varied significantly. For some species, passage time was over 30 days and transit time was over two days. In general, transit time was longer for nature-like passages. We suggest specific studies to be designed to disentangle attraction and entrance efficiency at sites with poorer findability rates and also aim to quantify the effects of passage delays on the migration of target species.
11:15	Marie-Pierre Gosselin	Towards the next level of environmental flows for fish: Introducing the work of the International Energy Agency-Hydro Task 19 Hydropower and Fish 2.0. Norwegian Institute for Nature Research mariepgosselin@gmail.com Klaus Jorde, KJ Consult, Klagenfurt, Austria; Alban Kuriqi, CERIS, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal; Piotr Paraziewicz, National Inland Fisheries Research Institute, Piaseczno, Poland; Luiz G. M. Silva, ETH Zürich, Department of Civil, Environmental and Geomatic Engineering, Institute for Environmental Engineering, Zürich, Switzerland

		E-flows have been at the forefront of Ecohydraulics research for decades and several guidelines exist in various parts of the world e.g., for the EU, North America, the World Bank. In recent years an initiative has come from the EU to develop a universal method for e-flows, that can be applied from a local to a regional scale. The International Energy Agency (IEA) -Hydro Task 19 is a group of expert scientists in fields related to hydropower and its effects on fish. Among its work topics, environmental flows (e-flows) are a central subject. The plan is to focus on applied methods at local and regional scales, including tradeoffs between ecology and power production. In that respect, the main aim of the IEA-Hydro Task 19 is to draw attention to the next level of e-flows and this universal method under development and serve as a main platform for discussion and dissemination. Among the planned tasks and deliverables of the IEA- Hydro Task 19 are factsheets, among which one focuses on e-flows. It aims to communicate the significance of e-flows in conserving aquatic ecosystems to a diverse audience of people interested in energy and the environment and not at all experts in hydropower and environmental issues (e.g., authorities, politicians, industry, technical personnel and consultants, among others). The factsheet provides a definition of eflows, why they are necessary, an overview of the large variety of methods that exists to help define them. It also identifies the challenges that remain in the definition and implementation of e-flows for fish and an indication of the research needs. Here we will present the work of theIEA Hydro- task 19 with special focus on the e-flow problematic, present the fact sheet and provide and update on the activities and work on the group on that topic.
11:30	Véronique Gouraud	Towards a characterization and classification of the ecological impacts of thermopeaking EDF R&D LNHE Véronique.gouraud@edf.fr Agnes Barillier, EDF CIH – Center for Hydropower Engineering, Savoie Technolac, La Motte Servolex; Baran Philippe, ECOGEA, Muret, France Hydropeaking operation of hydropower plants is used to meet peak electricity production requirements. It generates significant flow variations in rivers downstream of power plants, the impacts of which are well described in the literature. Hydropeaking can also induce changes in water temperature regimes. These changes, which have been less well studied, are linked to the natural vertical thermal stratification of water bodies, the complexity of the chain of catchment structures, and to the methods used to divert turbined water (depth of intake) and release it. They are characterized by artificial temperature variations in the receiving watercourse over the course of a nycthemeral cycle, known as ""thermopeaking"", with changes in gradient, amplitude, frequency and even seasonality. The aim of our work was i) to provide methodological elements for characterizing the ecological impacts of thermal alterations linked to hydropeaking and their variability according to the configuration of the facilities ii) to identify research actions to be developed in the future on the impacts of thermopeaking. To this end, we have carried out a state-of-the-art study of thermal alterations associated with hydropeaking and their impact on biological communities. Using our knowledge of the characteristics of the French hydroelectric fleet, we identified several types of alteration linked to the characteristics of the facilities and illustrated them using 5 study sites for which we had temperature time series and biological data. The results enable us to suggest some key metrics for characterization. They highlight typical potential impacts depending on the different configurations encountered. Research questions were then formulated on the basis of these results.
11:45	Simon Führer	A multi-stressor framework to study effects on cyprinid fish populations in Austrian rivers University of Natural Resources and Life Sciences, Vienna, Austria simon.fuehrer@boku.ac.at Alexander J. Piro: Lammi Biological Station, University of Helsinki, Lammi, Finland; Stefan Auer: University of Natural Resources and Life Sciences, Vienna, Austria; Stefan Schmutz: University of Natural Resources and Life Sciences, Vienna, Austria; Franz Greimel: University of Natural Resources and Life Sciences, Vienna, Austria; Norbert Höller: University of Natural Resources and Life Sciences, Vienna, Austria; Daniel S. Hayes: University of Natural Resources and Life Sciences, Vienna, Austria
12:00	Mengzhen Xu	Assessing the Effects of Environmental Factors on Filtration Rate of Golden Mussel (Limnoperna fortunei)

		Tsinghua University mzxu@tsinghua.edu.cn Jiahao Zhang, State Key Laboratory of Hydroscience and Engineering; Tsinghua University; Yao Yang, State Key Laboratory of Hydroscience and Engineering Filtration rate is a crucial characteristic for bivalves that engage in filter feeding, and is subject to regulation in response to various environmental factors. Golden mussel, Limnoperna fortunei, known as intensively invasive species in South America and many Asian regions, has been observed to exhibit a wide range of filtration rate, resulting in challenges in hydraulic modeling and impact assessment. In this study, we performed a series of experiments and developed a mussel pump model to assess the filtration rate of golden mussels with different shell lengths and to investigate the impact of environmental factors that influence the filtration rate, i.e., food type, water temperature, and flow condition. We found that filtration rates increased with shell length, while filtration rates per unit weight decreased with shell length. Additionally, we observed that filtration rates were comparable when the mussels were fed with food that share similar/identical cellular properties, e.g., Saccharomyces cerevisiae and Chlorella pyrenoidosa. The temperature's effect on filtration rates followed a skewed unimodal pattern, with an optimal temperature near 20 °C. Interestingly, the experiments also showed that the golden mussel can filter at low temperatures (2 °C), indicating its capacity for overwinter survival in cold regions. Moreover, the golden mussel's filtering was promoted under low-velocity flowing conditions. The relationship between filtration rate and multiple factors was explicable using our pump mussel model, which could be simplified to reveal the effect of each single factor. The model shows superior mechanical explanations and better accuracy performance compare to previous statistical models.
Borduas Ballroom 3 May 7	**Session 18:Integrating fish behavior in fish passage and exclusion**	**Chairs: Steve Cook**
10:15	Andy Goodwin	Toward near- and real-time prediction of fish passage and guidance with ELAM theory-informed generative AI U.S. Army Engineer Research and Development Center r.andrew.goodwin@gmail.com R. Andrew Goodwin, U.S. Army Engineer Research and Development Center; Seth A. Schweitzer, Cornell University; Daniel P. Zielinski, Great Lakes Fishery Commission; James R. Kerr, University of Guelph The decisions of volitional, freely moving fish frequently dictate the success of multi-million-dollar engineered structures and management actions. The ability to predict fish response ahead of time, either moments in advances or during the design phase of an engineered structure, has the potential to save time and money as well as living resources. Decision-support tools must operate well outside the calibration conditions as the future often looks different than the past. The U.S. Army Corps of Engineers, Research and Development Center has developed a tool that can hindcast and predict near-future fish response to infrastructure designs and management actions. The tool – a Eulerian-Lagrangian-agent Method (ELAM) – leverages $65+ million USD worth of river and fish movement data, and has achieved unique success in predicting near-future 3-D/2-D fish passage, guidance, and movement. The model has accurately predicted patterns prior to field data availability in out-of-sample conditions, where the future condition is different from the calibration condition(s). The model leverages cognitive relationships between stimuli, perception, and action to make predictions of what fish will do at the scale of river infrastructure and water operations management. We will discuss new basic research in ELAM-theory informed generative AI with the focus of developing applied technology that can self-generate new agent- and individual-based models of animal movement behavior as well as operate in near- and real-time. We will also discuss an emerging tool providing the requisite near-/real-time measurements of fine-scale hydrodynamics needed to realize on-the-fly dynamic action to volitionally guide and pass fish. Fish movement depends on the species, but work unifying past data into a common framework facilitates value-added benefits to existing data, the ability to understand fish behavior more quickly, and the ability to better incorporate animal behavior into the fast-paced nature of design and management actions.
10:30	Scott Miehls	Field and lab evaluations of downstream migratory behavior of juvenile sea lamprey and use of white light as a potential guidance cue.

		U.S. Geological Survey smiehls@usgs.gov Nicholas Johnson, U.S. Geological Survey; Alex Haro, U.S. Geological Survey Michael Wagner, Michigan State University; Ellen Marsden, University of Vermont; Christopher Holbrook, U.S. Geological Survey Downstream migration during the juvenile life stage is likely a critical point in the life history of many fish species and a better understanding of downstream migratory behavior may allow more effective management of those species. Migratory behavior across fish species largely occurs at night, presumably as a predator avoidance mechanism and light has been shown to modify orientation and locomotory behaviors in fish by inducing positive or negative phototaxis. Here we summarize multiple studies that document nocturnal downstream migratory activity by juvenile sea lamprey and studies, both complete and underway, attempting to make use of this presumably negative phototaxis to guide downstream migrants. Sea lamprey (Petromyzon marinus) are threatened or endangered in much of their native range while at the same time are a devastating invasive species in the Laurentian Great Lakes, and thus management solutions are sought both for conservation and control of this species. Diel activity was determined for newly metamorphosed sea lamprey using day/night net sampling and passive integrated transponder (PIT) telemetry in two natural streams and PIT telemetry in an artificial stream. Downstream migration was primarily nocturnal in all studies. Building on this, we tested the potential for light to be used as a guidance cue for downstream migrant juvenile Sea Lamprey. Lab and field studies demonstrated a slight lateral attraction response to low intensity white light across varying water velocity. High intensity white light reduced the rate of downstream movement in the lab and ongoing testing is underway to investigate vertical guidance potential. Simple white light has the potential to serve as a relatively inexpensive and easily deployed tool for downstream guidance if behavioral responses are sufficient.
10:45	Fabio Tarena	Artificial light at night affects fish passage rates in two small sized cyprinids Politecnico di Torino fabio.tarena@polito.it Claudio Comoglio; Alessandro Candiotto; Daniel Nyqvist An increasing presence of instream structures degrades habitats, fragments rivers and blocks fish movements worldwide. As barrier removal is often not an option, the most widespread solution to restore longitudinal connectivity is the implementation of different fish passage solutions. Fishway functionality, however, is highly variable. To design a functional fishway, several aspects of the fish's interaction with its environment need to be taken into consideration. For example, light and darkness cycles can influence migration strategies and behaviour of several freshwater species, with time of the day often regulating fish movement and passage through the structure. A current issue is the increasing presence of artificial lighting within rivers. In a fish passage setting, fish are exposed to artificial light at night (ALAN) in the form of light pollution, but, sometimes, also as a part of the fish passage solution. Although likely highly species specific, the effect of artificial light on fish passage behavior has been little explored. Here we study the passage behavior of two small sized fish species, Italian riffle dace (*Telestes muticellus*) and gudgeon (*Gobio gobio*), over a scaled deep side notch weir in an hydraulic flume in three different light conditions: daylight, darkness and ALAN. Both species passed the obstacle at high efficiencies under all light conditions, and their passage behaviors were influenced by light. While ALAN reduced passage success and resulted in delayed passage for G. gobio, T. muticellus passed at higher rates under the artificial light compared to night treatment. Both results indicate a risk of negative effects from ALAN on passage performance at real fishways - or movement rates in lit river reaches - for both species.
11:00	Vindhyawasini Prasad	Assessment of bubble screens as a dispersal barrier to control the movement of drifting invasive grass carp (*Ctenopharyngodon idella*) eggs University of Illinois at Urbana-Champaign vindhya2@illinois.edu Henry Doyle, Graduate student at University of Illinois at Urbana-Champaign (UIUC); Cory Suski, Professor at Department of Natural Resources and Environmental Sciences, UIUC; Patrick Ryan Jackson, United States Geological Survey (USGS), Central Midwest Water Science Center, Urbana, IL; Amy George, USGS Columbia Environmental Research Center (CERC), Columbia, MS; Benjamin H. Stahlschmidt, USGS CERC, Columbia, MS; Duane Chapman,

		USGS, CERC, Columbia, MS; Jesse R. Fischer, USGS, CERC, Columbia, MS; Rafael O. Tinoco, Associate Professor at Civil and Environmental Engineering, UIUC, Urbana, IL Various configurations of bubble screens (BS) were tested in a laboratory flume to efficiently redirect and capture drifting invasive grass carp (Ctenopharyngodon idella) eggs. Laboratory experiments were performed over a range of mean channel flow velocities (0.23–0.75 meters per second [m/s]) and results from three different test groups are presented – (i) surrogate eggs, (ii) live eggs, and (iii) preserved eggs. The BS redirected up to 100% of the surrogate eggs of three different densities at low velocity (0.23 m/s), and up to 60% at high velocity (0.75 m/s). The optimal configuration for surrogate eggs, which exhibited lateral displacement on the water surface, was not effective for the live eggs due to small but relevant differences in densities and settling speeds. By contrast, live eggs closely followed the spanwise recirculation patterns created by the BS and were distributed nearly uniformly across the width of the flume for most configurations. An alternative BS setup with a diffuser parallel to the flow utilized these patterns to capture drifters along the flume sidewalls instead of at a single downstream location. To obtain experimental results representative of real egg behavior, grass carp eggs were preserved using formalin solution and rehydrated before each test in a solution of fluorescent dye to allow for particle tracking of the naturally transparent eggs. Preserved eggs had the same specific gravity as live eggs after rehydration with fluorescein solution of 0.1 grams per liter. Up to 88% of the preserved eggs were captured at low velocity (0.23 m/s) and up to 59% at high velocity (0.75 m/s). The measured velocity and turbulent fields around the BS showed a strong correlation between secondary recirculation and redirection efficiency for all drifters, showing potential for scaling the models for field applications.
11:15	Jessica Stanton	Underwater acoustic deterrent effects on invasive carp behavior downstream of a navigation lock U.S. Geological Survey jcstanton@gmail.com Jessica C. Stanton, U.S. Geological Survey; Marybeth K. Brey, U.S. Geological Survey; Christa M. Woodley, U.S. Army Corps of Engineers; Andrea K. Fritts, U.S. Geological Survey; Matthew Sholtis, U.S. Geological Survey; Theodore Castro-Santos, U.S. Geological Survey Fish deterrent technologies have the potential to play an important role in the management and control of invasive carps (Silver Carp, Hypophthalmichthys molitrix; Bighead Carp, H. nobilis; Grass Carp, Ctenopharyngodon idella; and Black Carp, *Mylopharyngodon piceus*) in waterways in the United States. Preventing or slowing movements of invasive fishes around pinch-points, such as navigation locks and dams, can minimize propagule pressure in upstream locations and provide additional time and opportunity for removal or other management actions. We will present an evaluation of an underwater acoustic deterrent system (uADS) installed at Lock 19 on the Mississippi River near Keokuk, Iowa in 2021. The uADS installed at Lock 19 in the downstream lock approach projects engineered sounds similar to those shown in laboratory settings to trigger negative phonotaxis in some invasive carps. We analyzed the movement behavior of Silver, Bighead, and Grass Carps in relation to the operation status of the uADS. Movements were monitored by surgically implanting acoustic telemetry transmitters into the fish and establishing an array of acoustic receivers that can estimate two-dimensional fish positioning. We used a Time to Event analysis (Cox regression) to evaluate the rates carp made movements that advanced upstream toward the deterrent and the lock doors, as well as the rates that fish retreated from the lock approach. We found the rates that fish performed these behaviors were affected by the operation status of the uADS and other environmental conditions. This analysis is valuable to understanding the expected effectiveness of the uADS installation and the conditions when such a deterrent is most effective at slowing invasive carp movement at a navigation lock.
11:30	Guangning Li	Experimental study on fish behaviors affected by local color inside a fishway China Institute of Water Resources and Hydropower Research lgnchina@163.com Shuangke Sun, China Institute of Water Resources and Hydropower Research; Haitao Liu, China Institute of Water Resources and Hydropower Research; Tiegang Zheng, China Institute of Water Resources and Hydropower Research

		The construction of dams blocks the migration route of fishes, posing serious threat to fish resources and ecological security. As one of the main environmental protection measures, the fishway plays an irreplaceable role in mitigating the barrier effect of dams. However, the efficiency of fishway has always been worried. In this study, an innovative method was proposed that adding color to the inner wall of a vertical slot fishway to improve the fish passage rate and fish passage speed. For fish, colors can be divided into approach color and repelling color. Reasonable utilization this physiological preference of fish can effectively change their swimming behaviors. Juvenile fish of Schizothorax prenanti which is one of the main protected objects in China was selected, and comparative fish passing experiments were carried out to analyze the effects of configuring local colors on fish behaviors. The result shows that green and yellow are the approach and repellent color for Schizothorax prenanti, respectively. By configuring local colors of the guide wall and partition wall at the upstream and downstream of the pool, the fish passage trajectory was significantly changed, which in turn affected their passage rate and passage time. The configuration of local green to the guide wall and partition wall on the upstream negative side, and local yellow to the sidewall of the guide wall on the upstream negative side, the guide wall on the downstream positive side, and the partition wall on the downstream positive side can shorten the overall passage time of Schizothorax prenanti by 9% and increase the passage rate by 23%. The method of configuring local colors in the pool is an improved method combining fish ethology and hydraulics. It can be applied to the fishway design and the improvement of operation effect, which has a certain practical application value.
11:45	Kendra Vorenkamp	Quantifying the schooling benefit of small-bodied fish for optimal fishway design SUNY University at Buffalo kendravo@buffalo.edu Kendra Vorenkamp, Department of Civil, Structural, and Environmental Engineering, SUNY University at Buffalo, NY, USA; Joseph Atkinson, Department of Civil, Structural, and Environmental Engineering, SUNY University at Buffalo, NY, USA; Sean Bennett, Department of Geography, SUNY University at Buffalo, NY, USA When considering aquatic connectivity in a world impacted by climate change, fish passage design incorporates many variables that factor into a project's cost/benefit analysis. If smaller fishes obtain a swimming advantage through schooling, then the fishway design velocity can be increased by accommodating schooling fish, which can reduce project cost. In this study, we evaluated the schooling benefit of Emerald Shiners (Notropis athernoides) during volitional swim tests of both endurance and ramp critical velocity (Ucrit) to determine an appropriate water velocity for a design to allow fish passage across an identified velocity barrier in the Niagara River near Buffalo, New York. Emerald Shiners are a small-bodied schooling fish that are prey to many sport fish and migratory birds, relying on aquatic connectivity for population and ecosystem sustainability. Alongside an individual control (school size = 1), school sizes of 5, 10, and 20 were tested. Overall, there was a significant improvement in the swimming ability of a fish within a school versus a fish swimming alone, seen both in the endurance tests (increased projected success rate via sustained swimming) and Ucrit tests. In general, individual fish were found to be able to swim faster for longer periods of time as school size increased. For example, the final fish to fatigue in a school of 20 was observed to have an average Ucrit of approximately 75 cm/s s compared to ~50 cm/s (school of 1), ~55 cm/s (school of 5), and ~65 cm/s (school of 10). If velocity-barrier fishways incorporated space for fish to school, the design water velocity can be higher, reducing the cost of projects with the potential for higher rate-of-passage success.
Leduc-Fortin May 7	**Session 19: Man-made & natural barriers**	**Chairs: Adrian Jordaan**
10:15	Scott Hinch	A conservation physiological perspective on dam passage by fishes University of British Columbia scott.hinch@ubc.ca Nolan Bett, Pacific Salmon Ecology and Conservation Laboratory (University of British Columbia) For many freshwater and diadromous fishes, dams create a significant conservation challenge by fragmenting migratory routes, modifying habitats and

		altering patterns of water movement. Despite advances in fish passage strategies and infrastructure, passage can still be delayed or prevented. Fish can experience a variety of physiological issues as a consequence of both attempted and successful passage with upstream migrants affected by disorientation, energetics and anaerobic processes associated with movements through dam tailraces. Our review identified that whereas fishway ascension has generally been found to be neither seriously physiologically stressful nor energetically taxing, disorientation and stress from dam passage can be severe in downstream migrants, compromising energy reserves, immune systems, and smoltification (in salmonids). There are also many ways that downstream migrants can be seriously injured or delayed during dam passage. All of these negative physiological responses can be compounded by carryover effects that continue to threaten fish survival and fitness even after successful passage in both upstream and downstream directions. Physiological assessments have played a significant role in some locations to help those that manage dams, water flow, and passage infrastructure gain insight into passage problems. Yet only a few physiological studies have guided modifications to passage infrastructure or led to changes in operational approaches, including addressing physiologically mediated carry-over effects. We demonstrate the importance of an interdisciplinary and integrative research and monitoring approach, which includes conservation physiology, for improving dam passage.
10:30	Fielding Montgomery	Effects of rail infrastructure on Pacific salmon and steelhead habitat connectivity in British Columbia Canadian wildlife federation Fieldingm@cwf-fcf.org Betty D. Rebellato, Canadian Wildlife Federation; Richard E. Bailey, Fisheries and Oceans Canada; Nick Mazany-Wright, Canadian Wildlife Federation; Craig A. Mount, BC Ministry of Water Land, and Resource Stewardship; Simon M. Norris, Hillcrest Geographics; Morgan L. Piczak, Carleton University; Ivan Winther, Fisheries and Oceans Canada; Nicolas W. R. Lapointe, Canadian Wildlife Federation; Provincial conservation planning and connectivity modelling is crucial to understanding the scope of the threat of fragmentation, the relative impact by various infrastructure, and to prioritize potential projects. We implemented this approach in B.C. to quantify the relative impact of rail infrastructure on the connectivity of habitat for Pacific salmon (Oncorhynchus spp.) and anadromous Rainbow Trout (O. mykiss). We assessed 1. How much longitudinal spawning and rearing habitat may be blocked by rail-stream crossings, regardless of effects of non-rail barriers; 2. to what extent do potential non-rail barriers (e.g., road-stream crossings, trail-stream crossings, and non-hydro dams) exacerbate longitudinal salmon habitat fragmentation in streams with rail-stream crossings; 3. which rail-stream crossings potentially block the most habitat individually and in combination with other potential barriers; 4.what extent of lateral (i.e., floodplain) habitat may be disconnected by rail infrastructure. Natural habitat accessibility was modeled for each species based on swimming ability and stream gradient and potential spawning and rearing habitat were identified using intrinsic potential models. Blocked habitat was measured as the spawning and rearing habitat upstream of anthropogenic structures that may be barriers fish movement. Similar estimates of lateral habitat fragmentation were made by modelling lateral habitat along the floodplain, overlaying rail-stream crossings and lines, and identifying areas that may be disconnected by them. From an initial 4,000 rail-stream crossings, our assessment identified 10 streams where 41% of the estimated 126 km of spawning or rearing habitat may be blocked by rail barriers alone. Additionally, roughly 4.5% (62,381 ha) of total potential lateral habitat in the study area may be disconnected by rail infrastructure. By identifying rail barriers that contribute substantially more to the fragmentation of Pacific salmon and steelhead habitat this process can guide and support effective restoration work of limited resources and inform management decisions to maximize return on investment.
10:45	Morgan Wright	The rockslide that blocked salmon migration in the Fraser River, British Columbia School of Environmental Science, Simon Fraser University Morgan.wright@sfu.ca Jeremy G. Venditti,; David A. Patterson; Kendra A. Robinson; Brian Menounos; Derek Heathfield; Jonathan W. Moore,; Kyra Baird; Ryan Bradley.; Evan Byrnes, Julia Carr, Shawn Chartrand; Mike Church,; Lizzie Dingle; Mike Hawkshaw; Jeff Larimer; Isaac Larsen, D; J. Toby Minear, Gregory L. Owens;

		Colin Rennie,; Chloe Ross; Matteo Saletti,; Erin Seagren; Aaron Steelquist; Nick Viner; Michael Willis; Sara Smith Wuitchik, On November 1st, 2018 the Big Bar Landslide temporarily blocked Fraser River, the most productive salmon-bearing watershed in Canada, presenting a barrier to upstream salmon migration in 2019 and 2020. Collapse of a steep bedrock wall deposited 89,000 m^3 of rock into one of the narrowest sections of the Fraser River, damming the channel for over 7 hours and impounding 650,000 m^3 of water. The rockfall debris formed a bank-to-bank step with an 'overfall' that was ~4 m at low flow and ~7 m at high flow. The overfall resembled a waterfall, but without a freefall into a plunge pool. A backwater formed upstream that extends ~750 m upstream at low flow, but several kilometers at high flow trapping incoming sediment. The overfall generated a hydraulic barrier to upstream salmon passage, and significantly impeded salmon migration to the Upper Fraser Basin in 2019 and 2020, but rock work has partially ameliorated the impact. Fish passage monitoring indicates success in passing the landslide in 2019 was species and discharge dependent with population-specific estimates ranging from <1% to over 80% success. Passage success was particularly low for early timed populations exposed to the highest flow in 2019; so few fish successfully migrated to the spawning grounds that there was a risk of functional extinction of those runs. The landslide is an example of an ecohazard, similar to a natural hazard, but with immediate, direct, and cascading impacts on the biosphere, rather than on people and infrastructure. Collapse of bedrock canyon walls in the Fraser River are geologically commonplace, but the risk they pose to migratory fish populations in mountainous river systems is largely unknown.
11:00	Morgan Wright	The search for hydraulic barriers to salmon migration in a bedrock river School of Environmental Science, Simon Fraser University Morgan.wright@sfu.ca Max Hurson, Simon Fraser University; David Patterson, Fisheries and Oceans Canada; Kendra Robinson, Fisheries and Oceans Canada; Jeremy Venditti, Simon Fraser University Each year a variable portion of adult Pacific salmon in the Fraser River, British Columbia, die trying to retrace and ascend the river network to their natal spawning grounds. A major factor in migration failure is the severe hydraulic conditions experienced in the Fraser Canyon where encounter velocities can exceed upstream swim speeds of adult salmon, creating a migration barrier. Hydraulic barriers – a specific form of migration barrier – are defined as reaches where upstream fish migration is stopped or delayed due to high water velocity. Several barriers have been identified along the river and have structures in place designed to help facilitate fish passage. We explore other locations apt to be hydraulic barriers based on measured centerline velocity, finding 22 high velocity locations. We identify three flows associated with barriers: 1) plunging flows where the channel is deep and the fastest velocities are observed along the bed, 2) rapids where flow is fast and shallow, or 3) overfalls where fast flow occurs over a substantial drop in elevation. We used drone footage at various discharges and large-scale particle image velocimetry to examine flow structure at typical plunging flows, rapids, and overfalls. We then compared surface velocities with published salmon swimming capabilities to determine which locations are likely to create the greatest migration barriers. Overfalls, creating vertical barriers in addition to high velocity across the entire channel width in laterally constricted reaches, present the greatest barriers. Pacific salmon populations are already threatened by external factors – including climate change, habitat degradation, fishing, and disease – and cannot afford to have these impacts amplified by additional barriers to migration. Our observations provide novel information for salmon conservation that can be used to better understand salmon migration, which in turn helps to inform future mitigation efforts to improve salmon survival rates.
11 :15	Lindsay Davis	Examining the Hydraulics of a Series of Clustered Alternating Vortex Rock Weirs with Drone-based Image Velocimetry GEO Morphix Ltd. lindsayd@geomorphix.com Paul V. Villard; GEO Morphix Ltd. Bryce Molder; GEO Morphix Ltd. Tye Rusnak; GEO Morphix Ltd Many natural channel designs include elements to improve the potential for fish passage. Not only must these designs provide low velocity pathways to facilitate passage, particularly for smaller fish, but also need to provide rest areas. When evaluating fish passage, full flow field observations become extremely relevant.

		Until recently, particle image velocimetry was not readily available for field application. There is now software that offer a solution to measuring channel flows from aerial video footage. One example is pyOpenRiverCam, an open-source library of programs to perform image-based river flow analysis developed by Rainbow Sensing. It utilizes large particle-tracking techniques to determine flow velocities at the water surface and can generate ortho-projected velocity plots that allow detailed interpretations of flow characteristics, comparable to outputs of resource extensive hydraulic models. This information can help practitioners better evaluate flow patterns, fish passages, or understand characteristics of certain elements of natural channel designs. Vortex rock weir elements have been implemented in various natural channel designs. These features can enhance channel stability in relatively steep and confined streams, while also preserving and improving overall fish passage during both low and high flow conditions. Although effective for larger fish, they can be problematic for passage of smaller fish. A design consisting of clusters of alternating vortex rock weirs is assessed under a range of flow conditions through the application of traditional velocity measurement techniques and particle image velocimetry based on drone and aerial videos. This allows the channel design approach to be assessed, while illustrating the potential utility of aerial video-based particle image velocimetry techniques.
Pilot **May 7**	**Session 20: Fish passage: opportunities for funding and collaboration 2**	**Chairs: Nick Anderson**
10:15	Kelly Hughes	Merging infrastructure asset management surveys with fish barrier identification ATS Environmental kellyh@ats-environmental.com Kendra Vorenkamp, Department of Civil, Structural, and Environmental Engineering, SUNY University at Buffalo, NY, USA; Joseph Atkinson, Department of Civil, Structural, and Environmental Engineering, SUNY University at Buffalo, NY, USA; Sean Bennett, Department of Geography, SUNY University at Buffalo, NY, USA When considering aquatic connectivity in a world impacted by climate change, fish passage design incorporates many variables that factor into a project's cost/benefit analysis. If smaller fishes obtain a swimming advantage through schooling, then the fishway design velocity can be increased by accommodating schooling fish, which can reduce project cost. In this study, we evaluated the schooling benefit of Emerald Shiners (Notropis athernoides) during volitional swim tests of both endurance and ramp critical velocity (Ucrit) to determine an appropriate water velocity for a design to allow fish passage across an identified velocity barrier in the Niagara River near Buffalo, New York. Emerald Shiners are a small-bodied schooling fish that are prey to many sport fish and migratory birds, relying on aquatic connectivity for population and ecosystem sustainability. Alongside an individual control (school size = 1), school sizes of 5, 10, and 20 were tested. Overall, there was a significant improvement in the swimming ability of a fish within a school versus a fish swimming alone, seen both in the endurance tests (increased projected success rate via sustained swimming) and Ucrit tests. In general, individual fish were found to be able to swim faster for longer periods of time as school size increased. For example, the final fish to fatigue in a school of 20 was observed to have an average Ucrit of approximately 75 cm/s s compared to ~50 cm/s (school of 1), ~55 cm/s (school of 5), and ~65 cm/s (school of 10). If velocity-barrier fishways incorporated space for fish to school, the design water velocity can be higher, reducing the cost of projects with the potential for higher rate-of-passage success.
10:30	Paul Matson	Building a national-scale dataset of fish passage facilities at hydropower developments in the United States Oak Ridge National Laboratory matsonpg@ornl.gov Bryan Bozeman, Oak Ridge National Laboratory; Christopher DeRolph, Oak Ridge National Laboratory; Gbadebo Oladosu, Oak Ridge National Laboratory; Debjani Singh, Oak Ridge National Laboratory; Jesus Morales, United States Fish and Wildlife Service; Jessica Pica, United States Fish and Wildlife Service; Bryan Sojkowski, United States Fish and Wildlife Service; Bjorn Lake, National Oceanic and Atmospheric Administration; Nick Anderson, National Oceanic and Atmospheric Administration; Shannon Ames, Low Impact Hydropower Institute; Maryalice Fischer, Low Impact Hydropower Institute

		Environmental sustainability has become an existential criterion for hydropower developments – hydropower cannot be considered an eco-friendly technology if it does not provide for basic river functions such as the passage of aquatic organisms. Hydropower dams can act as aquatic barriers to the upstream movement of migratory fish in rivers, reducing population connectivity within watersheds as well as restricting access to habitats necessary to complete complex life histories. Further, the operations of hydropower developments, particularly during downstream migration, may cause fish to suffer injury or mortality while attempting to pass through energy generation turbines, from impingement on barrier screens, or while passing over spillways. Fish passage facilities is used to mitigate risks of hydropower dams and operations to migratory fish, but information on the location, types, characteristics, and costs of such facilities are incomplete at a national scale in the United States. In partnership with US federal agency and industry stakeholders, we are creating a georeferenced dataset of fish passage facilities at US hydropower developments. This dataset will contain attribute information desirable to a diverse range of stakeholders, including data on passage facilities and technologies, engineering characteristics, targeted fish species, operations scheduling, estimated costs, and passage performance studies. In addition, non-public information on passage facilities, including engineering characteristics, operations, and costs, will be collected using online surveys of owners/operators of hydropower developments. Products from this project will address a large gap in knowledge of the deployment of fish passage technology and be freely available to the U.S. hydropower community (i.e., Federal and State regulators and resource agencies, non-governmental organizations, Industry members, and other stakeholders) to aid in project planning and regulatory licensing activities. This work will support the development of decision support tools and information to improve environmental performance and ensure hydropower's long-term value as a flexible, renewable energy resource.
10:45	Nick Mazany-Wright	The Canadian Aquatic Barriers Database: tools to support freshwater connectivity restoration and management decisions Canadian Wildlife Federation nickw@cwf-fcf.org Alex Laudadio Canadian Wildlife Federation; Katherine O'Hearn Canadian Wildlife Federation; Nicolas Lapointe Canadian Wildlife Federation We know that aquatic barriers are prevalent in Canada's freshwater ecosystems, that barrier removal is needed to restore connectivity to vital habitat for aquatic species, and that restoration projects are expensive, but we do not have the answers to some important questions. How many barriers exist in Canada? How much habitat is not accessible for species? How do we identify the most important barriers to restore to maximize benefits? To answer these questions, we created the Canadian Aquatic Barriers Database (CABD). The CABD is a standardized and open repository for barrier and connectivity data in Canada, developed to inform freshwater ecosystem and infrastructure management. Currently, the CABD includes information on dams and associated structures (>36,000), waterfalls (>22,000), and fishways (>400), with integration of stream crossing data underway. By centralizing and standardizing over 200 existing barrier datasets, representing structures large (dams) and small (stream crossings), the CABD represents the most comprehensive information source for aquatic barrier data in Canada. The CABD and an associated suite of tools provides a more complete understanding of freshwater connectivity and fish passage in Canada, while allowing users from across the country to help fill remaining data gaps. The CABD supports assessment and reporting on the status of habitat connectivity, informs management and regulatory decision-making, underpins barrier restoration planning and prioritization projects to improve connectivity and fish passage for important species, and supports research and monitoring initiatives to better understand the effects these barriers have on freshwater ecosystems and the species they support.
11:00	Gillian O'Doherty	Evolution of Best Practices for Aquatic Organism Passage at Waterway-Roadway Crossings Federal Highway Administration gillian.odoherty@dot.gov Roger Kilgore, Kilgore Consulting and Management; Joe Krolak, FHWA; Gillian O'Doherty, FHWA; Abhishek Kapoor, FHWA; Brian Yanchik, FHWA; Daniel Buford, FHWA

		This presentation outlines the evolution of best practices in the planning, environmental permitting, design, construction, and monitoring for aquatic organism passage (AOP) at waterway-roadway crossings. The Federal Highway Administration (FHWA) in support of its National Culvert Removal, Replacement, and Restoration Grants Program (Culvert AOP Program), has developed a new AOP Implementation Guide that describes current best practices and how they have evolved to meet a need for transformative approaches. The primary goal of the Culvert AOP Program is to improve or restore anadromous fish passage through the replacement, removal, repair, or improvement of culverts or weirs. The Culvert AOP Program provides grants to states, local governments, and Indian tribes to achieve this goal. However, the AOP Implementation Guide incorporates a broader vision applicable to the entire needs for AOP across the United States. The presentation describes best practices nationwide describing how these practices may vary across the United States. The presentation will describe the importance of clearly articulating project goals for AOP and tools for prioritization of retrofit and new construction projects, including consideration of ecosystem benefits, community benefits, sustainability and resilience, and implementation feasibility. The presentation will also describe typical components of successful AOP projects including identification and prioritization of barriers; project design and delivery methods; and the essential role of post-construction monitoring. The presentation will include case studies across the United States to illustrate the variety of methods and tools for effective AOP projects. Finally, the presentation describes the role of these approaches in a wider vision to evolve and transform AOP within a transportation framework.
11:15	Craig Mount	Update on the Provincial Fish Passage Program in British Columbia, Canada BC Ministry of Water, Land and Resource Stewardship craig.mount@gov.bc.ca Freshwater habitat fragmentation caused by culverted crossings on roads has been recognized as a problem in British Columbia (BC), Canada for several decades. BC has traditionally been a resource-based economy and with a land mass larger than California, Oregon and Washington combined, BC is now left with a massive legacy of roads (>550,000 km) on the landscape. Conservative estimates place the number of culverted crossings on these roads at more than 400,000 - many of which represent a barrier to fish migration. As a result, improperly designed / installed / maintained closed-bottom culverts and the resultant isolation of thousands of kilometres of fish habitat are one of the greatest threats facing the significant number of native BC fish species which have a migratory component to their life cycle (anadramous and otherwise). The multi-agency BC Provincial / Federal Fish Passage Technical Working group was formed in 2007 to coordinate the response to this challenging issue. As a follow-up to presentations given at this conference in previous years, this presentation will provide an update on recent progress made by the BC Fish Passage Technical Working group. Emphasis will be on the evolution of the Strategic Approach, data collection and data management (PSCIS database) as well as the broader data lifecycle. Improvements to the modelling of freshwater fish habitat for prioritization of assessments and restoration work will also be covered. Some examples of recent remediation projects and their associated benefits will be highlighted. Finally, current challenges and potential opportunities will also be discussed.
11:30	William Twardek	Collaboration between fish passage scientists and engineers: Insights from an international questionnaire Ecofish Research wtwardek@ecofishresearch.com Steven J. Cooke Fish Ecology and Conservation Physiology Laboratory, Department of Biology and Institute of Environmental and Interdisciplinary Science, Carleton University; Sean J. Landsman, Institute of Environmental and Interdisciplinary Science and Department of Biology, Carleton University Successful implementation of fish passage requires collaboration between groups with very different backgrounds and expertise, including scientists and engineers. To investigate the nature of collaboration between these groups, we surveyed fish passage scientists and engineers from around the world. Respondents spanned 23 countries across North and South America, Europe, Oceania, and Asia, and included 123 scientists and 60 engineers. Respondents were asked both closed and open-ended questions on the importance, mechanisms, and potential

		barriers to collaboration, and how collaboration can be improved. Free responses to open-ended questions were analyzed in NVIVO 12 using inductive thematic coding to identify recurring themes amongst respondents. Findings from this research have the potential to enhance collaboration between scientists and engineers, to the benefit of fish passage and fish populations.
12:15-13:45	**Jean-Paul Lemieux**	**LUNCH (on-site)**
Suzor-Côté Ballroom 1 **May 7**	**Session 21:Insights on thermal habitat**	**Chairs: Christian Torgersen**
13:45	Francine Mejia	Closing the gap between science and management of cold-water refuges in rivers and streams USGS fmejia@usgs.gov Valerie Ouellet, Contractor with Integrated Statistics, Inc. in support of NOAA Fisheries Human activities and climate change threaten coldwater organisms in freshwater ecosystems by causing rivers and streams to warm, increasing the intensity and frequency of warm temperature events, and reducing thermal heterogeneity. Cold-water refuges are discrete patches of relatively cool water that are used by coldwater organisms for thermal relief and short-term survival. Globally, cohesive management approaches are needed that consider interlinked physical, biological, and social factors of cold-water refuges. We review current understanding of cold-water refuges, identify gaps between science and management, and evaluate policies aimed at protecting thermally sensitive species. Existing policies include designating cold-water habitats, restricting fishing during warm periods, and implementing threshold temperature standards or guidelines. However, these policies are rare and uncoordinated across spatial scales and often do not consider input from Indigenous peoples. We propose that cold-water refuges be managed as distinct operational landscape units, which provide a social and ecological context that is relevant at the watershed scale. These operational landscape units provide the foundation for an integrated framework that links science and management by (1) mapping and characterizing cold-water refuges to prioritize management and conservation actions, (2) leveraging existing and new policies, (3) improving coordination across jurisdictions, and (4) implementing adaptive management practices across scales. Our findings show that while there are many opportunities for scientific advancement, the current state of the sciences is sufficient to inform policy and management. Our proposed framework provides a path forward for managing and protecting cold-water refuges using existing and new policies to protect coldwater organisms in the face of global change.
14:00	Batistin Bour	Détection de refuges thermiques en rivière par drone/Thermal refuge identification using drone CERFO bbour@cerfo.qc.ca Maxime Brousseau, CERFO; Marc-Antoine Martineau, CERFO; Charles Marseille, CERFO; Annie Ménard, Cégep de St-Félicien Les refuges thermiques sont cruciaux pour plusieurs espèces de poisson, particulièrement face aux changements climatiques et aux activités humaines qui altèrent les habitats aquatiques. Ces refuges, zones où l'eau présente des températures plus fraîches durant l'été, sont essentiels pour la survie et la reproduction de ces espèces. Ils jouent un rôle vital dans la régulation du métabolisme des poissons, en offrant un abri lors des périodes de températures extrêmes, qui peuvent être stressantes ou même mortelles. Une cartographie précise des refuges thermiques est une information capitale pour la gestion et la conservation des écosystèmes fluviaux. Dans ce contexte, l'utilisation de drones pour l'acquisition de données thermiques en rivière représente une avancée technologique majeure. Les drones, équipés de capteurs thermiques, permettent une collecte de données rapide et précise, sans perturber l'écosystème. Cette méthode complète avantageusement les relevés traditionnels sur le terrain, souvent limités et coûteux. L'acquisition de données thermiques par drone offre une vue d'ensemble détaillée des variations de température dans différents segments de la rivière. Elle permet d'identifier les zones de refroidissement liées à des affluents, des sources souterraines, ou des structures ombragées. Les gestionnaires des ressources aquatiques peuvent utiliser cette information pour prendre des décisions éclairées en matière de conservation, comme la création de

		zones protégées, la restauration d'habitats ou élaborer des stratégies de gestion durable des ressources aquatiques. Cette étude démontre que l'utilisation des drones dans ce contexte est une approche innovante qui ouvre la voie à une gestion plus proactive et adaptative des ressources aquatiques face aux défis environnementaux actuels.
14:15	Baptiste Marteau	Unravelling summer thermal habitat conditions in salmonid-bearing rivers using infrared thermal mapping Université Rennes 2 baptiste.marteau@univ-rennes2.fr Baptiste Marteau, UMR6554 LETG, Université Rennes 2, Rennes, France + SCIMABIO Interface, Thonon-les-Bains, France + UMR5600 EVS, Université de Lyon, Lyon, France; Arnaud Caudron, SCIMABIO Interface, Thonon-les-Bains; Alexandre Richard, SCIMABIO Interface, Thonon-les-Bains; Steve Dugdale, School of Geography, University of Nottingham, Nottingham, United-Kingdom; Hervé Piégay, UMR5600 EVS, Université de Lyon, Lyon, France. The decline of cool-water adapted species (e.g. salmonids) across Western Europe is thought to be partly caused by the loss of key physical habitats in rivers. The thermal conditions experienced during summer heatwaves, such as those observed in 2022 and 2023, are likely to further degrade habitat suitability for temperature-sensitive fish species. A better understanding of the current thermal status of salmonid-bearing rivers is therefore crucial for managing ongoing population declines. Among the tools available, airborne thermal infrared remote sensing offers a useful balance between the spatial resolution (<50 cm) and the scale of action (>50 km) to monitor temperature along river corridors. Using this technique, we mapped thermal habitats of four salmonid-bearing rivers in the French and Swiss Pre-alps during the summers 2022 and 2023. Building on the results from these surveys, we compared different methods found in the literature to identify and classify cool-water habitats. In an attempt to provide a series of advice on good practice when processing airborne thermal data, we identified some strengths and pitfalls in the use and application of the tools. In addition to methodological advancements, metrics drawn from the results helped identify key thermal structures and areas of interest in the light of the needs of temperature-sensitive fish species that are likely to explain their distribution. The results also highlighted the prevailing role of anthropogenic factors, such as dams and weirs, in disrupting the spatial distribution of thermal habitats as well as their potential accessibility. This work was carried out in response to the growing need of local river managers for a better understanding of the global functioning and status of their rivers. As such, our results and conclusions form a base for a more integrated management of river systems over the next decade.
14:30	Eisinhower Rincon	Deriving distributed daily flow and water temperature time series in data-sparse region: Case study the Northern Quebec region. INRS eisinhower.rincon@inrs.ca Andre St-Hilaire - INRS; Normand Bergeron - INRS; Stephen Dugdale - University of Nottingham Arctic and subarctic regions are among the most threatened regions globally against climate change. Changes in the amount of liquid precipitation and the onset of the snowmelt are among the main drivers of future climate change in the Canadian Arctic regions. Studying such remote areas is very challenging because of the difficulties associated with the acquisition of in-situ measurements. In this study, we used the CEQUEAU model, a semi-distributed coupled hydrological/water temperature model for simulating both flow and water temperature. We took the Mélèzes River, a large and relatively-pristine unregulated basin (41 297 km 2), as our study case. The model was forced with hydro-climatological data from 1979-2020 acquired from the ERA-5 reanalysis. CEQUEAU's hydrological model component was calibrated using one surface flow station and validated with a second station located in an upstream sub-basin. Water temperature derived from Landasat TIR imagery at 21 different sites was used to calibrate the model's thermal component, using three types of calibration strategy. Results from flow simulation show excellent performance of the CEQUEAU model with Kling-Gupta Efficiency (KGE) metric >0.8. The calibration of the water temperature models delivered root mean square errors (RMSE) < 2.0 °C for the best calibration strategy. The validation of the water temperature simulations with a three-year in situ data logger dataset yielded an RMSE = 1.38 C for the summer temperatures. These results show the robustness

		of the CEQUEAU model to derive consistent water temperature and flow time series in data-sparse regions, as well as the accuracy of reanalysis and Landsat TIR images as reliable sources of information for hydrological and water temperature modelling. Managers can now have confidence in CEQUEAU and these secondary sources of information to perform studies in similar regions across Canada.
14:45	Nicolas Francisco Gamarra	Numerical Modeling of Stream Temperature in a Regulated Section of the Lech River Technical University of Munich nicolas.gamarra@tum.de Nils Rüther; Chair of Hydraulic Engineering, TUM School of Engineering and Design, Technical University of Munich, 80333 München, Germany; Roser Casas-Mulet; Chair of Hydraulic Engineering, TUM School of Engineering and Design, Technical University of Munich, 80333 München, Germany Anthropogenic interferences have altered the thermal regime of freshwater habitats and climate change is projected to intensify pressures on aquatic organisms. However, stream temperature is often not adequately incorporated into river management and numerical model-based assessment tools. The EU-Life project "CONTEMPO2" aims for an innovative environmental flow concept at the Lech River in Germany. Increasing the residual flow by reconnecting cold-water tributaries from the floodplain should reduce temperature and increase oxygen concentrations in summer. Using TELEMAC-2D coupled with WAQTEL, the study strives to accurately represent the current hydrodynamic and thermal characteristics across the site to support further restoration measures. As discharge measurements revealed a significant groundwater contribution within the river, we implemented groundwater sources into our model by acquiring UAV-based thermal infrared imagery (TIR) and identifying spatial patterns in water surface temperature. We then installed stream temperature loggers and took groundwater temperature point measurements that provided water temperature values along both the inflow boundary and the groundwater sources. Time series of meteorological data recorded at nearby weather stations determined the atmospheric boundary conditions. The hydraulic model was calibrated using the water surface elevation data acquired in the field. To ensure accuracy regarding stream temperature dynamics and spatial stream temperature heterogeneity we evaluated the model against temperature logger time series and the surface water temperature from TIR images. Calibrating parameters that influence tracer transport and heat exchange rates between the atmosphere and the river led to satisfactory results. We identified strengths and weaknesses of the model outputs considering characteristics such as water depth, flow velocity, and areas of groundwater inflow, which enabled us to identify and discuss the uncertainties associated with the model database and the modeling and calibration approach. Overall, this study helps advance our current understanding of deterministic stream temperature modeling and provides valuable insights for future research.
15:00	Davide Vanzo	Too hot to handle: modelling thermal dynamics in a residual-flow Alpine river Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zürich vanzo@vaw.baug.ethz.ch Ezio Bonetti, ETH Zürich; David F. Vetsch, Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zürich; Francesco Caponi, Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zürich The water temperature has a key role in several ecological processes that occur within the river corridors. Among others, it influences the rate of biogeochemical processes, the behaviour of macroinvertebrate as well as the fish community at different life stages. The water temperature results from multiple heat exchanges that depend on the hydraulic regime, atmospheric conditions, riparian vegetation, groundwater fluxes, and river morphology. How river temperature responds to different discharge and atmospheric conditions is particularly relevant for river adaptation strategies in a changing climate. In this context, we analyse and model the river water temperature dynamics in a 30 km reach of the Maggia river in Canton Tessin (Switzerland). Here the hydrological regime is heavily impacted by several dams and intake systems, leading to lower-than-natural discharges that contribute to high water temperatures in summer. To improve the ecological conditions of the river, but also to alleviate the high summer temperatures, new environmental flow conditions have been proposed. To quantify the spatio-

		temporal dynamics of river temperature under current and new discharge release scenarios, we set up and run a 1D HEC-RAS model of the Maggia river. The model enables the quantification of maximum and minimum temperatures, daily temperature variation and longitudinal warming rate. Thermal suitability for brown trout under different scenarios is also assessed. Results show to which extend high temperatures can be mitigated by new environmental flows, revealing a strong reduction of thermal lethal conditions for brown trout. Eventually, the study highlights the relevance of considering river temperature in habitat assessment and restoration.
15:15	Mostafa Khorsandi	Assessing the surface downward longwave irradiance models using ERA5 input data for station and watershed scales in Canada Institut national de la recherche scientifique mostafa.khorsandi@inrs.ca Mostafa Khorsandi (INRS); André St-Hilaire (INRS); Richard Arsenault (ETS); Suraj Patel (INRS) Longwave radiation (LR) is a critical component of the energy balance, affecting water temperature during hot summers. Both incoming and outgoing LR are challenging to measure, particularly under varying conditions influenced by clouds and canopy cover. This research leverages data from the ERA5 reanalysis database, including air temperature, dew point temperature, cloud cover, and leaf area index (LAI), to evaluate nine DLI models against measured DLI data in Canada. The results demonstrate the feasibility of using ERA5 data for all-sky conditions, with RMSE performance metrics ranging from 30 to 38 W/m². ERA5 DLI data exhibits superior performance, with RMSE values ranging from 30 to 32 W/m², suggesting its suitability as input data for hydrological and ecological models. At a river basin scale, LR's role in cooling river water temperature during hot summers is crucial, yet quantification remains limited. This study employs nine DLI models and inputs from ERA5 within the CEQUEAU hydrological-thermal model for the Nechako watershed in central British Columbia, Canada. Model 9, which explicitly considers canopy effects through LAI, yields the most reliable results. These results are employed for multisite calibration of water temperature modeling at the watershed scale. Various formulations of the Stephan-Boltzmann equation effectively quantify DLI's impact on water temperature. ERA5 DLI data also demonstrates acceptable performance. The enhanced performance of Model 9 highlights the potential for partitioning DLI into open areas and canopies, utilizing mathematical formulations and ERA5 data as input for hydrological and ecological models. This research advances our understanding of DLI heat budget modeling in hydrological-thermal studies from micro to macro scales.
Krieghoff Ballroom 2 May 7	**Session 22: Safe downstream passage**	**Chairs: Adrian Jordaan**
13:45	Sterling Watson	Improved turbines for fish passage: a timely innovation for today's hydropower fleet Natel Energy sterling@natelenergy.com Abe Schneider and Natel Energy Among today's energy generating resources, hydropower has the longest legacy, with the majority of US hydropower facilities exceeding well over 50 years of age. While setting an early foundation for fossil-free energy, this legacy has also contributed to major reductions in freshwater biodiversity due to river fragmentation, habitat loss, and the direct effects of turbines on fish. Despite increased awareness and advocacy, these adverse effects of hydropower persist due to locked-in infrastructure and design decisions made 50-100 years ago. Innovations targeted at improving fish passage success upstream and downstream have focused on either "adding on" infrastructure to prevent entrainment and reroute fish to safer pathways, or altering operating schemes (for example, nightly shutdowns). These innovations face resistance from hydropower operators because of the additional cost and complexity that they introduce, and also do not address intrinsic hazards posed by the turbines. Mitigating the risk of turbine passage itself at existing hydropower sites is difficult because of the constrained design space imposed by legacy civil works and generating equipment. Accordingly, most "fish-friendly" hydropower turbines have been installed in small, niche, new hydropower sites. However, new methods for turbine design exist that enable very high (98-100%) survival

		rates of key migratory fish species like eel, while integrating into the constrained design space created by historical decisions around hydropower plant design. At this opportune moment with aging equipment coming up for replacement and relicensing, innovations in turbine design for safe fish passage are essential to consider, as they will lock in fish survival outcomes for decades to come. We will present an example of how these new methods apply to low-to-medium head hydropower facilities (40 meters head or less) and can be applied at turbine scales up to 50 MW or more, in many cases requiring no more modification than runner replacement alone.
14:00	Jesse Wechsler	Juvenile Alewife Passage through a Compact Hydropower Turbine Designed for Fish Safety Kleinschmidt Associates jesse.wechsler@kleinshcmidtgroup.com Sterling M. Watson, Abraham D. Schneider, Gregor B. Cadman, and Ian F. Gagnon (Natel Energy); Lynette C. Gardner, Bryan R. Apell, Paige C. Thompson, and Chris R. Frese (Kleinschmidt Associates) Hydropower turbines are being developed to provide safe, effective downstream passage and to mitigate the effects of hydropower operations on the environment. This presentation describes the results of a turbine passage survival study conducted with juvenile alewives (Alosa pseudoharengus), a major migratory species on the Atlantic coast of North America. The study was conducted at a small hydropower plant in Freedom, Maine, with a single Restoration Hydro Turbine (RHT) manufactured by Natel Energy operating under 7.5 m of gross head. Groups of 140 to 170 fish were released directly into the intake of a 55-cm-diameter RHT and recaptured with a specialized trap at the turbine discharge outlet. The combined immediate and 48-h survival rates (+ 95% CI) for all treatments, corrected for control mortality, were 98.2 + 2.0% and 100.0+ 6.6%, respectively. The passage of juvenile alewives through the runner region of the turbine was also captured with high-speed video. The results of the study demonstrated that the RHT, which is specifically designed for fish safety, is a safe and effective way to pass juvenile alosines downstream at hydropower facilities.
14:15	Eric De Oliveira	LIFE4FISH project: Improvement of downstream migration success through successive HPP in the channelized River Meuse EDF R&D eric.de-olivera@edf.fr De Oliveira E. (EDF R&D);Hoffman C. (Normandeau Associates, Inc.); Theunisen P. (Luminus); Erpicum S. (University of Liege); Mchiels O. (Arcadis); Sonny D. (Profish Technology The LIFE4FISH project develops an integrated approach to migratory fish conservation in the Lower Meuse river basin (Belgium), especially European eels and Atlantic salmon. The project aimed to develop new solutions to reduce the cumulated impact of 6 successive hydropower plants, with a maximal loss of production of 5%. 2 solutions have been tested and evaluated for the salmon smolts, a bypass designed to attract them and an opening spilling gate close to the hydropower plant with different water level. For silver eels, complete turbine shutdown during peaks of migration was also monitored as an efficient method, while an electrical barrier tested at one HPP as a potential solution brought satisfying results for eels migrating at lower river discharge. An important contribution of this project is the development of migration prediction models for both species that now drive turbine-dam management. The application of these solutions at all sites allowed us to protect silver eels beyond the target level, while still above it for salmon smolts unless a remarkable progress. The project reveals that other impacts are limiting the success of these efforts. Silver eels tracked by telemetry suffered from presumed significant mortality when passing by the dam bottom gate, while reduced flow velocity between navigation dams associated with flow abstraction by a navigation canal are probably the most important impacts encountered by salmon smolts. Specific research and development of solutions are required for these navigation dams that are not eligible to removal due to their importance for transport. Associated to this project, Luminus retrofit two of the three turbine groups with eco-sustainable turbine runners, which was completed in 2021. To quantify the direct effects of turbine passage at Monsin for these fish species, Luminus completed this survival and injury study in January 2022 by using the HI-Z Tag recapture technique.

14:30	Falko Wagner	Quantitative Behavioral Analysis of Fish Passage: A Laboratory Study of Hydraulic Conditions Relevant to Turbine and Pump Inlets Institute of Aquatic Ecology and Fish Biology Jena falko.wagner@igf-jena.de J. Ellings (Aquatic Ecology Research Unit, Department of Animal Sciences and Aquatic Ecology, Ghent University, Belgium); I. Kopecki (SJE - Ecohydraulic Engineering GmbH, Stuttgart, Germany); T. Roessger (Institute of Hydraulic Engineering and Technical Hydromechanics, Technische Universität Dresden, Germany); J.A. Tuhtan (Department of Computer Systems, Tallinn University of Technology, Estonia); S. Hoerner (Laboratory of Geophysical and Industrial Flows (LEGI), Grenoble INP, CNRS, University Grenoble-Alpes, Grenoble, France, Institute of Fluid Dynamics and Thermodynamics, Otto von Guericke University Magdeburg, Germany) Existing research has established the need to account for fish behavior when assessing the risk of injury and mortality during passage through turbines, pumps and other hydraulic structures. Previous studies indicate that actively swimming fish typically have a higher risk of mortality during turbine passage compared to their passive counterparts, with eels being a notable exception due to their unique swimming behavior. Here we aim to enhance the accuracy of mortality predictions for fish, by including knowledge of their behavior. This information is required in numerical models to account for fish swimming activity. The Reduction of Animal Testing in Turbine Passages through Robotic Fish, Flow Simulations, and Predictive Models (RETERO) project conducted ethohydraulic tests in a flume, providing hydraulic conditions common to turbine and pump inlets. The study focused on categorizing fish reactions and swimming behavior with spatial velocity gradients (SVG) from 0.01 to 2.2 s^{-1} and flow velocities up to 3 m/s. Infrared video tracking was used to capture fish trajectories, the swimming speed, direction and body orientation. In this work, we present data-driven methods to identify physical thresholds for fish reactions to SVGs, assess the reaction probabilities when flow velocity exceeds burst swimming speeds and classify the dominant fish movement modes before and after reactions. The flume studies in RETERO reveal behavioral patterns in adult brown trout with avoidance reactions at SVG thresholds consistent with prior research. As flow velocities exceeded theoretical burst swimming speeds, the majority of fish exhibited active downstream movement, delaying in most cases their controlled drift. This research provides valuable insights into fish behavior and provides a set of generalized behavioral rules which can be implemented by numerical models, enabling a more accurate assessment of the risks fish face when navigating turbines, pumps, and hydraulic structures.
14:45	Linus Kaminski	Evaluation of Downstream Fish Passage Design Criteria across Weirs using Numerical Simulations Federal Waterways Engineering and Research Institute Germany (BAW) linus.kaminski@baw.de Carsten Thorenz (BAW); Roman Weichert (BAW) Weirs are of great importance for hydropower production and navigation, but they also impair the continuity of rivers. Weir structures, especially those including hydropower plants, typically have several possible downstream routes for fish to pass with varying risks. One route is over the weir, which can potentially lead to injury or mortality of fish. A commonly used assessment of fish passage over the weir is based on the tailwater level in relation to the water level difference. However, this assessment has been criticised. On the one hand, damage to fish has been observed even when the criteria are met, and an increase in the necessary underwater level has been demanded; on the other hand, it is generally doubtful whether this simple assessment can reflect the complex situation. In certain situations, the hydraulic jump can be shifted downstream by the momentum of the nappe, resulting in supercritical flow at the point of impact and, therefore, a lack of necessary water cushion, even if the required tailwater depth is present further downstream. Here, the applicability of the assessment of downstream fish passage based on the tailwater level is tested using numerical simulations. Various configurations with different weir heights and tailwater levels were simulated using the open-source CFD library OpenFOAM®. Here, situations are considered in which the criteria for the tailwater level are met and situations in which this is not the case. The influence of the tailwater level is evaluated with the help of particles added to the simulations, which represent passively migrating fish. The movement of these particles is tracked during the downstream passage. Collisions of these particles in the tailwater are analysed

		and used to compare the individual situations and evaluate the tailwater level criterion.
15:00	David F. Vetsch	Evaluation of downstream fish passage measures for a run-of-river hydropower plant with pondage VAW / ETH Zurich dvetsch@ethz.ch Seline Frei, Laboratory of Hydraulics, Hydrology and Glaciology (VAW) of ETH Zurich; Silvio Zingg, Grid- & Hydro Engineering, BKW Energie AG; Sandra Krähenbühl, Grid- & Hydro Engineering, BKW Energie AG; Ismail Albayrak, Laboratory of Hydraulics, Hydrology and Glaciology (VAW) of ETH Zurich; The Aare river in Switzerland has a species-rich fish population and is an important fish migration corridor. However, there are several run-of-river hydropower plants (HPPs) that hinder fish passage in the river. Thus, the rehabilitation of relevant HPPs is urgently needed. At some HPPs, a new fish ladder has already been built or the existing one is to be renewed and extended to provide upstream passage of Atlantic salmon in the future. Regarding safe downstream fish passage, it is still unclear which technologies to use. In particular, the situation at the HPP Mühleberg is challenging and measures to establish a safe downstream passage are not obvious. This is mainly due to the fact that the HPP Mühleberg has a pondage, the lake of Wohlen, and the water depth upstream at the dam is up to 20 m. To provide a sound basis for the evaluation of potential downstream fish passage measures, the flow field covering a part of the lake, the approach flow to the HPP and the weir was simulated with a numerical 3D model for a range of operational conditions. In the present contribution, we will illustrate and discuss the evaluation of various options for downstream fish passage, including fish guidance racks (FGR) with an adjacent bypass, weir, or turbine passage. Some measures could be ruled out due to the situation but it turned out that FGR may be a potential measure. However, the layout of the HPP requires a rather unconventional arrangement of the FGR which may pose challenges for its implementation. In future, swimming paths in the lake, behavior and biomechanical properties of target fish species could be determined from a fish monitoring study and combined with the obtained results from the numerical simulations to design further measures for fish downstream passage at the HPP Mühleberg.
Borduas Ballroom 3 May 7	**Session 23: Hydrodynamics in fishway designs 2**	**Chairs: Daniel Zielinski**
13:45	François-Xavier Cierco	Design of a fish pass influenced by regulated hydraulic works a.gudot@cnr.tm.fr Gudot Aurélien; Haond Muriel; Balayn Pierre; Vannier Olivier et Cierco François-Xavier The concessionary of the Rhône River for the production of hydroelectricity, river transport and agricultural use, CNR operates several dams and hydropower plants in south-east of France. Due to the increment of the of ecological instream flow, the construction of small hydro power stations (SHP) combined with fish passes is under study in order to optimise the renewable power production with minimum impact on biodiversity. The main challenge is thus to ensure the fish pass availability when the water level is influenced by the complex interaction of the inlet discharge, the scheme operation and even, in this particular study, a tributary flow joining the Rhône immediately downstream the dam. As a result, the water elevation/discharge relationship is no more unique and request to be considered carefully. To that purpose we produced a statistical analysis of the upstream and downstream water level registered between 2014 and 2021. As mentioned, these measurements were affected by the scheme operation. Regarding French regulations, the fish pass has to be operational 90% of the time of the fish migration period. Thus, the above upstream and downstream water elevation must be defined. Considering that these two variables are neither independent nor correlated, an analyse using bivariate statistics becomes necessary. The chosen method consists in analysing the hydraulic head, without any regard of the discharge. Knowing the temporal distribution of the upstream and downstream water elevation, the temporal distribution of the head is built. The value of the 5% and 95% hydraulic depth are then determined, which sets the operating range of the fish pass. Then, these head should be linked to an

		upstream and a downstream water elevation. For this fish pass the most often observed couple was chosen (upstream and downstream water level) knowing the dimensional hydraulic head.
14:00	Tyler Kreider	Shikellamy NLF: Value of Pre- and Post-Construction Site Investigations Kleinschmidt Tyler.Kreider@kleinschmidtgroup.com Gabriel Martin (Kleinschmidt) The implementation of fish passage improvements at the lower four dams on the Susquehanna River (in Pennsylvania and Maryland) triggered the need for the fish passage at the Adam T. Bower Memorial Dam (the World's longest inflatable dam), located in Shamokin Dam, PA. The eight-foot dam is inflated seasonally to support recreation upstream at Shikellamy State Park, but this impedes passage of American Shad, as well as seasonally isolating local fish populations. After two previous fish passage design projects stalled prior to construction, Kleinschmidt was asked to evaluate the existing nature-like fishway (NLF) design, develop design criteria for a new NLF, and lead the design and construction aspect of a new NLF at this site. Kleinschmidt also performed post-construction hydraulic verification of the fishway flow, depth, and velocity against the 2-D HEC-RAS model used in design of the fishway. The project had unique characteristics which included the inflatable dam operation and need for continued maintenance access to the dam at the fishway. Valuable lessons from construction will be discussed, including geotechnical investigations and work at the riprap/bedrock interface. Additionally, results from the post-construction hydraulic verification will be summarized to inform future NLF design hydraulic modeling and fishway flow dynamics, as well as a reason to consider sizing riprap with a healthy factor of safety.
~~14:15~~	~~Marcela Politano~~	~~Spillway deflectors design at sinop dam with a three-phase flow numerical model~~ USACE marcela.s.politano@erdc.dren.mil S. Das IIHR- Hydroscience & Engineering, The University of Iowa, IA, USA; J. Martin IIHR- Hydroscience & Engineering, The University of Iowa, IA, USA; J. Mafra Sinop Energia, MT Brazil; L. Beche Centre d'Ingénierie Hydraulique, edf, La Motte-Servolex, France; E. Florentin Centre d'Ingénierie Hydraulique, edf, La Motte-Servolex, France Elevated total dissolved gas (TDG) poses a significant threat to aquatic organisms, potentially leading to gas bubble disease (GBD). The severity of GBD depends on various factors, including the fish species, age, supersaturation levels, and exposure duration. In the past, fish exhibiting GBD symptoms have been observed on the Teles Pires River in Brazil during spillway releases. Gas supersaturation occurs by the dissolution of air bubbles carried deep into the tailrace by plunging spillway jets. Currently, TDG uptake in Sinop Dam is mitigated by gradual changes in spillway gates. While this approach has been effective to avoid GBD, it precludes the use of an immediate spill if such action was required. To further reduce the risk of supersaturation and enhance dam operation flexibility, spillway flow deflectors that redirect the plunging flow horizontally are proposed. This study presents a numerical analysis based on the open-source code OpenFOAM to assess the design of spillway deflectors at Sinop Dam. The model assumes three phases: air, liquid and bubbles in the liquid phase. The solver includes the dissolution of bubbles and an air entrainment model specifically developed by one of the authors for spillway operations. Two numerical models were developed: a sectional model encompassing one and a half spillway bays and a tailrace model covering the entire spillway, powerhouse and one kilometer downstream of the dam. The model was validated against pressure measurements obtained in a 1:100 reduced-scale hydraulic model for the 10- and 100-years flood event, as well as TDG field data collected in the tailrace. The model was used to determine the deflector length and location at the spillway face, aiming to minimize bubble transport to depths where dissolution is enhanced. Numerical details, criteria for deflector design and predicted TDG with and without the designed deflector will be presented and discussed
14:30	Gordon Clark	Application of hydrodynamic models of varying complexity for assessment of upstream passage and habitat suitability of smelt (Osmerus mordax) under pre- and post-construction conditions for dam removal on the Jones River in Kingston, MA. Stantec

		gordon.clark@stantec.com Michael R. Chelminski; Stantec Consulting Services Inc. Comparison of pre- and post-dam removal conditions for upstream passage and spawning habitat for rainbow smelt (Osmerus mordax) using hydrodynamic models of varying complexities is presented for the removal of the first barrier to fish passage on the Jones River in Kingston, MA. The Jones River contains one of the largest areas of smelt spawning habitat in the state of Massachusetts with the Elm Street Dam representing the first barrier to upstream fish passage. Previous studies have found that large populations of smelt in the Jones River were depositing eggs in densities that exceeded the capacity of the available substrate close to the Elm Street Dam. Design and permitting for removal of Elm Street Dam was initiated in 2014 to support restoration of the natural riverine ecosystem and removal of the dam was substantially completed in the Fall of 2019. To support the design and regulatory elements of the dam removal project, numerical hydraulic simulations were performed to inform the potential for upstream passage and spawning habitat suitability for rainbow smelt. Following dam removal construction, bathymetric survey data was collected and incorporated into the model to evaluate the post-construction conditions. The development of both the pre- and post-construction models presents an opportunity to reflect on various elements of the dam removal implementation process, including the relative effectiveness of the design and modeling approach. Furthermore, development and application of multiple hydrodynamic models to address questions of model complexity and quantification of fish passage and habitat suitability, as well as on-going monitoring efforts at this site, are presented.
14:45	Adrian Strain	Computational Fish Dynamics: Using 3D hydrodynamic numerical models to assess and design fish passage facilities HDR adrian.strain@hdrinc.com Anna Mallonee; HDR As the need to hydraulically assess existing fish passage facilities and evaluate potential designs becomes more prevalent, three-dimensional (3D) hydraulic model development, specifically computational fluid dynamics (CFD) modeling, has become more widely used in fish passage projects. By resolving the flow fields three-dimensionally, CFD offers an opportunity to further understand complex hydraulic conditions. The fully resolved flow fields can be used to identify possible hydraulic barriers, refine designs, and evaluate mitigation alternatives. Two recent project examples highlight the use of CFD at fish passage facilities, showing how 3D modeling can be useful for both evaluation and design. At the Lowell Hydroelectric Project on the Merrimack River in Lowell, Massachusetts, CFD was used to characterize existing conditions hydraulics at the upstream and downstream facilities and evaluate potential fish passage designs for American Shad, Herring, American Eels, and more. CFD models were developed at specific areas of interest and included the powerhouse forebay, existing fish ladder with bypass, and the tailrace. All areas were evaluated for velocities and flow patterns, and a graphical representation was used to determine adequacy of existing or potential fish passage designs. The second example is an assessment of the design of a vertical slot fishway off the Sacramento River in Sacramento, California. CFD modeling was used for fishway design evaluation for potential green sturgeon passage with a velocity-focused analysis. Model results were used to identify areas of high velocity by assigning a velocity threshold specific to green sturgeon. Multiple iterations of design were evaluated and coordinated with local agencies to minimize areas of high velocity, particularly at locations where the velocity threshold was exceeded. The use of CFD and other 3D models can provide additional insight to provide more confidence in model results, design elements, and whether fish passage criteria are met at a specific project site.
15:00	Seth Schweitzer	Large scale, high resolution, image-based flow velocity measurements for fish management applications Cornell University seth.schweitzer@cornell.edu Edwin A. (Todd) Cowen, Cornell University Accurate hydrodynamic measurements are key to understanding, predicting, and influencing fish navigation behavior near features such as river junctions,

		barriers, water intakes and other structures. Image based velocity measurement methods use a camera at a fixed location to provide high resolution measurements, in both space and time, over extremely large areas—hundreds or thousands of m^2. Image based methods do not require contact with the water, which simplifies their use relative to methods such as acoustic Doppler current profilers (ADCPs). In contrast to the significant spatial and temporal averaging required by ADCPs to produce velocity measurements along a 1D path extending from the instrument, image based methods can make instantaneous velocity measurements, allowing the calculation of metrics of turbulence over large spatial areas. We present the results of surface velocity measurements using visible-light and infrared imagery in support of a fish migration management project at the junction of the Sacramento River and Georgiana Slough at Walnut Grove, California, USA. This is a tidally-forced and hydrodynamically complex river junction in which the direction of flow and the rate of entrainment between the river and connecting channels vary depending on tidal cycle and total river discharge. The California Department of Water Resources (DWR) installed a a Bio-Acoustic Fish Fence (BAFF) at the site in 2023, in order to encourage migrating fish to navigate towards the Sacramento River, and a higher survival probability. Infrared quantitative image velocimetry (IR-QIV) was used at the site to measure the surface velocity field including calculating metrics of turbulence. When using infrared imagery there is no requirement for illumination or seeding of the flow with particles. This allows continuous measurements, day and night, for extended periods of time, which are then compared with fish track records to assess the efficiency of the BAFF.
Leduc-Fortin May 7	**Session 24: Eel migrations in regulated rivers**	**Chairs: Valérie Tremblay**
13:45	Hervé Capra	Determining the downstream migration routes of silver eels through a run-of-river hydroelectric scheme on the lower Rhône River (France) INRAE herve.capra@gmail.com HERVÉ CAPRA, INRAE, UR RiverLy, Lyon-Villeurbanne, France; HERVÉ PELLA, INRAE, UR RiverLy, Lyon-Villeurbanne, France; MATHIEU ROCLE, Compagnie Nationale du Rhône, Ecological Engineering, Lyon, France; FRANCK PRESSIAT, Compagnie Nationale du Rhône, Ecological Engineering, Lyon, France; This study aimed to improve knowledge-understanding of the routes taken by silver eels during their downstream migration through the Caderousse run-of-river hydroelectric-scheme on the Rhône River. Our approach was based on four actions: (1) capture and mark eels (surgical implantation of acoustic transmitter + RIFD), previously identified as silver eels upstream of the Caderousse scheme, (2) release the marked individuals in the capture zone (3) deploy hydrophones to detect their passage by all possible routes through the hydroelectric scheme (lock, dam and bypass section) and (4) find out whether downstream individuals arriving upstream of the Camargue delta use either the “Petit Rhône” or the “Grand Rhône”. A total of n= 234 eels were tagged (minimum mass = 600 g). N=75 eels were detected on their downstream way, mainly at night. Most (n=62) of tagged eels crossing the scheme used the route of the hydropower plant and n=13 the route of the dam/bypass section. No eels were detected in the Petit Rhône branch. Only n=16 eels arrived in Arles (Grand Rhône branch) and 20% of the eels detected immediately downstream of the powerplant never arrived two kilometers downstream. A tagging effect was observed with n=28 individuals moving downstream during the 20 days following their release. The eels moved downstream quickly (1 to 3 m.s-1) and 2/3 of those arriving in Arles (Grand Rhône) took less than 45 h (0.4 m/s) to cover 62 km, including two other schemes. A sharp increase in flow and a rapid drop in water temperature appear to be a pair of highly influential environmental factors. Finally, n=93 marked individuals that had not yet run downstream were detected at least once during mobile tracking, and n= 66 were never contacted.
14:00	Alexandre Guindon	Juvenile American eel tracking using acoustic telemetry at the Carillon hydro-electric facility Hydro-Quebec guindon.alexandre2@hydroquebec.com Florian Bonnaire, AECOM ; Chris Elvidge, Carleton University The Carillon dam is the first barrier encountered by juvenile American eels during their migration up the Ottawa River. The Carillon lock is located next to the hydro plant and allows access upstream. Previous studies conducted by

		Hydro-Quebec have shown limited numbers of eels trying to find a way past the dam. These were capture-mark-recapture studies that used a single capture system (ladder traps). A telemetry study was performed in 2023 to : 1. Assess the validity of the ladder trap capture method at this location, 2. Trace the movement of eel downstream of the dam and spillway, 3. Determine if juvenile eels use the lock for upstream passage. Forty-one juvenile eels (mean length 400 mm, SD = 66 mm) were captured in the vicinity using a combination of ladder traps, electrofishing and net fishing, then surgically implanted with V6-2x tags (Innovasea Systems Inc). A further 9 juvenile eels were captured at the exit point of the Beauharnois dam eel ladder, to compare behaviours across origins. Three arrays of VR2-Tx receivers were deployed: below the Carillon dam, 2km downstream and in the Carillon lock. Preliminary results show good tag retention, steady diel migrations consistent with a night-time exploratory behaviour and a generalized out-migration downstream at the end of the summer.
14:15	Felix Eissenhauer	A mark-recapture approach to estimate the population size and demographics of American eel elvers (Anguilla rostrata) arriving at a dam in a large river University of New Brunswick (UNB) felix.eissenhauer@unb.ca Thomas Pratt (DFO); R. Allen Curry (UNB); Tommi Linnansaari (UNB); Philip Harrison (UNB) Habitat fragmentation by barriers prevent endangered American eels from moving between the ocean and freshwater. The Mactaquac Dam is the first dam on the Wolastoq | Saint John River and is impassable for elvers (juvenile eels), resulting in large numbers of elvers congregating in the tailrace downstream of the dam every year. We assessed the size and age structure of the arriving population using mark-recapture and otolith ageing techniques. Over three years, 30,000 elvers were marked with visible implant elastomer tags and otoliths from 500 individuals were collected. Our data indicates a high number of elvers in their second freshwater year recruiting to the dam, with a portion of these elvers exhibiting return behavior to the tailrace in the subsequent year. Annual data will be used to develop a method for future population estimates based on an index of abundance. This will provide insights on impacts of the hydropower dam on elver recruitment and allow a long-term assessment of population trends which will support decision-making processes on both sustainable fishing quotas and fish passage solutions.
14:30	Jenna Rackovan	Downstream Passage Evaluation to Restore American Eel in the St. Croix River, Maine Alden Research Lab jrackovan@aldenlab.com Kim Capone; Nate Olken; Greg Allen, Alden Research Lab Anadromous fish are a vital building block of the St. Croix River, Maine, connecting near-shore and off-shore ecosystems. The effects of inadequate riverine passage between spawning, rearing, and overwintering habitats for anadromous species are wide-ranging and include loss of a prey base for marine mammals and birds, loss of forage for commercially important groundfish in Passamaquoddy Bay and the Gulf of Maine, loss of traditional uses of culturally important species by Passamaquoddy people, and the loss of recreational and economic opportunities for local communities. Three fish passage barriers on the lower St. Croix River are the primary limiting factor to increased productivity of anadromous species: Milltown Dam, Woodland Dam, and Grand Falls Dam. The rivers and lakes above these St. Croix River dams historically supported large runs of river herring (Alewife and Blueback Herring), Atlantic Salmon, American Shad, Sea Lamprey, and American Eel. The Maine Department of Marine Resources (MDMR) is in the process of removing Milltown Dam and designing updates and improvements to upstream and downstream fish passage at Woodland and Grand Falls dams. We conducted pre-implementation studies to assess downstream passage of radio-tagged American Eel at Woodland and Grand Falls Dams. Results on movements and passage routes during the downstream migration season will be presented. The study results will be used to inform engineering design of downstream facilities at both dams.
14:45	Jesse Waldrip	Continued Search for the Silver Bullet for Silver Eels

		Kleinschmidt Associates jesse.waldrip@kleinschmidtgroup.com Lucas Stiles (Kleinschmidt Associates) In many rivers along the east coast of the North America and throughout Europe, downstream migrating eels must pass over, around, or through dam structures—including hydroelectric turbines—that interrupt their path back to the ocean to spawn. Due to a variety of natural and anthropogenic factors, American Eel and European Eel population numbers are down. Providing mature eels (silver eels) with safe and effective downstream passage increases the chances the eels will reach their breeding grounds and sustain populations. Resource agencies, hydroelectric project owners, researchers, and consultants throughout the Atlantic coast of North America and Europe continue to work to identify the safest and most effective ways to pass silver American eels around hydroelectric facilities. There are so many variables involved in downstream eel passage planning, design, and implementation that finding a "silver bullet," a "one-size-fits-all" solution to safe downstream passage has proven elusive despite many years of research and testing. This presentation will follow up on the downstream eel passage symposium that was conducted at the 2022 Fish Passage Conference in Richland, WA. This presentation is intended to provide further discussion and overview of the latest practices, policies, and guidelines being implemented and review recent advancements to the current state of the art and potential future methods and technologies for safely passing downstream migrating eels around dams and hydroelectric stations.
15:00	Jean-François Dumont	Temporary : American eel habitat connectivity : the Québec action plan Ministère de l'Environnement, de la Lutte aux Changements climatiques, de la Faune et des Parcs jean-francois.dumont@mffp.gouv.qc.ca Since the beginning of the colonial era, the hydrography of Quebec territory has been considerably modified by all kinds of infrastructure limiting the free movement of fish. All these developments, carried out for different purposes, have gradually restricted the area of habitat available for the American eel. It's distribution area has been reduced by approximately 12,000 km². In Quebec, the eel has even completely disappeared from some watersheds, including those of the Ottawa River and the St-François River, for example. This loss of growing habitat limits the silver eels production and has been identified many times as one of the primary causes of the population decline that all North American jurisdictions with an hydrological connection to the Atlantic ocean are currently witnessing. As a contributor to the efforts required by this situation, Quebec implemented an action plan specific to the American eel in 2022. This plan identifies several solutions relating to the recovery of quality habitats that are still inaccessible to eel. The presentation 1- provides a precise historical overview of the situation which prevailed before the decline, 2- offers a contemporary state of the situation using monitoring indicators and 3- illustrates the projects and interventions that Quebec is piloting to give a better access to productive and safe habitats to eels. All these efforts are deployed with the collaboration of many organizations that subscribe to the directions proposed by Quebec in its action plan.
Pilot May 7	**Session 25: IAHR**	**Chairs: Gregory Pasternack**
13:45	Greory Pasternack	How to write a good paper for an International Scientific Journal: The Example of the Journal of Ecohydraulics and other IAHR journals University of California at Davis gpast@ucdavis.edu Maurice D Ledoyen. Department of Land, Air, and Water Resources, University of California, Davis, CA. The availability and distribution of suitable physical cover features are important ecological variables influencing the presence, abundance, and behavior of organisms. In riverine ecosystems, salmonids prioritize various cover features at all life stages, such as streamwood, aquatic vegetation, riparian shrubs, and large bed elements (LBEs, constituting boulders and bedrock ~ >0.5 m dia.). Physical cover is especially critical for juvenile salmonids, providing a predation buffer, hydraulic and thermal refugia, visual isolation, and increased foraging opportunities. The purpose of this study was to map diverse cover types in unprecedented detail, analyze their spatial and statistical attributes, and then evaluate their habitat roles for fry and juvenile size classes of rearing Chinook

		salmon (Oncorhynchus tshawytscha) and rainbow trout (O. mykiss). The study mapped, modeled, and evaluated ~ 37.1 km of the lower Yuba River (California, USA) at submeter resolution. Cover data was generated from topo-bathymetric data and 2-cm resolution aerial imagery by expert-based object mapping and automated object extraction workflows. New expert-based cover HSCs were developed in this study. Spatially based aggregate cover availability statistics were generated for each discharge, hydrologic zone, geomorphic reach, and river landform. Ecohydraulic model outputs provided a more comprehensive analysis of discharge-based preferred habitat availability, especially including new findings about flood refugia. Finally, observed cover objects were used to train a Random Forest machine learning algorithm to predict the locations of each type solely on the basis of meter-resolution bare-Earth terrain metrics.
15:30-16:00	**Break-Foyer**	
Suzor-Côté Ballroom 1 **May 7**	**Session 26: Restoring aquatic connectivity**	**Chairs: Valerie Ouellet**
16:00	Mariana Unda	An approach to integral ecological connectivity in terrestrial and aquatic landscapes Red de investigadores en Ecohidrología y Ecohidráulica (REDECOHH), Bogotá, Colombia undamariana@gmail.com Alejandra Moreno, Red de investigadores en Ecohidrología y Ecohidráulica (REDECOHH), Bogotá, Colombia; David Zamora, Departamento de Ingeniería civil y agrícola, Universidad Nacional de Colombia and Stockholm Environment Institute - SEI Latinoamérica; Alejandro Zuluaga, Red de investigadores en Ecohidrología y Ecohidráulica (REDECOHH), Bogotá, Colombia and Universidade Federal do Pará, Brasil; Ana Carolina Santos, Red de investigadores en Ecohidrología y Ecohidráulica (REDECOHH), Bogotá, Colombia and Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá, Colombia. The increase in ecosystem degradation along with the fragmentation, transformation and loss of habitat and its impact on biodiversity, have generated special interest in the study of landscape ecology. Although most connectivity studies for landscape conservation and planning focus mainly on the analysis of ecological connectivity in terrestrial ecosystems and lesser in river systems, it is important to consider that these are mutually dependent and the instability of one can affect the ecological functioning of the entire landscape. There is a limited number of investigations in ecological connectivity from a perspective that integrates hydrological aspects with terrestrial and aquatic ecology. One of the most popular and interesting tools in landscape ecology are the connectivity metrics or indices. In accordance with the above, a conceptual base evaluation and a ecological connectivity model were carried out based on the graph theory, the adaptation to circuit theory and the analysis of indices that evaluate the terrestrial, aquatic and hydrological components. The indices or metrics of Probability of Connectivity (PC), Equivalent Connected Area (ECA) and Human Footprint (HFI) were used for the terrestrial component, Population Connectivity (PCI) and Dendritic Connectivity (DCI) for the aquatic component and Water Connectivity and Flow Length (FL) for the hydrological component. These indices or metrics were selected to identify variable relationships and processes that define relevant and useful aspects to support effective management and conservation of the landscape. The proposed model contributes to the management of water resources as well as of biodiversity and ecosystems. By identifying variable relationships and terrestrial and aquatic processes, the model becomes a tool for the effective management and conservation of the landscape.
16:15	Roman Zurek	Restoration of the ecological continuity of the Vistula River and the lower stretches of the Soła and Skawa rivers on 165 km distance – issues and successes. Zakład Badań Ekologicznych zurek@iop.krakow.pl Karol Ciężak; Zakład Badań Ekologicznych; Piotr Sobieszczyk; Państwowe Gospodarstwo Wodne "Wody Polskie, Regionalny Zarząd Gospodarki Wodnej w Krakowie During 2021-2023, the Regional Board of Water Management in Krakow built fish ladders and fish ramps on 7 water dams and weirs. It open 165 km of river for fish migration. 2 of them were close-to-nature type, 4 typical technical fish passes or mixed type and one brush block fish pass. 2 fish passes join function of

		fish pass and kayak ramp. All fish passes were controlled dry and hydraulically. Then, working fish pas was verified by fish. Depending on the situation, we used different techniques: acoustic transmitters, PIT tags, fish traps and scanners. Technical fish pass Dwory passed 23 species and 1541 fish up and 70 down during one month (August) 2023. Passed 23 species including small specie like Pseudoraspora parva, Gobio gobio or Alburnus alburnus. Two slots fish pass Smolice during 22 days passed 2252 up and 213 down. 46% of them were bleaks Alburnus alburnus. River Skawa: Fish pass Podolsze – acoustic telemetry 180 kHz was used. After 42 days 55% of 30 taggged fish pass upward. Fish pass Grodzisko. Fish counter registered during 40 days 206 fish migrating up and 39 down of 10 species. 28,5 % of fish were not identified, 70 idiv. Brush fish pass Wadowice - during 25 days passed 11 species and 164 individuals. 61% of them were Stone loaches (Barbatula barbatula). Here were fish traps used. River Soła - Broszkowice – during 5 days 8 species in 175 number passed up. Fish trap was used. Scanner registered 13 fish migrating up and 44 down during 20 days. Bielany –acoustic telemetry 180 kHz. After 48 days 22 fishes of 4 species passed riffle of fish pass. It is 73.3% of released tagged fish. Polish construction standards should not be applied to technical fish ladders. They allow too much error. Catchment Board officials avoid field visits. They do not clean inlets/slots of leaves, branches, etc. Sometimes the fish ladder is a competition for water with pond owners. Not always attraction flows are enough. Lack of elements that help dissipate the energy of the additional water before it re-joins the rest of the flow. Scanner Vaki doesn't register small fishes. Scanner Simsonar register small fish like common minnow.
16:30	Gizachew Teshome	Diversity, abundance and spatiotemporal distribution of Labeobarbus species in below and above irrigation dam of the Megech River, Lake Tana sub-basin, Ethiopia Addis Ababa University gizachew2006@gmail.com Abebe Getahun at Department of Biology, College of Natural and Computational Sciences, University of Gondar, Ethiopia; Seyoum Mengistou at Department of Biology, College of Natural and Computational Sciences, University of Gondar, Ethiopia; Minwyelet Mingist at Department of Fisheries and Wetland Management, Bahir Dar University, Bahir Dar, Ethiopia Lake Tana is the largest freshwater body in Ethiopia, with a high fish diversity, including 18 Labeobarbus species. The aim of this study was to determine the diversity, abundance and spatiotemporal dynamics of Labeobarbus species in the Megech and Gumaro Rivers. Intensive fish samplings were carried out during the rainy and dry seasons from January 2021 to January 2023, and species diversity and abundance were recorded from six sampling sites. A total of 28 morphometric parameters were measured to characterize the unidentified Labeobarbus species and compare with known Labeobarbus species, and the data were analyzed using PCA plots. Multivariate analysis was used to test the spatiotemporal abundance and distribution of species. A total of 2035 specimens belonging to15 species and 3 families, were collected from all the sites. Thirteen species belong to the genus Labeobarbus and the remaining species were O. niloticus and C. gariepinus. Labeobarbus nedgia was the most abundant (605), followed by Labeobarbus beso (556), and Labeobarbus intermedius (368). The highest Shannon diversity index was scored in the main flowing river of Megech, below the irrigation dam, followed by the downstream site of this site and above the irrigation dam. Morphometric characterizations between unidentified Labeobarbus specimens with L. nedgia, and L. beso showed separate identities except few samples that overlay in the PCA plot. Meanwhile, the mean values of most morphometric parameters showed significant differences between the "new" and other Labeobarbus species, which indicate that the unidentified species may be potentially a new species. A PERMANOVA test detected significant differences in the spatiotemporal abundance and distribution of fishes between the study sites and months. Further detailed study is needed of the population genetics of the potentially new Labeobarbus species and conservation strategies developed for the sustainable use of these resources.
16:45	Bijoy Kumar Ghosh	Hydraulic impact on fish migration in a sariakandhi fish pass of Bangladesh. Kabi Nazrul Govt. College, DSHE, Dhaka-1000, Bangladesh bkghoshbuet7@gmail.com The importance of open water fish in our socio-economic regime has recently drawn the attention of the policy makers of the country. FCD/FCDI projects mainly serve the agricultural interests, but it interfere fish migration. This

		inevitably affects the open water fisheries sector as migratory routes. Nursing grounds of many species of fish are hampered and disturbed for these projects also. In order to permit fish migration in rivers, it is necessary to maintain conditions that help migrants reach their spawning grounds. To overcome obstacles, such as hydraulic structures, placed in the path of migrating fish, structures must be designed to assist the fish to pass them. The periodic and directed travel of fish mainly for feeding, breeding and over coming adverse climatic conditions is called migration. Fish passes are constructed to allow normal breeding migration and to ensure natural route of fish movement. The concept of a fish passes is relatively new in Bangladesh. At present, two Fish passes and two fish friendly structures are constructed. These are Fish Pass in Jamuna to Bangali River at Sariakandi in Bogra, fish Pass in Kawadighi Haor of Monu river in Moulovibazar, fish friendly structure in Lohajong river of Tangail and fish friendly structure at Morichardanra in Chapainawabganj. Fish fry, spawning and hatchling movement from Jamuna to Bangali River was the main objective of Sariakandi Fish Pass Project. The Fish Pass Project of Sariakandi is necessary for the development of the dominant fishes like catfish and small fishes. The structures will also aid in efficient development of the carp fishes. Spawning migration, mainly in carp fish, in the study area was found to begin at the 2nd week of May and continue up to the 3rd week of July. Catfish migrations began at the last week of March and continue up to the 2nd week of June. Fish fry and hatching movement from Jamuna to Bangali river was the main objective of Sariakandi fish pass project. The study also found that there were seven major category migratory species in the project area and the fish pass is contributing positively for growth of fishery resources in then study area. During the monsoon carp fish is the dominating migratory species. Carpfish migrates in a higher velocity, whereas, catfish migrates in a lower velocity. Some problems were found in the operation and management of fish pass. Key word: FCD/FCDI projects, Nursing grounds, Hydraulic structures, Natural route, Dominant Fishes, Peak migration.
17:00	Mahmoud Omer Mahmoud Awadallah	Physical habitat diversity and connectivity in response to varying sediment supply in an Alpine river widening ETH Zürich awadallah@vaw.baug.ethz.ch Paul Demuth, ETH Zürich; David F. Vetsch, ETH Zürich; Volker Weitbrecht, ETH Zürich; Robert M. Boes, ETH Zürich; Davide Vanzo, ETH Zürich Fluvial habitat assessment is an important tool for river restoration projects aiming at improving river hydro-morphological conditions by promoting near-natural hydro-morphodynamic processes. In near-natural river systems, floods alter morphology in a way that eventually affects habitat composition and distribution. The resulting morphologies are not only sensitive to flood intensity but also to the sediment regime associated with the reforming flood event. How the different levels of sediment regime influence habitat quality and quantity remains an open question. The objective of this study is to analyze how different sediment deficit levels, due to sediment regime discontinuity, influence different metrics of physical habitat compositions. This is investigated for a subalpine gravel-bed river widening setup of 1 % longitudinal slope, 675 m length, 27 m channel width, and a widening ratio up to 4. The widening morphologies were created experimentally (scale-factor $\lambda = 30$) using different sediment supply scenarios (i.e., 100 %, 60 %, and 20 % of the initial channel's transport capacity) during a steady bed-forming 1.5-year flood event. Using a two-dimensional hydrodynamic model and a habitat delineation tool, a wide range of discharges are simulated on the respective morphologies from relatively low to high discharges. Physical habitats are delineated using 2D depth and velocity outputs on an unsupervised classification algorithm with spatial contiguity and maximum habitat area constraints. Two hypotheses are evaluated: i) at low flows, morphologies created by sediment supply closer to the full channel transport capacity provide greater abundance of mild habitats, shallow-alike and glide-alike habitats, and less longitudinal variability as compared to starved-sediment morphologies; and ii) the influence of sediment scarcity level on the different habitat metrics diminishes linearly as discharge increases. This study is anticipated to quantitatively understand how changes in sediment regimes influence fluvial habitat dynamics and connectivity, therefore enhancing our comprehension of habitat template trajectories.
17:15	Kyu Jin KIM	A study on the longitudinal continuity assessment method of Korean rivers considering the swimming ability of fish living in Korea

		Kongju National University kyujin1999@naver.com Jae Goo, KIM; Alpha Research Ecology Institute; Joo-Duk, Yoon; Research Center for Endagered Species, National Institute of Ecology; Min-Ho, Jang*; Kongju National University River connectivity allows fish to move upstream or downstream, which has a significant impact on survival. In previous studies, the domestic river connectivity survey and evaluation methods has already been studied, and as a result, it has been suggested that ICE and ICF be modified and used according to the domestic current status. Accordingly, this study developed an investigation evaluation method that modified ICE and compared it with ICF to reconsider its applicability. Accordingly, a domestic river longitudinal connectivity evaluation method was developed to compare the characteristics of each fish species (maximum swimming speed, maximum jump height, minimum depth for swimming, minimum preparation for fish movement), obstacles and fishways. The developed evaluation method was found to be simpler, more cost-effective, and time-efficient than the ICF method. However, it is judged that research on the swimming ability and jumping ability of domestic fish species and evaluation methods for movable beam should be added.
17:30	Miriam Lebeau	Restoring aquatic connectivity for culturally significant species at risk in the Restigouche River watershed Gespe'gewa'gi Institute of Natural Understanding mlebeau@ginu.co Lebeau, Miriam; Arsenault, Michael; Chiasson, Billie; Gillis, Carole-Anne; Gespe'gewa'gi Institute of Natural Understanding Restoration work to improve habitat connectivity for Atlantic salmon, American eel, and Brook trout was conducted in the Restigouche River watershed from 2020 to 2023. This ongoing collaborative project funded by the Canadian Nature Fund for Aquatic Species at Risk is being led by the Gespe'gewa'gi Institute of Natural Understanding (GINU), an indigenous non-profit with 17 years of experience conducting research and gathering traditional knowledge about aquatic ecosystems. The project is guided by a two-eyed seeing approach which highlights the reciprocal relationships between these threatened species and our Mi'gmaq member communities. Through interviews with knowledge holders, concerns were raised about changes in land use and migratory patterns. The methodology for remotely identifying, classifying and prioritizing barriers to fish migration at the watershed scale includes the use of a GIS based framework utilizing LiDAR derived digital elevation models. Most of the prioritized restoration sites identified with remote sensing were culverts that were either perched and/or high slope velocity barriers. A decision-tree for the prioritization of sites for restoration was used and key factors were road access, property type, habitat quality and quantitative habitat gain. Field assessments were conducted at the prioritized sites allowing for restoration techniques to be selected and designed. The types of interventions implemented by GINU, and project partners include culvert replacement as well as construction of rock weirs, eel ladders and baffles. Efficacy of restoration is evaluated by conducting eDNA and electrofishing surveys before and after the work. This allows for any changes in fish community composition and upstream migration of target species to be detected. Movement of Atlantic salmon and American eel to previously inaccessible upstream habitats have already been observed in four streams.
Krieghoff Ballroom 2 May 7	**Session 27: Advances in numerical methods 2**	**Chairs: André St-Hilaire**
16:00	David F. Vetsch	An experimental study on seed dispersal by hydrochory in an alpine river floodplain VAW / ETH Zurich caponi@vaw.baug.ethz.ch Ilaria Rita Guiducci, Swiss Federal Institute for Forest, Snow and Landscape Research WSL; David F. Vetsch, Laboratory of Hydraulics, Hydrology and Glaciology, ETH Zurich; Sabine Fink, Swiss Federal Institute for Forest, Snow and Landscape Research WSL

		The dispersal of plant seed by water (i.e. hydrochory) is a fundamental process maintaining plant biodiversity in river systems. Seeds of several riparian plant species float on the water surface and retain their germination ability even after days in or under water, enabling plants to colonize new areas along river channels. Previous studies suggest that the process of transport and deposition of seeds depends on channel hydraulics and morphology, and seed traits. However, data on the relationships between those components are scarce and limited to studies on low-land rivers. In this work, we designed outdoor field experiments with seed mimics to understand the relationship between channel hydro-morphology and seed size in a gravel bed, alpine floodplain. The experiments were conducted in a 100 m-long reach of a secondary channel of the Moesa river near Cabbiolo, Switzerland. We released seed mimics (colored, floating wood cylinders) of three sizes and recorded the number and pattern of the particle deposition in 10 subsections of 10 m length along the investigated reach. To quantify water depth and flow velocity distributions of the channel, we ran a 2D hydrodynamic model calibrated with field measurements. Results show that the number of floating particles decreases exponentially with distance from the point of release, as observed by previous studies. The decay rate mainly depends on the discharge. Statistical analyses also showed that mimic deposition occurs mostly in shallower areas for the largest mimics and in deepest areas for the smallest particles. This can be attributed to the ways mimics of different sizes interact with bed roughness elements (e.g., large gravel, boulders, in-stream vegetation). These results provide the first quantitative relationship between channel hydro-morphology and seed dispersal and deposition for a gravel bed river and allow quantifying seed travel distances, which are pivotal for understanding riparian vegetation dynamics.
16:15	Binbin Wang	Development, evaluation, and application of a three-dimensional egg drift model (SDrift) for invasive carps in the Lower Missouri River Department of Civil and Environmental Engineering, University of Missouri wangbinb@missouri.edu Huijie Wu (Department of Civil and Environmental Engineering, University of Missouri, Columbia, Missouri, United States); Robert B. Jacobson (School of Natural Resources, University of Missouri, Columbia, Missouri, United States) Turbulence plays an important role in suspension and transport of fish eggs of bighead carp (Hypophthalmichthys nobilis), silver carp (H. molitrix), and grass carp (Ctenopharyngodon idella). Suspension of carp eggs in water column is essential to the survival and recruitment of these species because it keeps them from sediment burial or severe abrasion in the bedload. To understand the effect of turbulence on the kinematics of carp eggs, we conducted a laboratory experiment using approximately 220 surrogate carp eggs to investigate their suspension and Lagrangian behavior under various turbulence intensities (10-50 mm/s) in the absence of mean flow. We generated six turbulence conditions using eighteen bilge pumps under a modulation of a pair of stainless grids in the flow field. The pumps were turned on and off with various input voltages. The flow fields were measured using a particle image velocimetry (PIV) and a Doppler acoustic velocimeter (ADV) profiler. The images were analyzed to derive the vertical distribution of surrogate carp eggs in the water column. The result indicates that both turbulence intensity and intermittency affect the suspension of surrogate carp eggs. Acknowledgements: This work is supported by USGS Aquatic Invasive Species Competitive Grants Program (Grant number G21AP10172). The authors express their gratitude to Duane Chapman at the USGS Columbia Environmental Research Center (CERC) for his invaluable insights into the experiment.
16:30	Binbin Wang	Suspension of surrogate carp eggs in grid-modulated jet-stirred turbulence Department of Civil and Environmental Engineering, University of Missouri wangbinb@missouri.edu Geng Li (Department of Civil and Environmental Engineering, University of Missouri, Columbia, Missouri, United States); Ruichen Xu (Department of Civil and Environmental Engineering, University of Missouri, Columbia, Missouri, United States); Robert B. Jacobson (School of Natural Resources, University of Missouri, Columbia, Missouri, United States) Bighead carp (Hypophthalmichthys nobilis), silver carp (H. molitrix), and grass carp (Ctenopharyngodon idella) are aquatic invasive species in North America. These species have been found in many parts of the greater Mississippi River basin, from small streams to large rivers. In this study, we developed, evaluated,

		and applied a three-dimensional egg drift model, namely SDrift, to understand their transport process in a variety of water systems. SDrift is a Lagrangian particle tracking model by implementing the solver for the stochastic differential equation to obtain the prediction of carp egg transport in highly turbulent rivers. We evaluated the model in a straight uniform channel, an idealized curved channel, and an eight-kilometer reach in the Lower Missouri River. The model performed well within the prediction range of well accepted turbulent dispersion theories, and demonstrated an excellent ability for investigating the role of local turbulence on the egg retention. The representative reach in the Lower Missouri River provides an opportunity to evaluate the function of in-stream hydraulic structures (e.g., wing dikes and L-head dikes) in egg retention. The results indicate that the role of hydraulic structures depends on discharge conditions and river morphology, which all determine the hydrodynamics that are responsible for the suspension and transport of carp eggs. Acknowledgements: This work is supported by USGS Aquatic Invasive Species Competitive Grants Program (Grant number G21AP10172). The authors express their gratitude to Duane Chapman, Caroline Elliott, and Bruce Call at the USGS Columbia Environmental Research Center (CERC) for his contribution to the invaluable experimental data for this modeling study.
16:45	Shigeya Maeda	Impact of Nest Size on Deposition of Detached Filamentous Algae within Fish Nests in an Agricultural Drainage Canal: Application of a 3D Hydrodynamic Model Ibaraki University shigeya.maeda.15@vc.ibaraki.ac.jp Xiaolan Lin (Ibaraki University); Hisao Kuroda (Ibaraki University) Artificial fish nests, commonly deployed in agricultural drainage canals, are a prevalent method for conserving fish habitats in Japan. However, these nests are vulnerable to malfunction due to excessive sedimentation from soil particles and detached filamentous algae (DFA). This study aims to assess the variation in DFA deposition severity on the soil surface within fish nests of differing sizes, utilizing the three-dimensional (3D) hydrodynamic model, iRIC NaysCUBE. NaysCUBE, integrating a flow model with a 3D Lagrangian-type driftwood motion model, was implemented in a section of an agricultural drainage canal, measuring 14.9 meters in length and 3.0 meters in width. The canal features fish nest cavities, each 1.0 meter in height, 1.14 meters in length, and 0.9 meters in width, on both sidewalls. Various DFA shapes, such as long bars and rectangles, were modeled numerically to simulate their deposition within the fish nests. The calibration of NaysCUBE involved comparing computational results with hydraulic observation data, monitored DFA movement, and sedimentation patterns in the study area. The model's application extends to analyzing the effect of reducing fish nest sizes on the DFA deposition process.
17:00	John Chapman	How do we consider the settling velocity of organic material? University of Minnesota chapm155@umn.edu Aaron Pietsch, Engineer with Antea Group The settling velocity of a particle is an integral parameter to estimate the movement and transport of material in fluid environments. Settling velocity can be used to predict the fate and transport of pollution particles and can even be used to determine if the particles contribute to nutrient loading in a watershed. Prediction of settling velocity for inorganic particles is generally well-researched and well-understood but organic particles tend to vary widely in their physical properties, such as shape and density. This presentation will discuss several options for estimating the settling velocity of organic particles and some of the interesting complications to settling velocity estimates caused by organic structures and variability. This presentation also presents data from settling velocity experiments with tree leaves and seeds to better understand how organic particles settle in the context of settling velocity equations. This work includes calibration Ferguson and Church settling velocity equation drag coefficients to organic material properties. We will provide modelers and designers with a better understanding of how to represent common organic particles in terms of settling velocity.
17:15	Jose Carlos Ramirez	Optimal Design of Stormwater Sewer Collectors in Sewer Networks UNAM jocar_431@live.com.mx

		Herrera Alanis José Luis; Arganis Juárez Maritza Liliana One of the main problems in a locality is the evacuation of wastewater and rainwater. The design of sewer networks is a complex issue that involves two fundamental components: network layout and hydraulic design. This work proposes an optimal design for stormwater sewer collectors in a specific area of Mexico City, considering constraints such as velocity, depths, and discharge level. The optimization method employed is the Golden Ratio. The modeling was carried out using the Matlab program. The costs considered in the analysis include cutting, demolition, and pavement placement, excavation, sand bed, trench filling, pipe supply and installation, and the placement of inspection wells. These costs are based on the current price catalog issued by the Water System of Mexico City. The velocity, depth, diameter, minimum slopes, and minimum cushion constraints adhere to the guidelines set by the "Manual of Drinking Water, Sewerage, and Sanitation" issued by the National Water Commission.
17:30	Li Gu	The Dispersion of Municipal Wastewater Effluent in a Fjord-type Estuary Metro Vancouver li.gu@metrovancouver.org Claudia Wu, Metro Vancouver; Cristina Quinn, Metro Vancouver Located on the southern coast of British Columbia, Canada, Burrard Inlet is a fjord-type estuary with complex topography that plays a dominant role on local hydrography and circulation. One of the five wastewater treatment plants (WWTP) owned and operated by Metro Vancouver provides wastewater treatment for about 180,000 residents and discharges the treated effluent through a diffuser installed at the bottom of the First Narrows in Burrard Inlet. In order to better understand the estuarine circulation, near- and far-field mixing and dispersion characteristics of the effluent, plume modelling was supplemented with dye tracer experiments. A three-dimensional baroclinic estuary circulation model (MIKE3 FM) with a built-in near-field mixing module was applied. During dye tracer experiments, Rhodamine WT dye was injected at pre-determined rates into the final effluent at the WWTP and measured in the receiving water using a fluorimeter mounted on a CTD (Conductivity-Temperature-Depth) profiling system. The model shows good agreement with the dye survey data and oceanographic measurements including salinity, temperature, tidal level and current. Findings indicate the circulation and effluent transport are largely influenced by the prevailing topography at the First and Second Narrows. Tidal water pushes through these narrow and shallow passages at high speed, creating jet-like outflows at exits and then spirals off into large eddies. Sub-tidal mean circulation reflects the typical estuarine exchange pattern - surface brackish water flowing out into the ocean and a counterbalance of salty ocean water flowing in at depth. The near-field initial dilution and plume depth are controlled by current speed and effluent discharge rate and, to a lesser degree, by seasonal change of density stratification. Modelling results indicate that, although only occasional short-lived near-field plume surfacing is possible, mixing can often bring the effluent to the surface in the far-field under spring tidal conditions.
Borduas Ballroom 3 May 7	**Session 28:Vegetation in ecohydraulics**	**Chairs: Luiz da Silva**
16:00	Un Ji	Quantifying patchiness effect of emergent woody riparian vegetation on reach-scale flow resistance jiun@kict.re.kr Inhyeok Bae, University of Science and Technology; Juha Järvelä, Aalto University School of Engineering Woody riparian vegetation is usually clustered in patches on sand bars and floodplains. Although such vegetation benefits river ecology by providing habitats, trapping particulate and solute substances, and sequestering carbon, it increases water levels and thus flood risk by resisting the flow. Therefore, accurate prediction of water level changes due to the vegetative flow resistance is important for river management for balancing ecological benefits with the hydraulic performance of the river. Much of the existing knowledge on hydraulic modelling of vegetation is limited to the condition of evenly distributed or aquatic plants that behave differently in comparison to patchy woody vegetation. In this study, the strong dependence of reach-scale flow resistance on the patchiness characteristics of emergent (non-submerged) woody vegetation was revealed. Experiments were conducted in a large-scale outdoor flume using full-

		scale artificial willow patches with the canopy density and patch geometry systematically altered. The vegetative flow resistance was quantified in terms of the Darcy-Weisbach friction factor determined through friction slope, which was derived using the water surface slopes measured by high-accuracy pressure sensors. Experimental data showed that the reach-scale flow resistance of leafy woody patches primarily depended on the blockage parameters (i.e., area or volume fraction of canopy occupation) and leaf area index (LAI). Subsequently, empirical relationships were constructed with good explanatory power implying that the blockage factors can work as robust predictors of the flow resistance. The new relationships presented in this study for assessing the patchiness effects are expected to be a practical solution to evaluate the reach-scale hydraulic impacts of patchy riparian vegetation.
16:15	Inga Prüter	The Livelihood Diversification Strategies, Landscaping of A Typical Fish Farms in Gwagwalada Abuja Nigeria. inga.prueter@tu-braunschweig.de Spröer, F. Technische Universität Braunschweig; Keimer, K. Technische Universität Braunschweig; Lojek, O. Technische Universität Braunschweig; Windt, C. Technische Universität Braunschweig; Nistor, I. University of Ottawa; Goseberg, N. Technische Universität Braunschweig and Coastal Research Center, Joint Central Institution of the Leibniz Universität Hannover and the Technische Universität Braunschweig Aquatic vegetation provides valuable benefits for riverine ecosystems, including erosion prevention, water purification and varying degrees of flood protection. An accurate assessment of the advantages requires advanced numerical models for the complex interactions between flexible submerged vegetation and river current-exerted forces. Assessing ecosystem benefits depends on the accurate estimation of the behaviour of vegetation in natural riverine conditions. Important empirical parameters to quantify the performance of vegetation, such as the drag coefficient of plants, are difficult to directly measure in the field. The limited availability of such calibration data necessitates the development, calibration and validation of a numerical model which can simulate the behaviour of vegetation elements, such as stems, under hydrodynamic loading with a direct coupling of the forces. This is the first study to validate the open-source numerical model REEF3D::CFD in a novel two-way coupling of stems and current, building upon previous work using the one-way coupling of aquaculture fish cage gear. The fluid structure interaction is simulated using a finite difference solver, based on the incompressible Navier-Stokes equations, coupled with a structural solver characterized by the geometrically exact Cosserat rod. The validation of the model with experimental data revealed that the structural solver in REEF3D::CFD effectively simulates the fluid-plant interaction for varying stem lengths, current velocities, and vegetation types. Under constant current flow, stem tip position deviations relative to the stem length and the simulated drag forces were consistently below 10% of the experimentally measured ones. Overall, the structural solver in REEF3D::CFD was shown to be a robust tool for modelling the fluid-plant interaction for flexible submerged vegetation scenarios. The use of field data measurements will enable further validation of this numerical model whose results are expected to provide valuable insight into the multiple benefits of flexible submerged vegetation in riverine ecosystems.
16:30	Eunkyung Jang	Implementation of the three-dimensional shape of woody riparian vegetation using remote sensing imagery jang@kict.re.kr Un Ji, Korea Institute of Civil Engineering and Building Technology/University of Science and Technology; Riparian vegetation rarely takes root in isolation; instead, it often appears as an organized colony in a patch form that affects flow resistance. Woody riparian vegetation patches significantly contribute to increased flow resistance during floods; therefore, accurate prediction of flood level changes by woody vegetation patches located in the channel and floodplain is essential for flood risk management. Numerous models have been proposed to estimate the effect of vegetation on flow resistance, using physical variables such as vegetation height, density, leaf area index, etc. Since a precise measurement of the physical form of the irregular and sporadic vegetation in the field is complex, remote sensing approaches are required, such as Unmanned Aerial Vehicle (UAV), and Terrestrial Laser Scanner (TLS). Remote sensing technology reconstructs an object in three-dimensions through a point cloud and then estimates its physical

		shape. It can be used for estimating simple information such as length and width or spatial information of the surface, but there are limits to estimating the volume scale. In specific riparian vegetation, which appears in clusters rather than as a solitary patch, surface spatial information alone is insufficient to measure three-dimensional patches connected by leaves, branches, and stems besides canopy information. Additionally, the precision of object representation varies depending on the distance between the points, interpolation method, and filtering used in the rendering process, thus making it necessary to analyze the sensitivity. Therefore, this study aims to analyze the process of variable extraction to measure the physical shape of vegetation patches in three-dimensions using UAV and TLS imagery and ultimately estimate the effect of vegetation patches on flow resistance. The findings can be used in studying flood level changes by analyzing the effects of vegetation on stream flow and in analytical studies for the decision to preserve and remove the appropriate vegetation patches.
16:45	Jiwon Ryu	Analysis of physical and geometric characteristics for emergent riparian vegetation patches using UAV spatial information jiwonryu@kict.re.kr Eun-kyung Jang, Korea Institute of Civil Engineering and Building Technology; Un Ji, Korea Institute of Civil Engineering and Building Technology, University of Science and Technology The cross-sectional and volumetric blockage portion by vegetation patches in the river is quantified as the parameters for representing the physical and geometrical characteristics of emergent vegetation patches. Because the vegetative flow resistance is related to these blockage parameters, practical approaches for analyzing the geometric characteristics of emergent riparian vegetation patches are required for the growth stage of the vegetation. However, it is challenging to manually measure and calculate the patch area covered by trees and herbs in a large stream. Unmanned Aerial Vehicle (UAV) technology has recently been used to approach the site closely or to cover a wide range of areas. Surveying technology using UAVs is already widely used for terrestrial surveying, and it has the advantage of constructing remote sensing data with high-precision resolution at a relatively low cost. Therefore, in this study, UAV imagery was used to investigate the occupied proportion of vegetation patches and physical and geometric characteristics in the river of South Korea. We quantified the extent of vegetation coverage per unit area, the length and width of vegetation patches along the river, and the ratio of rigid to flexible vegetation using UAV spatial information with Geographic Information System (GIS). By defining the unique patch shapes and patterns in the target river, we can more precisely estimate the change in river characteristics caused by vegetation. The results of this study are essential for river management and can help to make informed decisions about habitat preservation, flood control, and river environment improvement.
17:00	Jiaqi Liu	Reproduction of suspended sediment transport in partially vegetated alluvial channels: effects of using different 2D eddy viscosity models j.liu@un-ihe.org Francesco Bregoli; Department of Water Resources and Ecosystems, IHE Delft Institute for Water Education, Delft, the Netherlands, Department of Environmental Science, Radboud University, Nijmegen, the Netherlands; Wim Uijttewaal; Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, the Netherlands; Giulio Calvani; Platform of Hydraulic Constructions (PL-LCH), IIC, School of Architecture, Civil and Environmental Engineering, EPFL, Lausanne, Switzerland; Alessandra Crosato; Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, the Netherlands, Department of Water Resources and Ecosystems, IHE Delft Institute for Water Education, Delft, the Netherlands Riparian vegetation is found on river banks and along the edge of bars that emerge during low flows. In laboratory experiments, the effects of riparian vegetation on hydro- and morpho-dynamics are studied in partially vegetated channels. Observations indicate that the gradient of the mean stream-wise velocity at the interface between the open and the vegetated flow enhances the occurrence of large horizontal coherent structures. These dominate the momentum transfer and the intensity of transverse velocity fluctuations and affect the local transverse suspended solids transport, impacting the sediment deposition distribution and the local morphological development. Numerical models adopt different descriptors of the horizontal turbulence structure, which influence the results of their simulations. In addition, several eddy viscosity approaches are implemented, which also affect the large horizontal coherent flow

		structures (LHCS). This study analyses the effects of 2D horizontal flow field description on suspended sediment transport in partially vegetated channels. Published flume experiments are reproduced in Delft3D, in which plants are represented by rigid cylinders with specific diameters and distribution densities. Three approaches predicting the effects of vegetation on sediment transport are considered in combination with eddy viscosity models. They are: the Baptist, Drag force, and Single Stem approaches for the effects of vegetation, which are combined with either the Hybrid Vegetated Flow, Elder's, or Constant Value eddy viscosity approach. The resulting flow field and sediment transport predictions are compared and discussed. Preliminary results show that the chosen approach influences morphological development and should be carefully selected.
17:15	Ana Santos	¿Intensive care in complex swamps? Path of diagnosis and care considering local experts and scientists asantos@humboldt.org.co Vargas-Betancourt, Monica L. Universidad de Antioquia; Amador, Jorge. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt; Hernandez-Manrique, Olga Lucia, BC3 Basque Centre for Climate Change;Silva, Tatiana. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt; Merlo, Anny. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt; Espinosa Aguirre, Natalia. Universidad de Antioquia; Hernandez, Esnedy. Universidad de Antioquia; Roa, Margarita. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt; Hernandez, Monica. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt This work aimed to understand swamp health in the north of Colombia by integrating local community experiences and scientific knowledge to improve wetland ecological functions. Swamps are wetlands located in the lower basin of large rivers. Their primary function is to dampen the flood pulses of the rivers. As socio-ecological systems, swamps' health is being deteriorated by anthropic pressures, and "intensive care" is required to recover their resilience and improve the relationship between society and nature. Local communities' knowledge, monitoring biotic, abiotic, and socioeconomic variables obtained with in situ measurements and remote sensors, and the results of hydrodynamic models were integrated into the research. The results indicate that the swamps' health is affected by the loss of connectivity, invasive species, alluvial gold mining, and land tenure. The monitoring records around chlorophyll, changes in land use and cover, sediments, the temperature of the water, and artisanal fishing are coherent with the local communities' environmental history. The workshops development with the local communities showed a low knowledge of politics about water, biodiversity, and land management. In addition, governance and interaction of local communities with stakeholders at the government level are too weak. On the other hand, climate variability and prolonged flooding related to ENSO-La Niña represent damage to the health of the swamp complex due to the incursion of pollutants transported from the upper and middle basins where Colombia's principal Citys and industries are. In contrast, drought brings high fish mortality. The primary intensive care raised by local experts and scientists is aligned with the recovery of water connectivity, improving alluvial mining management, overfishing, and waste and wastewater management. Finally, local communities are intensely interested in establishing an education and awareness route to care for swamps, recognizing that they are their primary source of well-being.
Leduc-Fortin May 7	**Session 29: Restoring aquatic organism passage**	**Chairs: Danielle Frechette**
16:00	Cailey McCutcheon	Make it FAST: A field-based tool for rapid fish passage assessment cmccutcheon@geoprocess.com Court Berryman, Tara Bortoluzzi, and Steve Cho from the Department of Fisheries and Oceans Canada (DFO) and Sarah Grass, Jeffrey Hirvonen and Ken Glasbergen from GeoProcess Research Associates The Department of Fisheries and Oceans Canada (DFO) has been working with GeoProcess Research Associates to develop a rapid field assessment tool that can assess the likelihood of fish passage through watercourse culvert crossings using focused field data collection and rapid analyses: Fish pAssage Screening Tool (FAST). FAST utilizes a phased screening approach to assess fish passage using site-specific information related to watercourse characteristics and hydraulic, culvert crossing structure geometry, and targeted fish species swimming performance metrics from DFO's Swim Performance Online Tool (SPOT). The

		tool has been developed by an interdisciplinary team including engineers and biologists, which is reflected in FAST's performance and capabilities. FAST is a unique field tool due to its utilization of a combination of hydraulic calculations, site-specific field measurements, and fish-swimming capabilities. This allows FAST to strike a balance between cursory visual assessment methods and onerous, comprehensive desktop modelling assessments. DFO is evaluating additional applications for FAST, including culvert crossing design verification. The hope is that the tool can be used by DFO, as well as a variety of other users, including biologists, engineers, geomorphologists, regulators, other practitioners and the public to make an informed evaluation of the likelihood of fish passage at watercourse culvert crossings. While there is still work to be done, the tool is being ported into a mobile-compatible platform and field tests have identified areas of refinement. The team has engaged with multiple agencies and has received feedback about how FAST could be refined or integrated into other inventory or assessment processes. We look to expand these connections as FAST is finalized.
16:15	Shane Scott	Aquatic Organism Passage (AOP) Solutions at Culverts and Fish Barrier Management in North America shane@ssaenvironmental.com Culverts, bridges, and similar in-water structures rank second only to dams in their obstruction of fish and other aquatic organisms. These structures have a detrimental impact on habitat connectivity for numerous species, as they restrict access to crucial spawning and rearing habitats. Significant efforts have been devoted to the removal and replacement of culverts to enhance aquatic organism passage (AOP). These projects are resource-intensive and may take years to complete. In addition, the number of AOP barriers is so numerous that many will not be addressed in a timely manner, if at all. However, there are many opportunities to improve AOP through barrier modification where removal or replacement is not feasible or timely. This presentation aims to provide an insightful exploration of low-cost, rapid solutions for retrofitting culverts and similar structures to improve AOP. The spectrum of corrective actions will include retrofitting culverts with weirs and floating ramps to improve access and passage through the culvert. Real-world case studies will be presented to demonstrate how barriers can be modified to improve AOP. We will also describe Computational Fluid Dynamic modeling used to quantify the AOP benefits of these culvert modifications. Additionally, we will describe a Fish Passage Barrier Assessment and Prioritization program being used to plan and implement corrective actions to overcome AOP barriers on a watershed scale.
16:30	Christian Fox	Identifying Cost-Optimized Road-Stream Crossing Barrier Removals christian.fox@tnc.org Christian Fox, The Nature Conservancy in Maine; Steve Tatko, Appalachian Mountain Club; Sean Morrison and Mike Burke, Inter-Fluve Sea-run Atlantic Salmon (Salmo salar) have been expatriated from all of the United States except Maine. Stream connectivity throughout Maine is fragmented by many thousands of barriers, most underperforming road-stream crossings, that prevent access to critical spawning and rearing habitat for Salmon and other sea-run fish. Replacing these crossings with "Stream Smart" structures is a proven strategy to restore access and rebuild Salmon populations while at the same time improving transportation infrastructure. However, these projects are increasingly expensive and there is limited engineering and construction capacity available; consequently, implementation must be strategic and coordinated. The Nature Conservancy in Maine holds a comprehensive state-wide dataset of road-stream crossing barriers and has ranked these for restoration priority using dozens of ecological and societal variables. This information currently guides choices across many sectors, but these decisions are made on a per-project basis, and the dataset does not account for implementation cost. Our Optimization Analysis builds on this Statewide Barrier Prioritization dataset and adds calculated replacement cost information to identify sites that offer "the best bang for the buck" in restoration value. The analysis identified populations of replacement projects that together achieve maximum reconnection of high-quality Salmon habitat for available budgets using the OptiPass Migratory Fish Passage Optimization Tool developed by Dr. J.R O'Hanley. Subsequent to the Optimization Study, significant post-processing of the results was required to identify crossings to advance for replacement, five of which are currently in progress. This presentation will present our study design, process, and results to assist others in improved decision-making for project selection.

16:45	Justin Duncan	Review of emerging regulatory and policy tools and a prescription for successful aquatic habitat restoration at scale justind@cwf-fcf.org The Canadian Wildlife Federation (CWF) has conducted a review of regulatory, policy and funding tools across Canada, the United States, European Union and other regions that support habitat connectivity and restoration of fish passage in particular. This presentation will include a summary of the policies and funding currently being made available to support aquatic habitat restoration in the US (including at the state level) and EU (including some national level programs) and contrast this to the lack of similar programming in most of Canada and how this discrepancy is borne out in the clear difference in recent habitat connectivity and fish passage restoration results. The conclusion will be that a prescription of regulatory tools, including both carrot and stick approaches, combined with sustained funding, is generally necessary where the objective is to restore aquatic habitat connectivity at scale.
17:00	Andrew Anderson	Whiskey Creek - a tale of never ending barriers andrew.anderson@gov.bc.ca Sean Wong, Senior Biologist at BC Ministry of Transportation and Infrastructure Whiskey Creek is a tributary to the Little Qualicum River near Qualicum Beach, BC that has undergone a series of fish passage improvements over 20+ years. This case study highlights the diverse technical expertise, dedication, and partnerships created between local stewards and government agencies at all levels in their quest to restore aquatic habitat on central Vancouver Island. Improvements began in 1999 with the removal of a silt-laden dam that restored over 8 km of instream habitat to previously extirpated trout and salmon species. The removal led to increased awareness towards fish passage barriers throughout the watershed, with the next major barrier (a perched pipe-arch culvert at Melrose Road) being targeted three years later. Tailwater modifications using two fish-friendly rocks weirs simulating natural riffle-pool morphology eliminated the perched culvert at Melrose Road in 2002, but were unravelled during a rain-on-snow event in January 2005. The BC Ministry of Transportation (MoTI) became engaged in 2005, utilizing their culvert retrofit program to improve and restore fish passage at MoTI managed roads. That summer MoTI built a more robust riffle-pool sequence at Melrose Road that included three rock weirs, spawning platforms, off-channel habitat, and a groundwater fed side-channel. These works remained intact even after another large rain-on-snow event in January 2018 that resulted in a washout and complete road closure. MoTI responded with a temporary bridge that survived two years before being replaced again by a concrete box culvert. Unfortunately the box culvert was not embedded and its construction resulted in dismantling much of the 2005 and 2018 restoration works. This led to a DFO non-compliance for contravention of the Fisheries Act with corrective measures required by August 2023. MoTI has since improved fish passage through new tailwater controls, added roughness to the box culvert, and enhancements to the existing off-channel features.
17:15	Anna Mallonee	Quiota creek fish passage program: would updated guidelines have improved resiliency of fish passage designs? anna.mallonee@hdrinc.com Samantha Anderson, (HDR); Mike Garello, PE (HDR) The Cachuma Operation and Maintenance Board implemented ten fish passage projects along Quiota Creek in the Santa Ynez Valley in southern California between 2008 and 2020. At the time of implementation, these projects successfully removed fish passage barriers, restored ecological connectivity for juvenile and adult O.mykiss over the determined range of fish passage flows, and significantly improved both private and public access. Design criteria for each project was based upon the precipitation and flow frequency information available at the time construction began in 2008. In early 2023, a region-wide storm event brought heavy rainfall to the area, the intensity and duration of which caused significant changes to Quiota Creek throughout each of the ten projects. The National Oceanic and Atmospheric Administration believes the storm to have been equivalent to a 24-hour duration 25- to 50-year recurrence interval based upon current analysis of precipitation duration-intensity frequency data collected over the contemporary period of record through 2023. Observations following this major storm event included (a) bank erosion and deterioration of bank slope protection, (b) loss of pool habitat, reducing available cool water refugia previously present during summer months, (c) aggradation in reaches with lower gradients, causing a decrease in flood conveyance capacity and increasing potential for overtopping and flooding, (d) damage to rock weirs and roughened channels installed during the original construction, and (e) formation of new leap height fish passage impediments due to redistribution of bedload. This case study reviews design guidelines, criteria, and considerations at the time of design (2008 through 2020) and compares them against a modified climate-impacted set of design criteria

		using the guidelines presented in the recently published resiliency guidance for fish passage projects (NOAA, 2022) to answer the question: would these updated guidelines have improved the resiliency of fish passage designs at Quiota Creek?
17:30	Michael Chelminski	Dam Removal and Upstream Fish Passage michael.chelminski@stantec.com This presentation discusses opportunities and constraints for restoration of upstream fish passage associated with removing small dams in the northeast United States. Usual drivers for dam removal are elimination of costs and risks to dam owners and restoration of upstream passage for aquatic fauna. Opportunities for restoring upstream fish passage as part of dam removal are often constrained the adjacent physical environment and what organisms will realize improved passage. In addition to identifying potential project-specific goals for restoration of upstream fish passage at the location of a project dam, this presentation discusses the potential need to address upstream passage and restoration of aquatic habitat in former impoundments. Dams are often located on natural falls or adjacent to cascades due to exposed bedrock and relative ease of construction. Certain natural features may not restore upstream fish passage or may limit upstream passage to specific hydrologic conditions (e.g., higher flows). Similarly, dam removal may retain structures, such as mill buildings, that encroach into the pre-development waterway and result in conditions that may limit or prevent upstream fish passage for some or all fish species. Site-specific physical constraints associated with upstream fish passage for dam removal include (1) potential natural barriers (e.g., falls, cascades) along a project waterway, (2) encroachment of structures into waterways adjacent to dams, and (3) realignment of waterways concurrent with dam construction. Consideration of upstream fish passage following dam removal must be addressed as part of dam removal planning and design can affect associated design and permitting needs. In some cases, it can be identified that upstream passage for all species and life stages is not possible or practical and reevaluation of project-specific goals and objectives can be necessary. Consequent limits on upstream passage may conflict with project goals and regulatory objectives and acquisition of necessary permits.
17:45-18:45	**TC on Ecohydraulics meeting-Suzor-Côté Ballroom 1**	
17:45	**Fish Passage – SC meet in Foyer**	

May 8 (Wednesday) Room/hours		
7:00-8:30	**Breakfast served at Level 2 Jean-Paul Lemieux**	
8:30-9:30	**Intro – Ballrooms** **Plenary 4. Theodore Castro Santos: Shadowboxing the Anthropocene: the emergent, divergent, and evolving challenges of fish passage**	
9:30-10:15	**Break – Foyer**	
Suzor-Côté Ballroom 1 **May 8**	**Session 31: Working across the riverscape**	**Chairs: Normand Bergeron**
10:15	Christian Torgersen	Riverscape approaches in practice: Perspectives and applications USGS ctorgersen@usgs.gov Céline Le Pichon, INRAE Landscape perspectives in riverine ecology have been undertaken increasingly in the last 30 years, leading aquatic ecologists to develop a diverse set of approaches for conceptualizing, mapping and understanding 'riverscapes'. During the last two decades, scientific literature on riverscapes has increased rapidly, indicating that the term and associated approaches are serving an important purpose in freshwater science and management. We trace the origins and theoretical foundations of riverscape perspectives and approaches and examine trends in the published literature to assess the state of the science and demonstrate how they are being applied to address recent challenges in the management of riverine ecosystems. We focus on approaches for studying and visualizing rivers and streams with remote sensing, modelling and sampling designs that enable pattern detection as seen from above (e.g. river channel, floodplain, and riparian areas) but also into the water itself (e.g. aquatic organisms and the aqueous environment). Key concepts from landscape ecology that are central to riverscape approaches are heterogeneity, scale (resolution, extent and scope) and connectivity (structural

		and functional), which underpin spatial and temporal aspects of study design, data collection and analysis. Mapping of physical and biological characteristics of rivers and floodplains with high-resolution, spatially intensive techniques improves understanding of the causes and ecological consequences of spatial patterns at multiple scales. This information is crucial for managing river ecosystems, especially for the successful implementation of conservation, restoration and monitoring programs. Recent advances in remote sensing, field-sampling approaches and geospatial technology are making it increasingly feasible to collect high-resolution data over larger scales in space and time. We highlight challenges and opportunities and discuss future avenues of research with emerging tools that can potentially help to overcome obstacles to collecting, analysing and displaying these data. This synthesis is intended to help researchers and resource managers understand and apply these concepts and approaches to address real-world problems in freshwater management.
10:30	Katrina Vaughan Cook	Connecting a river to it's estuary: A conservation success story for juvenile Chinook Salmon Katrina.vcook@gmail.com Steph Lingard, University of British Columbia; Edith Tobe, Squamish River Watershed Society; Caroline Melville, InStream Fisheries Research Large-scale habitat reconnection projects in aquatic environments are rare and as such, there is little information on the effectiveness of these actions. Since 2019, the Squamish River Watershed Society, a small non-profit organization, has progressively added fish passage opportunities across a five-kilometer dike separating the Squamish River from it's estuary. The Squamish River, in southwestern British Columbia, drains 3600 km of land into a fjord estuary and is a highly valued waterway. The river and it's estuary are within the traditional territory of Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and the rapidly growing modern community of Squamish. The objective of the restoration program is to connect the river to it's estuary to support the out-migration of juvenile Chinook Salmon. Chinook are considered an at-risk species in this region and access to the refuge and food sources of estuarine habitat is critical during the rearing period. We have been monitoring the movements of juvenile salmon through culverts and large breaches using various telemetry technologies annually since 2018, a year prior to that start of fish passage restoration activities. Preliminary analysis of data suggests larger berms improve passage conditions over large culverts, and that juveniles express diverse rearing patterns while in an estuary. The project represents a conservation success story. Execution of the restoration actions required collaboration among government, First Nations, and the wider community, and we were able to confirm success of the initiative using cutting-edge telemetry tracking technology. The insights gained from this project will help to inform large scale reconnection initiatives for Pacific Salmon in estuarine environments.
10:45	Simon Geist	Getting a handle on the influence of longitudinal connectivity on fish population dynamics geist@bafg.de Cornelia Schütz, BfG; Annika Hürter, BfG; Matthias Scholten, BfG The quality of fishways has so far been assessed as attraction and passage efficiency of a given construction. To determine whether such a local fishway efficiency allows the development of stable (sub-)populations of potamodromous fish species in the respective river section, a management tool would need to consider at least population dynamics, available habitats, and connectivity across impoundments. Population models exist for several riverine fish species, but only less than a handful approaches for minor rivers take all three necessary aspects into account. For major and heavily impounded rivers like many of the German Federal Waterways, no applicable modeling framework for the evaluation of continuity is available to date. With the project "FischPop", we plan to develop a model which shows the influence of continuity measures on fish populations against the background of the respective available habitat. We will present the conceptual model design that includes a population model and modules on connectivity and habitat as well as a model library and data from project areas for calibration and validation. The available habitat supply will determine the carrying capacities within the population model and the connection of multiple subpopulations will integrate the aspects of fishway efficiencies (upstream and downstream passability). As such the metapopulation will be modeled across multiple impoundments. We aim for model results that will represent the development of the populations over time to allow an estimation of trends (e.g. increase, decrease, stagnation) and support restoration management decisions in major impounded rivers.
11:00	Wouter van de Bund	A method for characterising free-flowing rivers in Europe combining assessments at catchment and local scale wouter.van-de-bund@ec.europa.eu

		Martina Bussettini, Italian Institute for Environmental Protection and Research (ISPRA), Italy; Cosimo Peruzzi, Italian Institute for Environmental Protection and Research (ISPRA), Italy; Andrea Goltara, Italian Centre for River Restoration (CIRF), Italy The European Union has set ambitious objectives for restoring and protecting free-flowing rivers, addressing both longitudinal and lateral connectivity through removing barriers. European rivers are highly fragmented by on average ca. 2 longitudinal barriers each river km, while data on lateral fragmentation are still to a large extent unavailable. Removing dams and other longitudinal barriers within a river reach is an important measure to achieve free-flowing rivers, but it is crucial to also consider possible effects of up- and downstream barriers on ecological and hydromorphological conditions. Here we propose a method to determine whether a river reach should be considered "free-flowing" in the context of the implementation of the EU Biodiversity Strategy 2030. The proposed approach aims to ensure that key river functions, such as sediment transport, flooding of floodplains, lateral erosion, and fish mobility are not significantly impaired. The main elements of the assessment method are (1) segmentation into homogeneous reaches; (2) assessment of relevant longitudinal barriers within the reach; (3) type-specific criteria ensuring that lateral barriers are not significantly compromising river functions; (4) defining type-specific minimum lengths for a free-flowing reach; and (5) catchment scale criteria to ensure that river functions are not significantly compromised by upstream barriers for sediment, and that there are no unmitigated downstream migration barriers for target fish species. Achieving free-flowing rivers therefore requires not only the removal of barriers within the reach but also the mitigation of the effects of barriers up- and downstream, through sediment management and measures to ensure fish migration. It is expected that this method will be used by countries and river management authorities to demonstrate how barrier removal and accompanying restoration measures contribute to the European free-flowing river target. In this paper we demonstrate the application of the method in two Italian rivers in different physiographic contexts.
11:15	Beatriz Negreiros	Multi-dimensional river connectivity analyses leveraged by a database approach beatriz.negreiros@iws.uni-stuttgart.de Sebastian Schwindt, Institute for Modelling Hydraulic and Environmental Systems; Silke Wieprecht, Institute for Modelling Hydraulic and Environmental Systems Advances in measurement techniques have generated great amounts of data on rivers that enable to investigate processes driving connectivity at multiple scales. While river research has been historically focused on data analysis, more tools are necessary to ensure that collected datasets are structured, stored, and maintained adequately at the first place. Databases enable to link and structure parametrical geospatial data of different types and formats, which often result from fieldwork surveys at rivers. Inspired by data analytics, this study employs a unique river database and an interactive web application (River Analyst) to leverage multi-dimensional river connectivity analysis. River Analyst was developed according to state-of-the-art web development practices, notably the Django framework in Python, and can be run locally in any computer or hosted online as a web application. This study demonstrates the use of database queries of dissolved oxygen (DO) and grain size characteristics to assess connectivity at two restored reaches of the Rhine river. The results at a coarse-grained site show similar surface and subsurface DO, in particular in the shallow (< 0.2 m) hyporheic zone, suggesting high vertical connectivity. Statistical tests at a sand-dominated site showed significantly lower DO values in the shallow hyporheic zone relative to surface water, which indicate that oxygen-rich surface water could not penetrate the riverbed. Qualitatively, frozen sediment cores showed that this vertical (dis)connectivity can be attributed to a much finer sediment composition and a silt to clay-dominated sediment layer hampering local up-/downwelling. Depth profiles showed low subsurface DO at the disconnecting fine-sediment layer. At one river transect, an increase of DO in deeper regions of the hyporheic zone indicated external sources of oxygen-rich water, thus suggesting ongoing lateral or longitudinal hyporheic flows. This study exemplifies one of the many insights into connectivity processes that are facilitated by database schemes.
11:30	Edward Dilks	eDNA metabarcoding as a tool for assessing spatial distributions of fish communities in a heavily fragmented UK river edward.dilks@nottingham.ac.uk Stephen Dugdale, University of Nottingham; Hanna Hartikainen; University of Nottingham; Matthew Johnson, University of Nottingham; Francois Edwards, APEM; Scott McKenzie, Trent Rivers Trust

		Freshwater biodiversity continues to decline at an alarming rate, in part driven by ongoing connectivity loss. Frequently, research on fish movement within fluvial environments focuses on the effects of large dams. However, small obstacles such as weirs are orders of magnitude more abundant and are often spatially concentrated in such a way as to present a significant cumulative barrier to passage. There is a clear need therefore to assess the impacts that these small barriers have on fish populations in order to better inform future restoration efforts. Traditional methods of riverscape survey are often costly, both in terms of time and finance, and due to inherent biases can often provide an incomplete picture of communities present. This study on a UK river heavily fragmented by small historical barriers uses environmental DNA (eDNA) metabarcoding to generate data on fish community assemblage throughout the riverscape. Pseudo-abundance data were generated from metabarcoding data through both statistical and exogenous standard spiking techniques. These data were then compared to historical catch records, electrofishing data and qPCR results for key species of interest (Salmo trutta, and Thymallus thymallus) to assess the accuracy of these pseudo-abundance measures. Our results demonstrate that eDNA-based pseudo-abundances can offer fine-scale insights into the spatial distribution of fish within the riverscape at spatial resolutions not readily achievable by conventional field methods. Subsequent research will focus on the construction of simple 1D hydraulic flow model to derive origin of waterborne eDNA and better account for longitudinal transport through the system. This will also facilitate the calculation of flow-mediated passability for barriers present within the river (at differing flow levels). When coupled with fuzzy logic-derived habitat suitability models (HSMs), our data will ultimately help to identify the role of these numerous small barriers in defining fish species distribution in a heavily impounded watercourse.
11:45	Nick Lapointe	Conservation successes from the application of a watershed connectivity restoration planning process nlapointe@cwf-fcf.org Nick Mazany-Wright, Canadian Wildlife Federation; Fielding Montgomery, Canadian Wildlife Federation; Craig Mount, British Columbia Ministry of Water, Land and Resource Stewardship; Simon Norris, Hillcrest Geographics; Betty Rebellato, Canadian Wildlife Federation Aquatic barriers to fish movement are prevalent across much of Canada and affect fish production and population viability. Given the number of barriers and costs of connectivity restoration, prioritization methods are needed to help address this conservation issue efficiently. A watershed connectivity restoration planning framework based on the international Conservation Standards is being implemented in eight watersheds across Canada. This planning framework involves engaging local partners to define a geographic scope, select focal fish species, estimate the current habitat connectivity status, define concrete goals for gains in connectivity, and prioritize barriers to achieve those goals. Novel spatial models identify habitats that would be accessible to focal species in the absence of anthropogenic barriers and the subset that are suitable for spawning, rearing, or refuge. A connectivity model overlays barriers to estimate how much suitable habitat is connected, and which barriers contribute the most to fragmentation. Barriers are ranked, with consideration of pairs and sets of barriers that must be addressed together to restore connectivity. Model outputs are used to estimate connectivity status and prioritize field assessments, focusing on potential barriers with the most suitable habitat upstream. Based on field results, barriers are confirmed or removed from the model if they are passable or if upstream habitat is unsuitable. Uncertainly regarding connectivity status is reduced rapidly by iteratively focusing on sites with the most habitat upstream. In the Horsefly River Watershed in BC, this process reduced consideration of thousands of potential barriers in a watershed to 17 that blocked 43% of disconnected Pacific Salmon habitat. Since identifying these 17 barriers in 2021, we have continued to engage with barrier owners and conservation partners. As a result, two of the barriers have been removed and progress is being made to address most of the others.
12:00	Donné Mathijssen	Examining the benefits for fish after 31 years of improving water quality, connectivity, and habitat diversity in a novel ecosystem donne.mathijssen@wur.nl Peter Paul Schollema, Regional Water Authority Hunze & Aa's, Veendam, The Netherlands; Jeroen Huisman; University of Applied Sciences Van Hall Larenstein, Leeuwarden, The Netherlands; Anthonie D. Buijse, Department of Freshwater Ecology and Water Quality, Deltares, Delft, The Netherlands; Hendrik V. Winter, Wageningen Marine Research, Ijmuiden, The Netherlands; Leopold A.J. Nagelkerke, Wageningen University and Research, Wageningen, The Netherlands Human activities have irreversibly transformed ecosystems, hindering the achievement of restoration goals based on historical benchmarks and giving rise to new ecosystem states. The Westerwoldse Aa stream basin (The Netherlands) exemplifies such a novel ecosystem with three main biotopes along its sea-to-source gradient: 1) estuary, 2) canals, 3) streams. Human interventions, including land reclamation, dredging, canalization, peat excavations, and pollution have altered the functioning of these biotopes. Most of these changes in landscape

		and available habitat were made from 1960 to early 1970s. From 1990 - 2021, comprehensive measures have been implemented to improve water quality, in-stream habitat quality, and connectivity across the entire stream basin. We evaluated the combined effect and development of these components over time. Water quality gradually improved after changes in legislation regarding wastewater treatment. Total nitrogen decreased below threshold concentrations of 2.5 mg L-1 for the first time in 2017 which is 47 years after the first efforts were initiated to reduce nutrient load of the surface waters. Habitat diversity was increased following re-meandering, which incresed the total stream length from 69.8 to 80.6 km. Longitudinal connectivity improved through constructing 34 fish passages along the main stem of the stream. However, specialised rheophilic and diadromous fishes, that became locally extinct, are slow in their recovery, and require more time to recolonize the area. Some rheophilic species as dace (Leuciscus leuciscus) still occur in adjacent stream basins. Hydrological conditions in connecting canals form an invisible, behavioural barrier and prevent natural recolonization of the Westerwoldse Aa stream basin. Moreover, the migration of diadromous fish species is affected by the abiotic conditions at the estuary-freshwater transition, as they determine the operation of some technical fish passages. With inland conditions appearing suitable again, this may delay the recovery of populations of these species.
Krieghoff Ballroom 2 **May 8**	**Session 32: Innovative fish passage designs**	**Chairs: Jesus Morales**
10:15	Boyd Kynard	Performance of a New Alternating Side-Baffle Fishway at Passing Diverse Potamodromous and Diadromous Fishes drboyd@umass.edu Jerry Sweeten, Senior Restoration Ecologist, Ecosystems Connections Institute, 9130 North 600, East, Denver, IN 46926, USA; Brian Kynard, BK-Riverfish, llc, 28 Echo Hill Road, Amherst, MA 01002, USA; Cassandra Holmes, Ecologist, Hobart, IN 46342, USA; Kevin Pangle, Professor of Ecology, Central Michigan University Department of Biology, Mt. Pleasant, MI 48859, USA; Kevin Haupt, Fisheries Biologist, United States Fish and Wildlife Service, Carterville Office, Marion, IL 62592, USA; Donovan Henry, Assistant Property Manager, Crab Orchard National Wildlife Refuge, Marion, IL 62592, USA BK-Riverfish, llc invented and patented in the USA and Canada a new technical upstream fishway design: the Kynard Alternating Side-Baffle Fishway. In 2017, a 23-m-long prototype Model 2 fishway (0.6 m wide x 0.6 m high on 8.3% slope (1:12) with 56 side-baffles) was installed at the 1.5-m-high Stockdale Mill Dam, Eel River, IN to monitor performance of the fishway at passing diverse potamodromous fishes. Each spring-fall during 2018-2021, “passed” fish were captured in a funnel trap set in the ladder exit during a 72-h per week sampling effort with the following results: 1) 25,000 individuals representing 52 species (85%) of the 61 species in the Eel River ascended the fishway, and 2) small and large fish ascended: small = 30 mm TL (five darter species); large = 750 mm TL (Golden Redhorse, Moxostoma erythrurum). The prototype was not damaged by winter ice or floods, and it passed debris that was shorter than the fishway width. Captured diadromous fish observed during trials in an experimental Model 3 fishway (0.9-m-wide x 0.3-m-high with 8 side-baffles) found the following: 24 adult Blueback Herring, Alosa aestivalis, (mean TL = 263 mm) made 10 ascents (41.7%); five schooling adult American Shad, A. sapidissima, (mean TL = 437 mm) made four ascents; and 23 of 75 (30.7%) American Eel juveniles, Anguilla rostrata, (mean TL = 167.6 mm) ascended the fishway. The fishway requires a low fishway flow to create water 30.5 cm deep at side baffles, i. e., in the Model 2, this is 1 ft3/s (0. 0283 m3/s) and in the Model 3, this is 1.7 ft3/s (0.0481 m3/s), making the fishway a good choice for drought regions.
10:30	Scott Miehls	Test of Archimedes screw style fish lift for passage of non-jumping migratory fish species. US Geological Survey scottmiehls@gmail.com Daniel Zielinski, Great Lakes Fishery Commission; Sean Lewandoski, U.S. Geological Survey; Jesse Eickholt, Central Michigan University; Barriers limit migration of fish species around the world thus managers are tasked with improving access to blocked tributaries. In many instances those same managers are also tasked with limiting the spread of invasive species, for which barriers are an effective tool, leading to the need for technologies that selectively pass desirable species while blocking invasives. Further, successful passage of traditional, technical fishways can vary widely among species of fish. For example, many of the non-salmonid, native species desired for passage demonstrate poor success with passing traditional fishways designed with jumping, salmonid species in mind. Here we present an overall conceptual model for selective passage of non-salmonid (i.e. non-jumping) fish species and results from recent studies to test the components of this model. We recently demonstrated that sorting fish along morphological differences holds promise and that imaging tools combined with computer learning algorithms

		could be effective at differentiating among species groups. However, to achieve a high level of success the fish needed to be dewatered for imaging which is a challenge for non-salmonid fish that are less likely to volitionally enter false fishway sections. The Archimedes screw fish lift (ASFL), offers a simple means to capture and lift fish into the scanner. Pilot tests in a fish crowding structure near a migratory barrier demonstrated a prototype ASFL was effective at capturing and safely lifting suckers spp. and that attraction flow was an important factor impacting capture. Future work includes plans to test the ASFL outside a confined space and if flow enhancement can be used to improve capture success. Pairing an optical sorting technology with the ASFL could result in a novel selective passage tool and allow managers to simultaneously achieve competing objectives.
10:45	Kimberly Capone	Evaluation of the Fishheart Hydraulic Fishway for Passing American Shad Upstream at a Hydropower Dam kcapone@aldenlab.com Jenna Rackovan, Alden Research Laboratory; Steve Amaral, Alden Research Laboratory; Mika Sohlberg, Fishheart Ltd Providing effective passage facilities for anadromous fish at hydropower dams is a top priority for resource agencies due to declining stocks and restoration efforts. Many east coast U.S. facilities have not met goals for safe, timely, and effective passage, which has led to requests from resource agencies to implement enhancements to improve passage at poorly performing sites. For projects without upstream passage, the installation of new facilities can be an economic burden to many dam owners, costing in the range of $5 million to $20 million for installation with additional recurring costs for operation and maintenance. As an alternative to traditional upstream passage fishway designs, Fishheart Ltd (based in Finland) has developed a new innovative and comprehensive solution for passing fish upstream at dams. The Fishheart is a floating system installed in the tailrace that uses attraction flow to bring fish into the passage conduits for transport to the head pond (similar to a locking system). The Fishheart system has been accepted for upstream passage of salmonids in Finland, but prior to our study had not yet been tested with migratory fishes in North America. We evaluated passage of American Shad (Alosa sapidissima) through the Fishheart hydraulic fishway at the Santee Dam in South Carolina. Approach and entry of American Shad into the Fishheart system were assessed using PIT tag and acoustic telemetry, and fish that successfully passed through the system were evaluated for survival and injury. The results of this study will be used to inform the design and operation of the Fishheart for future use with alosids, and potentially other migratory species at hydropower dams in eastern North America.
11:00	William Peirson	Tube Fishway Attraction and Transport of Salmonids Upstream Over Dams and Weirs peirson@live.com.au John H. Harris, Tube Fishways Pty. Ltd. The tube fishway has been developed to help address the fragmentation of river systems by tens of thousands of large water storage dams and millions of weirs. The overall objective of the tube fishway is effective, self-powered, unattended upstream passage for diverse populations of migrating fish at minimum fishway construction cost. Its effectiveness has been demonstrated to date by large scale laboratory trials with hatchery Australian native fish. This contribution describes recent tube fishway hatchery studies with juvenile Oncorhynchus mykiss (Rainbow trout) which complement the classic, but rarely referenced, study of mature salmonids by Slatick (1970). During present studies, a 150mm diameter fishway was installed in a 5.7m diameter tank. We directly observed fish response to the key hydraulic processes vital for unattended tube fishway operation in the field. Attraction of trout into an enclosed tube (the so-called transfer chamber) was most effective with dynamic flow conditions. The trout were attracted to the dynamism of narrow aerated jets but were observed to swim towards the source via the more quiescent regions around the jet. Fish attraction was stimulated by more rapid fishway cycles. Direct observations inside the transfer chamber indicated that counter swimming is not significant during the transport cycle. Upstream passage of 80mm fish was achieved at a rate equivalent exceeding 300 fish per hour. Comparison is made with the outcomes of Slatick's studies with a sustainable rate of 180 fish per hour estimated for a 0.6m tube fishway providing upstream passage over a 120m high dam.
11:15	Brett Pflugrath	An Evaluation of the Stralkin Helix: a Novel Bi-directional Fish Passage System brett.pflugrath@pnnl.gov Jenna Brogdon; Robert Mueller; Sharon Atkin; Jerry Straalsund New and modified installations of clean, renewable hydropower generation and other water control infrastructure should provide improved environmental outcomes and ecosystem

		balance. The high cost, complexity and multi-species passage failure rates of conventional fish passages continue to drive the critical need for new modular fish passage solutions. The Stralkin Helix, a modular, bidirectional fish passage system, is proposed as an alternative to conventional systems that are often unidirectional, expensive and can be harmful to threatened species. Developed by Percheron Power, LLC, this system is designed for low head applications and is inspired by the Archimedes Screw. Its unique open center design offers attraction flow for upstream-travelling fish, allows for bi-directional passage and greatly reduces the risk of fish injury. The first full-sized prototype of the Stralkin Helix was tested at the Pacific Northwest National Laboratory's (PNNL) Aquatic Research Laboratory (ARL) in Richland, Washington, U.S.A. These tests aimed to evaluate the performance of the helix and to understand fish behavior in relation to the helix. Fish movements in both directions were quantified using Passive Integrated Transponder tags implanted in the fish, which helped identify individual fish as they travelled through the helix. Post-passage, the fish were observed for injury and stress for 24 hours. Favorable results from the Stralkin Helix could revolutionize fish passage systems, offering a safe, timely and cost-effective alternative to traditional methods. This innovative solution has the potential to significantly improve our ability to balance the needs of hydropower generation with the preservation of aquatic ecosystems.
11:30	Leticia Carrero-Díez	Uphill flow rock ramps: A new fish friendly ladder. Design, modelling, and monitoring of the first experience in Spain. leticia.carrero@upm.es Anna Pedescoll, Icthios Gestión Ambiental S.L; Carolina Martínez Santa-María, Universidad Politécnica de Madrid; Carlos Marcos, Confederación Hidrográfica del Duero; Rafael Aguado, Icthios Gestión Ambiental S.L; Gustavo González, Icthios Gestión Ambiental S.L; J. Anastasio Fernández-Yuste, Universidad Politécnica de Madrid Longitudinal connectivity in rivers is vital for juvenile as well as adult fish. Successful fishways passage is a function of the ability of fish to select appropriate paths where their swimming capacity is not exceeded. A promising new design of nature-like rock ramp with uphill flow corridors has been recently developed. The uphill flow ramp while keeping key elements of traditional rock-ramps, exhibits a distinctive hydraulic performance by inducing upward flows paths opposite to the main flow in the ramp. The characteristics of the uphill velocity depend mainly on the specific arrangement of boulders in the zig-zag distribution within the row. The pioneering uphill flow ramp established in Spain was designed using robust empirical equations. We employed a numerical model which solves the 2D depth-averaged shallow water equations in combination with fish responses assessed with PIT tag telemetry for ten different species (2 native and 8 invasive). This methodology was adopted to analyze the hydraulic performance of the ramp and concurrently its biological efficiency. Key hydraulic variables such as water depth and streamwise velocity were analyzed. The 2D model results confirm the presence of upward corridors on the ramp. They could be characterized by both their extent and the magnitude of variable uphill velocity. Therefore, the ramp is perfectly functional, allowing the passage of both rheophile and benthic species, such as Iberian gudgeon or black bullhead catfish. The analysis of the number of records by species showed differences in the use of the ramp throughout the year. While common bleak passages occurred all year round, Iberian gudgeon used it mainly in autumn and the rest of the species in spring. Among them, Iberian barbel is the only species that used the ramp as part of its home range. Likewise, passage capacity of the invasive species was confirmed, which should be taken into account in future permeabilization projects.
11:45	Janine Bryan	Fish passage technology design to assist fish guidance via flow modulation janine.bryan@whooshh.com Katherine Leighton Littoral Power Systems; Kevin Mulligan USGS; Kevin Stewart Oakridge National Laboratories; Paul Jacobson EPRI Fisheries have been challenged, as have most disciples, to incorporate Diversity, Equity, and Inclusion (DEI) into our practices and to find ways of doing things that are efficient, economical and sustainable, while leveraging renewable resources. With these principles as a foundation, we asked, "But what of fish passage?" Traditional fish passage technologies have been optimized to facilitate passage of select species and thus are not an efficient means of passage for many species. The economics of fish ladders and lifts are staggering. Unfortunately, these technologies, especially given climate change, are not sufficient to ensure sustainable fish populations that embody watershed DEI. A Department of Energy funded project was undertaken to explore the possibility of redirecting hydropower draft outflow to attract upstream migrating fish to a semi-submerged modular fish passage device. The Zero-Ascend Omnispecies (ZAO) module design was undertaken to produce a false weir entry at the waterway surface level, potentially allowing any fish species the ability to enter. The designs depict a Whooshh fish transport system housed in a Littoral Power System

		prefabricated standard modular hydropower h-Modulor™ system which is semi-submerged downstream of a hydropower draft outflow. The draft outflow is a disruptive flow byproduct of hydropower generation. We asked, “Could this largely untapped and yet renewable resource be leveraged to attract and guide upstream migrating fish to the ZAO module for fish passage?” CFD modeling conducted by Oak Ridge National Laboratories suggested that the shape may be able to direct the draft outflow to create an attraction flow capable of guiding fish to the ZAO module. A small-scale study was conducted at the US Geological Survey S.O. Conte Anadromous Fish Research Laboratory flume to investigate the ZAO module design features as they relate to flow modulation and American shad upstream migration behavior. Observations from this study will be presented.
12:00	Michael Messina	Technology Benefiting Nature – Multi-Species Fish and Elver Passage at Low-Head Dams mike.messina@whooshh.com Bernhard Meyerhoffer, FishCon GmbH Thousands of low head dams and barriers impede impede fish migration around the world. For the past 100+ years, the methods for assisting fish past dams has been largely the same: ladders, fishways, truck-and-transport and lifts. And yet, in that same 100+ years, mankind has accelerated technological development on so many other fronts - why keep doing things the same way when there is so much new technology available to benefit nature? The FishLock(tm) fish passage system is a patented improvement on a conventional fish lock that allows for both upstream and downstream volitional passage of multiple species within a river catchment area. These systems have undergone extensive testing in Austria and have gained acceptance under both Austrian and German fish passage regulatory guidelines. These solutions have now been commercialized and are rolling out in Austria, Germany and Switzerland. Similarly for elver, rather than reinstalling traditional ramps every couple of years, there are new systems available, the SwitchBack™ and the Elverator™ that provide collection/passage in an environment that protects against predation and disease. These are portable and modular, and can be stored away when not in use. In a comparative study, one of these systems, the Elverator,™ collected 3x the number of elver than traditional methods. Using technology to benefit fish passage has multiple benefits: For fish, there is less stress due to reduced handling and delay; for dam owners, there is less expense and more water is saved since none is diverted to operate a ladder or fishway; and for regulatory authorities and river managers, connectivity is provided that accommodates multiple species, regardless of the swimming capacities of different fish. Using technology and innovation to benefit fish has the potential to effectively and economically open up more river kilometers of habitat to more species.
Borduas Ballroom 3 May 8	**Session 33: Fishway monitoring & evaluation 1**	**Chairs: Daniel Deng**
10:15	Juan Francisco Fuentes-Pérez	Advancing Fishway Management: Shaping the Future of Fishway Monitoring juanfrancisco.fuentes@uva.es Francisco Javier Bravo-Córdoba, Centro Tecnológico Agrario y Agroalimentario ITAGRA.CT. Avenida de Madrid 44, Campus La Yutera, 34004, Palencia, Spain; Ana García-Vega, Centro Tecnológico Agrario y Agroalimentario ITAGRA.CT. Avenida de Madrid 44, Campus La Yutera, 34004, Palencia, Spain; Fco. Javier Sanz-Ronda, Group of Applied Ecohydraulics, Sustainable Forest Management Research Institute, University of Valladolid. Avenida de Madrid 44, Campus La Yutera, 34004, Palencia, Spain; In the face of the inherent dynamics of river systems and under near-future climatic scenarios, effectively managing hydraulic structures like fishways is a substantial challenge. This study introduces an innovative approach to fishway management through the deployment of an advanced sensor network. The final architecture of this network consists of a diverse selection of nodes, such as water level nodes to monitor fishway hydrodynamics and boundary conditions, environmental sensors to monitor triggers for fish movements as well as custom IR fish counters to evaluate the fishway usage. The network was designed with cost-effectiveness in mind to broaden its application . Now widely utilized in two EU-funded projects, H2020 Smart Fishways (101032024) and LIFE21 Kantauribai (101074197), this network enables continuous and real-time monitoring, a vital tool for enhancing migration by adapting to changing river conditions. In this work, we provide a detailed overview of the technology and the insights gained from two years of real-time monitoring. We illustrate how the network incorporates hydrological variability into fishway assessments, monitoring and validation processes, as well as in detecting malfunctions and implementing smart management strategies for fishway operations. Additionally, continuous intra- and inter-annual monitoring has allowed to conduct in-depth analyses of fish movements in relation to environmental factors, leading to models that predict optimal working conditions and future fishway performance, thus significantly boosting fish conservation efforts. This study underscores the importance of continuous monitoring of fishways and the integration of

		hydrological variability in their study. Our findings advocate for a shift towards low-cost, reliable, and adaptive management systems capable of navigating the complexities of dynamic river environments and their associated structures. By incorporating technical adaptations from the design phase and focusing on long-term analyses, our approach sets a new standard in fishway management, aligning conservation goals with the necessities of managing dynamic riverine systems.
~~10:30~~	~~David Nijssen~~	Comparison of methods to determine the efficiency of multispecies fishways nijssen@bafg.de Cornelia Schütz, German Federal Institute of Hydrology; Nicole Scheifhacken, German Federal Institute of Hydrology; Matthias Scholten, German Federal Institute of Hydrology Determining the efficiency of multispecies fishways has proven challenging and different approaches have been proposed. Classically a box trap -or a more recent alternative: a video tunnel- is used to detect fish that have successfully navigated the fishway in comparison to the fish community in the tailwater, which is often characterized by electrofishing. A European norm uses telemetry to assess fishway efficiency (CEN/TC230/WG24/EN17233:2021). We have simultaneously applied all these methods, supplemented by eDNA surveys, over the course of one year in a small navigable lowland river with a vertical slot fishway in Germany. The comparison clearly highlights the strengths and shortcomings of each method. Within the fishway, box traps proved to be very efficient in capturing all ascending fish independent of turbidity, but were quite labour-intensive. Video tunnels allowed free up- and downstream migration during deployment, but were unable to dependably specify cyprinids below 15 cm in moderately turbid water. In the tailwater, electrofishing detected large quantities of recently hatched fish at the banks of the river that were too young to ascend the fishway, but failed to reliably capture larger and especially bottom-dwelling fish species. Fishes caught in fykes that were deployed in the tailwater proved more balanced in size, but their composition showed an overabundance of bottom dwelling species. Environmental DNA was able to detect all but a few rare species but lacked transferable size/abundance estimates. Radiotelemetry allowed analysis of motivation as well as passage efficiency, but only for a limited number of larger fish species. Since each method provided a different piece of the puzzle, but none were able to cover the entirety of the abundance, species and size distribution of the fish community in the tailwater in comparison with the fishway, we propose a combination of methods optimized for their strengths throughout the year.
~~10:45~~	~~Moon Seong Heo~~	~~Investigating the effectiveness of fishways installed on 16 weirs in large rivers in S. Korea~~ hms1590@nie.re.kr Jeong-Hui Kim, EcoResearch Incorporated; Min-Ho Jang, Kongju National University; Keun-Sik Kim, National Institute of Ecology; Ju-Duk Yoon, National Institute of Ecology This study analyzed the monitoring results of fishways at 16 weirs constructed in four large Rivers in S. Korea to provide data for the operation and management of fishways. Among the total collected fish, primary freshwater fish showed 92.3%, while only 5.6% was for migratory species. Seasonal fishway usage revealed that fishes were using fishway mostly from May to October, with the highest number of individual recorded during June to August. Most fish species were using fishway during their spawning season, whereas utilization rate was sharply dropped after spawning season. Fishway discharges were positively correlated with number of fish species and individuals, and this result means high discharge can attract more fishes. Therefore, for freshwater fishes in S. Korea, it is necessary to efficiently operate fishways that target primary freshwater fish during the spawning season.
11:00	Panos Panagiotopoulos	A large-scale passage evaluation for multiple fish species: lessons from 82 fishways in the Netherlands Wageningen University & Research panos.panagiotopoulos@wur.nl Anthonie D. Buijse and Leopold A.J. Nagelkerke, Aquaculture and Fisheries group, Wageningen University & Research; Hendrik V., Winter Department of Freshwater Ecology and Water Quality, Wageningen Marine Research River fragmentation is highly prevalent in the human-dominated lowland landscape of the Netherlands. Fishways, built as measures to facilitate passage of fishes alongside barriers, have been mostly evaluated in single-case studies, which complicates drawing more generic conclusions on the effectiveness of fishways. Instead, we compared fish monitoring data of 82 fishways with data of fish observed in adjacent water stretches, conducting the first nationwide study on passage for the full spectrum of fish species present. In total, 35 out of 38 (92%) native species recorded in fishways' surroundings used fishways, while per fishway the median was 59% related to a variety of factors (fish behaviour, fishway type, monitoring

		design). The species using fishways most frequently were perch Perca fluviatilis (71/78 of fishways present) and roach Rutilus rutilus (70/79). Small-bodied fish species, often considered as "resident", were also observed using fishways: gudgeon Gobio gobio (68/77), stone loach (32/70) Barbatula barbatula, spined loach Cobitis taenia (13/59), and sunbleak Leucaspius delineatus (10/53). Logistic regression models showed the effect of monitoring duration and timing in detecting specific fish species ascending fishways. Our large-scale analysis highlights the need to account for all native fish during fishway design and monitoring.
11:15	Luiz Silva	Quantifying fish passage efficiency at hydropower plants in the Upper Rhine River catchment in Switzerland. lumartins@ethz.ch Tina Dubach - ETH-Zürich; Andris Wyss - ETH-Zürich; Ismail Albayrak - ETH-Zürich In Switzerland, restoring river connectivity is of utmost importance to meet the goals set by the Swiss Water Protection Act. To achieve that, the country set an ambitious goal of providing effective fish passage for more than 700 hydropower plants until 2030. This goal provides a unique opportunity to learn and adapt strategies and decisions based on acquired knowledge as the design, implementation, and monitoring of fish passages advance. We used a dataset of over 20,000 pit-tagged fish to quantify passage efficiency at eight hydropower plants in the Upper Rhine River, including the Limmat, Aare and Rhine Rivers. We calculated findability (number of fish that entered the fish passage) and passage efficiency and determined the passage and transit time for different species. The findability varied between 68 and 8%, decreasing at larger dams located in the Rhein, while absolute passage efficiency varied between 38 and 80%. The attraction flow ratio calculated for the studied sites showed a range of 0.3 to 4% of the competing flows in the tailrace. Therefore, attraction and entrance conditions can be improved for larger river systems, such as the Rhine River, but the dataset analysed did not allow for disentangling these two components. Passage efficiency was similar among fishways (e.g. vertical slot and nature-like), but transit times varied significantly. For some species, passage time was over 30 days and transit time was over two days. In general, transit time was longer for nature-like passages. We suggest specific studies to be designed to disentangle attraction and entrance efficiency at sites with poorer findability rates and also aim to quantify the effects of passage delays on the migration of target species.
11:30	Nich Burnett	Four years of monitoring upstream fish passage at Site C, a new hydroelectric dam in British Columbia, Canada nich.burnett@bchydro.com Nich Burnett, BC Hydro, Vancouver, BC, Canada; Brent Mossop, BC Hydro, Vancouver, BC, Canada BC Hydro is currently constructing the Site C Clean Energy Project (the Project), a third hydroelectric dam (1100 MW) on the Peace River in northeastern British Columbia, Canada. BC Hydro is implementing a staged approach to upstream fish passage at the Project, whereby a temporary upstream fish passage facility is being operated during the river diversion phase of construction (2020 to 2024). Following the closure of the diversion tunnels and reservoir filling in the fall of 2024, a permanent upstream fish passage facility will be operated at the outlet of the generating station to provide fish passage during the operations phase of the Project. Operation of the permanent facility is scheduled to commence in April 2025. Here we discuss the results from four years of operating the temporary facility and monitoring 19 fish species (including Bull Trout, Arctic Grayling, and Mountain Whitefish) as they approach, enter, and pass the weir-orifice fishway and access feeding and spawning habitat upstream of the Project. We used telemetry, capture-recapture, and genetics across different spatial scales (meters to hundreds of river kilometers) to understand the biological effectiveness of the facility. Results are discussed in the context of making informed adjustments to the mechanical and biological operation of fish passage facilities and applying lessons learned to the design, construction, and operation of facilities.

11:45	Shokoofeh Abbaszadeh	Bio-inspired robotic fish for assessment of injury risks during the fish passage abbaszadeh@ovgu.de Gert Toming, Department of Computer Systems, Tallinn University of Technology, Estonia; Jeffrey Andrew Tuhtan, Department of Computer Systems, Tallinn University of Technology, Estonia; Roberto Leidhold, Institute of Electrical Power Systems, Otto von Guericke University Magdeburg; Stefan Hoerner, LEGI, Université Grenoble-Alpes, CNRS, Grenoble-INP, Grenoble, France & Institute of Fluid Dynamics and Thermodynamics, Otto von Guericke University Magdeburg, Germany A major contributor to the decline of freshwater fish biodiversity is disrupted river continuity, including the increased risk of fish injury and mortality during passage through pumping stations and turbine passages. In addition to barrier removal, improved mitigation strategies are needed to reduce the risk of mortality at hydraulic structures. Live fish tests are the most common method to assess the risk of injury and mortality during passage through hydraulic structures. The reduction of animal testing in turbine passages through the use of robotic fish, flow simulations and predictive models (RETERO) project has been developed to explore the use of surrogate technologies to replace the need for live fish testing to the greatest extent possible. Here, we introduce a bio-inspired, flexible fish robot with integrated sensors to replace live fish tests. The fish robot is equipped with a propulsion system and pressure and acceleration sensors that record both the local hydraulic parameters as well as collisions during passage, and can be compared with existing passive sensor systems. The RETERO fish robot enables complex measurements in turbulent flows and can provide important data to better understand fish, e.g., to explore their active sensing space and to validate numerical simulations of fish-flow interactions. It is therefore suitable for a wide range of applications such as ethohydraulic assessment of flow fields in rivers, bypass systems, fish passes, and for laboratory applications. In this work, the authors provide an overview of the current state of robotic fish development and provide first laboratory tests of the device.
Leduc-Fortin May 8	**Session 34: Fish locomotion in unsteady flow**	**Chairs: Theodore Castro-Santos**
10:15	Katharina Bensing	Hydrodynamic detection, ranging and imaging: the role of the fish body in ethohydraulics k.bensing@wb.tu-darmstadt.de Jeffrey A. Tuhta, Tallinn University of Technology; Boris Lehmann, Technical University of Darmstadt In most ethohydraulic studies, flow field properties and fish behavior are observed separately, and data are evaluated under the assumption that the presence of the fish does not change the underlying properties of the flow field. Undistorted velocity measurements are subsequently correlated with fish movement patterns, neglecting potential impacts of the fish body. A notable exception are neuroethological and neurobiological studies, where hydrodynamic measurements of near-body flow fields are collected simultaneously with biological information. However, in the majority of these studies, fish are often immobilized or fixed, hindering their free and natural movement.In this work, we introduce the use of innovative fish sensory sondes (FSS) to simultaneously record the pressure fluctuations at three points on the head region as well as the upstream flow field using an Acoustic Doppler Velocimeter (ADV) in a large flume (L/W/H = 40 m/2 m/1.2 m, discharge up to 1 m^3/s) at the Technical University of Darmstadt. The FSS were tested in different setups with and without an angled rack. Here, we present two major findings or hypotheses resulting from this study: 1. The presence of the fish body and its size are important for hydrodynamic imaging and ranging, utilizing the self-generated pressure field as a receptive space. Here, it is imperative to consider the relative velocity between the body and fluid for accurate interpretation. 2. The fish's body serves as a velocity-pressure transducer, and we show that it is likely that fish are capable of receiving undistorted flow information from turbulent fluctuations. These outcomes hold significance for advancing our understanding of how fishes receive and react to flow information through their lateral line. Additionally, these findings provide valuable insights for determining suitable turbulence parameters for future ethohydraulic studies and can also be used to enhance individual-based models.
10:30	Florence Gibouin	Swimming kinetics of fish in different turbulence conditions florence.gibouin@univ-poitiers.fr

		Julien Dumas, Institut Pprime, CNRS-Université de Poitiers-Isae Ensma & Pôle R&D écohydraulique, OFB-IMFT-PPRIME, France; Pierre Sagnes, Office Français de la Biodiversité (OFB), Direction de la recherche et de l'appui scientifique, France & Pôle R&D écohydraulique, OFB-IMFT-PPRIME, France; Damien Calluaud, Institut Pprime, CNRS-Université de Poitiers-Isae Ensma & Pôle R&D écohydraulique, OFB-IMFT-PPRIME, France; Gérard Pineau, Institut Pprime, CNRS-Université de Poitiers-Isae Ensma & Pôle R&D écohydraulique, OFB-IMFT-PPRIME, France; Laurent David, Institut Pprime, CNRS-Université de Poitiers-Isae Ensma & Pôle R&D écohydraulique, OFB-IMFT-PPRIME, France; This work aimed to study the swimming kinetics of fish inside a 5 pools turbulent channel where flow conditions were restrictive with regard to fish size and swimming ability. Chub (Squalius cephalus, L.) and roach (Rutilus rutilus, L.) were used as experimental subjects, with mean total length of 17.2 cm and 16.4 cm respectively. The experimental flow rate was set to 28.4 L/s, whereas mean flow velocity and turbulent kinetic energy were modified by tilting the channel (slopes of 5%, 7.5% and 10% were used). In addition, grids of different spacings were placed between pools to control the turbulence conditions, i.e. the typical size of vortices generated, from 1 cm to 5 cm. A camera registered fish movements during 5 minutes in each experimental condition. During the phase of stationary swimming, i.e. when the fish swam but stayed in a given position in the pool, the video analysis enabled to determine both tail beat amplitude and frequency related to each turbulent condition. In parallel, flow measurements by ADV and PIV were performed to estimate the relationships between fish swimming kinetics and local features of turbulent flow. There were no significant differences in swimming kinetics between species. Tail beat frequencies were almost constant, close to 3.6 Hz, whatever the flow conditions. Nevertheless, tail beat amplitudes were larger in small vortices than in large vortices conditions. Swimming numbers and Strouhal numbers were calculated and studied as a function of the Reynolds values measured in the channel. Fish trajectories in the pool were also analysed and superimposed to velocity and turbulent kinetic energy fields. These results should help to understand the relationships between fish swimming behaviour and the turbulence conditions in pool fishways.
10:45	Sam Steele	Sprinting Capabilities of Yellowstone Cutthroat Trout in a Swim Chamber samsteele4@gmail.com Katey Plymesser, Montana State University; Matt Blank, Montana State University, Western Transportation Institute; Alexander Zale, U.S. Geological Survey; Kevin Kappenman, United States Fish and Wildlife Service; David Dockery, Wild Rivers Consulting LLC; Cooper Cowan, Montana State University Yellowstone Cutthroat Trout (Oncorhynchus clarkii bouvieri; YCT) inhabit the upper portions of the Yellowstone and Snake River basins of Montana, Wyoming, and Idaho. Although individual populations of YCT remain intact in headwater streams, anthropogenic activities have resulted in substantial declines in their historic range and core population abundance. We quantified the Usprint swimming mode of YCT to aid in passage assessment, design, and other projects involving YCT restoration and conservation. Sixty hatchery-raised YCT were swum individually in a swim chamber. The test section of the Loligo System 185L swim chamber was 80 cm long, with a rectangular cross-section of 25 cm by 25 cm. Fish were placed into the swim chamber initially at a low water velocity (45.7 cm.s-1) to acclimate for ten minutes before water velocities were increased by 7.6 cm.s-1 every 15 seconds until the fish became impinged on the downstream screen of the test section. The maximum water velocity that a fish held its position was reported as the maximum anaerobic sprinting velocity (Usprint). Overall, the mean Usprint velocity observed was 3.91 body lengths.s-1 (SD ± 0.56) equivalent to an absolute velocity of 1.48 m.s-1 (SD ± 0.18). Usprint values ranged from 0.86 m.s-1 to 1.85 m.s-1 for YCT with total lengths of 314 mm to 456 mm. YCT preformed gait transitions from sustained-prolonged to burst-glide swim mode at a mean water velocity of 0.88 m.s-1 (SD ± 0.15) and from burst-glide to strictly burst at 1.13 m.s-1 (SD ± 0.18). Overall, these metrics are valuable for assessing existing passage success probability and guiding the design of future fishway projects, which is essential for the restoration and conservation of YCT populations.
~~11:00~~	~~Misheel Bold~~	~~Evaluating effect of temperature on swimming performance of freshwater fish to design fishways in Korea~~ tongue_tied3@naver.com Kyu-Jin KIM; Jun-Wan KIM; Beom-Myeong CHOI; Jin-Young YOON; Ju-Deok Yoon; Min-Ho JANG Swimming performance of fish is an important factor in the survival of fish and migrating through man-made barriers between estuary and river. Swimming performance of fish is affected by a number of factors and one of the factors is temperature. Therefore, in this

		study, we measured swimming performance of 5 Korean freshwater fish species on 15 °C, 22 °C , 29 °C temperature differences. The fish used in this study were collected during October, 2020 to May, 2021 and measurement for swimming speed of each fish was done by using Loligo® System, a swim tunnel respirometer in April to May of 2021. The average value of the burst critical swimming speed (Ucrit) at 15 °C for each species was 1.03±0.01 m s^{-1} for *Rhynchocypris oxycephalus*, 0.96±0.02 m s^{-1} for *Gnathopogon strigatus*, 1.08±0.02 m s^{-1} for *Zacco koreanus*, 0.98±0.02 m s^{-1} for *Hemibarbus longirostris*, 0.81±0.06 for *Lepomis macrochirus*. At 22 °C , average Ucrit for each species was 1.03±0.02 m s^{-1} for *R. oxycephalus*, 1.02±0.02 m s^{-1} for *G. strigatus*, 1.16±0.03 m s^{-1} for *Z. koreanus*, 1.10±0.02 m s^{-1} for *H. longirostris*, 0.78±0.09 for *L. macrochirus*. Lastly, at 29 °C , average Ucrit for each species was 1.08±0.01 m s^{-1} for *R. oxycephalus*, 0.95±0.04 m s^{-1} for *G. strigatus,* 1.16±0.03 m s^{-1} for *Z. koreanus*, 1.16±0.02 m s^{-1} for *H. longirostris*, 1.03±0.06 for *L. macrochirus*. The influence of temperature on Ucrit for each species was significantly low but effect of temperature was positive for most species. Using the Ucrit values of freshwater fish measured in this paper, it is possible to design fishways that some fish can't migrate upstream for the management of fish population. In order to understand the physiology of fish and assess the migration barriers at streams and rivers it will be necessary to continue evaluating the swimming performance of other freshwater species in Korea.
11:15	Ianina Kopecki	Estimating fish swimming speed using non-invasive backpack sensors in a laboratory flume at high flow velocities SJE Ecohydraulic Engineering GmbH kopecki@sjeweb.de Jeffrey A. Tuhtan, Department of Computer Systems, Tallinn University of Technology; Falko Wagner, Institute of Aquatic Ecology and Fish Biology, Jena, Germany; Tom Roessger, Institute of Hydraulic Engineering and Technical Hydromechanics, Dresden University of Technology, Germany; Tobias Hägele, SJE Ecohydraulic Engineering GmbH, Backnang, Germany; Matthias Schneider, SJE Ecohydraulic Engineering GmbH, Backnang, Germany; Stefan Hoerner, University Grenoble-Alpes, Grenoble-INP, CNRS, LEGI, Grenoble, France & Otto von Guericke Universität Magdeburg, Germany The response of fish to hydraulic conditions with velocities exceeding their sprint swimming speed and strong spatial velocity gradients was observed using wild-caught brown trout in a laboratory flume. Absolute flow velocities in the flume ranged from 2.3 to 8.5 body lengths per second (BL/s) for fish with BL of 20 to 34 cm. Positions and trajectories were acquired at 60 Hz using a calibrated array of infrared video cameras. The observed movement velocity was superimposed on two-dimensional numerical models of the local flow fields to obtain the relative fish speed. Additionally, one group of fish were equipped with non-invasive backpack sensors attached to the dorsal fins. The total pressure, linear acceleration, magnetic field intensity and rate of rotation was recorded at 100 Hz, and data were synchronized to each video-frame using a novel electromagnetic pulse system. Separate tests showed that there were no significant differences in the swimming activity of wild-caught brown trout with or without dorsal fin mounted sensors. This study presents the results of the daylight experiments, where the majority of fish maintained positive rheotaxis, descending at mean swimming speed exceeding 1.5 BL/s. We provide evidence that the swimming speed of brown trout under extreme hydraulic conditions correlate with the tail-beat frequency which can be derived from gyroscope sensor data as well as the accelerometer data averaged over time scales larger than those corresponding to single tail beat movements. Experiments confirm that the relationship between the tail-beat frequency and swimming speed is dependent on the fish body length and exhibits unique features for tail-beat frequencies above 5 Hz. These findings are well-supported by fundamental research on fish locomotion for multiple freshwater species. Our results provide valuable insight into the response of brown trout to high-speed flows commonly found in fishways, intake structures and within turbines and pumps.
11:30	Kamal Prasad Pandey	FishPath Project: Behavioral Responses of Atlantic Salmon Smolts to Vertical Eddies pandeyk@ethz.ch Ismail Albayrak, VAW, ETH Zurich; Torbjørn Forseth, Norwegian Institute for Nature Research (NINA); Armin Peter, FishConsulting GmbH; Igor Iliev, SINTEF Norway; David Florian Vetsch, VAW, ETH Zurich; Eric Lillberg, Vattenfall Research and Development, Sweden; Bjørn Winther Solemslie, Norwegian Institute for Nature Research (NINA)); Ole Gunnar Dahlhaug, Norwegian University of Science and Technology (NTNU); Robert M. Boes, VAW, ETH Zurich; Ana T. Silva, Norwegian Institute for Nature Research (NINA) The “FishPath” project aims at developing a cost-effective turbulent Eddies based behavioral Guidance System (EGS) for safe downstream passage of Atlantic salmon (*Salmo salar*) and European Eel (*Anguilla anguilla*). The project goals are to understand how fish respond to different types and sizes of turbulent eddies created by innovative

		structures and to use this knowledge to develop an alternative and safe pathway for fish around hydropower plant intakes to a bypass. This study focuses on the response of salmon smolts to vertical eddies. We conducted systematic live-fish tests with vertical triangular prismatic structures, so-called Vertical Elements (VE), in a 13.5 m long, 0.5 m wide and 0.7 m deep laboratory flume at the Laboratory of Hydraulics Hydrology and Glaciology of ETH, Zurich, Switzerland. The first VE was located near the flume left wall in flow direction, while the second VE was located 0.69 m downstream at the flume center. Such arrangement created two turbulent vortex streets behind the VEs extending downstream, and a relatively high-speed flow street near the right wall. Two sizes of VE (75 mm and 100 mm on longest side of right-angled triangles) and two flow velocities (0.3 m/s and 0.60 m/s) at a flow depth of 0.475 m, were tested. 3D flow fields were numerically simulated using the Ansys software. Fish were tested in groups of three, totaling nine tests (27 fish per velocity and VE combination) for 20 minutes, and recorded with a 3D stereo camera system. Larger VE (100 mm) guided 85% of the fish to the flume right wall with fish avoidance reaction to the eddies, while the small VE guided 67%. The velocity effect was statistically negligible. Fish behavioral responses to the eddies based on their 3D fish tracks will be presented in the conference.
11:45	Adam Grodek	Movement and behavior of minnows in experimentally derived complex, turbulent flows adamgrod@buffalo.edu Dr. Sean Bennett, University of Buffalo, Department of Geography The general objective of this research is to evaluate and assess the movement and behavior of emerald shiners (notropis atherinoides) in complex, turbulent river flows. Specifically, this research observes and documents live minnow movement in a laboratory hydraulic flume in order gather empirical, laboratory-based data on fish movement and behavioral tendencies. Fish were emplaced in a recirculating hydraulic flume with dimensions of 7.32 m in length, 1.11-m in width, and 0.30-m in water depth. After an acclimation period, fish were recorded using a digital camera in several experimental swimming trials lasting up to several minutes. Fish were identified and tracked in recordings using YoloV8 object detection algorithms. Velocity data were derived from video imagery using Streams V3.03. Fish swimming trajectories were superimposed on velocity data to show fish swimming pathways in relation to velocity fields generated during experimental trials. Results suggest minnows demonstrate behaviors which include: 1) avoidance of complex turbulent flows when moving as singular fish or in small schools; 2) entrance to and navigation through complex turbulent flows in larger schools of fish, and 3) exploratory behaviors where smaller groups of fish ostensibly learn about currents generated in the hydraulic flume. Ultimately, this research proposes a novel approach to consider and categorize the decisions both individual fish and schools of fish make as they navigate through complex, turbulent river flows. In addition, this research seeks to provide innovative guidance on fish gross tendencies and emergent behaviors in such flows, lacking in the published scientific literature. This research seeks to contribute to the broader understanding of how both individual fish and schools of fish adapt to changing river flow conditions. This work can be used to challenge fundamental ideas that are used in fish passage design, conservation of waters and fishes, and stream restoration activities which are generally costly.
12:00	Joschka Wiegleb	Improving fish pass design via understanding fish swimming patterns in challenging flow j.wiegleb@soton.ac.uk Andrew S. Vowles, University of Southampton; Melike Kurt, University of Southampton; Paul Kemp,University of Southampton Engineered infrastructure can fragment rivers and impede the upstream migration of fish. Hydraulic structures in the form of fish passes (or fishways) are frequently installed to facilitate fish passage across these obstacles. All fish migrating upstream must be able to pass these structures with a minimal delay. How local flow conditions instantaneously affect the swimming behaviour of fish when ascending the challenging flows is less understood. The swimming performance of fish can be affected by flowing water in different ways, as flow conditions can have positive, as well as negative impacts on passage success. We observe fish swimming against different flow fields, predicting that fish will exhibit swimming patterns adapted to the water flow encountered to facilitate upstream swimming. Combining fluid dynamics, ecology, and data science to a multidisciplinary approach, we explore the relationship between the instantaneous characteristics of water flow and fish swimming behaviour. With characterising the trajectories of live and artificial fish swimming in different flow fields using video tracking, we apply Infrared Particle Image velocimetry to measure the flow around the swimming fish. This advances understanding on the mechanisms that fish use when passing challenging water flow and the flow conditions that minimise the swimming costs in fish. This knowledge will support the design of purposeful fish passes that can be adapted to the

		needs of the wider fish community. Such information is important for maximising the efficacy of fish passes.
Pilot **May 8**	**Session 35: Modelling aquatic habitats**	**Chairs: Davide Vanzo**
10:15	Eva Enders	Insights on a cumulative effects modelling approach for the prioritisation habitat restoration efforts eva.enders@inrs.ca Lauren Jarvis, DFO; Matt Bayly, ESSA; Alex Tekatch, ESSA; Jordan Rosenfeld, UBC Conservation and sustainable management of salmonid populations are crucial to ensure their continued cultural and economic significance, as climate change, river fragmentation, and habitat degradation are threatening the sustainability of salmonid populations. Despite decades of research, many aspects of the ecology and physiology of salmonids remain incompletely understood due to their intrinsic complexity. In particular, understanding the cumulative effects of environmental stressors on salmonid populations and their habitat requires further research. We developed the Cumulative Effects Model for Prioritizing Recovery Actions (CEMPRA) framework, which uses a series of standardized stressor-response functions to link environmental attributes to the system capacity of a target species, to allow for the prioritisation of recovery actions for data-limited species and species-at-risk, with the flexibility to accommodate both data-poor and data-rich study systems. The model outputs can be used to develop working hypothesis for population-specific recovery action hypotheses that can subsequently be tested and that will further inform fisheries management and recovery actions.
10:30	Daniele Tonina	Mapping salmon rearing carrying capacity at the riverscape: The role of fish size, multi-life stage interactions, and fish behavior dtonina@uidaho.edu Jenna Duffin, Center for Ecohydraulics Research, University of Idaho, Boise, USA, CBEC eco engineering, Inc. Boise, Idaho, USA; Ernest Keeley, Idaho State University, Pocatello, Idaho, USA; Elowyn Yager, Center for Ecohydraulics Research, University of Idaho, Boise, USA; Rohan Benjankar, University of Southern Illinois, Edwardsville, Illinois, USA; Brian Kennedy Center for Ecohydraulics Research, University of Idaho, Boise, USA: Daniele Tonina Center for Ecohydraulics Research, University of Idaho, Boise, USA Here, we introduce a novel method for quantifying the carrying capacity of juvenile salmonids across an entire river system, considering both spatial and temporal factors. This method considers two key aspects: (1) energy requirements, influenced by fish behavior (territoriality), water temperature, and growth stage and (2) available energy, determined by fish size, food availability, and flow hydraulics. We utilize advanced techniques in numerical modeling, bioenergetics, surface hydraulics, and remote sensing through topobathymetric surveys. Specifically, we have developed an ecohydraulic model that integrates a two-dimensional hydraulic model with a bioenergetics model spanning the entire 106 km length of the Lemhi River in Idaho, USA. This model combines flow hydraulics with the biological needs of juvenile salmonids to assess carrying capacity at the reach level, considering micro-habitat details throughout the river. This approach allows us to investigate how flow, temperature, food availability, and bathymetric variations impact carrying capacity spatially and temporally. Our findings reveal that increasing food availability, relative to average values at the study site, has a minimal impact on juvenile carrying capacity, while a decrease negatively affects it. Carrying capacity in habitats is inversely related to stream water temperature and varies with the life stage of juvenile salmonids along the river. Notably, carrying capacity increases with fish size, as larger fish can inhabit areas with swifter flows, but territorial behavior moderates this trend. Our study underscores the significance of drift concentration, temperature, fish size, fish behavior, and the multi-life-stage perspective in assessing habitat quality and juvenile carrying capacity at the riverscape level.
10:45	Francisco Martinez-Capel	Habitat assessment in present and climate change scenarios for native fish in the Júcar River (Antella, Spain) fmcapel@upv.edu.es The Mediterranean region, a climate change hotspot, experiences a faster yearly surface temperature warming rate than the global average, with a substantial decline in precipitation. These changes can significantly impact freshwater ecosystems by altering river basin flow regimes. Understanding the local-level effects of climate change on these ecosystems is crucial for proactive management and conservation. Therefore, this study focuses on predicting the impact of climate change on freshwater fish habitat in the lower

		Júcar River Basin, particularly the Antella stretch. Three models were employed: a conceptual hydrological model (Témez) integrated with the GAMS as a water resource management tool to predict discharge under four CMIP6 climate change scenarios (SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5) across short-term (2022-2040), mid-term (2041-2070), and long-term (2071-2100) timeframes. Hydraulic conditions were modelled using HEC-RAS (1D) and calibrated through bed roughness value adjustments. Fuzzy rule-based models, combining empirical data on hydraulic preferences with expert knowledge, evaluated the resulting hydraulic conditions at different flow rates. This integrated approach allowed the prediction of climate-induced alterations in habitat suitability for two Iberian native fish species, Luciobarbus guiraonis and Squalius valentinus. The climate change scenarios project decreasing precipitation (up to 30%) and rising temperatures (up to 4 °C) by the century's end. Average streamflow is expected to change from +9% to +17%, -7% to +6%, and -24% to +19% compared to historical mean flow in the short, mid, and long-term periods. Consequently, a decline in habitat suitability for fish is anticipated, with variations spanning from 6% to 39% depending on scenarios and fish species. These alterations are notably species and size-dependent. Addressing this challenge necessitates a stronger focus on monitoring, conservation, and aquatic biodiversity management. Furthermore, this study underscores the importance of integrating hydrological, hydraulic, and habitat simulation approaches to comprehensively assess climate change impacts in the Júcar basin for informed mitigation.
11:00	Shinji Fukuda	Effect of flow intermittence on fish fauna in an agricultural channel network in Tokyo, Japan shinji-f@cc.tuat.ac.jp Irrigation channel networks have been regulated for rice-based agriculture and rural development in Japan. For instance, irrigation begins when rice paddies are flooded for paddling before transplanting (e.g., March to May) and ceases before harvest (e.g., September to October). If there is no stream or channel with permanent flow in an irrigation system, the channel network dries up in the non-irrigation period. The modernization of agriculture and irrigation facilities can further degrade valuable habitats for both terrestrial and aquatic ecosystems. However, it is widely recognized that paddy environments offer important habitats for various aquatic species, thereby forming a biodiversity hotspot in Japan. Therefore, it is important to understand the seasonal dynamics of instream flow conditions and species responses, as well as the recovery of fish fauna after severe flow intermittence due to drought and/or construction works in an irrigation channel network. As such, improved management strategies that consider the balance between agricultural production and ecosystem health can be established. In this study, we report the results of a series of monthly surveys on instream flow conditions and fish fauna in an irrigation channel network in Tokyo, Japan, from May 2014 to March 2020. During the survey period, two severe flow intermittence events were observed in the irrigation system, while slight and severe flow intermittence events occurred in a spring-fed urban stream flowing into the irrigation system. The results indicated rapid recovery of fish fauna in the system, partly because of irrigation, which brings water and fish species from the source river. Flow conditions varied between and within survey reaches, which may hamper knowledge extraction from data-driven habitat models using machine learning. Species-specific care and data treatment may be needed for an improved modelling practice for this study.
11:15	Samuel Valman	Operationalizing the hyper-temporal benefits of CubeSats through artificial intelligence to provide new opportunities for measuring and monitoring geomorphic change in rivers. samuel.valman@nottingham.ac.uk Stephen Dugdale, School of Geography, University of Nottingham, United Kingdom; Doreen Boyd, School of Geography, University of Nottingham, United Kingdom Remote sensing methods are continuously producing new opportunities to measure large-scale river geomorphology, overcoming spatial and often financial constraints of traditional in-situ monitoring. However, the majority of these methods lack the temporal resolution to capture the dynamism inherent in river systems. The PlanetScope CubeSat constellation uses ~200 low-cost optical satellites to provide hyper-temporal daily imagery of the Earth. However, combining this information, captured at different altitudes, times of day, and atmospheric conditions comes at the cost of reductions in radiometric quality. Therefore, segmenting images into land and water, the foundation of all subsequent river research, has proven difficult to automate. We applied a novel Artificial Intelligence method to automate the extraction of river water masks from PlanetScope imagery. Our method was tested on 36 rivers from 12 global biomes and was found to produce highly accurate water masks (median F1 accuracy score of 0.93). This enabled us to test PlanetScope's ability to measure hyper-temporal change in channel shape and form in the Amazon during recent droughts. 35 river islands were chosen in the Madeira River and their size and shape were

		monitored to measure how droughts changed the wetted area of a large river system. We also quantify how changes in these islands impact the sinuosity of the channel centerline at a finer temporal resolution than has ever previously been carried out at this scale. Building on prior satellite remote sensing studies on river islands, our work pushes the envelope regarding the speed and scale of post-event monitoring. Our approach sheds new light on how the Amazon and its islands have shifted in recent years in response to changing hydroclimatic conditions, and gives an indication of how, through the operationalization of the PlanetScope constellation, geomorphic variables can be measured or monitored in exciting new ways.
11:30	Karine Smith	Investigating fluvial processes in an ice-covered riffle-pool sequence karines@geomorphix.com Jaclyn Cockburn, PhD, University of Guelph; Paul Villard, PhD, GEO Morphix Ltd Velocity and bed shear stress are controlled by discharge, channel geometry and boundary conditions. Ice cover in cold-region rivers creates an additional boundary which moderates velocity and shear stress at the bed, effectively influencing winter habitat connectivity. Field studies and hydrodynamic modelling were combined to evaluate the impact of ice cover on velocity and bed shear stress across a channel segment with variable bed roughness. The study site is located at a riffle-pool sequence within Sixteen Mile Creek, a low-order channel in Southern Ontario, Canada, which provides key habitat for the endangered Silver shiner. Maximum velocity magnitude and position above the bed, velocity distribution and bed shear stresses were analyzed under open water and ice-covered conditions. Using acoustic doppler velocimeter (ADV) and acoustic doppler current profiler (ADCP) high resolution velocity profiles were collected during ice cover, open water, and open water with significant increases in vegetation cover. Flow directions were found to vary significantly under ice cover in comparison to open water conditions. Additionally, maximum velocities were located closer to the bed under ice cover, resulting in larger winter bed shear stress values. A narrowing of the thalweg under ice cover was also identified. Subsequent flow simulations using River2D, a two-dimensional hydrodynamic model, identified significant changes in depth-averaged velocity distribution and flow directions under ice cover within the riffle-pool sequence. Notably, a recirculating eddy was present during ice-covered conditions along the left bank of the assessed pool, where Silver shiner have been located. Results from this study demonstrate the importance of incorporating ice-covered fluvial processes within river management and research to ensure habitat connectivity in cold-region rivers is appropriately represented.
11:45	Beatrice Pinna	River habitat modeling for the entire macroinvertebrate community beatrice.pinna@polito.it Alex Laini, Department of Life Sciences and Systems Biology, University of Turin; Giovanni Negro, Department of Environment, Land and Infrastructure Engineering, Polytechnic University of Turin; Gemma Burgazzi, Department of Environment, Land and Infrastructure Engineering, Polytechnic University of Turin; Pierluigi Viaroli, Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma; Paolo Vezza, Department of Environment, Land and Infrastructure Engineering, Polytechnic University of Turin; Macroinvertebrates are rarely considered as ecological target in river habitat models. Existing approaches are primarily focused on single species and overlook the functionality and the ecological needs of the entire macroinvertebrate community. The main aim of this work is to produce a method of habitat modeling for the macroinvertebrate community. The recently developed Flow-T index was applied at the mesohabitat scale by employing a Random Forest (RF) regression. Three rivers characterized by braiding morphology, gravel riverbeds and summer low flow were selected for the analysis. Different datasets were used, collected from both field data collection and 2D hydrodynamic models, to calibrate and validate the model. 12 different mesohabitat descriptors were selected by the RF model because of their importance for the macroinvertebrate community. Among these habitat descriptors, different frequency classes of water depth, flow velocity, substrate grain size and connectivity to the main channel can be found. The cross-validation R2 coefficient (R2cv) for the training dataset of the Trebbia River (2019 campaign) is 0.71. Instead, the R2 coefficient for the validation datasets (R2cv), which include the Trebbia, Taro, and Enza Rivers (2020 campaign), is 0.63. The simulated results and the experimental data show good agreement, demonstrating sufficient accuracy and reliability of the model. The findings of the study indicate that the model is able to recognize the ecological response of the macroinvertebrate community to potential changes in flow regimes and alterations in river morphology. The presented method reports an innovative extension of the MesoHABSIM model applied to the entire macroinvertebrate community. This approach

		holds potential for broader applications in designing environmental flows, in areas where fish are not present, in both perennial and non-perennial rivers.
12:00	Justus Hargett	Predicting embeddedness from bankfull shear velocity across entire gravel-bedded river networks justush@vt.edu Justus Hargett, Virginia Tech (first author, student, and presenter) Sierra Smith, Virginia Tech; Jonathan Czuba, Virginia Tech Excess fine sediment (<2 mm) deposition on gravel streambeds can degrade habitat quality for stream biota. Stream ecologists commonly measure fine sediment accumulation via a metric called embeddedness, a measure of the extent to which coarse particles are surrounded by, or embedded into, a finer substrate. Average embeddedness of a stream reach is physically measured to assess habitat quality and there are no widely used methods to estimate or predict embeddedness from remotely sensed data. Our results from Virginia and North Carolina, U.S.A., show that we can predict embeddedness from freely available, remotely sensed stream variables used to calculate bankfull shear velocity. We have further analyzed data from the United States Environmental Protection Agency National River and Stream Assessment, which includes measurements of physical habitat, fish, and macroinvertebrates to assess how well our prediction performs across the U.S. and which fish and macroinvertebrate metrics are correlated with embeddedness. These results show that we can generally predict embeddedness across the U.S. with a +/-15% error. Also, we found negative correlations in selected regions between embeddedness and intolerant fish taxa (R2 = 0.42) and EPT (ephemeroptera, plecoptera, and trichoptera) macroinvertebrate individuals (R2 = 0.38). We are measuring embeddedness at a few sites in Virginia to examine how embeddedness changes over time in response to changing flow conditions and to what extent our predictive relationship holds. Ultimately, we are able to make predictions of embeddedness throughout entire gravel-bedded river networks, which can lead to more robust assessments of aquatic habitat and biota.
12:15-12:45	**Jean-Paul Lemieux**	**LUNCH (to go) – you can either use the room or take your lunch to eat at destination depending on the visit you choose**
12:45	**Technical tours depart from lobby – find your visit**	
18:00-22:30	**Banquet starts 19hrs, bar open at 18hrs**	

May 9 (Thursday) Room/hours		
7:00-8:00	**Breakfast served at Level 2 Jean-Paul Lemieux**	
Borduas Ballroom 3 May 9	**Session 36: Aquatic habitat modelling and management**	**Chair: Marianne Bachand**
08:30	Donatella Termini	Early-Warning of climate change disturbance in rivers by means of freshwater mussels' response donatella.termini@unipa.it Donatella Termini, University of Palermo (Italy); Nina Benistati, University of Palermo (Italy); Ashkan Pilbala, Luigi Fraccarollo, Sebastiano Piccolroaz, University of Trento (Italy); Vanessa Modesto, Dario Manca, Nicoletta Riccardi, The National Research Council (CNR) - IRSA-Verbania (Italy); Tommaso Moramarco, The National Research Council (CNR) - IRPI, Perugia (Italy) Climate change alters the hydrological regime and, consequently, the magnitude of flows and hydrodynamics in rivers. The variations of the hydrodynamic conditions affect the functions of biological communities which are controlled by the interplay between biological, physical-chemical and hydraulic processes. Literature (among others Butler et al., 2012) indicates that some species, called as "ecosystem engineers", have a significant impact in the aquatic environment and, thus, are important in studying the effects of climate changes in rivers. The present study concerns freshwater mussels (FMs), which meet the criteria to be considered as typical "ecosystem engineers". Despite the general understanding of the ecological contribution of FMs, little is known about the physical interactions between mussels and the flow and how such interactions impact on mussels' response. Recently, laboratory tests performed by the research group of the present work on different FMs populations (Modesto et al., 2023; Termini et al., 2023) suggested that FMs could be used as early warning system (BEWS) of flow discharge variations. In the present work the analysis is extended also by using data collected in a selected reach of Paglia river

		(Italy). The mussels' valves opening/closing have been recorded by using Hall sensor technology and Arduino platform and the FMs' behavioural response have been examined in terms of valves' opening/closure frequency and amplitude. The obtained results have confirmed that FMs' behavioural response can be used as BEWS for identifying the impacts of climate changes in rivers.
08:45	Cameron Stevens	A habitat-based solution for spawning salmonids in a regulated sub-Arctic river in the Northwest Territories, Canada cameron.stevens@wsp.com Cam Stevens, WSP Canada; Matthew Miller, Stantec; Mark Poesch, University of Alberta There are hundreds of operating hydro facilities across Canada located in water frequented by fish. The management of those facilities often require environmental design features or solutions, such as mitigation or offsetting, to reduce harm to fish to meet requirements under environmental protection policies in Canada. The responsibility to implement environmental solutions typically falls on proponents despite a paucity of formal guidance and applied research on how to reduce or offset harm. In collaboration with the regional utility company, we evaluated the performance of an artificial spawning bed for adfluvial salmonids that was recently constructed below a hydro facility in the Yellowknife River in the Northwest Territories. Design inputs considered previously documented substrate requirements for lake-spawning populations in the Great Lakes, concepts used for habitat rehabilitation projects in the Northwestern United States, and results from historical monitoring of the abundance and distribution of spawning salmonids in the Yellowknife River. Reproductive data were collected on adfluvial Lake Trout and Lake Whitefish using snorkel surveys of the enhanced substrate within the artificial spawning bed and nearby natural substrate in the same section of the river. Results indicated a delayed response in the use of the artificial spawning bed during the first year of monitoring, but with higher egg densities (by up to three-times) on the spawning bed versus natural substrate when considering all years combined. Higher egg survival rates were also observed on the artificial spawning bed for Lake Whitefish. The results suggest that the installed spawning bed has the potential to benefit the overall productivity of the fishery in the river by increasing juvenile recruitment in populations. A contributing factor to the successful outcome was the inclusion of a substrate composition with interstitial spaces to anchor drifting eggs and to protect eggs during the incubation period. The results from this study begin to address major gaps in the formal documentation of in-river habitat solutions for hydro facilities and provide a field-verified concept for fish habitat enhancement and rehabilitation in Canada.
09:00	Zhonglong Zhang	CE-QUAL-W2 Hydrodynamic and Water Quality Simulation Capabilities in Support of Reservoir Operation and Management zz3@pdx.edu Scott Wells, Department of Civil & Environmental Engineering, Portland State University, USA CE-QUAL-W2 (W2) is a 2D laterally averaged hydrodynamic and water quality model with over 30 years in development. The W2 model is capable of simulating multiple reservoir and riverine water bodies. The model solves the 2D advection-diffusion equation for water temperature and water quality constituents. Water quality constituents simulated by the model range from general constituents, inorganic solids, bacteria, dissolved gases, and Fe, Mn, Hg to nutrient cycles and eutrophication in water bodies. The user can specify any number of generic constituents, suspended solids, algae, and epiphyton, macrophyte, and zooplankton groups. W2 also includes zero-order and first-order methods and sediment diagenesis simulation for quantifying SOD and sediment-water fluxes of nutrients. The model produces detailed outputs for all water quality constituents at any longitudinal, vertical and temporal point. W2 has been successfully applied to hundreds of rivers, lakes, and reservoirs in the U.S. and throughout the world. The model has been used as a management tool to evaluate direct and indirect effects from various stressors, perform thermal and water quality investigations, update reservoir operation manual, and develop environmental impact statement. In the Columbia River system, reservoir operations have resulted in elevated total dissolved gas (TDG) from reservoir release and along the riverine systems. TDG supersaturation causes gas bubble trauma that can lead to fish mortality in downstream systems. Predicting TDG production and behavior in a reservoir and riverine system is a challenge. Multiple W2 models have been used to predict TDG and other water quality constituents of concerns from reservoir projects and to further understand the impacts of reservoir operations and spill flow on the supersaturation of TDG. This presentation will discuss the water quality simulation capabilities of the latest W2 model and its applications in support of reservoir operation and management.

09:15	Iana Kopecki	Conflict between canoeing and fish habitat – A habitat-based assessment approach kopecki@sjeweb.de Matthias Schneider, SJE Ecohydraulic Engineering GmbH, Backnang, Germany; Johannes Ortlepp, Hydra Buero für Gewässeroekologie Muerle und Ortlepp GbR, Niefern-Oeschelbronn, Germany; Thomas Speierl, Fachberatung für Fischerei, Oberfranken, Germany; Viktor Schwinger, Fachberatung für Fischerei Oberfranken, Germany; Tobias Häggele, SJE Ecohydraulic Engineering GmbH, Backnang, Germany The Wiesent River is one of the last remaining salmonid rivers in southeast Germany with a viable, stable population of European grayling (*Thymallus thymallus*) and brown trout (*Salmo trutta m. fario*). The river flows through the culturally and geologically attractive region known as "Franconian Switzerland". Canoeing became very popular along the river, leading to the establishment of several commercial canoe rental stations. However, recently canoeing appears to be causing significant disturbance to the local grayling and brown trout populations, particularly as periods of low flow become more frequent and prolonged, mainly in summer. This stress that obviously depends on discharge level, manifests in a lower abundance and fitness (condition factor) of the above species in the stretches with frequent canoeing. In order to assess the impact of the canoeing on fish habitats, numerical hydrodynamic models were set up and habitat simulations for grayling and brown trout were performed using the CASiMiR Fish software. Using electrofishing, fish were caught for biometric surveys, population control and validation of habitat models in 9 different river sections. Habitat disturbance was assessed using an agent-based model predicting the spatial location of the frequent canoe pathways in the stream. The fish habitat models and canoe routes were then overlayed to identify areas with the highest potential for conflicts. Taking into account a depth-dependent change in habitat suitability, this approach enabled quantifying the disturbance intensity caused by boats crossing the potential habitats for different river flow rates. Results were used to define flow-dependent canoeing regulations. Based on the findings, a management concept has been developed, that is intended to significantly reduce the impact of canoeing on the grayling and brown trout population in the Wiesent River.
09:30	Nicolas Guillemette	Analysis of Dredged Sediment Impacts on Water Quality and Aquatic Habitats in the St-Lawrence Estuary nguillemette@lasallenhc.com Benoit Ruest, Lasalle|NHC, Quebec, Canada; Catherine Lalumiere, Englobe, Quebec, Canada; Annie Bérubé, Englobe, Quebec, Canada; Annie Taillon, Norda Stelo, Quebec, Canada; Caroline Ratié, Société portuaire du Bas-Saint-Laurent et de la Gaspésie (SPBSG); David Parent, Société portuaire du Bas-Saint-Laurent et de la Gaspésie (SPBSG) The Port of Matane is located on the south shore of the St. Lawrence estuary, directly in the heart of the city of Matane. The harbor is protected on both sides by breakwaters, and the port facilities are used by a variety of users, including the Société Portuaire du Bas Saint-Laurent et de la Gaspésie (SPBSG), the Société des Traversiers du Québec (STQ), and a group of fishermen. The SPBSG recently launched a redevelopment project for Matane's port facilities, with the aim of rebuilding the commercial wharf and modernizing the port's facilities, including the construction of a new 220 m-long wharf and capital dredging of some 200,000 m^3 to maintain minimal depth for navigation purpose. Dredging operations release sediments into the water column that could cause non desirable water quality impacts on aquatic habitat within the vicinity of the mixing zone. Hence, the characterization of the magnitude and behavior of the dredge plume is key to assess and manage environmental impacts. Among the habitats of interest for aquatic fauna that have been identified within the study area are the Matane River - a salmon river - and a riparian wetland targeted for conservation in the MRC's regional wetland and water management plan (PRMHH). Further offshore, some special-status cetacean species (e.g. beluga and blue whale) are also considered in this study. This paper presents and innovative approach that was applied to support both the engineering works and the environmental impact assessment study using a high-resolution numerical model to evaluate and predict the water quality impact of dredging operations in the port of Matane. Capturing the near and far-field dilution and dispersion of the suspended sediments is essential to assess the Water Quality criteria for the Protection of Aquatic Life and help develop a more comprehensive real-time monitoring program during dredging works using buoy-based turbidity.
09:45	Christian Haas	Best practice for effective camera monitoring in river ecosytems – using cameras in open water to determine fish behavior and migrations I am Hydro christian.haas@iamhydro.com Matthias Meyer, Kristof Reuther, Basil Wagner, Maurus Meier, Leon Engelberger

		Kraftwerke Oberhasli The deployment of camera systems in river ecosystems can be challenging. Migration corridors can be wide, debris and sediment transport can influence the setup and the hardware is vulnerable to flood events. This presentation explores the complexities of implementing different camera hardware in rivers, emphasizing the importance of strategic planning, knowledge on behavior and adaptive methodologies to ensure the success of migration or behavioral studies. A variety of hardware will be shown and very low cost to high cost and effort implementations will be presented. Behavioral studies on the impacts of recreational canoeing activities on salmonid species as well as influence of Hydropeaking show the applicability for this method. In addition, Exaples of monitoring spawning migration of Northern pike and Migratory Brown trout over several years and in different waterbodies underline the value of this approach. The study shows best practices derived from many camera implementations, including optimal camera placement, and using structures to increase the efficiency of this monitoring approach in rivers and streams. The presentation will also cover technological adaptations that enhance camera performance under diverse conditions and the integration of motion detection and AI software to conserve storage and improve data relevancy. Case studies demonstrating successful monitoring projects from water bodies all over Europe will be highlighted to illustrate how these practices have been effectively applied in real-world scenarios. The study aims to provide practical insights and recommendations to maximize the efficacy of camera-based monitoring of fish in river environments.
Leduc-Fortin May 9	**Session 37: Optimizing fishway designs**	**Chairs: Guillermo R. Giannico**
08:30	Bjorn Lake	Goldilocks and the three fishways - Our attempt to design a fish ladder that is just right. bjorn.lake@noaa.gov Katopodis and Williams (2012) provide a historical context to fish passage development. In their review, they document the development of many of the fishway types used today as mitigation for the effects of dams. The development of most volitional fishway types occurred during the first half of the twentieth century, specifically for salmonids. Because salmon are highly motivated, strong swimmers, and leapers, fishways developed for salmon have not been as effective for passing other migratory species (Mallen-Cooper and Brand 2007, Silva et al. 2017). Nevertheless, salmon fish ladders are ubiquitous at dams with fish passage. These installations have led to debate on the efficacy of technical fish passage as an appropriate mitigation measure (Limburg and Waldman 2009, Brown et al. 2013). On the East Coast of the United States, contemporary volitional fishway design is rare as most design engineers select from a list of previously installed volitional fishway types. This has led to fishways that are too small or too big and too steep or too gradual for the target species and barrier attributes. NOAA Fisheries, along with our federal partners at the U.S. Geological Survey, are attempting to develop a volitional fishway design that is effective for a multitude of species and scalable to fit barrier attributes. In this talk, I will present our approach to a new volitional fishway design that may address some of the gaps in existing technology.
08:45	Sean Bennett	Fishway Design for the Emerald Shiner (Notropis atherinoides) in the Upper Niagara River, New York scottmiehls@gmail.com Daniel Zielinski, Great Lakes Fishery Commission; Sean Lewandoski, U.S. Geological Survey; Jesse Eickholt, Central Michigan University Barriers limit migration of fish species around the world thus managers are tasked with improving access to blocked tributaries. In many instances those same managers are also tasked with limiting the spread of invasive species, for which barriers are an effective tool, leading to the need for technologies that selectively pass desirable species while blocking invasives. Further, successful passage of traditional, technical fishways can vary widely among species of fish. For example, many of the non-salmonid, native species desired for passage demonstrate poor success with passing traditional fishways designed with jumping, salmonid species in mind. Here we present an overall conceptual model for selective passage of non-salmonid (i.e. non-jumping) fish species and results from recent studies to test the components of this model. We recently demonstrated that sorting fish along morphological differences holds promise and that imaging tools combined with computer learning algorithms could be effective at differentiating among species groups. However, to achieve a high level of success the fish needed to be dewatered for imaging which is a challenge for non-salmonid fish that are less likely to volitionally enter false fishway sections. The Archimedes screw fish lift (ASFL), offers a simple means to capture and lift

		fish into the scanner. Pilot tests in a fish crowding structure near a migratory barrier demonstrated a prototype ASFL was effective at capturing and safely lifting suckers spp. and that attraction flow was an important factor impacting capture. Future work includes plans to test the ASFL outside a confined space and if flow enhancement can be used to improve capture success. Pairing an optical sorting technology with the ASFL could result in a novel selective passage tool and allow managers to simultaneously achieve competing objectives.
09:00	Filipe Romão	Cyprinid Passage Performance Thresholds: Exploring literature recommendations filipe.romao@tecnico.ulisboa.pt Ana L. Quaresma, CERIS – Civil Engineering for Research and Innovation for Sustainability, Instituto Superior Técnico, University of Lisbon, Av. Rovisco Pais, 1049-001 Lisbon, Portugal; Joana Simão, LNEC – National Laboratory for Civil Engineering, Hydraulics and Environment Department, Water Resources and Hydraulic Structures Department, Av. Do Brasil 101 1700-066 Lisbon, Portugal; Francisco J. Bravo-Córdoba, GEA-Ecohidráulica, Centro Tecnológico Agrario y Agroalimentario Itagra.ct, Palencia, Spain; Teresa Viseu, LNEC – National Laboratory for Civil Engineering, Hydraulics and Environment Department, Water Resources and Hydraulic Structures Department, Av. Do Brasil 101 1700-066 Lisbon, Portugal; José M. Santos, CEF – Forest Research Centre, Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Tapada da Ajuda, 1349-017 Lisbon, Portugal; Francisco J. Sanz-Ronda, GEA-Ecohidráulica, Area of Hydraulics and Hydrology, Department of Agroforestry Engineering, University of Valladolid, Palencia, Spain; António N. Pinheiro, CERIS – Civil Engineering for Research and Innovation for Sustainability, Instituto Superior Técnico, University of Lisbon, Av. Rovisco Pais, 1049-001 Lisbon, Portugal Worldwide, barriers in river systems prevent fish movements and fragment habitat connectivity. River continuum loss is a main cause of freshwater fish species decline. With no obvious solution besides barrier removal, which, in many cases, is not an option, fishways are the most widespread solution. Early design guidelines for pool-type fishways, established for cyprinids, indicate a pool volumetric dissipation power (Pv) under Pv<150 Wm-3, while most frequent slope values range below 10 % for small-scale hydropower facilities. In this study, an experimental approach was set to question the amplitude of these recommendations and to explore fish passage thresholds. For this, the passage performance of a potamodromous cyprinid (Luciobarbus bocagei) was assessed in a full-scale fishway facility, with four Vertical Slot Fishways (VSF) configurations, varying in discharge (Q) and pool water depth (hm) and by installing a deep notch (DN): VSF1 (Q = 81 ls^{-1}; hm = 0.55m); VSF2 (Q = 110ls^{-1}; hm = 0.80 m); DN1 (Q = 71 ls^{-1}; hm = 0.55 m); DN2 (Q = 99 ls^{-1}; hm = 0.80 m). The slope was set to 15,2 %, and the head drop between pools was Δh = 0.28 m, generating a Pv ranging from 222 in VSF1 to 187 Wm^{-3} in DN2, which exceeded design guidelines. Passage performance was evaluated using PIT telemetry and processed through time-to-event analysis. The hydrodynamics and turbulence patterns were determined using a computational fluid dynamics (CFD) model. Findings, as opposed to predicted, showed outperformance in VSF1. CFD results showed that turbulence and velocity maximum magnitudes do not change significantly for all scenarios; however, their distribution in the pools is quite different. Larger zones, with turbulent kinetic energy higher than 0.05 m^2s^{-2} were noticeable in DN configurations compared to VSF1, thus affecting passage efficiency, which aligns with the passage performance results. Overall, this study complements literature recommendations, reinforcing the need to jointly assess species-specific fish passage criteria, while alerting against the use of broad recommendations.
09:15	Cornelia Schütz	Fishway bottleneck: Passage of an entrance slot by small-bodied fish schuetz@bafg.de Martin Henning, Federal Waterways Engineering and Research Institute (BAW); Veronica Wiering, Federal Waterways Engineering and Research Institute (BAW); Marlene Kundruhn, Federal Institute of Hydrology (BfG); Matthias Pitsch, Federal Institute of Hydrology (BfG); Marcus Herbst, Federal Institute of Hydrology (BfG) Fishway entrances must meet contradicting requirements: their discharge and flow velocity must create a sufficient attraction flow, but velocities must not exceed swimming capabilities of the target fish fauna. In this conflict between attraction for large fish and passability for small fish it is a challenge to find a good compromise for the fishway entrance design. In several flume experiments we investigated fish passage through an entrance slot typical for large German rivers. We quantified passage probabilities of small fish (Gudgeon, Spirlin and juvenile Roach) at different flow velocities, and also investigated how rough substrate and velocity fluctuations changed passage results. Although our model predictions may not pro-vide a concrete velocity threshold for an optimum compromise, we are able to show species specific results that will inform fishway

		design decisions. In this presentation we will present the framework for the investigations and the results of experiments with different slot veloci-ties as well as those regarding the influence of rough substrate. The influence of flow velocity fluctuations will be presented by Focht & Schütz (see abstract submission Focht et al.).
09:30	Lina Focht	Effect of Velocity Fluctuations on Vertical Slot Passage of Small Non-Salmonid Fish lina.focht@baw.de Cornelia Schütz, Federal Institute of Hydrology; Marie Habedank, Federal Institute of Hydrology, present address: Land agency for safe dykes, clean water and maintaining biodiversity; Patrick Heneka, Federal Waterways Engineering and Research Institute Fishway slots are designed for a target mean flow velocity. In reality however, velocities fluctuate around their mean value. It is conceivable that these fluctuations produce short periods of spatially and/or temporally reduced flow velocities which may facilitate passage through the slot for small fish or weak swimmers. This is especially true for the entrance slot of a fishway, where high mean velocities are needed to enhance attraction flow propagation.To investigate this matter, we conducted a flume study to investigate the effect of velocity fluctuations on fish passage through a 0.4 m wide vertical slot with a mean velocity of 1.5 m/s. Juvenile Roach and Gudgeon were tested for their passage success in three different hydraulic treatments: A) smooth flow with low fluctuations; B) flow with random turbulent fluctuations that are similar to the flow in a real vertical slot fishway and C) smooth flow where velocities were periodically reduced by 0.3 m/s for 1.5 s every 15 s. A generalized linear mixed model (GLMM) was used to analyze the influence of the treatments and additional variables like fish length, time of the day or temperature on the passage success. Furthermore, for treatment C), we tested whether fish actually passed the slot during reduced velocities. Key findings indicate that flow fluctuations do not significantly affect fish passage success for the tested species. This is a follow-up study to Schütz et al. (also submitted to ISE-FP 2024).
09:45	Panos Panagiotopoulos	Unraveling socio-ecological complexities in improving fish migration: Understanding fishways as heterogeneous networks Wageninen Unievrsity and Research panos.panagiotopoulos@wur.nl Anthonie D. Buijse, Department of Freshwater Ecology and Water Quality, Deltares, Delft, The Netherlands; Hendrik V. Winter, Aquaculture and Fisheries group, Wageningen University & Research, The Netherlands and Wageningen Marine Research, IJmuiden, The Netherlands; Leopold A.J. Nagelkerke, Aquaculture and Fisheries group, Wageningen University & Research, The Netherlands In the context of connectivity restoration in rivers, fishways play a crucial role in facilitating fish migration, but their form, function, and effectiveness are often determined by various socio-ecological complexities. This study sheds light on these complexities through the case of fishway development in the management area of the water authority “Brabantse Delta” in the Netherlands. Inspired by network approaches, originating from Science and Technology studies (STS), we investigated the planning, realisation, operation, and maintenance of fishways as an assembling process of heterogeneous networks involving human and non-human actors. Using data from interviews with key stakeholders, field observations, and document analysis, the research unveiled fishways as networks consisting of human and various non-human actors such as farmers, fish, water flows, debris, and policies. Moreover, we show that fishways are also embedded as actors or 'nodes' within broader networks that in turn influence their functioning. By following fishways across the different phases of their implementation trajectory, and tracing the participation or withdrawal of actors, we explore the changes in the networks and their subsequent impact on fishway functioning. This study offers insights into the socio-ecological complexity and power dynamics that affect fishway effectiveness, emphasizing the need for a networked approach that acknowledges both human and non-human actors in strategies to improve fish migration.
10:00	Tracey Steig	Insights into Migration Success of Alewife Through a Hydro-Facility using Complementing Technologies tracey.steig@innovasea.com Samuel Andrews, Acadia University; Rod MacLean, Innovasea Systems Inc.; Jean-Marc Nicolas, Nova Scotia Power Inc.; Jean Quirion, Innovasea Systems Inc.; Matt Richards, Innovasea Systems Inc.; Barbara Rowdon, Innovasea Systems Inc.; Michael Stokesbury,

		Acadia University; Colleen Burliuk, Innovasea Systems Inc.; Terry Toner, Nova Scotia Power Inc.; Dale Webber, Innovasea Systems Inc. Upstream and downstream migration of Alewife (*Alosa pseudoharengus*) was evaluated through a pool and weir fishway and two downstream bypasses at the White Rock Hydroelectric Facility (Nova Scotia Power Inc.), on the Gaspereau River, Nova Scotia, Canada using a recently developed miniaturized ultrasonic transmitter and a next generation Tagless Fish Tracking system. Both were developed as part of the OceanAware project funded by Canada's Ocean Supercluster and in May 2022, 250 Alewife were externally tagged with the transmitters to evaluate their passage success and migration. During the migration, tagged Alewife were monitored both by acoustic receivers, and by the Tagless Fish Tracking system that employed real-time video and artificial intelligence (AI) techniques to produce real-time fish counts at the upstream fish ladder exit. From April to June 2022, the Tagless AI system counted 918,169 Alewife, which was verified by human counts to within 95%. The addition of the acoustic monitoring system provided valuable data on route choice, survival, and passage efficiency. Acoustic receivers placed in the turbulent fish ladder and bypass channel detected tagged fish with 100% efficiency. Alewife migrated to different destinations in the river system, suggesting several spawning locations, with 64% of migrating fish returning to the facility and 50% returning to the estuary. Passage efficiency through the power turbines and surface bypasses was 95%. The results from both the ultrasonic tagging system and the Tagless AI system showed strong diurnal patterns in the upstream and downstream migration with the upstream migration exhibiting the strongest diel signal.
Pilot **May 9**	**Session 38: Aquatic Habitat quality**	**Chairs: Carole-Anne Gillis**
08:30	Mostafa Khorsandi	Assessing the surface downward longwave irradiance models using ERA5 input data for station and watershed scales in Canada mostafa.khorsandi@inrs.ca André St-Hilaire, INRS; Richard Arsenault, ETS; Suraj Patel, INRS Longwave radiation (LR) is a critical component of the energy balance, affecting water temperature during hot summers. Both incoming and outgoing LR are challenging to measure, particularly under varying conditions influenced by clouds and canopy cover. This research leverages data from the ERA5 reanalysis database, including air temperature, dew point temperature, cloud cover, and leaf area index (LAI), to evaluate nine DLI models against measured DLI data in Canada. The results demonstrate the feasibility of using ERA5 data for all-sky conditions, with RMSE performance metrics ranging from 30 to 38 W/m². ERA5 DLI data exhibits superior performance, with RMSE values ranging from 30 to 32 W/m², suggesting its suitability as input data for hydrological and ecological models. At a river basin scale, LR's role in cooling river water temperature during hot summers is crucial, yet quantification remains limited. This study employs nine DLI models and inputs from ERA5 within the CEQUEAU hydrological-thermal model for the Nechako watershed in central British Columbia, Canada. Model 9, which explicitly considers canopy effects through LAI, yields the most reliable results. These results are employed for multisite calibration of water temperature modeling at the watershed scale. Various formulations of the Stephan-Boltzmann equation effectively quantify DLI's impact on water temperature. ERA5 DLI data also demonstrates acceptable performance. The enhanced performance of Model 9 highlights the potential for partitioning DLI into open areas and canopies, utilizing mathematical formulations and ERA5 data as input for hydrological and ecological models. This research advances our understanding of DLI heat budget modeling in hydrological-thermal studies from micro to macro scales.
08:45	Todd Buxton	Promoting diurnal thermal stratification in river pools for water management, species conservation, and fish passage in a warming climate tbuxton@usbr.gov Yong G. Lai, Technical Service Center, U.S. Bureau of Reclamation, Colorado, USA Thermal barriers to salmon migration to spawning grounds are having an impact on these populations in this age of climate change. A remedy on the Trinity River, California is to maintain dam releases unnaturally high to provide cold water for migration in summer, but this suppresses the stream food base and may limit future salmon populations by reducing juvenile fish size and survival to adult via this positive relationship. We explored whether lower summer releases from the dam can promote thermal stratification in pools so the cold-water needs of adult salmon and warmer water requirements of other species can be met. Our investigation uses a three-dimensional (3D) computational fluid dynamics (CFD) model with field measurements to identify flows and water temperatures that form and maintain thermal stratification in deep pools under variable meteorologic conditions. Under low flows, we observed a pool above the dam as well mixed and thermally homogenous

		until temperatures began to stratify at sunrise. Stratification strengthened through the day until shading and sunset cooled the inlet flow and decayed the thermal gradient, which then collapsed and returned the pool to a well-mixed state. The diurnal stratification process was closely predicted by the 3D CFD model, providing a new tool for identifying critical flows for stratification under local temperature conditions. We find the diurnal stratification enables salmon to wait out thermal barriers in the heat of day in cold pool bottoms and then resume upstream migration under colder temperatures at night. We also found the stratified pool provided similar daily average temperatures as when flows were an order of magnitude higher and stratification was prevented in a pool downstream of the dam, indicating significant water savings may be realized with stratification in regulated streams while also providing the diversity in water temperatures freshwater biomes require.
09:00	Sandrine Picotte	Cumulative Impacts of Pollutant Discharges: Exploring Thermal Refuges in the Rimouski River Ecosystem sandrine.picotte@uqar.ca Souhir Marsit, Département de biologie, chimie et géographie, Université du Québec à Rimouski, 300 allée des Ursulines, Rimouski, Québec, Canada; Richard St-Louis, Département de biologie, chimie et géographie, Université du Québec à Rimouski, 300 allée des Ursulines, Rimouski, Québec, Canada; Simon Tweddell, Organisme des Bassins Versants du Nord-Est du Bas-Saint-Laurent, 5 rue Saint-Paul, Rimouski, Québec, Canada; Emmanuelle Chrétien, Département de biologie, chimie et géographie, Université du Québec à Rimouski, 300 allée des Ursulines, Rimouski, Québec, Canada; Karine Blouin, Organisme des Bassins Versants du Nord-Est du Bas-Saint-Laurent, 5 rue Saint-Paul, Rimouski, Québec, Canada The Savane Creek, which flows into the Rimouski River, creates a thermal refuge where Atlantic salmon (Salmo salar) could seek shelter during extreme heat events. However, this area is at risk of experiencing anthropogenic pressures that may have cumulative adverse effects on aquatic fauna. The creek runs alongside agricultural areas (input in organic matter, fertilizers, and pesticides), a highway (emission of hydrocarbons and persistent road salt input), and a closed sanitary landfill site for the past 20 years (leachates rich in metals and synthetic compounds) upstream from the thermal refuge. The aim of this project is to characterize and quantify, over an annual cycle starting in October 2023, the pollution of the Savane Creek and the Rimouski River and to identify its sources. We will establish the connections between pollution and disturbances at the lower trophic levels by assessing the specific composition of the microbial community within the biofilm (bacteria and yeast) using DNA metabarcoding and potential stress using biomarkers (EROD, metallothionein, oxidative stress) on salmon prey (i.e. benthic macroinvertebrates). The results generated by this project will be used to develop a management plan for assessing and quantifying environmental damage to thermal refuges for salmon near a landfill site. This plan will be easily transferable to several similar locations to the one in this project.
09:15	Markus Noack	Riverbed clogging - functional relationships between governing key parameters markus.noack@h-ka-ab.de Alcides Aybar Galdos, Karlsruhe University of Applied Science, Institute for Applied Research, Germany The vertical connectivity in fluvial river systems is often used as an approximation for functional hyporheic exchange processes including hydrological, biogeochemical or nutrimental characteristics. As a transition between surface and groundwater the hyporheic zone contains features of both domains with specific gradients of governing parameters leading to specific habitat conditions for many aquatic organisms. It is widely known that riverbed clogging hinders this vertical connectivity, but no physical-based parameters and their values are known that distinguish between a clogged and a un-clogged (healthy) riverbed. Most often quality-based parameters are applied describing different visually different categories/classes of clogging or single parameters such as fine sediment contents are used. However, the complex processes of the phenomenon riverbed clogging cannot be described by single parameters and in terms of river assessments qualitative information is often biased by subjectivity. Therefore, we developed a multi-parametric approach (MultiPAC) to assess riverbed clogging by measuring vertical profiles of hydraulic conductivities, dissolved oxygen contents, porosities and particle size distributions. We applied MultiPAC in seven different rivers of the same specific rivertype but with different assessment according to the European Water Framework Directive 2000 (WFD). We used different univariate and multivariate statistics to derive functional relationships between the measured results of MultiPAC with catchment characteristics, WFD-assessments and results of biological monitoring (macroinvertebrates, meiofauna). So far, we achieved promising results showing e.g. significant correlations between the measured values of MultiPAC and e.g. the results of the assessment according to the WFD allowing to derive physical-based objective and rivertype-specific reference values for riverbed clogging. We are still at the

		beginning of our analyses and currently we are aiming on the development of a rivertype-specific assessment tool for riverbed clogging by including additionally biological data (macroinvertebrates, meiofauna with DNA-analyses) and catchment characteristics (erodibility, hill slope, land use).
09:30	Jean N Namugize	Water quality and sediment monitoring in the Nile basin countries jnamugize@nilebasin.org Michael Kizza; Nile Basin Initiative Water quality deterioration is an issue in the Nile basin as it is elsewhere in the world and is ascribed to point sources and non-point sources of pollution. Lack of funding resources to support implementation of regional water and sediment monitoring programs; inadequate systems for data acquisition, management, processing and dissemination of water quality results and information to the end users are some of the challenges in the basin. This study seeks to understand the current situation of national and regional water quality and sediment monitoring programs in the Nile Basin. A situation analysis that combines review of literature and field visits was conducted in the nine riparian countries of the Nile basin over a period of nine months, from July 2022 to March 2023. This included site visits of the water quality and sediment monitoring institutions/agencies, water quality monitoring stations and collection of data from the countries. Results indicate inconsistency in the collection of water quality data, the monitoring frequency varies from a country to another, basic physical chemical and bacteriological parameters are generally measured, lack of reagents and funding resources, lack of advanced laboratory equipment that can measure the pollutant of big concerns like heavy metals and pesticides. Where advanced laboratory instruments exist, they are not functioning due to inadequate maintenance and lack of spare parts or reagents. This highlights the need for capacity building of laboratory technicians in operation and maintenance of equipment, initiation of the inter-laboratory proficiency testing schemes in the region.
09:45	Mathewos Kebede	Impacts of water hyacinth (*Eichhornia crassipes*) on the diversity and abundance of fishes and littoral macroinvertebrates in Koka Reservoir, Ethiopia mathewos_temesgen@yahoo.com Senessa Daba Urgea, Department of Biology, Madda Walabu University, Ethiopia. This study aimed to assess the impacts of water hyacinths on the diversity and abundance of fishes and littoral macroinvertebrates in Koka Reservoir, Ethiopia. Descriptive and exploratory design was employed to get primary data. The area was initially categorized as highly infested, moderately infested, less infested, or infestation-free. One site was randomly selected from each. Temperature, pH, DO, TDS, and EC were measured in-situ using portable multi-parameter probes, whereas NO3-, BOD5, and TP content were analyzed in the laboratory. The fish and macroinvertebrates samples were taken three times in monthly interval. Fish samples were obtained from fishermen's daily catches. For BMI collection, a multi-habitat sampling approach of 25*25cm area was implemented using a standard D-shaped hand net. The result showed a significant physicochemical difference among the study sites ($p < 0.05$), with the Hargisa exhibiting the highest DO, pH, NO3- and PO43- content, respectively. Hargisa site had the highest water turbidity, EC, TDS, and BOD5. Turbidity and E. crassipes were positively and significantly correlated ($r = 0.953$, $p = 0.046$). Four fish species comprising 192 individuals were recorded. The highest composition was observed at Barko and Dambal site, with largest share of O. niloticus (38.53%) and C. carpio (31.77%). The fish abundance didn't differ significantly between the study sites ($p > 0.05$). C. gariepinus displayed a negative correlation with WH infestation ($r = -0.982$, $p < 0.05$). Similarly, a total of 871 macroinvertebrates from 10 orders and 18 families were found, with the highest abundance recorded at Barko site. The SDI, H-FBI, and %CHIR varied significantly among the sampling sites ($p< 0.05$). SDI was negatively correlated with E. crassipes ($r = -0.977$, $p = 0.023$). Generally, E. crassipes changed the water's chemistry and greatly impacted the diversity and abundance of fishes and macroinvertebrates. Therefore, effective management of E. crassipes is crucial to maintain the lakes healthy and consistent ecosystem services.
10:00	Morihiro Harada	Spatio-temporal distribution of flood disturbance and community response in a mountainous river system in Central Japan harada.morihiro.i3@f.gifu-u.ac.jp Hisanao Toyama, Gifu University; Shigeya Nagayama, Gifu University This study proposes a method for evaluating the spatio-temporal distribution of flood disturbance intensity throughout a river system and applies the proposed method to the Nagara River basin located in the Chubu region of Japan. The proposed method uses a

		rainfall-runoff inundation model (RRI model) with additional source code to calculate flood disturbance intensity at the time resolution of houry for each small segment that makes up the water system. As a measure of the real flood disturbance intensity, the RRI model is extended to be able to calculate the fluvial shear force acting on the riverbed surface. The results of the calculations are organized as indices focusing on the magnitude and duration of flood disturbance. The relationship between the freshwater fish community distribution and flood disturbance indices in 2020 and 2021 obtained by environmental DNA analysis is presented. The variability and mobility of freshwater fish community distribution in response to flood disturbance will be discussed and the effectiveness of the method will be presented.
10:15	Muhammed .A. Oyinlola	Unveiling the Complex Interplay: Evaluating Hydrothermal Exposure Risks for Key Aquatic Species in the Nechako River System, British Columbia, Under Climate Change Muhammed.Oyinlola@inrs.ca Mostafa Khorsandi, Canadian Rivers Institute and centre Eau Terre Environnement, Institut National de la Recherche Scientifique, Québec, Canada; Rachael Penman: Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada; Erika Eliason: Pacific Salmon Ecology and Conservation Laboratory, Department of Forest and Conservation Sciences, 2424 Main Mall Vancouver, BC Canada V6T 1Z4, Canada; Noa Mayer: Pacific Salmon Ecology and Conservation Laboratory, Department of Forest and Conservation Sciences, 2424 Main Mall Vancouver, BC Canada V6T 1Z4, Canada; Natalie Butler: Pacific Salmon Ecology and Conservation Laboratory, Department of Forest and Conservation Sciences, 2424 Main Mall Vancouver, BC Canada V6T 1Z4, Canada; Jacey VanWert: Pacific Salmon Ecology and Conservation Laboratory, Department of Forest and Conservation Sciences, 2424 Main Mall Vancouver, BC Canada V6T 1Z4, Canada; Madison L. Earhart: Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada; Richard Arsenault: Hydrology, climate and climate change laboratory, École de technologie supérieure (ÉTS), Montréal, Quebec, Canada; Hinch Scott: Pacific Salmon Ecology and Conservation Laboratory, Department of Forest and Conservation Sciences, 2424 Main Mall Vancouver, BC Canada V6T 1Z4, Canada; Colin J Brauner: Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada; Andre St-Hilaire: Canadian Rivers Institute and centre Eau Terre Environnement, Institut National de la Recherche Scientifique, Québec, Canada Water temperature holds an essential role in the physiological dynamics of aquatic species, significantly influencing their survival and developmental processes. In the management of water quality conditions for endemic species, resource programs are commonly used. Specifically, the Nechako River system in British Columbia has implemented the Summer Temperature Management Program to regulate water temperatures and prevent them from exceeding a 20°C threshold downstream during the migration and spawning season of Sockeye salmon (Oncorhynchus nerka). This intervention involves manipulating the timing and volume of water releases through a spillway. However, the consequences of this program on other resident species, such as white sturgeon (Acipenser transmontanus) and Chinook salmon (Oncorhynchus tshawytscha), remain a concern. In response to these considerations, we present an integrated approach that incorporates a hydrological model and life stage-specific experimental thermal tolerance data. Our aim is to assess water releases and potential hydrothermal exposure risks, considering combined climatic and socioeconomic scenarios (SSP-RCP 245 and 585). We further examine the effectiveness of the program in protecting Sockeye salmon migration under climate change. Our findings show a significant increase in projected thermal exposure risks under the high emission-fossil fuelled scenario across all life stages for the species under investigation. This research underscores the necessity of a comprehensive management program that considers the diverse species within the Nechako River system. It prompts a re-evaluation of the current management plan, particularly in light of growing concerns about the effects of climate change on the Nechako River ecosystem.
10:30 - 11:00	**Break – Foyer**	
Borduas Ballroom 3 May 9	**Session 39: Fishway monitoring & evaluation 2**	**Chairs: Bjorn Lake**
11:00	Ryan Hill	Limitations of non-volitional upstream passage for alewife (*Alosa pseudoharengus)* and blueback herring (*Alosa aestivalis*) chill5@unb.ca Antóin M. O'Sullivan; J. Derek Hogan; Tommi Linnansaari; R. Allen Curry; Philip M. Harrison, Canadian Rivers Institute; University of New Brunswick

		Fishways that rely on mechanical structures (e.g., lifts, locks, and transport systems) to move fish around a barrier are considered “non-volitional” because they prevent fish from passing at the time of their choice. We used PIT telemetry (n = 10,292 fish tagged, 4 years) to evaluate upstream passage at a non-volitional (trap, lift, and truck) fishway that passes between 1-3 million river herring (Alosa species) each year at the lowermost dam on the Wolastoq | Saint John River, NB. Between 26% and 62% of tagged fish reached the fishway crowding pool, while less than 14% passed upstream. River herring experienced considerable passage delays after reaching the crowder entrance (max = 27 days) and made multiple attempts to pass. The probability of passing on the date of first detection was only 10%, and positively correlated with the rate of fishway operation (i.e., fish lifts/unit time). The rate and probability of passage were greater for alewife than blueback herring and increased with total-length for both species. The fishway failed to provide timely passage as migrants became available, resulting in a migratory bottleneck that contributed to upstream passage delays, low passage efficiency, and selective passage conditions that favored larger individuals and alewife over blueback herring. Ultimately, this study suggests that non volitional fishways may create additional conservation and management challenges if their design and operation regimes do not consider the size and behavior of target populations.
11:15	Matt Blank	Westslope Cutthrout Trout Passage Through Scaled Denil Fishways mblank@montana.edu Cole Buller, Montana State University; Katey Plymesser, Montana State University; Kevin Kappenman, United States Fish and Wildlife Service; David Dockery, Wild Rivers Consulting; Al Zale, Montana State University Habitat fragmentation, caused by structures like dams, culverts, and weirs, is one of the largest threats to Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in the western United States and Canada. Denil fishways have been installed at low-head diversions to facilitate their movement past these structures and maintain habitat connectivity. Recent research has focused on scaled Denil fishways, which require less water for operation than standard sized Denil fishways and leave more water for other uses such as irrigation. The purpose of this study was to examine the passage of Westslope Cutthroat Trout in a 0.6-scale Denil fishway to assess hydraulic conditions that allow, limit, and prevent passage. To do this, we prescribed twelve treatments of headwater and tailwater (or approach) depth combinations. Each treatment was replicated three times for a total of 36 trials with 10 fish in each trial. Fish movements and passage efficiencies were tracked using passive integrated transponder (PIT) tag telemetry. Overall, 68% (256/379) of the fish successfully passed through the fishway. Mixed effects regression models were used to assess relationships among passage success, hydraulic variables, and fish length. Results from this analysis indicate headwater to tailwater depth ratio and bulk tailwater velocity (as calculated at the downstream end of the fishway) are the best metrics to predict the passage efficiency of Westslope Cutthroat Trout in a scaled Denil fishway. In general, passage success increased with lower headwater to tail water depth ratios (i.e., depths at the up and downstream ends of the fishway were similar) and lower tailwater velocities. This presentation will also integrate results from a separate study conducted by the authors on Arctic Grayling passage through scaled Denil fishways.
11:30	Alejandro Perez	Fish Passage in the Belo Monte Fishway, Amazon River Basin, Brazil alejandro.giraldo.perez@gmail.com Gouraud Véronique, EDF R&D LNHE - Laboratoire National d’Hydraulique et Environnement, Chatou, France; Baran Philippe, ECOGEA, Muret, France Hydropeaking operation of hydropower plants is used to meet peak electricity production requirements. It generates significant flow variations in rivers downstream of power plants, the impacts of which are well described in the literature. Hydropeaking can also induce changes in water temperature regimes. These changes, which have been less well studied, are linked to the natural vertical thermal stratification of water bodies, the complexity of the chain of catchment structures, and to the methods used to divert turbined water (depth of intake) and release it. They are characterized by artificial temperature variations in the receiving watercourse over the course of a nycthemeral cycle, known as "thermopeaking", with changes in gradient, amplitude, frequency and even seasonality. The aim of our work was i) to provide methodological elements for characterizing the ecological impacts of thermal alterations linked to hydropeaking and their variability according to the configuration of the facilities ii) to identify research actions to be developed in the future on the impacts of thermopeaking. To this end, we have carried out a state-of-the-art study of thermal alterations associated with hydropeaking and their impact on biological communities. Using our knowledge of the characteristics of the French hydroelectric fleet, we identified several types of alteration linked to the characteristics of the facilities and illustrated them using 5 study sites for which we had temperature time series and biological

		data. The results enable us to suggest some key metrics for characterization. They highlight typical potential impacts depending on the different configurations encountered. Research questions were then formulated on the basis of these results.
11:45	Etienne Cormier	Saint-Jean River in Quebec - Salmon Fishway design, construction and performance monitoring work etienne.cormier@wsp.com Alain Chabot, WSP Canada Inc. The waterfall on the Saint-Jean River on the Cote-Nord region in Quebec, located 69.5 km from the mouth of the river with the St. Lawrence River, is classified as impassable with reserve. As part of the "Côte-Nord Atlantic Salmon Habitat Enhancement" Program, a project to build a fishway at this natural waterfall for Atlantic salmon was submitted to improve spawning conditions and increase the salmon population, and it was accepted. The work was completed in 2018 at a cost of $1.4M. One of the main design criteria was that the fishway needed to fit into the existing natural environment. This fishway gives salmon access to numerous high-quality habitats upstream of the waterfall. This river has a theoretical salmon production potential of 4,000 salmon, 40% of which are upstream of the waterfall. The height of the waterfall that the fishway must pass is 4.0 m. The fishway has a width of 2 m, a length of 16 m, a slope of 25% and is composed of four concrete weirs with a drop between pools of 1.05 m. The operational flow range of the fishway is 0.3 to 0.9 m^3/sec and no flow control structure has been implemented. The energy dissipated in the basins ranges from 194 to 573 W/m^3. There is no road access to the site, so the work was carried out entirely by helicopter, which presented a huge construction challenge. The performance monitoring work of the fishway was carried out during 2 years following construction and demonstrated the effectiveness of the fishway in its operating range, although the design criteria are outside the recommended range.
12 :00	Christian Haas	Beyond the surface: exploring fish dynamics with camera based monitoring I am Hydro christian.haas@iamhydro.com Matthias Meyer, Kristof Reuther, Basil Wagner, Maurus Meier Kraftwerke Oberhasli AG (KWO), Department of Ecology, Jeffrey A. Tuhtan, Gert Toming, Jürgen Soom Department of Computer Systems, Tallinn University of Technology We explain and explore over a decade of practical experience, advantages, and limitations of underwater camerabased systems as a cost-effective tool to monitor shallow riverine aquatic environments. This work primary covers important topics which are largely ignored in the academic literature and includes the practical limitations of camera monitoring in the field, including mounting and protection systems, underwater conditions at fish passage facilities, and field conditions in wild rivers. Specifically, we present examples on how to best setup underwater cameras to observe fish behavior at migration barriers, fish protection structures, and within laboratory conditions, highlighting that before installations are made, it is first important to clarify the research questions and statistical evaluations methods. Videos with fish in them alone are not science, but they can provide sound scientific evidence if they are installed, maintained and processed properly. We highlight this with recent field studies on the behavior of large migratory brown trout (Salmo trutta) using camera monitoring as well as monitoring with physical fish traps, revealing substantial differences in the species and sizes found in each monitoring system. Consequently, we show that the perceived species and size selectivity based on the physical fish trap system was actually caused by the use of the physical monitoring process itself. Furthermore, this work explores real-world examples of camera systems outfitted with low-power embedded computer vision algorithms capable of filtering fish videos in real-time. We argue that the integration of these technologies into meaningful scientific and policy knowledge gains is likely to require experts, not replace them. A further and infrequently discussed advantage of video monitoring is that it has a minimal potential impact on fish behavior and is non-invasive. The findings from this presentation underscore the significance of camera monitoring systems as an efficient and versatile method for freshwater aquatic research, showcasing their ability to obtain dependable data to improve our baseline understanding of wild fish behavior in both built and natural environments.
Leduc-Fortin **May 9**	**Session 40: Agricultural & urban habitats stream restoration**	**Chairs: Eva Enders**
11:00	David Bidelspach	Awe Restoration – "Ecosystem Restoration in Urban Stream Management Corridors to Stimulate Mental Health Treatment and Community Revival" david.bidelspach@fivessr.com

		David Bidelspach, RiverSHARED.org; Lee Stucky, AHero USA; Imanthie Bandara 5SSR, PLLC; Dachner Keltner, UC Berkeley Ecosystem and Stream Restoration has been done for decades to improve habitat, fish passage and water quality but very rarely does a project focus on community revival and mental health treatment. The future of ecosystem restoration includes using ecosystem restoration as a tool for mental health treatment through connection to the emotion of wild awe. Wild awe allows humans to be more grounded and humbler. Treatment of mental health disorders such as post-traumatic stress disorder could be improved by increased connection to wild awe. Scheduled and routine journeys into ecosystem restoration areas could increase connection to wild awe in urban environments. Urbanization has disconnected people from nature and crime rates have increased with disconnection from nature. Communities planned around wild awe could produce positive results related to mental health treatment and reduced crime rates. Ecosystem restoration will be achieved in many urban environments by the removal of concrete channels and the replacement of a 4-stage corridor for restoration and a linear park and side channel wetlands. Ecosystem restoration will improve fish passage, floodplain connectivity and decrease flood risk. The ecosystem restoration will also incorporate a recreational activity called “Fishing Links”. “Fishing Links” is a concept to promote native fish communities in natural ecosystems and restore wonderment and awe to the people connected to the ecosystem restoration area. A “guardian” program incorporates local at-risk groups for maintenance and stewardship of the “Fishing Links” courses. Community revival and mental health treatment are being used as a goal for an ecosystem restoration project that relies on the restoration of ecohydraulics to maximize the wonderment and awe of the restored ecosystem. These projects are being done in conjunction with many partners and stakeholders through RiverSHARED.org. This presentation will share an example of the potential Toulmin Springs Soul Revival ecosystem restoration project in Prichard Alabama.
11:15	Peter Flödl	Particle-bound pollutants and river restoration - challenges and insights peter.floedl@boku.ac.at Hauer Christoph, CD-Laboratory for Sediment Research and Management, Institute of Hydraulic Engineering and River Research, Department of Water, Atmosphere and Environment, University of Natural Resources and Life Sciences Vienna, Am Brigittenauer Sporn 3, 1200 Vienna, Austria; Barák Vojtěch, Department of Zoology and Fisheries, FAFNR, Czech University of Life Sciences Prague, Praha Suchdol, Czech Republic Aquatic ecosystems are heavily modified and disturbed by anthropogenic impacts. This has led to a sharp decline in biodiversity in rivers. In order to improve the ecological status of European water bodies, it is important to reduce hydromorphological alterations. However, the removal of transverse structures can lead to a remobilisation of the accumulated sediments and the nutrients and pollutants bound to these particles. Such measures therefore face the challenge of minimizing high pollutant concentrations in the short term, protecting endangered species and promoting biodiversity in the long term. As an example, to protect the highly endangered freshwater pearl mussel Margaritifera margaritifera, ten transverse structures were removed in a border river between Austria and the Czech Republic (Central Europe). The sediment was only removed from two transverse structures with high deposition rates. At the other eight (smaller) transverse structures, the accumulated sediment was left in the river. In this study, pre- and post-monitoring of selected abiotic and chemical parameters was carried out for the first time in terms of a novel ecohydraulic assessment to evaluate the benefit but also the risk of weir removal. In addition, areas with increased erosion and accumulation potential were identified using a hydrodynamic model. The river restoration was carried out in January during low flow. Post-monitoring was carried out after a small spring flood. The short-term alterations of selected abiotic and chemical parameters are presented. These initial results will also highlight the challenges posed by particle-bound pollutants in aquatic ecosystems and their role in ecohydraulics in general. Insights into the complex entry pathways, sinks and sources in rivers should demonstrate the risks not only for the ecosystem but also for humans.
11:30	David Gould	Building a Municipal Stream and Wetlands Restoration Program Town of Plymouth dgould@plymouth-ma.gov Over the last twenty years the Town of Plymouth (MA) has undertaken the removal of 7 jurisdictional dams, 5 non-jurisdictional dams, and over a dozen water control structures on 4 different river systems in Town. It has restored over 80 acres of wetlands and has multiple dam removals and wetland restoration projects in various stages of planning and implementation right now. Partnering with dozens of state, federal and non-governmental agencies has led to sustained success in being able to conduct restoration throughout the

		community over the last two-decades. Over that period of time, we have been able to develop a river restoration program that ensures that restoration is always considered during the municipal planning of infrastructure projects like bridge or culvert replacements and in open space acquisitions of important habitat. We have integrated this program into capital planning, budgeting and finance and open space planning. This includes the development of unique funding sources for projects and actually acquiring dams and agricultural land with the intent to restore river habitat. We have built community support through unique outreach and monitoring efforts that have captured the public's attention. These include presentation series, festivals, multiple PIT tag projects, annual volunteer herring counts, machine learning to document run size and an underwater camera that livestreams to the web that has included participation of people in every US state and 58 countries around the world. The presentation would provide a history of the development of the stream and wetlands restoration program along with an overview of individual projects, community outreach and support, and the development of funding mechanisms to implement projects going forward.
11:45	Juan Escajadillo	Integration of Fluvial Hydraulics, Plan Formulation Process and Bioengineering Measures for Riverbank Stabilization along a River Bend-Case Study USACE jcescajadillo2021@gmail.com Riverbank erosion, stream migration, and flooding have been a longstanding problem in the Raritan River Basin in New Jersey. Many of these problems were solved within the scope of specific studies considering conventional engineering alternatives. Unfortunately, while many of these conventional engineering techniques solve the immediate problem, they are not always the safest or most environmentally conscious choice for the long term. Recently, much more attention has been paid to the environmental aspects of the projects and applied bioengineering mitigation measures with an emphasis on eliminating the need for hard armoring or reducing the quantity of riprap to be utilized at riverbanks and streams. It is acknowledged that pure bioengineering may not be appropriate in all streams, because it may not result in effective bank stabilization; yet, an evaluation of several bioengineering stabilization methods were evaluated to identify an acceptable alternative for streambank protection that is economically feasible, environmentally acceptable, rising biodiversity increasing stream ecological function and best counteract the physical phenomenon of bank erosion defending the streambank and protecting a project floodwall, utility lines, and private properties located along stream bend segment B-2, Green Brook, NJ.
12:00	Renée Gravel	Small streams in agricultural landscape: an undervalued source of restauration sites? Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs renee.gravel@mffp.gouv.qc.ca What if small streams in agricultural landscape were a good target for restoration? Headwater streams account for 60-85% of the river network. In Quebec, little is known about the life that thrives there and about the contribution of those streams to the well-being of aquatic ecosystems. In the Montérégie region, headwater streams have been extensively modified to facilitate agricultural drainage. They have been recalibrated into simplified linear, wide and deep channels. They are traditionally maintained by recurrent cleaning, representing ~100 interventions per year for ~250 km of dredging. Monitoring was carried out to examine the effect of different types of interventions on fish communities and habitat,and identify lessons for enhancing future restoration projects. Fishing was carried out in three watersheds, where a rehabilitated stream, a control stream and a collector stream were monitored before and after work. Three types of restoration were tested: the two-stage channel, shrub bank planting and deflectors with shrub plantation. Nineteen species were caught in the headwater streams, contradicting the perception that they harbor only a handful of highly resilient species. The fish community responded adequately to the change in physical habitat quality following the intervention. The predominant physical parameters are the presence of water, shelter and heterogeneity of water velocity, water thickness and substrate. In the absence of improvement in physical parameters, the community returned to its prevalent state within two years. And when physical quality was improved, the fish community improved in abundance, richness and structure. The traditional drainage approach leaves headwater streams vulnerable to degradation pressures. This is set to worsen because of climate change. Drainage costs should not be increased, and ecological functions and ecosystem services should be preserved. Given their number and frequency, each drainage intervention is an opportunity to review our approach to promote the restoration of headwater streams.
Pilot **May 9**	**Session 41: Hydropeaking ecological impacts**	**Chairs: Patricia Johnston**

11:00	Robert Naudascher	Repeated hydropeaking reveals fine scale movement responses of juvenile fish naudascher@ifu.baug.ethz.ch Luiz G. M. Silva; Markus Holzner; Robert Boes; Roman Stocker, ETH Zurich Hydropeaking causes rapid discharge fluctuations that threaten, in particular, the early life-stages of riverine fish species. These life-stages utilize habitats broadly characterized by low water depths and low flow velocities, which relocate in space and time during hydropeaking events. The rate at which habitat relocation occurs is related to hydromorphological characteristics such as gravel bed inclination and the slope of the rising and falling limb (ramping rate) of river discharge. To cope with such alterations fish must relocate along spatial gradients of flow depths and velocities. Studies aiming to quantify fine scale movement behavior of early life-stages of fish under varying discharges are scant. Traditionally, the effects of hydropeaking have been quantified by counting the number of drifted or stranded individuals neglecting the preceding movement behavior. Here we present a novel laboratory approach integrating image-based tracking techniques and a semi-artificial gravel bed, which enables to quantify fine scale movement behavior of young trout (*Salmo trutta*) in relation to local hydrodynamic conditions. By varying the average bulk flow velocity from 8 - 35 cm/s within 3 minutes and 1 minute two distinct ramping rates were tested with individual wild and hatchery reared brown trout. For three consecutive hydropeaking events fish relocated laterally to avoid high flow-velocities during up-ramping and stranding during down-ramping. Our setup allowed to quantify time scales of relocation and critical water-depth thresholds. The available flow field had a significant influence on exploratory behavior and hydrodynamic space use. This work contributes to provide a mechanistic understanding of fish movement behavior in periods of flow alteration and sheds light on hydrodynamic factors which contribute to stranding or drift of individuals.
11:15	Yann Le Coarer	Horizontal ramping rates to link hydropeaking and fish densities INRAE yann.lecoarer@inrae.fr M.H. Lizee, INRAE, Aix Marseille Univ, RECOVER, Aix-en-Provence, France; L. Beche, CIH, Hydro Engineering Center Service Environnement et Société Savoie Technolac, La Motte Servolex, France; G. Carrel, INRAE, Aix Marseille Univ, RECOVER, Aix-en-Provence, France; M. Logez, INRAE, RIVERLY, Villeurbanne Cedex, France In the Durance River, 15 years monitoring of two sites, (upstream and downstream of hydropeaking), allowed us to model cyprinid fish densities as a function of hydropeaking. The horizontal ramping rate (HRR) calculation method has been developed for assessing the response of fish communities to hydropeaking in complex geomorphological contexts. We calculated HRR for each flow interval in the hydrological record using 2D TELEMAC hydraulic simulations in extended reaches around each fish sampling site. Fish densities were recorded during the summer periods in electrofishing sampling units associated with depth and velocity measurements. We corrected the densities observed in by taking into account hydraulic representativeness of the sampled units as compared to those of the entire reach calculated from the 2D hydraulic simulations. We found that there was a strong link between HRR metrics and corrected fish densities particularly for juvenile cyprinids, and to a lesser extent for adults. The methodology used has proved to be highly effective in the study sites and offers a numerous prospects for understanding the effects of hydropeaking on aquatic populations.
11:30	Maria João Costa	Examining native fish attraction to artificial flow refuges of differing geometries and upon the presence of the invasive bleak (*Alburnus alburnus*) amidst pulsed flows IST-ID mariajcosta@tecnico.ulisboa.pt Renan Leite, CERIS, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001, Lisboa, Portugal, and Forest Research Centre (CEF) and Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Tapada da Ajuda, 1349-017 Lisbon, Portugal; José Maria Santos - Forest Research Centre (CEF) and Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Tapada da Ajuda, 1349-017 Lisbon, Portugal; Isabel Boavida - CERIS, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001, Lisboa, Portugal Recommending solutions for fish habitat enhancement in rivers affected by hydropeaking is challenging. Flume research has already identified flow cues and behavior patterns in the presence of structures, providing clues for the design of improved habitat conditions for fish. Yet, in the context of widespread biological invasions, there is limited knowledge of

		how invasive species interact with natives, particularly in hydro-peaked rivers. We examined how flow conditions created by two types of artificial flow refuges (AFR) could alleviate the impacts of pulsed flows for Iberian barbel (*Luciobarbus bocagei*). Considering the best output, we evaluated whether the invasive bleak (Alburnus alburnus) affected the use of the AFR by barbel. We installed AFRs at an indoor flume, which conferred overhead cover and low-velocity areas. First, we tested two AFRs differing in the approaching angle, i.e., 0° vs. 45°. Then, we selected the best AFR to test the effect of bleak on its use by barbel. We tested two flow events: a base- (BF, 7 $L.s^{-1}$) and a pulsed flow (PF, 60 $L.s^{-1}$), registering the frequency and time of use of the AFR by fish. To verify if flow and bleak would set off physiological adjustments in barbels, we measured glucose and lactate. The 45° AFR was the most frequently used and with the highest permanence time. The lowest lactate and glucose levels were observed in the 45° AFR for BF. Bleaks hindered the ability of barbels to use the AFR, particularly during PF. Glucose and lactate were the highest for barbels with bleaks and in PF in comparison with BF with just barbels. These results confirm the role of approaching angles in attracting fish and the impact of invasive on native species in fluctuating flow environments, highlighting the importance of managing artificial flow fluctuations and biological invasions.
11:45	Jean-Michel Matte	Response of juvenile Atlantic salmon to artificial flow downstream of an hydroelectric dam INRS jean-michel.matte@inrs.ca Louis Belzile; WSP Canada Inc.; Normand E. Bergeron, Institut national de la recherche scientifique, INRS, Québec; Francis Bérubé, Institut national de la recherche scientifique, INRS, Québec; Jean-Christophe Guay, Hydro-Québec; Patricia Johnston, Hydro-Québec Atlantic salmon populations are faced with an increasing number of anthropogenic stressors, including the construction of hydroelectric dams in riverine environments. One of the potential impacts of hydroelectric plan is that it introduces artificial flow regimes downstream. More specifically, electrical demand fluctuates over the 24h-cycle, during which power generation through turbines is adjusted and can result in important flow fluctuation in the river downstream. Constraints for management are often applied to mitigate impacts on salmon populations, but the potential effects of artificial water flow on salmon behavior and the efficacity of mitigating constraints remain difficult to quantify empirically. To this end, a large grid of 296 transponder antennas with complete coverage was installed below the Romaine-1 hydroelectric dam in juvenile rearing habitat (3200 m^2). Juvenile Atlantic salmon were tagged with passive integrated transponders, and their movement was monitored continuously in 2016-2020. Using hierarchical state-space models accounting for interindividual variability and temporal autocorrelation, preliminary results demonstrate that increasing flows correlate with fewer and shorter movements, and a lower probability to leave the antenna grid. However, important seasonal patterns emerge wherein increasing flows lead to higher chance to leave the experimental site in summer and spring, and lower probabilities in fall and winter. These results support the prediction that pulses of higher flows lead to reduced activity in the Romaine River (e.g., sheltering behavior) rather than emigration downstream. Furthermore, these results highlight the importance of applying flow management strategies on a seasonal basis.
12:00	Brent Mossop	Lessons learned from reach-scale channel modifications in a large river: balancing multiple objectives at the Site C Clean Energy Project BC Hydro brent.mossop@bchydro.com Barry Chilibeck, Northwest Hydraulic Consultants Ltd; Dave Hunter, BC Hydro; Aaron Blezy, Northwest Hydraulic Consultants Ltd.; Ben Olsen, BC Hydro; Nich Burnett, BC Hydro BC Hydro is building the Site C Clean Energy Project, a third hydroelectric dam on the Peace River in northeastern British Columbia, Canada. Site C will provide 1,100 MW of dependable capacity to meet peak demand for electricity and integrate intermittent renewable resources into the BC Hydro system. We designed and built river channel modifications along a 6 km reach to meet multiple objectives: enhance fish habitat, maintain target water elevations at fishway entrances, optimize tailrace water elevations for power generation, and provide alluvial materials for the construction of the Project. The habitat objectives were to increase wetted area across operational flows, provide hydraulic complexity, and restore inactive side channel and back channel habitats that can provide important feeding, spawning and overwinter habitats for 32 fish species. These designs also reduced the risk of fish and invertebrate stranding from dewatering (e.g., by deepening shallower lateral and point bars) and increased deep habitats (e.g., deeper than the hydrostatic compensation depth during periods of spill and elevated total dissolved gas). Channel modifications were predicted to be more effective than alternatives such as

		operational (flow) modifications to meet these habitat objectives. We enhanced on the order of 100 ha during an adaptive process of design, construction, monitoring and learning, over 12 years. Intensive physical and biological effectiveness monitoring demonstrates that the enhancements have met the overall objectives. However, despite combining decades of geomorphic and fisheries research on this river system with advanced modelling techniques, some pervasive challenges in river restoration remain, such as long-term resilience in a dynamic river environment, defining physical and biological effectiveness criteria for regulatory compliance, and scaling site- to population-level effectiveness. We review lessons learned from these large-scale enhancements that may be relevant to practitioners, managers, and regulators.
END – Thank you so much to you all!		

Poster number	Presentation Title	Presenter
1	sAImon HDR theo.malone@hdrinc.com Kelly Flint, HDR; Jaak Vandensype, HDR The need for fish passage analyses is accelerating worldwide. This pressure is due to several factors, including: relicensing of mid-century hydropower facilities, aging transportation infrastructure, and increasingly stringent regulations. As demand grows, fish passage practitioners must improve operational efficiency and capacity to keep pace with the ever-expanding volume of work. Current methods of fish passage analysis often lack efficiency, reproducibility, and scalability. Our proposed tool, sAImon, aims to transform this process by automating the analysis of fish navigation for passage assessments. It leverages readily available inputs, such as hydrodynamic modeling results and decades of data on fish behavior and swimming ability, enabling users to analyze passage in dynamic environments more thoroughly and efficiently. Existing tools, such as the ArcGIS fish habitat modeling tool (Merwade et al. 2004) and the Physical Habitat Simulation System (USGS 2007) can estimate fish habitat abundance, however, these tools don't fully address the needs of fish-passage specific applications. Applicability of tools like FishXing (USDA 2012) are limited to culvert crossings and do not integrate recent technological advancements. In contrast, our proposed tool elevates fish passage analyses by applying statistical methods to enhance the industry's capabilities and productivity. The sAImon fish passage analysis tool uses a combination of AI and agent-based modeling (ABM) methods to simulate fish passage through natural and built environments. The tool evaluates fish passage potential for use in project planning, assessment, design, and monitoring. The objective of our team’s research is to advance the application of AI and ABM in fish passage analysis. We aim to significantly improve workflow efficiency and generate innovative tools that will empower fish passage practitioners to harness the dynamic capabilities of AI. This will enable the industry to deliver existing services more economically, lowering barriers to entry, and expanding fish passage services across the globe.	Theo Malone
2	Kivi and the fish: a new sensor for parametrising near bed hydro-morphological parameters University of Brighton g.maniatis@brighton.ac.uk Gert Toming; Tallinn University of Technology, Tallinn, Estonia Jeffrey A. Tuhtan; Tallinn University of Technology, Tallinn, Estonia In this presentation, we introduce Kivi, a smart pebble sensor developed for monitoring sediment grain movement in riverine environments. Kivi combines inertial, impact, and pressure measurements, integrating features from previous research into a single, multi-sensor device. Its design includes two pressure sensors, an Inertial Measurement Unit (IMU), and a high-g accelerometer, facilitating a complete resolution of the force equations that describe sediment mobility. Here the focus is the design and development of Kivi, with an emphasis on its application in eco-hydraulic research. Building on the initial calibration results, which include static pressure measurements, impact tests, and primary IMU data, we present findings on near-bed flow velocity estimations and sediment mobilization data, underscoring Kivi's relevance in studying sediment transport and its implications for fish habitats and migration routes. We also present a conceptual model for local (grain to reach scale) hydro-morphological controls, wherein the sensor's ability to measure detailed	Georgios Maniatis

	flow conditions and sediment dynamics offers a new perspective in assessing and enhancing habitat conservation and restoration efforts.	
3	American Eel passage in New York State: the current restoration landscape and potential for future mitigation measures at hydroelectric projects in significant waterways of the Great Lakes and Mid-Atlantic United States US Fish and Wildlife john_wiley@fws.gov Arianna Ramirez U.S. Fish and Wildlife Service The American Eel was historically found in 17 of 18 watersheds in New York State, including the Great Lakes-St. Lawrence River, Hudson-Mohawk River, Delaware River, and the upper Susquehanna River, but its upstream migratory range has generally been impeded or entirely precluded by dams. The U.S. Fish and Wildlife Service's New York Field Office works to conserve, protect, and enhance fish species and their habitats, including for the American Eel. New York State rivers have the second most hydroelectric dams of any state in the United States, totaling approximately 230. Currently, 20 hydroelectric dams in New York have installed upstream eel passage measures, and 5 projects are scheduled to implement both upstream and downstream eel passage measures within the next decade. We have begun conducting annual inspections of the existing eel passage facilities in New York and are now incorporating eDNA studies into basin-level assessments. Here, we present a preliminary inventory of eel passage in New York State. Our observations highlight the importance of fishway inspections to ensure they provide safe, timely, and effective passage for American Eels. The maintenance and small modifications of eel ladders can make a notable difference in the American Eel's ability to transit eel ladders and reach upstream habitat. Based on the current Federal Energy Regulatory Commission relicensing schedule for several hydroelectric dams in New York, we expect additional improvements in habitat access and downstream protection for the American Eel in the future.	John Wiley
4	Aménagement de frayères et mise en valeur de la ouananiche dans le réservoir Romaine-4 / Implementation of landlocked salmon population in the Romaine-4 reservoir Englobe nicolas.ouellet@englobecorp.com Nicolas Ouellet, Englobe corp.; Frédéric Burton, Englobe corp.; Patricia Johnston, Hydro-Québec; Robert Dumont, Englobe corp. Hydro-Québec a construit un complexe hydroélectrique de 1 550 MW sur la rivière Romaine (Côte-Nord, Québec). Les quatre aménagements hydroélectriques de ce complexe produisent en moyenne 8,0 TWh par année. Afin de répondre à ses engagements et aux obligations, Hydro Québec met en œuvre depuis 2015 un programme de mise en valeur de la ouananiche dans le réservoir de la Romaine 4, qui inclus: -Caractérisation des tributaires du réservoir Romaine-4 et la sélection des deux tributaires présentant le meilleur potentiel salmonicole; -Évaluation de franchissabilité d'obstacle pour les futurs géniteurs (visite à plusieurs niveaux d'eau, jaugeages, avis d'expert); -Sélection de la population source et la capture de 215 smolts pour créer le pool de géniteurs en pisciculture; -Ensemencement de 235 000 alevins de ouananiches de 2018 à 2023 dans les deux tributaires sélectionnés du réservoir, suivi de la croissance des juvéniles et des densités; -Établissement d'un état de référence de la présence de ouananiche dans les tributaires du réservoir présentant un potentiel salmonicole par ADN environnemental; -Conception, aménagement et suivi des frayères aménagées dans le ruisseau Katahtauatshupunan. Quatre frayères d'une superficie totale de plus de 1 000 m² ont été aménagées durant l'hiver 2023. Précédemment, l'acquisition et l'analyse de données de terrain (topographie, bathymétrie, courantométrie); la définition des critères de conception; la modélisation hydrodynamique, la production des plans d'aménagement et l'évaluation des intrants nécessaires (volume d'enrochement et d'excavation, accès, transport) ont été réalisés. Près de 600 m³ de matériaux ont dû être transportés par un chemin d'accès hivernal de 23,5 km. Le suivi de l'intégrité en août 2023 (topographie, bathymétrie et survols de drone), suggère que malgré la complexité de construction en conditions hivernale, les frayères aménagées sont conformes aux	Nicolas Ouellet

	plans de construction. Le suivi de leur utilisation par les géniteurs de ouananiches sera fait dans les prochaines années.	
5	New multidisciplinary approach in habitat study: The optical habitat of fish INRS-ETE simon.joly-naud@inrs.ca Eva Enders ; INRS-ETE Isabelle Laurion ; INRS-ETE The optical habitat of rivers is defined by the concentration of dissolved and suspended particles, and by the color of the riverbed. These elements can significantly reduce light availability through absorption and reflection. Almost 50% of light is absorbed in the first meter of the water column, the rest depending on what the water is carrying. Increasing concentrations of colored dissolved organic matter (CDOM) in aquatic ecosystems in the Northern Hemisphere are causing freshwater browning. CDOM can effectively absorbs ultraviolet and blue rays. In Arctic and sub-Arctic regions, browning is caused by the thawing of permafrost and the greening of landscapes. The load of suspended particles, or turbidity, can effectively absorb a broad spectrum of long-wave radiation. Land use and mining activities increase episodes of high turbidity. The attenuation of light in highly turbid waters, combined with high concentrations of CDOM and the preferential color of the riverbed, can result in a significant loss of light and contrast. For visual predators such as Atlantic salmon, brook trout and Arctic char, light availability is a key factor. In their juvenile stages, these fish forage by drift feeding, swimming steadily upstream and actively intercept drifting prey. Loss of light and contrast could have a negative effect on foraging efficiency by increasing response time to a visual stimulus, affecting prey selection, and reducing striking success. Nevertheless, dark habitats can be beneficial as they can provide shelter from predation or modify the predation avoidance behavior of individuals. These issues will be addressed as part of a PhD project starting in 2024 at INRS under the direction of Dr Eva Enders and Dr Isabelle Laurion. This presentation will highlight a profound knowledge gap and propose a new multidisciplinary approach, merging behavioral ecology, bio-optics, and geography, for the study and modeling of fish habitat.	Simon Joly-Naud
6	Projet Innocuité : validation des ouvrages de dévalaisons, poissons et sensors EDF vincent.mataix@edf.fr V.Mataix EDF CIH Environnement, Toulouse / D.Courret et S.Tomanova, OFB, IMFT, Toulouse,/ Th.Lagarrigue et A.Frey, Ecogéa, Muret / L.Tissot, et Y.Bercovitz, EDF R et D, LNHE, Chatou But du projet : acquisition de connaissances pour s'assurer que le transfert des poissons dévalants est réalisé sans dommage aussi bien lorsqu'ils transitent par les exutoires de dévalaison que par les ouvrages évacuateurs de crue (seuil, clapet, vanne, etc…). Depuis 2019 des essais sont réalisés en rivière et en laboratoire avec des poissons et des capteurs Sensors fish (PNLL) et Rapid Sensors (Université de Tallin). On présentera ici les essais poissons réalisés sur 2 ouvrages de dévalaisons d'usine hydroélectrique, Gesse sur l'Aude et Pébernat sur l'Ariège. Pour valider l'ouvrage, on mesure les dommages observés sur les poissons (truites ou smolts) transitant par la dévalaison. La goulotte de dévalaison de Gesse présente les caractéristiques suivantes : 8m de chute, 11m/s à l'impact, fosse de réception de 1.7m de profondeur, débit de 200l/s. 108 truites ont transité sans dommage par la goulotte de dévalaison. La conformité de la dévalaison est donc validée par les services de l'environnement de l'état. La dévalaison de Pébernat se réalise via un clapet avec 3m de chute, une vitesse à l'impact de 8m/s un débit de 2m3/s, 2 fosses de réception, rive droite 0.72 m et rive gauche 1.24m. Les premiers essais (smolts) réalisés fin 2019 indiquent des dommages pour les poissons arrivant sur la fosse à 0.72m (7% de dommages mineurs mais 2% de dommages majeurs). La fosse de réception est donc creusée pour créer un matelas d'eau uniforme à 1.24m. Les nouveaux essais réalisés en 2023, après les travaux, permettent de valider la dévalaison : 99% des smolts sont indemnes, seuls 1% subissent des dommages mineurs. Les essais vont se poursuivre sur 2024 et 2025 in situ et en laboratoire pour valider les capteurs Rapid Sensors et mettre en adéquation les mesures physiques enregistrées par les capteurs et les dommages biologiques subies par les poissons.	Vincent Mataix

7	Experimental and numerical study of traditional Taiwan diversion dike National Yang Ming Chiao Tung University zeromic@gmail.com Ren-Kai Jhong, National Yang Ming Chiao Tung University; Bj-Jie Shiu, Water Resources Planning Brance, Water Resource Agency; Wei-Ming Wong, Water Resources Planning Brance, Water Resource Agency More than 300 years ago, during the Kangxi period of the Qing Dynasty, there was a traditional Taiwan diversion dike called Shigou, which was used to guide river flow for irrigation. The Shigou was taught by the legendary Mr. Lin and widely used in Babaozhen Irrigation Canal, Zhuoshui River. This facility was gradually replaced by geometry-like rigid structure until the past fifty years. It was an important river diversion facility in the early agricultural society of Taiwan. The Shigou is mainly composed of bamboo or wood like a circular or pyramid-shaped tent structure. When placing the Shigou, first place the flat head near the water, and the construction workers will assemble the wood underwater with the pointed end of Shigou facing the river bank. Then adjusting the Shigou flat head direction to guide the water flow. After completing several Shigou structures, then it is filled with local stones. This kind of structure composed of natural materials is relatively friendly to the ecological environment. However, the Shigou mostly provides oral teaching and lacks academic information related to hydraulics, and this construction method is close to being lost. In this study, the experiment and numerical modeling of Shigou are applied to a mobile-bed laboratory channel. Different water depth with submerge and non-submerge Shigou respectively are considered in the experiment. The image recognition and machine learning are applied to obtain the surface flow velocity distribution. A 2-D numerical model is applied to simulate the flow field of Shigou and comparing with the experimental results. It shows that the numerical results are agreed well with the experimental data. The non-submerge Shigou would increase the flow discharge about 21% near the bank of intake. The Shigou provides good water conduction effect and friendly ecological environment.	Chung-Ta Liao
8	Development of a multispecies fishway for warmwater species - A case study and template for further projects Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP) keelan.jacobs@mffp.gouv.qc.ca Multispecies fishways are increasingly considered and implemented in the province of Québec to restore habitat connectivity to important spawning habitats for warmwater species (northern pike, Esox Lucius; yellow perch, Perca flavescens; centrarchids, and cyprinids). In 2008, the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs and Ducks Unlimited designed and built a semi-natural multispecies fishway as part of a larger wetland restoration project in the Ruisseau de feu watershed, a tributary of the Rivière des Prairies in the city of Terrebonne. Research aimed to measure passage efficiency (northern pike, yellow perch, brown bullhead, Ameiurus nebulosus; smallmouth bass, Micropterus dolomieui and pumpkinseed, Lepomis gibbosus) using pit tags to test different slot forms. Results showed that a trapezoïd form with a mean water velocity of 0.4 m/s in the slot provided optimal fish passage. Further studies refined the design by reducing the drop between basins from 15 cm to 7.5 cm with a form that concentrates water flow to the center of the slot (trapezoïd or half circle). After nine years of operation, 20 species from small cyprinids to larger northern pike and common carp (Cyprinus carpio) have used the fishway to access the managed marsh. Design criteria developed and tested in the Ruisseau de Feu project are used to develop new fishways in the St. Lawrence system, increasing connectivity to spawning habitats. The lessons learned contribute to the best practices for creating functional multispecies fishways for warmwater species.	Keelan Jacobs
9	Experimental investigation of screw-based upstream and downstream passage Hycor Ecohydraulics franz.geiger@hycor.de Mathilde Cuchet; Hycor Ecohydraulics Yannic Fuchs; Technical University of Munich (TUM) Susanne Schwerbaum, Technical University of Graz	Franz Geiger

	The suitability of pish passage facilities at a newly installed residual flow hydropower plant was clarified by field investigations. The site is located at the Ostrach, an alpine, meta-rhithral river in southern Germany, with 5 m³/s average discharge. Fish downstream passage was meant to be provided by a screw turbine, which also enables energetic use of the residual flow. The passability of the screw turbine and potential fish damage were investigated by a series of targeted test with fish injection, including several fish species, fish size classes and turbine discharges. An innovative experimental setup could achieve 99 % recovery rate of inserted fish and no relevant fish injury due to catch and handling. This enabled precise quantification of the injury and mortality rates. Additional underwater video observations provided insight to behavioral aspects. Fish upstream passage was meant to be provided by a "fish ascending screw". This novel approach consists of an Archimedes screw which lifts water from the tailwater to the headwater. The transport process should also transfer fish to the headwater. The actual fish passage activity was investigated for 129 days in two migration periods. All fish which arrived in the headwater were caught and checked for species, size and potential injury. An additional underwater video monitoring was conducted at the screw entrance and the fish population in the tailwater reach was determined in both migration periods by electrofishing. The results revealed, that screw-based fish passage solutions can be an option for very particular sites but should be considered unsuitable for further sites, depending on the site conditions and the fish population. Moreover, a couple of improvements of the given setup were conducted, based on the observations during the monitoring, which should be accounted for in future installations and developments.	
10	Large-bodied fish movement within Lake Winnipeg and its surrounding obstructed and semi-obstructed tributaries Fisheries and Oceans Canada travis.durhack@dfo-mpo.gc.ca Enders, E.C., Institut national de la recherche scientifique; Watkinson, D.A., Fisheries and Oceans Canada; Pegg, M.A., University of Nebraska-Lincoln School of Natural Resources; Stuart, M., University of Nebraska-Lincoln School of Natural Resources; Caskenette, A., Fisheries and Oceans Canada; Jarvis, L., Fisheries and Oceans Canada; Kovachik, C., Fisheries and Oceans Canada; Leroux, D., Fisheries and Oceans Canada; Glowa, S.E., Fisheries and Oceans Canada; Gutowsky, L.F.G., Fisheries and Oceans Canada; Large-bodied riverine fish routinely move vast distances during foraging or migration in connected systems, however movements are too often interrupted by water control structures. The Lake Winnipeg fish movement study is an acoustic telemetry program with ~250 receivers deployed to assess the movement of large-bodied fish in the Lake Winnipeg Basin. Within the receiver network are several water control structures with and without fish passage where migration is impeded for many fishes, including Bigmouth Buffalo (Ictiobus cyprinellus), Channel Catfish (Ictalurus punctatus), Lake Sturgeon (Acipenser fulvescens), Freshwater Drum (Aplodinotus grunniens), and Walleye (Sander vitreus). For instance, only a small percentage of each tagged species appear to pass the dam and fishway at the St. Andrews Lock and Dam (~44 river kilometers upstream of Lake Winnipeg in the Red River). Given the known consequences of river fragmentation on fish populations, current and future water control structures should be modified or designed in consideration of species in this study, particularly those with a conservation status (e.g., Bigmouth Buffalo and Lake Sturgeon) or high cultural and economic value (e.g., Walleye and Channel Catfish).	Travis Durhack
11	Branch Pond Fishway Design and Construction Kleinschmidt alex.coulling@kleinschmidtgroup.com Maranda Nemeth, Atlantic Salmon Federation The Branch Pond Dam located in Palermo, Maine presented a unique challenge for fish passage. The project site is located at the downstream end of Branch Pond which feeds into the West Branch Sheepscot River. This river flows into the larger Sheepscot River that eventually discharges into the Atlantic Ocean in Wiscasset, Maine. The dam was previously integral with the foundation of an old mill building that has not been in use in many years. Once the mill building was removed, the dam was inspected and determined to require both structural and dam safety repairs to retain water and pass flood flows as part of a long-term solution to fish passage. This	Alex Coulling

	presentation will provide an overview of this multi-disciplined project and the collaboration and modifications required to provide a fish passage solution at this site. Once designed, there were still some unknowns regarding the existing conditions that would need to be identified during construction with adjustment to the design, as needed. This presentation will also offer an overview of the construction that is nearly complete at the site. The dam is currently operated by Branch Pond Lake Association and the improvements to this project were funded through various grants and managed by the Atlantic Salmon Federation.	
12	Dave's Creek Substation Flood Mitigation Repairs HDR kacy.grundhauser@hdrinc.com The Dave's Creek Electrical Substation is located on the Kenai Peninsula in Alaska and sits along Quartz Creek, a productive spawning habitat for Kenai River salmon and resident fish. Heavy precipitation in summer 2021 threatened the substation, which provides electrical distribution for several small communities. Floodwaters caused Quartz Creek to migrate, occupying its main channel as well as a remnant side channel located closer to the substation. Exacerbating the situation, a large precipitation event of nearly 17-inches within a 24-hour period occurred in winter 2021. The following spring thaw of 2022 revealed Quartz Creek primarily flowing through its remnant channel, creating an unacceptable level of risk to downstream infrastructure. In March 2022, Chugach Electric Association, the owner and operator of the substation, launched temporary, emergency action by placing 40 super sacks in the stream channel to divert flow and mitigate erosion while HDR started engineering design. Aimed to protect the substation, redirect water back into the main channel, and maintain spawning habitat, two permanent design alternatives were considered: (1) a steel sheet pile wall and (2) a riprap guide bank. Project stakeholders included seven agencies and planning committees, ranging across federal, state, and local levels. The preferred alternative of the riprap guide bank focused on native materials, aquatic friendliness, and natural aesthetics. Once design was solidified, seven permits were developed, reviewed, and approved by September 2022 to allow project construction to commence in October 2022. The fast-approaching winter encouraged construction speediness but not without necessary design revisions due to agency requests and existing site conditions. 1,500 cubic yards of Class III riprap was used to construct a trench, frontage embankment, and guide bank with a self-launching toe. The presentation will dive into all angles of the project—highlighting the balance between emergency engineering and aquatic-conscious design.	Kacy Grundhauser
13	A novel index for vulnerability assessment of archaeological sites to flood hazard: Development and a practical application in the Waban-Aki nation, Canada Environnement et Changement climatique Canada, Gouvernement du Canada khalid.oubennaceur@ec.gc.ca Jean Morin; Environnement et Changement climatique Canada, Gouvernement du Canada Karem Chokmani; Institut national de la recherche scientifique, Centre Eau Terre Environnement Mathieu Roy; Environnement et Changement climatique Canada, Gouvernement du Canada Marianne Bachand; Environnement et Changement climatique Canada, Gouvernement du Canada Olivier Champoux; Environnement et Changement climatique Canada, Gouvernement du Canada Gabriel Poirier; Environnement et Changement climatique Canada, Gouvernement du Canada Antoine Maranda; Environnement et Changement climatique Canada, Gouvernement du Canada Geneviève Treyvaud; Grand Conseil de la Nation Waban-Aki Anas El Alem ; Institut national de la recherche scientifique, Centre Eau Terre Environnement Archaeological sites across the globe are increasingly at risk from natural hazards, notably flooding. This research aims to develop and test a new indicator, known as the Indigenous Archaeological Site Vulnerability index (IASV), to assess the vulnerability of archaeological sites to flooding within the Richelieu River watershed in Quebec, Canada. The IASV integrates flood hazard variables with the observed vulnerability level of the archaeological site within the watershed. Flood hazard variables were determined by analyzing historical flood records, including the yearly	Khalid Oubennaceur

	mean water depth and the yearly duration of inundation. The vulnerability assessment of archaeological sites was conducted through on-site inspections of 37 documented sites situated within the watershed. The IASV is developed, validated, and applied to potential archaeological sites across the Richelieu River region using the stepwise regression method. The study found that the yearly mean water depth and yearly flood duration were the best-combined predictors of the site level of degradation (R2=0.8). Additionally, cross-validation was carried out using the same data sample, resulting in a good model fit (R2=NASH=0.71). IASV values ranged from 0 to 100, with higher values indicating higher site vulnerability. In conclusion this study underscores that the IASV had a good model fit and could be an efficient tool for assessing the vulnerability of archaeological sites to flooding and the impacts on their restoration and management.	
14	Assessing Phenol Pollution and Developing a Conservation Plan for the African Bony Tongue Fish (Heterotis niloticus) in the Epe River, Lagos Nigeria Department of Zoology,University of Lagos excellencedolu2010@gmail.com Prof Bamidele Akinsanya,Department of Zoology, University of Lagos,Nigeria The African bony tongue fish (Heterotis niloticus) is currently facing a severe threat to its survival in the Epe River due to the accumulation of phenol in its natural habitats. This study aimed to develop a comprehensive conservation plan to safeguard the species and its habitats from extinction. Extensive field surveys were conducted in the Epe River between February and August 2022. The primary objectives were to assess the concentration of phenol in the water as well as its impact on the liver and intestine of Heterotis niloticus.Liver and intestinal samples were collected from 38 freshly caught fish and subjected to phenol analysis using a Gas chromatography-mass Spectrometry (GC-MS) model. The study revealed the presence of three phenol congeners, namely 4-chloro-3-methyl-phenol and 2,4,6-trichlorophenol, in both the water samples and fish tissues, while 2-Nitrophenol was absent. The levels of these congeners were found to be significantly higher ($P<0.05$) in the fish and water samples.Thus indicating potential risks to health and the overall ecosystem. Although the surface water parameters in the study area, such as temperature, conductivity, turbidity, dissolved oxygen, total dissolved solids, and salinity, did not vary significantly from the standard limits, the bioaccumulation of phenol remains a major concern. Therefore, this research highlights the urgent need for stricter regulations and legislation to control pollution and the release of toxic waste into water bodies. By enforcing more stringent laws and regulations, industrial activities can be compelled to comply with environmental standards, ultimately aiding in the preservation of migratory fish species and their delicate ecosystems.	Excellence Akeredolu
15	Assessment of land use and land cover change and their impact on the water quality of streams in Limbe Minicipality, Cameroon University of Buea b.asmare@yahoo.com Fonge Beatrice Ambo; Anyinkeng Nicoline Inland aquatic ecosystems, including streams and rivers, cover only 0.0001 percent of the earth's surface area. They provide ecosystem services such as drinking water, transportation, hydropower generation, recreation, tourism, and spiritual activities. Land use land cover change (LUCC) from natural vegetation to agriculture land, grazing, urbanization, and industry is increasing globally, altering the water quality and the ecological integrity of the surface water system. This study aims to assess land use and land cover change and their impact on stream water quality in Limbe 1 municipality. The study was conducted during the rainy season, and sampling points were selected based on human activities. Water samples were taken in duplicate from each selected site using 500-ml plastic containers. Hanna multi-prober meter model number HI9829 was used for in-situ measurements. Bacterial counts were carried out at the Life Sciences Laboratory of the University of Buea. A one-way ANOVA with the Tukey pairwise test was used.The result of land use and land cover change from 1990 to 2021 showed that vegetation cover, agricultural land, and hydrology declined by 8.07, 4.76, and 10.6 hectares, respectively, while settlement expanded by 23.54 hectares. From the field, temperature ranged from 22.95 to 25.84 mg/l; pH, 8–9.41; DO, 1–5.85 mg/l; turbidity, 12.4–449.5 NTU; phosphorus, 1-3.45 mg/l. Heavy metal levels were above WHO (2017) acceptable limits for drinking water. Iron ranges from 0.39 to 0.49 mg/l; cadmium from 0.025 to 0.03 mg/l; and lead from 0.07 to 0.15 mg/l. The bacteria load exceeded the standard set by the WHO (2017) for drinking water. Total bacteria count ranges from 8500–41,000 CFU/mL; total coliforms, 720–6400 CFU/mL; E. coli, 65–300 CFU/mL; and salmonella, 1–46 CFU/mL. LUCC has affected the physicochemical and bacteriological quality of the stream water. Hence,	Betelhem Asmare Melese

	it needs management and sustainable utilization of the freshwater resources before it causes irreversible damage to aquatic ecosystems and biodiversity.	
16	Modelling interactions between hydropower management and climate change impacts on stream temperature in peri-Alpine streams Haute Ecole d'Ingénierie et d'Architecture de Fribourg (HEIA-FR) david.dorthe@hefr.ch Michael Pfister, Haute Ecole d'Ingénierie et d'Architecture de Fribourg (HEIA-FR); Stuart N. Lane, Faculté des géosciences et de l'environnement, Université de Lausanne (UNIL) In regulated river systems, the fluctuating discharges downstream of hydropower plants (hydropeaking) can induce thermal waves leading to a significant alteration of the natural thermal regime of the river (thermopeaking). Sustainable hydropower management requires consideration of these thermal alterations due to their substantial impact on the health of aquatic ecosystems. On a longer timescale, thermal regime alteration can also be caused by climate change through modification of stream temperature drivers such as air temperature, vegetation, and hydrological patterns. Assessing hydropower alteration on stream temperature should thus also consider how climate change can influence existing impacts and the effectiveness of current mitigation measures. Deterministic coupled hydrodynamic-thermal modelling is widely acknowledged for evaluation of stream temperature under different scenarios. However, there is a lack of references characterizing thermopeaking alteration evolution under climate change. To address this challenge, a process-based stream temperature model, previously calibrated for a regulated peri-Alpine River with a high-quality dataset is used. Based on existing literature, the main climate change processes affecting stream temperature are identified and integrated in the model. The outcome (1) highlights the challenges linked to downscaling of global longterm climate change processes for consideration in a model with a fine temporal and spatial resolution and (2) provides insights on how climate change is expected to influence thermopeaking regime in the future and its crucial influence when planning sustainable hydropower management.	David Dorthe
17	Conservation and Management Challenges and Opportunities for Diadromous Fish in Licensing of Hydropower Projects NOAA Fisheries melanie.harris@noaa.gov Nicholas Anderson, NOAA Fisheries; Alex McOwen, NOAA Fisheries; Bjorn Lake, NOAA Fisheries The U.S. National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) uses our authorities to protect, restore, and enhance diadromous fish and their habitats to support resilient ecosystems and diverse and abundant populations. This includes ensuring the sustainability of commercial, recreational, and tribal fisheries, and aiding in the recovery of threatened and endangered species. We seek to accomplish these goals by providing effective passage and increased access to rearing and spawning habitat using an ecosystem based approach, and working with tribes, federal, state and local governments, and stakeholders. Specific to hydropower, we engage in the licensing process for non-federal FERC regulated dams in order to require fish passage and recommend habitat improvements. With a term of 30 - 50 years, licensings are once-in-a-lifetime opportunities to restore access to previously blocked habitat, and improve in-stream flows and water quality. Hydropower licensing can include federal, state, and local resource managers, tribes, licensees, landowners, environmental organizations, fishing groups, and agricultural organizations, with different objectives and interests. Addressing varied objectives and interests in license conditions is one of the main challenges and opportunities of the process. Using a collaborative approach leads to more robust licenses with mutually agreeable conditions. Another challenge we face is limited or incomplete data for fish movements and migrations, habitat conditions, and engineering aspects of fish passage facilities, as well as uncertainty regarding climate change impacts. These data are essential in science-based conservation and management. To combat data gaps, we request studies to be conducted during the licensing process. Adaptive management measures are another approach which allow licensees to begin implementation of conservation measures and make modifications based on	Nick Anderson

	recommendations from NOAA Fisheries and others as information allows. Utilizing these approaches, NOAA Fisheries has enhanced in-stream habitat and improved access to thousands of river miles for diadromous fish.	
18	Eco-environmental Flow Assessment of the Weihe River and its tributaries: From eco-hydrological analysis to negotiations of stakeholders China Institute of Water Resources and Hydropower Research andychao2004@126.com Cunwen Niu, China Institute of Water Resources and Hydropower Research Yangwen Jia, China Institute of Water Resources and Hydropower Research Environmental flow plays a fundamental role in river ecosystem restoration. However, the implementation of environmental flow in water-stressed areas has so far only been achieved in a handful of rivers, mostly due to the failure to coordinate diverse stakeholders from the perspective of whole river basin in previous studies and lack of scientific support based on the water cycle mechanism and economic mechanism. The paper carries out quantitative rights and responsibilities analysis and game study on stakeholders of river environmental flow (SREF) based on the mechanism of river basin water cycle to support the negotiations of stakeholders for environmental flow targets. Firstly, besides the water users already considered in previous studies, we further take into account land use changes that affect water cycle of river basin to bring forward a new framework of SREF's participation. Then, the distributed hydrological model WEP-L is established to demonstrate quantitative responsibility of SREF's impacts on the river basin water cycle. Last, the incentive and constraint mechanism are constructed considering SREF's right and responsibility, and the preconditions and applicable schemes for realization of cooperative game of SREF are studied on basis of multi scenario analysis by game theory. The paper introduces a case study for the Weihe River, the largest tributary of the Yellow River in China, and its tributaries. This study is innovative for distinct interdisciplinary characteristics of ecology, hydrology, economics, and management. It provides technical support to strengthen the coordination of SREF with consideration of the whole river basin, which is of great significance to promote the implementation of river environmental flow.	Chunfeng Hao
19	Artificial eco-environmental water supplement in recent 20 years in China China Institute of Water Resources and Hydropower Research 13691098203@163.com Chunfeng Hao, China Institute of Water Resources and Hydropower Research; Ling Jia, China Institute of Water Resources and Hydropower Research Artificial eco-environmental water supplement plays an increasingly important role for afforestation of urban area and river ecosystem restoration along with great concern on sustainable development of coupled nature and human system in recent years. In China, artificial eco-environmental water supplement, including urban greenbelt water use and replenishment of rivers and lakes, is as high as 34.28 billion m3 in 2022 by national statistics, nearly 6% of the total water use, which is quadruple for both of the percentage and water quantity comparing with that in 2003. The artificial eco-environmental water supplement in the Yangtze River basin and Haihe Rive basin accounts for 24% and 22% of the national total quantity, respectively. The urban greenbelt water use has doubled to over 10 billion m3 with about 150% increase of urban greenbelt area at the same time period, and the living environment has been improved markedly accordingly. The replenishment of rivers and lakes have risen significantly in the last 20 years throughout the country to over 30 billion m3, to ensure the basic environmental flow of important rivers and lakes and promote the recharge to groundwater in the path of waterway. Besides, the water supply sources for artificial eco-environmental water supplement more and more depend on non-conventional sources, including reclaimed water of urban sewage works and mining water drainage, to reduce the fresh water use. Some regions, Beijing for example, have officially brought forward the Water Conservation Rules to encourage non-conventional water use for artificial eco-environmental water supplement. The ecological effects and benefits of artificial eco-environmental water supplement are fabulous and will increase continuously across China in the future.	Yaqin Qiu
20	HyPeak: an international network on hydropeaking research, practice and policy Karlsruhe University of Applied Science, Institute for Applied Research mnoack80@gmail.com Maria Alp,INRAE, RiverLy, Villeurbanne, France; Ramon J. Batalla, Fluvial Dynamics Research Group, University of Lleida, Lleida, Catalonia, Spain; Nico Bätz, Eawag Swiss Federal Institute of Aquatic Science and Technology, Switzerland; Maria Dolores Bejarano, Universidad Politécnica de Madrid, Madrid,	Markus Noack

	Spain; Isabel Boavida, CERIS, Civil Engineering Research and Innovation for Sustainability, Lisbon, Portugal; Maria Cristina Bruno, Research and Innovation Centre, Fondazione Edmund Mach, San Michele all'Adige, Italy; Hervé Capra, INRAE, RiverLy, Villeurbanne, France; Mauro Carolli, SINTEF Energy Research, Trondheim, Norway;Roser Casas-Mulet, Technical University of Munich, Germany; Gabriele Chiogna, Technical University of Munich, Germany; Maria João Costa, CERIS, Civil Engineering Research and Innovation for Sustainability, Lisbon, Portugal; Marie-Pierre Gosselin, Norwegian Institute for Nature Research, Trondheim, Norway; Jo Halvard Halleraker, Norwegian Environment Agency, Norway; Christoph Hauer, University of Natural Resources and Life Sciences, Vienna, Austria; Daniel S. Hayes, University of Natural Resources and Life Sciences, Vienna, Austria; Atle Harby, SINTEF Energy Research, Trondheim, Norway; Matthias Schneider, SJE Ecohydraulic Engineering GmbH, Germany; Diego Tonolla, Zurich University of Applied Sciences, Wädenswil, Switzerland; Davide Vanzo, ETH Zürich, Zürich, Switzerland; Terese Venus, University of Passau, Passau, Germany; Damià Vericat, Fluvial Dynamics Research Group, University of Lleida, Lleida, Catalonia, Spain; Guido Zolezzi, University of Trento, Trento, Italy Hydropeaking is the term used to define rapid and frequent artificial flow fluctuations in rivers caused by flexible hydropower production. The Network on Hydropeaking (HyPeak) was founded during the 13th International Symposium on Ecohydraulics in 2020 to propose a framework for crossing interdisciplinary perspectives on hydropeaking. Today, HyPeak has evolved into an established international non-profit, volunteer-based network aiming to translate the findings of hydropeaking research into practical applications and policy recommendations. However, bridges across disciplines remain to be developed, particularly regarding the social and economic sciences, whose links with the biophysical research are still weak. Additionally, HyPeak emphasizes the importance of a transnational perspective for researchers, policy makers, and practitioners, as effective river management and collaboration in electricity markets require cross-border cooperation and knowledge exchange. HyPeak focuses on several key research topics: i) assessing environmental effects and related socio-economic issues at various spatio-temporal scales; ii) improving mitigation measures and management strategies; iii) advocating for environmentally sustainable approaches to hydropeaking; and iv) offering recommendations for national and international policies, and the support for their integration. To address these goals, six high-priority tasks have been identified: i) providing an overview of the localization and typology of hydropeaking at a continental scale; ii) standardizing tools characterizing hydropeaking regime, iii) identifying the most informative indicators for assessing hydropeaking impacts, iv) promoting the development of technical approaches to limit the negative impacts of hydropower plant operation on river ecosystems, v) elaborating inter- and transdisciplinary approaches to find a compromise between ancillary, balancing and flexibility services to the grid and ecological sustainability, vi) enhancing the efficiency of knowledge and tool transfer between researchers and practitioners. The HyPeak Network welcomes new members at various levels of commitment. For any questions do not hesitate to contact us (hypeaknetwork@gmail.com) or register directly to stay informed about our activities (https://forms.gle/CsahiE6dWB5SuLaAA).	
21	Flood flows as a natural tool of river restoration: fish habitat and hyporheic flow Universitat Politecnica de Valencia fmcapel@dihma.upv.es Aramburú-Paucar, Jhoselyn M.; Puig-Mengual, Carlos Antonio; Muñoz-Mas, Rafael; Bertagnoli, Andrea; Tonina, Daniele Flow regulation in gravel-bed rivers impacts the hydrology, sediments and morphology, riparian vegetation, and vertical connectivity with the hyporheic zone. In this context, it has been suggested that flood events could be used as a restoration mechanism. In a Mediterranean-climate river system, we analyzed the impact of a nearly 25-year return period flood of the Serpis River (Spain) on river morphology, riparian vegetation, aquatic habitat quality for fish species, and hyporheic exchange. We collected pre- and post- flood riparian vegetation distributions and bathymetries, which were used to develop two-dimensional surface and three-dimensional subsurface numerical models to map surface and hyporheic hydraulics. Results show	Francisco Martinez-Capel

	that the large flood removed the invasive giant reed from large areas, reshaped the in-channel morphology, by forming new bars and pools and enhancing the complexity of the flow field by scouring around large boulders. The habitat availability for the endemic Eastern Iberian chub and invasive bleak increased. Hyporheic exchange did not show noticeable change under losing conditions, but there can be under neutral ambient groundwater condition. This study corroborates the beneficial effect that flood events or high flow releases may have on regulated streams and the potential use of high flow pulse as a restoration tool.	
22	Lake Saint-Pierre ecosystem rehabilitation : examples of habitat restoration and management adaptation in an agricultural context Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs du Québec marianne.theberge@mffp.gouv.qc.ca Philippe Brodeur, Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs du Québec In Lake Saint-Pierre (LSP), the largest fluvial lake in the St. Lawrence River, habitat use by wildlife is influenced by spring floods. More than 5000 ha of natural and agricultural lands are flooded annually. The intensification of agricultural practices, leading to the shift from perennial to annual crops, reduced the quality of breeding and growth habitats for aquatic wildlife and impacted biodiversity. Following the establishment of a moratorium on the yellow perch fishery in 2012, the Québec government implemented an action plan to restore the ecosystem and contribute to sustainable fishing. Through the LSP conservation program in force since 2018, several restoration projects have been carried out in the LSP floodplain by conservation groups to 1) increase habitat connectivity (119.2 ha), 2) restore wetland habitats (302 ha) or upgrade existing managed marshes (207.5 ha). The restoration approach, inspired by pristine wetland distribution and the historical floodplain landscape, as well as the restoration success are presented for two large-scale projects. The Saint-Barthélemy/Maskinongé project combined waterfowl and fish habitat use and the Castor/Mitan islands project included tree swamp and meadow rehabilitation. Both projects involved management challenges involving a significant reduction of financial incomes historically based on land rental for annual crops. Owners must adapt their funding and management to the new land use reality.	Marianne Théberge
23	Have changes in habitat, hydrology and temperature contributed to the decline of northern pike in the Quebec portion of the St. Lawrence River? MELCCFP marc.mingelbier@mffp.gouv.qc.ca Simon Bernatchez MELCCFP; Martin Laporte MELCCFP; Yves Paradis MELCCFP; Philippe Brodeur MELCCFP; Marianne Bachand ECCC Northern pike is an apex predator, commonly used as an indicator of aquatic ecosystems health. The fish community monitoring network deployed in the St. Lawrence River (SLR) since 1995 by the Quebec Ministry responsible for wildlife reveals a worrying decline in northern pike abundance in several sections of the river. The freshwater sector of the SLR comprises three large, slow-flowing fluvial lakes alternating with narrow, faster-flowing stretches and a few archipelagos. These various sections of the SLR are subject to contrasting hydrological regimes. Upstream, Lake Saint-François is fed mainly by the waters of the Great Lakes, and its water level is highly regulated by dams at both ends (annual range ~0.2 m). Next comes Lake Saint-Louis (annual range ~1.5 m), whose water level is influenced by the water discharge of the Great Lakes and that of the Ottawa River, the SLR's largest tributary. Finally, Lake Saint-Pierre, which is fed by additional tributaries, exhibits the highest water level variations (>3 m). We used this natural mosaic of highly contrasting habitats to investigate the potential effect of various hydrological and climatic variables on the decline of northern pike in the Quebec portion of the SLR. For each section of the river, time series of northern pike abundance were paralleled with locally modeled variables such as spawning habitat availability, spawning timing and duration of growing season. The results obtained in this highly contrasted system are discussed, and hypotheses for the northern pike decline are proposed.	Marc Mingelbier
24	Succession of fish diversity in a large-scale floodplain restoration at the Danube River over a 10-year period Aquatic Systems Biology, Technical University of Munich, Germany elisabeth.winter@tum.de	Elisabeth Winter

	Dr. J. Pander, Aquatic Systems Biology, Technical University of Munich, Germany; Prof. Dr. J. Geist, Aquatic Systems Biology, Technical University of Munich, Germany The channelization of the European Danube River has resulted in strong habitat alterations and disconnection of the main stem from the former floodplains. The large-scale restoration project MONDAU targeted the reconnection and revitalisation of one of the major Danube floodplain areas in Bavaria, Germany. Measures included the construction of a new river channel and the reconnection of backwaters to the Danube. In this project, the succession of fish diversity was assessed over a 10-year period in the different newly created habitat types “river course”, “small floodplain ponds” and “large backwaters”. Riverine habitats differed significantly in fish community composition from floodplain ponds and backwaters, with an overall high species diversity and occurrence of endangered riverine specialists. The communities in the floodplain ponds were less diverse, being dominated by lotic specialists tolerating low-oxygen conditions, some of them with high conservation priority. In contrast, backwaters were mostly dominated by generalists. Most recently, invasive Neogobius melanostomus also colonized the area, but with different success rates depending on habitat type. The overall high fish species richness within the area is primarily driven by the co-occurrence of different habitat types with variable levels of connectivity. The findings indicate the high value of such restoration measures targeting the creation of habitat mosaics with different levels of connectivity. They also illustrate the value of long-term monitoring of fish succession to fully cover population developments of rare species with complex life cycles.	
24	Effect of different distributions of flexible vegetation on lateral dispersion at the apex section of a meandering bend Università di Palermo donatella1.termini@gmail.com Nina Benistati; University of Palermo (Italy); Ashkan Pilbala; Luigi Fraccarollo; Sebastiano Piccolroaz; University of Trento (Italy); Vanessa Modesto; Dario Manca; Nicoletta Riccardi; The National Research Council (CNR) - IRSA-Verbania (Italy); Tommaso Moramarco; The National Research Council (CNR) - IRPI, Perugia (Italy); Climate change alters the hydrological regime and, consequently, the magnitude of flows and hydrodynamics in rivers. The variations of the hydrodynamic conditions affect the functions of biological communities which are controlled by the interplay between biological, physical-chemical and hydraulic processes. Literature (among others Butler et al., 2012) indicates that some species, called as “ecosystem engineers”, have a significant impact in the aquatic environment and, thus, are important in studying the effects of climate changes in rivers. The present study concerns freshwater mussels (FMs), which meet the criteria to be considered as typical “ecosystem engineers”. Despite the general understanding of the ecological contribution of FMs, little is known about the physical interactions between mussels and the flow and how such interactions impact on mussels’ response. Recently, laboratory tests performed by the research group of the present work on different FMs populations (Modesto et al., 2023; Termini et al., 2023) suggested that FMs could be used as early warning system (BEWS) of flow discharge variations. In the present work the analysis is extended also by using data collected in a selected reach of Paglia river (Italy). The mussels’ valves opening/closing have been recorded by using Hall sensor technology and Arduino platform and the FMs’ behavioural response have been examined in terms of valves’ opening/closure frequency and amplitude. The obtained results have confirmed that FMs’ behavioural response can be used as BEWS for identifying the impacts of climate changes in rivers. References Butler DR, Sawyer CF, 2012. Introduction to the special issue: zoogeomorphology and ecosystem engineering. Geomorphology 157–158. Modesto, V. et al. 2023. Mussel behaviour as a tool to measure the impact of hydrodynamic stressors, Hydrobiologia, 850, 807–820. Termini, D. et al. 2023. Identification of hydrodynamic changes in rivers by means of freshwater mussels’ behavioural response: an experimental investigation, Ecohydrology, e2544.	Donatella Termini

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