A1

Using optimization models to support barrier removal decisions for native migratory fishes in Great Lakes tributaries

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Abstract Body:
Tributaries to the Great Lakes are highly fragmented by dams and road crossings that restrict access to spawning grounds for numerous native fishes. The removal or modification of barriers can restore migratory pathways, but potential projects differ markedly in habitat gains, economic costs, and ecological risks. Our team has recently developed databases of the location, passability, and estimated removal costs of dams and road crossings throughout the Great Lakes basin. We are now using these data as input to a mathematical optimization model that identifies portfolios of barrier removals which offer the greatest increase in upstream spawning habitat access for a given budget. After calculating the cumulative passability of series of barriers, we find that the amount of accessible breeding habitat in the basin could be doubled for an investment of under $100M—well within the range of recent spending on restoration efforts. We will discuss initial results of this model, including the role of dams versus road crossings in optimal restoration portfolios, the spatial scale at which barriers are prioritized, and the temporal scale at which funding is disbursed. To overcome key limitations of the current model, we are now expanding the costs and benefits accounted for in the optimization. We conclude that optimization models are a valuable decision support tool when the number of potential fish passage projects is large relative to the available funding. By advancing both data accessibility and strategic prioritization, it should be possible to dramatically increase the cost-effectiveness of fish passage restoration in the Great Lakes basin.

Presenting Author Bio:
McIntyre is an Assistant Professor of Zoology specializing in conservation of freshwater fishes around the world. Much of the work by his team focuses on migratory fishes, and especially the potential to improve conservation outcomes by strategic analysis of where to remove existing barriers or build new ones.

Accounting for invasive species when prioritizing barrier removals in Great Lakes tributaries

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Abstract Body:
Access to historical spawning grounds for migratory fishes in the Great Lakes has been reduced by tributary fragmentation from dams and road crossings. Barrier removal or modification can improve habitat connectivity for native fishes, but can also increase available habitat for invasive species such as round gobies (Neogobius melanostomus), sea lamprey (Petromyzon marinus), and Asian carp. As a result, decisions about barrier removals or upgrades must account for trade-offs between benefits for native species and costs associated with enabling the spread of invasive species. To illustrate the complexity of this issue, we provide a case study focusing on round gobies. Round gobies rapidly invaded all five Great Lakes after their discovery in 1990, and their range continues to expand around the perimeter of the lakes and in many tributaries. We discuss the development of a species distribution model that accounts for habitat suitability and incorporates important factors that limit round goby distribution. Round gobies are intolerant of stream water calcium concentrations < 8 mg L-1. As a result, we can assume that round goby invasion will be restricted in tributaries known to have low calcium concentrations (e.g., much of Lake Superior basin). Round gobies are also limited by dams and some road crossings. We can infer a passability threshold for road culverts from current round goby presence records across the basin and use this threshold to determine current round goby invasion risk and which barrier removals may increase the chances of expanding round goby distribution. Our species distribution model will enable analysis of invasion potential under various patterns of barrier removals designed to maximize upstream spawning habitat for migratory fishes. Integrating predictions of invasion potential into our barrier remediation optimization models will enable the exploration of trade-offs between benefits for native migratory species and costs of managing invasive species.

Presenting Author Bio:
Margaret Guyette is a Post-doctoral Research Associate at the University of Wisconsin-Madison Center for Limnology. She is a freshwater ecologist with experience with research involving migratory fishes and landscape ecology.

Accounting for the benefits: mapping the key tributaries for migratory fish

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Abstract Body:
Fish migration into tributaries is critical for Great Lakes fish population/community structure, fisheries production, important nutrient exchanges, and other services. These migratory populations have been highly impacted by an extensive system of barriers in the region, as well as other impacts on spawning habitat. Unfortunately, progress toward connectivity for Great Lakes migratory fish has been slow, since there are also pressures to keep barriers and the region lacks a systematic method for comparing the costs and benefits of barrier removal among these issues. A basin-scale mathematical optimization model has been developed to prioritize barriers for repair or removal based on benefit-cost comparisons. Spatial data on migratory fish priorities is a critical data need for evaluating benefits of barrier removal within the model. Unfortunately, most migratory fish species in the Great Lakes lack conservation assessments and are largely understudied. Building on a pilot project conducted in Lake Huron, we are using a wide variety of riverine and coastal data to map and prioritize tributaries important to Great Lakes migratory fish. A large suite of species, that greatly exceeds the small set of migratory fishes that are usually considered in conservation assessments, are included in these analyses. Preliminary results from the pilot project will be presented and discussed, including some of the challenges in dealing with a guild that is mostly highly understudied. Approaches for using this data to conserve this diverse group of fishes, while also meeting population goals for a smaller subset of more data-rich migratory species, will be discussed. We will also describe our progress toward expanding this effort across the Great Lakes region.

Presenting Author Bio:
As an Aquatic Ecologist for The Nature Conservancy, Matt Herbert works with a variety of resource managers and researchers to improve our ability to effectively conserve aquatic systems. His projects generally work toward strategically increasing stream connectivity—particularly to the Great Lakes, restoration of native Great Lakes fishes, and conservation of streams in agricultural watersheds. These projects generally emphasize identification of which conservation practices and what locations will provide the most effective conservation benefits, and development of tools to promote delivery of that information. Matt joined The Nature Conservancy in Michigan in January 2007. He has a bachelor’s degree from Iowa State University and a master’s from Texas A&M University. Before joining the Conservancy’s Michigan Chapter, Matt spent more than three years with the Michigan Department of Natural Resources. Prior to moving to Michigan, he worked in Illinois as an aquatic ecologist with the Conservancy’s Illinois Chapter for four

years and with the Illinois Natural History Survey for four years.

Implementing Strategic Connectivity Restoration Projects

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Abstract Body:
The northern pike is Wisconsin's second largest predator fish and is an important part of the Green Bay ecosystem. Like many Great Lakes fish, northern pike migrate into tributary streams and wetlands to spawn. The northern pike population has been decreasing in the Bay of Green Bay due to loss of wetland spawning, through both habitat degradation and reduced access. A field survey of road crossings on all Green Bay tributaries was completed in 2013. Fish passage for northern pike was identified as a problem at 28% of structures (917 structures) with 175 of these located in Oconto County.

Since 2010, Oconto County has worked on roads with towns, villages, and private landowners to restore fish passage at 23 obstructions. Northern pike and other aquatic organisms now have access to 20 additional stream miles. Most barriers were caused by improper sizing and installation of culverts.

Oconto County will share how their fish passage program has grown and how it is leading to promotion and dissemination of best management practices.

Presenting Author Bio:
Ken has been with the Oconto County Land Conservation Division for 24 years and is responsible to oversee a multitude of county, state and federal programs for implementation of conservation programs ranging from the county's large agriculture community to the county's numerous lakes and streams.

The view from the field – what are the greatest policy needs and opportunities to get more of this work done

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Conservation Resources Alliance

Abstract Body:
The Conservation Resources Alliance in partnership with The Nature Conservancy and Huron Pines intends to restore connectivity of 600 miles of streams in the upper Great Lakes and improve habitat in over 5000 miles of streams. Through Great Lakes Fish and Wildlife Restoration Act funding, CRA with its partners were able to address high priority river barriers with the best science, while leveraging resources from numerous sources, creating greater efficiencies and broader impact. This 34-project initiative led to reconnection of 245 miles of stream and significant reductions in sediment loading in three years. This type of regional initiative is very instructive to developing a shared vision for what a regional connectivity collaborative should and could provide. We will address how we were able to create this joint initiative, called River Care, what allowed for development of shared priorities, and lessons learned. We will also present our strategy and needs for the next phase of work, which includes finishing restoration in small and medium sized watersheds, developing new tools for assessment, prioritization and quantifying benefits, expanding regional efforts to take advantage of efficiencies from carrying out multiple projects on a large scale, and tracking progress towards restoration benchmarks. Finally, we will discuss the importance of addressing lowest barriers to

accomplish the full reconnection of Great Lakes tributaries.

Presenting Author Bio:
Amy earned her Masters and Bachelors in chemical and environmental engineering at Michigan Technological University. She gained experience in business management and development as an engineering consultant. She has been the Director of Conservation Resources Alliance since 1992. Amy passions include fishing, skiing, biking and tennis, travel, and adventure.

B1

Three dimensional numerical model of Stairs Pipe culverts

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Abstract Body:
Fish passages are typically hydraulic structures designed to allow fish migration, which could be blocked by dams, roads or weirs. Throughout history, the passage of migratory species has been the main focus of mitigation actions related to environmental impacts due to large barriers. Recently, smallest barriers have been found to be the cause of reduction on fish community. A culvert fishway can improve the fish passage in small streams and has been widely studied. Specially in Belgium, the model known as stairs pipe culverts have been built in the field since 2008. This kind of culvert is an adaptation of the traditional drainage culvert that combines the baffles and the pools, which are based on Denil and the pool fish ladders. There are different baffles: the first (with an angle of 30° horizontal) working as a weir, raising the water level upstream and creating a small pool; the second (with an angle of 60° vertical) concentrating the flow, braking the water velocity and creating a counter current. The aim of this study was to obtain the velocity field and pool depth for different flowrates and slopes with numerical models. The 3D volume of fluid (VOF) model was applied. An unstructured mesh was used to incorporate the baffles layout. Scenarios for 5, 7.5 and 10% slope were simulated. The 5% slope scenario produced the maximum velocity around 1.6 m/s for all 5, 9, 13 L/s discharges and a minimum pool depth of 11 cm. In the high discharges the downstream pool was biggest and it drown part of the main jet, where is the highest velocities. The steeper the culvert is, the higher the velocities are. The results indicated that a different baffle angle disposition might improve the culvert for higher slopes.

Presenting Author Bio:
Hersília is professor at Civil Engineering Department of Centro Federal de Educação Tecnológica de Minas Gerais (Brazil) since 2007. Her scientific expertise are on ecohydraulic issues, acting on fish passages models (numerical and scale models); fish swimming capability (voluntary and non-voluntary tests); river models (2D and 3D numerical models) and fish habitat suitability.

Effective mitigation techniques for culverts

First Author Name:
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Abstract Body:
An overview of various techniques for improving fish passage through culverts and tide-gates.
A look at examples of methods used in New Zealand to retro-fit existing culverts with ramps and baffles etc. An introduction to newly developed rubber baffles Discuss the

benefits of retaining substrate in culverts to provide habitat.

Presenting Author Bio:
Kelly Hughes is an Environmental Engineer and Managing Director or ATS Environmental. He works with government agencies throughout New Zealand developing and implementing methods for reconnecting waterways and improving fish passage.

A predictive method for quantifying road culvert passability

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Abstract Body:
Rivers maintain diverse biota that are highly vulnerable to human disturbance. Globally, dams and roads fragment riverscapes, altering flows and fish movements. In the Laurentian Great Lakes Basin, efforts are being made to establish remediation priorities by identifying outdated dams or poorly constructed road crossings that prohibit or impede fish movement. To identify road culverts that could impede fish movement we developed a model to explain passability, as defined by culvert outlet drop and outlet water velocity, for three fish swimming groups, using remotely collected environmental variables. We found that regardless of fish swimming ability, the passability of road culverts is related to natural gradients in topography and stream size. While the probability of any particular culvert being impassable is relatively low, the sheer number of culverts in the basin means that, together, they could impede fish movement equally or greater than dams. Our models can be used to target regions and specific structures for on-ground assessments, and can play a part in broad-scale prioritization of remediation projects.

Presenting Author Bio:
Stephanie is a postdoctoral researcher at the Center for Limnology, University of Wisconsin-Madison. Her research has focused on conservation decision making, connecting ecological, social and economic data with decision science to determine optimal resource allocation to conserve and manage species, habitats and services.

Newton Creek Gets a Step Up

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Abstract Body:
Newton Creek crosses under the Roseburg Regional Airport in Oregon through a 550-foot long box culvert that drains to the South Umpqua River. The creek provides habitat for Coho salmon, steelhead trout, and cutthroat trout fish species.

Airfield safety requirements necessitated a taxiway relocation and extending the box culvert. The culvert outlet dropped four feet vertically, which created a barrier to fish passage. The extension required improvements to connect downstream to the upstream habitat areas. Engineered enhancements at the entrance, exit, and within the culvert included a pool and chute

fishway, a roughened downstream channel, and structures interspersed through the length of the culvert to simulate a natural streambed condition within it.

Because the culvert extension was within a FEMA-designated mapped floodway, fish passage improvements were designed to maintain hydraulic capacity to convey flood flows without increasing flood stages upstream or downstream. Design considerations included flow rates, velocities and storage:

• Hydraulic conditions support low flow fish passage and high flow flood conveyance.
• Features reducing fish passage design velocities cannot impede the 100-year regulatory flow conveyance.
• Flood storage provided by slope and channel characteristics must be maintained.

Current ground conditions were the basis for conversion and updates from the regulatory FEMA HEC-2 model to a HEC-RAS model. Using various design scenarios, iterative modeling determined that flood conveyance would maintain a no-rise in flood elevation.

Shallow baffles, cobbles and boulders, which were designed within the culvert as resting areas, dissipate energy to help control velocities during low flows and retain a shallow amount of natural bed material over time. Modifying these features accommodated the flood flows by requiring larger rock and boulders anchored to the floor of the box to withstand them.

Construction occurred during the summer 2013 in-water work period and now provides access to upstream habitat while maintaining suitable floodplain.

Presenting Author Bio:
Kari Nichols, PE is a water resources engineer with 15 years of experience in drainage and utilities design and construction management associated with municipalities, military and general aviation facilities, and private land development. Kari's years of experience on varying water resources projects have given her a deep understanding of state and federal codes and regulations pertaining to water resources protection. Kari routinely and effectively collaborates with project owners and regulatory agencies to achieve the best project outcome. Her solutions allow clients to attain project objectives while upholding best practices for environmental stewardship. Kari was the project manager for the Newton Creek culvert extension project at Roseburg Regional Airport. Kari's co-author, Jon Archibald, PE, is a senior water resources engineer with more than 15 years specializing in hydrologic and hydraulic modeling. For the Newton Creek project at Roseburg, he provided the floodplain modeling.

Design and Physical Model Testing of a Bottomless Baffled Culvert

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Abstract Body:
Recent studies suggest that the forces experienced by sediment in streams are similar to those experienced by fish. Thus, a culvert in which bed transport continuity is achieved is analogous to a culvert in which fish passage continuity is achieved. With this objective in mind, 1:8 scale model study was conducted in a 2-ft wide flume at Colorado State University to develop a new culvert technology. Thirty test runs were completed with unique combinations of baffled slat arrangement, slope, sediment input and discharge to arrive at the best design. The best design was then tested on a 1:4 scale of 20 unique sediment, slope, and flow conditions. The study found that sediment deposition and streambed continuity could be achieved by modifying a four-sided culvert to have baffled slats and an open bottom. This new culvert technology is presented as an alternative to stream simulation culverts in settings where they are either unnecessary or cost prohibitive. Of the ten expected outcomes of a well-designed stream simulation culvert, the six most important are achieved by the Bottomless Baffled culvert. These are flood conveyance, fish passage, stream profile continuity, hydraulic diversity, sediment transport continuity, and low flow continuity. The Bottomless Baffled culvert also achieves material efficiencies over a traditional concrete box culvert and requires less design expertise than a stream simulation culvert.

Presenting Author Bio:
Miles Yaw is a Graduate Research Assistant at the Colorado State University Hydraulics Lab. He is a graduate of the Washington State University Honors College with a degree in Civil Engineering, and is currently in his last semester of study for a Master's degree in Civil Engineering focused on River Mechanics.

Scott D. Aston, P.E. is the Vice President of Bridge Structures for Contech Engineered Solutions. He began his career with Contech in 2002 in the Bridge Solutions Engineering Group. Scott holds a Bachelor of Science degree in Civil Engineering from Ohio University and an MBA from Indiana University. He is also a member of ASCE.

C1

Evaluating a Columbia River Dam Tailrace Habitat with CFD

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Abstract Body:
McNary Dam, operated by the U.S. Army Corps of Engineers (USACE) Walla Walla District, is a hydroelectric power facility in the Pacific Northwest influencing anadromous fish migrations in the Snake and Columbia River systems. In order to further increase the survival of migrating fish, USACE is using a more comprehensive approach to enhance ESA listed anadromous fish passage and survival by considering exposure to predator habitat within the tailrace of the project. The approach presented is a first step for evaluation of predator habitat using CFD, where predator habitat is defined as: A) flow velocities below 4 fps, B) flow depth less than 10 meters, and C) distance from shore less than 75 meters.
CFD models have been historically used to assist in the understanding of the effect of operational or structural configurations on the tailrace flow pattern and Total Dissolved Gas (TGD) production. Two-phase flow models developed and calibrated at IIHR-Hydroscience & Engineering were used to predict the hydrodynamics, TDG distribution and particle exposure to predator habitat within the McNary Dam tailrace. Multiple river discharges with operational and structural modifications were numerically evaluated for comparison. Inert particles were injected into the domain and properties such as velocity, distance to the shore and depth about each particle were recorded to identify high-risk predation zones. Statistics were then generated for the particles based on criteria that defined exposure to predation zones within the tailrace. Salmonid passage based on historical run timing and route passage distribution was then applied to particle exposure statistics to determine if operational and structural modifications reduced exposure to predator habitat. Estimates of safe fish passage routes developed by the model will be cross-checked with salmonid survival data investigated in the spring & summer 2014.

Presenting Author Bio:
Ryan Laughery P.E. Ryan is a senior hydraulic engineer for the Walla Walla District Corps of Engineers. He obtained his bachelor's degree in civil engineering from Washington State University in 2002. From 2002 to current he has primarily been involved in the design and development of fish passage structures for Lower Columbia and Lower Snake River hydropower projects. For the past several years he has served as technical lead for the development of physical and numerical models for the evaluation of configurations and operations of hydropower projects to improve fish survival.

Prediction of Total Dissolved Gas below Overthrough Spillways

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Abstract Body:
Discharge through overthrough spillways (where water leaves the structure before contact with the lower pool) has been shown to produce high total dissolved gas (TDG) concentrations in the tailwater and the river reach downstream. As a part of their license renewal, Avista Corporation and Seattle City and Light are trying to mitigate high TDG concentrations at the Cabinet Gorge and Boundary Hydroelectric Projects to be below the 110% requirement of state agencies associated with the projects.

Our approach has been to take advantage of the pool below the spillway and tunnel, and assume that the air entrained into the pool by the spillway and tunnel is sufficient to develop a steady state concentration of TDG, such that additional air entrainment would not alter this concentration. The location of entrained air bubbles has been simulated with a computational fluid dynamics code. Gas transfer across the bubbles was then simulated with source/sink algorithms developed by the authors and applied to the bubbles. The model has some limitations, but does not require coefficients to be fit to the measured TDG concentration.

The quantity of air entrained is only one factor that generates high dissolved gas concentrations. The other two factors are the equilibrium TDG concentration, primarily determined by the depth of the entrained air bubbles, and the rate of gas transfer, which is determined by bubble size and the turbulence to which the bubbles are exposed. This paper will describe the predictive technique for TDG concentrations below overthrough spillways and document the model verification with TDG measurements below the Boundary and Cabinet Gorge Hydroelectric Projects.

Presenting Author Bio:
John Gulliver is a Professor of Environmental Engineering in the Department of Civil Engineering at the University of Minnesota.

Taming Total Dissolved Gas using Advanced Computer Simulations and Reduced Scale Models

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Abstract Body:
Total dissolved gas (TDG) refers to the amount of gases present in water. Air dissolution from bubbles entrained during spill events are the main source of gas supersaturation on the Columbia River Basin. Fish exposed to the resulting TDG supersaturation may suffer from gas bubble disease, which is comparable to the bends in human divers.
This article presents the results of a long-term research effort to predict TDG downstream of spillways using reduced scale laboratory models and advanced computer simulations. The major issues regarding the prediction of TDG are the gas distribution and effect of spillway jets on the flow field. The most important source for the TDG is the gas transferred from the bubbles to the water; therefore the two-phase flow in the stilling basin need to be properly represented. In addition, spillway jets may cause a significant change of the flow pattern, since they attract water toward the jet region. This phenomenon leads to mixing that modifies the TDG concentration field.
TDG production downstream of spillways is closely related to the spillway jet regime. A spillway jet that remains close to the free

surface minimizes bubble transport to depth reducing TDG production. On the other hand, a low tailwater elevation or elevated spill flowrate can create a plunging jet resulting in the highest TDG production. Reduced scale laboratory models were built at IIHR - Hydroscience & Engineering to predict spillway jet regimes to guide the design of TDG mitigation measures. Since laboratory models based upon the Froude number cannot adequately simulate the behavior of the bubbles, a two-phase anisotropic model was developed to complement the laboratory models and predict the hydrodynamics and TDG field.
This study presents comparison of model predictions against observed jet regimes in the laboratory models and field data collected in the tailraces of McNary, Wanapum, Wells, and Hells Canyon dams. The use of the models to evaluate different abatement options to manage TDG for compliance with water-quality standards will be presented and discussed.

Presenting Author Bio:
Marcela Politano is an Associate Research Engineer at IIHR-Hydroscience & Engineering, The University of Iowa. She holds a PhD from Instituto Balseiro, Argentina. Her background includes modeling of multiphase flows, total dissolved gas, and heat and mass transfer. She has expertise in numerical modeling of the hydrodynamics and water quality in rivers, tailraces, reservoirs and fish passage facilities. During the past 10 years, she had supervised over thirty projects for the power industry. She has been the project manager of numerical studies directed at reduction of TDG downstream of numerous hydroelectric projects in the USA.

The Effect of Turbulence in Hydropower Dam Fish Passageways on Pacific Lamprey Passage

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Abstract Body:
Pacific Lampreys (Entosphenus tridentatus) are an anadramous parasitic lamprey found in the northern Pacific Ocean. They migrate up the Columbia River and into its tributaries to spawn. Although, Lower Columbia Dams have fish passageways that are designed for anadromous salmon and steelhead, the passageways do not work for Pacific Lamprey. It has been suggested that the serpentine weirs within the fish passageways are a barrier for Pacific Lamprey. Consequently, a Lamprey dedicate passage systems have been designed and installed on the dams to provide passage and an experimental flume has been designed to study the conditions within the serpentine weirs. Here, we present the design of the new Lamprey passageways installed and the John Day Dam and the first results of the flow properties within the serpentine structure. Fish count data shows that the lamprey dedicate passageways prevent a challenge for the Lamprey. Serpentine flume experiments were designed to have three different weir lengths, a turbulence treatment, and three different flows. The velocities through the weir in the flume are similar to those experienced within the serpentine weirs, maximum of approximately 1.2 m/s. An automated acoustic

doppler velocimeter (ADV) has been employed to measure velocity and turbulence within the flume on a grid at three different depths near the flume bottom. The ADV data has been completed and is presented in this presentation. Passive integrated transponder (PIT) tags will be utilized to determine passage of the Lamprey through the obstacles within the flume. Lamprey will be studied within the flume with dual frequency identification sonar (DIDSON) cameras to monitor behavior and reactions to varying turbulence in specific areas of interest within the flume.

Presenting Author Bio:
Channing is masters engineering student with the University of Idaho Center for Ecohydraulics. Channing's focus is in hydraulics and fish passage. He graduated from the Georgia Institute of Technology in 2004 and is a Professional Engineer in Idaho, California, and New Mexico.

Burst swimming in areas of turbulent flow: delayed consequences of anaerobiosis in wild adult sockeye salmon

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Abstract Body:
Wild riverine fishes are known to rely on burst swimming to traverse hydraulically challenging reaches (e.g., high-gradient reaches, dam tailraces), and yet there has been little investigation as to whether swimming anaerobically in areas of turbulent flow can lead to delayed mortality. Using tri-axial acoustic accelerometer transmitters, we estimated the swimming activity of anadromous adult sockeye salmon (Oncorhynchus nerka) in the tailrace of a diversion dam in British Columbia, Canada and its effects on the remaining 50 km of their freshwater spawning migration. Consistent with our hypothesis, migrants that elicited burst swimming behaviours in high-velocity flows surrounding the entrance to a vertical-slot fishway were more likely to succumb to mortality following dam-passage. Fishway attraction flows predicted the swimming speed of sockeye salmon and contributed to the failure of migrants to reach breeding grounds. Females swam with more anaerobic effort compared to males, providing a mechanism for the female-biased migration mortality observed in this watershed. Alterations to dam operations prevented the release of hypolimnetic water from an upstream reservoir, exposing some migrants to supra-optimal, near-lethal water temperatures (i.e., 24 degrees C) that inhibited their ability to locate, enter and ascend the fishway. We present the first field-based evidence that turbulent-flow-induced burst swimming has delayed, post dam-passage survival consequences for sockeye salmon. Results from this study can be applied to any aquatic species that encounter velocity barriers during their lifetime, and have broad implications for the design and operation of fishway attraction flows. Our findings also show the need for research that investigates whether dams can impose other delayed or carry-over effects on wild aquatic animals.

D1

Effect of Upstream Fish Passage Structure Entrance Design and Head Differential on Attraction and Entry of Adult Shortnose Sturgeon

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Abstract Body:
Physical and hydraulic characteristics of upstream fish passage structures (e.g., fishways, fish lifts) are critical for effective attraction and entry of target species to be passed. These characteristics may be species specific, but have not been extensively quantified. We evaluated attraction and entry of adult, wild-caught shortnose sturgeon to experimental surface and submerged orifice entrance structures at several entrance head differential (water velocity) and siting (center of channel, side of channel) conditions, under controlled laboratory conditions. Attraction rates of sturgeon to entrances were relatively low compared to previously tested species (i.e., American shad). Experiments were run for 24 hours periods; sturgeon were attracted to and entered both surface and submerged orifice entrances during both day and night. Results from this study show a degree of interplay between attraction and passage for various entrance configurations and hydraulic conditions. For shortnose sturgeon, as for other species, one particular combination of factors may elicit significant attraction, but only modest passage.

Presenting Author Bio:
Dr. Haro is a Research Ecologist at the S.O. Conte Anadromous Fish Research Laboratory (Ecosystems Mission Area, U.S. Geological Survey) at Turners Falls, Massachusetts, USA and serves as a Principal Investigator and Section Leader of the Fish Passage Engineering Section at the Conte Lab. His present work involves migratory fish behavior, design, engineering, and evaluation of fish passage structures, fish swimming performance, and ecology and management of American eels. Dr. Haro provides extensive basic and applied research and advice to state, national, and international agencies, NGOs, and the private sector on fish passage technology and operations. He is also an Adjunct Associate Professor at the University of Massachusetts Department of Natural Resources Conservation and serves as a major advisor for graduate students, as well as an instructor for courses in fisheries biology.

Innovative Hybrid Design of Issaquah Creek Hatchery Water Supply Intake Using Physical Scale Modeling as a Collaborative Tool

First Author Name:
Zapel, Edwin T.

First Author Affiliation:
Northwest Hydraulic Consultants Inc

Abstract Body:
Hatcheries often play a key role in meeting fisheries restoration objectives and public demand for fishable stocks, but many hatcheries rely in whole or in part on surface water diversions to maintain their production facilities. These diversions often include a dam to divert flow through a screening system and on to the hatchery, but in many cases old dams were never provided with upstream fish passage, or very poorly functioning upstream passage facilities. This presentation focuses

on one particular intake that was designed using a physical scale model as a collaborative tool with participation of regulatory agencies, tribes, project proponents, and public representatives to achieve an acceptable solution. Issaquah Fish Hatchery is operated by the Washington Department of Fish & Wildlife, and the facilities are one of the most heavily visited by the public of any hatchery in the State of Washington's inventory. As such, it has very high visibility to the public and its performance as a key component of stock management receives considerable scrutiny. The hatchery facility itself has been modernized and updated, but the diversion dam located a half-mile upstream was in very poor condition and the upstream passage facility is non-functioning. A recent legislative initiative provided funding for the development of a replacement design for the intake facility that would remove the old dam and replace it with a naturalized grade control reach and intake structure that would withdraw flow from an artificial scour pool that would remain stable and clear over time. This presentation illustrates the effectiveness of the physical modeling approach to design, which allowed the entire design team to work together within the laboratory to collaboratively develop the new intake design and observe directly the anticipated performance under widely varying hydraulic conditions.

Presenting Author Bio:
Ed Zapel is a hydraulic engineer and fisheries scientist with more than 25 years of experience on a wide range of fish passage projects throughout the Pacific Northwest and California. Hi experience spans the spectrum from restoration of passage and habitat on small ephemeral steelhead streams to the largest fish ladders in the world on the Columbia River Federal Hydropower System dams.

Innovative Fish Passage: A Cost-Effective Solution for High-Head Hydro

First Author Name:
Ryan Greif

First Author Affiliation:
Mead & Hunt

Other Authors:
2. Kai Steimle, Aquatic Ecologist
3. Richard Brown, Senior Research Scientist

Other Authors Affilliations:
2. R2 Resource Consultants, Inc.
3. Pacific Northwest National Laboratory

Abstract Body:
Providing fish passage at high-head hydroelectric facilities can be prohibitively expensive due to the challenges associated with maintaining acceptable velocities and pressures for fish migrating over a large drop in elevation. Traditional solutions involve large concrete structures such as fish ladders, locks, lifts, or bypass flumes. Hauling operations are another option, using transport trucks, but these can also be prohibitively expensive due to high operating costs. Equally important, they can cause significant stress and delay for migrating fishes.

An innovative, cost-effective system for downstream fish passage at high-head hydropower facilities has been developed, and is currently awaiting prototype-scale testing. The system uses engineered decompression raceways to safely pass fish using conventional screens by regulating pressures and controlling bypass flows. The development of the decompression raceway allows proven in-conduit screening systems, such as Eicher-type or MIS-type screens, to be used at high-head hydropower facilities because it solves the problem of controlled decompression at the discharge location. Results from Computational Fluid Dynamic (CFD) model tests verify the hydraulic performance of the decompression raceways and their ability to meet fish passage criteria.

Hyperbaric pressure tests on salmonids verify low injury and mortality rates during controlled decompression scenarios. Decompression raceways expand the applicability of existing screening methods to allow volitional downstream fish movement at high-head facilities with minimal delay and a small physical footprint.

This presentation will be of interest to a diverse blend of stakeholders, including federal, state and local agencies, seeking a viable approach to add lower-cost fish passage at high-head hydropower projects.

Presenting Author Bio:
Ryan S. Greif specializes in hydraulic modeling, design and analysis of water conveyance systems, including applications at hydroelectric facilities. His other experience includes dam safety, flood control and agricultural water supply design. He applies engineering principles from a fresh perspective to produce environmentally and financially sound solutions. Ryan worked closely with Kai Staimle, who has experience focused on water quality and fisheries studies along with coordination of technical advisory committees on fish passage. Ryan also worked closely with Dr. Richard Brown, who studies the effects of passage through hydroturbines and other water management structures on the physiology of fish from North America and a variety of other regions such as Asia and Australia.

Design and Construction Practices for the Kenyon Mill Step-Pool Nature-like Fishway, Pawcatuck River, Rhode Island

First Author Name:
James Turek

First Author Affiliation:
NOAA Restoration Center

Other Authors:
Kristen Ferry

Other Authors Affilliations:
NOAA Restoration Center, Gloucester, MA

Abstract Body:
In 2013, NOAA in consortium with an array of governmental agencies, non-governmental organizations, and private industry project partners completed the last of three fish passage projects on the Upper Pawcatuck River through a 2009 ARRA-NOAA grant award and NOAA-RAE and NOAA-TNC partnership funding awards. While water supply needs prevented implementation of the preferred alternative to remove the 5-foot high Kenyon Mill dam, the highly successful public-private industry partnership facilitated the design and construction of a nature-like fishway with 5 stone weirs and pools on this 4th-order river (73-mi2 watershed). The 180-foot long fishway has been designed to efficiently pass river herring (Alosa aestivlis and A. pseudoharengus) and American shad (A. sapidissima) with operational flows of 88-461 cfs for these target species, as well as American eel (Anguilla rostrata) and resident species (e.g., Semotilis corporalis, Catostomus commersonii). Information will be discussed on the primary, in-line and secondary weir notch dimensions and flow velocities, EDF of pools, and other critical fishway features. The installation of a temporary by-pass channel along river-left bank not only afforded the construction of the fishway “in the dry”, but provided the opportunity to run fish passage test flows before project construction ceased in late 2013. Key design components of the structure were to ensure river flows through the fishway, particularly during low-flow periods by installing a geo-textile liner under the weirs and pools, a new concrete grade-control structure with weir slot at the head of the fishway, and a downstream sheet-pile cutoff wall as added protection to address potential sediment scour, particularly during high flows. Project costs will also be summarized as part of this presentation.

Presenting Author Bio:

James Turek has worked for 15 years as a Restoration Ecologist with NOAA Fisheries' Restoration Center stationed in Narragansett, RI. He is responsible for managing or providing technical assistance on an array of coastal habitat restoration projects in Narragansett Bay, Long Island Sound, Buzzards Bay and their watersheds. He has 30 years of experience in fishery biology and wetlands ecology, and his experience spans fish passage projects including dam removals, nature-like fishways and structural fishways, as well as tidal and freshwater wetland restoration and creation sites. He holds a Bachelor's Degree in Zoology and minor in Geological Sciences from the University of Maine at Orono, and a Master's Degree in Marine Affairs from the University of Rhode Island.

The Coleman Pond Fishway: Novel site identification, design, and construction of a nature-like pool and weir fishway.

First Author Name:
Bjorn Lake

First Author Affiliation:
Kleinschmidt Associates

Other Authors:
2. Matthew Bernier
3. John Burrows

Other Authors Affilliations:
2. NOAA Restoration Center
3. Atlantic Salmon Federation

Abstract Body:
The alewife (Alosa pseudoharengus) is a migratory fish species native to coastal watersheds in Maine. The Ducktrap River in Lincolnville, Maine has a run of alewives that spawn elsewhere in the watershed, in Pitcher Pond. On the southern portion of the watershed, the alewife migration to Coleman Pond was extirpated due to a barrier at an old mill dam. The mill has long since been removed, but a privately-owned, 5 foot high outlet dam has prevented the re-establishment of alewife spawning in Coleman Pond. This project involved novel approaches to site identification, engineering, and construction that culminated in the construction of a nature-like pool and weir fishway in 2013. The project was identified using statewide, non-FERC dam owner survey completed by Kleinschmidt in 2012. After identifying the willing dam owner, the NOAA Restoration Center and the Atlantic Salmon Federation partnered to administer the fish passage project with Kleinschmidt and Linkel Construction providing the design and construction services, respectively. The hydrology of the site provided a unique design challenge in that limited flows during the migration season precluded the construction of a rock ramp fishway using readily available materials on site. To overcome this obstacle, the design team developed a nature-like pool and weir fishway that met fish passage design criteria while still utilizing the material resources available. The resulting fishway provides a cost-effective example of alewife restoration that can be applied to other outlet dams in coastal watersheds in Maine.

Presenting Author Bio:
Bjorn is the Engineering Team Leader for the Ecological Services Department of Kleinschmidt Associates. He manages and executes non-hydro fish passage projects for the company along with other related restoration efforts. Before joining Kleinschmidt, Bjorn earned a doctorate degree in Civil and Environmental Engineering from the University of Maine.

A2

The Great Lakes IMDS: Helping advance lanscape-scale collaboration and strategic conservation

First Author Name:
Scott Sowa

First Author Affiliation:
The Nature Conservancy

Other Authors:
1. Mary Khoury, 2. Patrick Doran, 3. Brad Potter

Other Authors Affilliations:
1. The Nature Conservancy, 2. The Nature Conservancy, 3. US Fish and Wildlife Service

Abstract Body:
Scaling up our conservation actions across the entire Great Lakes Basin to address issues like coastal wetland restoration or restoring tributary connectivity will require unprecedented levels of collaboration. But how do you get dozens of agencies, hundreds of organizations, and thousands of people to collaborate when it is impossible for all of them to directly communicate and coordinate their actions? It is certainly not impossible as global enterprises like McDonalds, Starbucks, and General Motors accomplish this seemingly impossible task each day by using information supply chains to get the right information to the right people in the right format at the right time to address the complex logistics of the material supply chains. These information supply chains enable thousands of people to effectively communicate and coordinate in indirect and independent manner. The logistics of landscape-scale conservation are really no different from logistics faced by these global enterprises. As such, we believe the conservation community must start thinking and functioning like a conservation enterprise with much more emphasis on addressing the logistics of landscape-scale conservation. Fortunately, The Nature Conservancy, U.S. Geological Survey, and the Upper Midwest & Great Lakes Landscape Conservation Cooperative (UMGL LCC) are currently working with a broad network of partners to develop the Great Lakes Information Management and Delivery System (IMDS), which is designed specifically to support the complex logistics of landscape-scale conservation. Through its six integrated modules the IMDS engages and provides information to everyone that has a stake in Great Lakes Conservation and makes them part of the collaborative solution. This presentation will cover how we are using the IMDS to help us incorporate key business principles used by these global enterprises into our conservation strategies, for issues like tributary connectivity, and achieve landscape-scale collaboration and conservation.

Presenting Author Bio:
Scott Sowa currently serves as the Director of Science for The Nature Conservancy (TNC) in Michigan and as a Senior Aquatic Ecologist for TNC's Great Lakes Project. In these positions Scott provides scientific leadership and advice to TNC and its partners to help establish and implement holistic conservation strategies to protect and restore the Great Lakes ecosystem for the benefit of people and nature. Scott obtained a BS in Fisheries and Wildlife from Michigan State University and an MS and PhD in Fisheries and Wildlife from the University of Missouri.

Developing regional goals for connectivity restoration

First Author Name:
Todd Hogrefe

First Author Affiliation:
National Fish and Wildlife Foundation

Other Authors:
2. Mary Khoury

Other Authors Affilliations:
2. The Nature Conservancy

Abstract Body:
We lack shared goals for restoration of river connectivity in the Great Lakes basin. Although there have been efforts to articulate goals, the lack of alignment and systematic tracking of outcomes has limited their usefulness. We assert that setting comprehensive goals that are aligned regionally will allow all of us to better define the scope of the issue, provide a blueprint for action, account for the cumulative benefits we seek, and support an adaptive management approach to stream restoration. Comprehensive goals would help organizations make strategic decisions about where to focus their resources, leverage the work of other groups, and assess their individual and collective contributions to a regional effort. We will present one regional funder's view of why goals are important and how they could be used to inform future investments. We will then suggest a general framework for goals and a participatory approach to goal-setting. Ideally, goals will include the spectrum of performance indicators, including inputs of resources, interim outputs, interim outcomes, and ultimate outcomes (e.g., biodiversity goals, benefits to people). In addition, goals need to be expressed at nested geographic scales, ranging from the whole Great Lakes basin to individual lake basins and sub-basins. We will also outline a participatory process to develop specific goals, starting with focal migratory species.

Presenting Author Bio:
Todd Hogrefe is the Assistant Director for the National Fish & Wildlife Foundation Central Partnership Office based in Minneapolis. He began his work with the Foundation in 2008 and his primary responsibilities include administering special grants programs, strategic planning for the Foundation's Central Region, conducting outreach, and providing technical assistance to grant applicants. Prior to holding his position at the Foundation, Todd worked for the Michigan Department of Natural Resources and the Utah Department of Natural Resources, where he coordinated programs that focused on a wide range of wildlife and habitat issues, such as piping plover protection, shoreline conservation, wolf management, and the conservation of rare desert fishes. He received his Bachelor of Science degree in Biology from the Pennsylvania State University and his Master of Science degree in Fisheries & Wildlife from the Utah State University.

Toward a shared vision and strategy for improving connectivity across the Great Lakes basin

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2. Bradley Potter
3. John Dettmers
4. Mary Khoury

Other Authors Affilliations:
2. Us Fish and Wildlife Service, Upper Midwest and Great Lakes Landscape Conservation Cooperative
3. Great Lakes Fishery Commission
4. The Nature Conservancy

Abstract Body:
The Great Lakes basin has over 7000 dams and approximately 270,000 road-stream crossings. The extensive infrastructure of dams and stream crossings provides significant benefits to people in the Great Lakes basin, while simultaneously impacting the function of riverine and wetland systems this infrastructure intersects. For example, only 17% of Lake Michigan tributary habitats are currently accessible to Lake Michigan fishes due to dams. Some of these dams also serve to limit the infestation of invasive species. Many organizations and institutions have been working at local scales to enhance

connectivity of freshwater systems to improve the health of river systems, restore populations of migratory fish, and for societal benefits including recreation and safety. To successfully address an issue of this the scope and complexity across the entire Great Lakes will require broader collaboration among diverse groups of local municipal, state, tribal, and federal governments, non-governmental organizations, bi-national organizations, business, industry, and the public. To that end, the Great Lakes Basin Fish Habitat Partnership (FHP), the Great Lakes Fishery Commission (GLFC) and the Upper Midwest and Great Lakes Landscape Conservation Cooperative (LCC) propose organizing a comprehensive regional connectivity collaborative that works cooperatively to develop a decision framework for determining where in watersheds the optimal benefits of improved connectivity can be realized, while taking into account conflicting priorities. We will present a vision and possible framework for this collaboration and potential roles of various constituencies, including the FHP, GLFC, and LCC.

Presenting Author Bio:
Mark Brouder is the Project Leader for the Ashland Fish and Wildlife Conservation Office. He currently serves as the co-chair of the Great Lakes Basin Fish Habitat Partnership Steering Committee.

B2

Reconnaissance-Level Assessment of Dam Removal for Upstream Fish Passage

First Author Name:
Michael Chelminski

First Author Affiliation:
Stantec Consulting Services Inc.

Abstract Body:
A primary driver for dam removal is restoration of volitional upstream fish passage. Factors that must be considered in the selection of dam removal projects include 1) whether target fish can swim upstream to the target dam, and 2) whether target fish species can move upstream in the vicinity of the target dam in the absence of the dam.
Absence of target fish species immediately downstream from a dam may or may not be an indicator of successful passage up to the downstream side of an existing dam. Conditions that may prevent upstream fish passage to a target dam may include natural (e.g., falls) or built features (e.g., downstream dams, culverts). Absence of target species should not, however, be taken as an indicator of impassable downstream barriers. An example of this condition is where a dam is located at the head-of-tide and there is no suitable spawning habitat seaward from the dam. Similarly, presence of target fish species immediately downstream from a dam will not provide certainty that removal of the dam will provide for upstream fish passage beyond the dam.
This presentation presents recommendations for preliminary scoping of dam removal projects based on experience gained in the performance of approximately 65 formal dam removal reconnaissance studies. Recommended components of the reconnaissance-level assessment approach include identification of biological indicators and observation of physical characteristics that may be used to assess the potential for upstream passage of target fish species, including temporal (seasonal) variations in flow, and field assessment of the potential for upstream fish passage based on analog sites. The presentation also addresses identification of historic anthropogenic alterations at sites where fish passage may have occurred prior to dam removal but where dam removal may not provide for upstream fish passage due to apparent encroachment of adjacent structures.

Presenting Author Bio:
Michael Chelminski is an environmental consultant and Principal at Stantec Consulting Services Inc. The focus of his work is decommissioning of legacy infrastructure (i.e., dam removal) as a means to improve access for indigenous fish to their historic habitats. He has performed reconnaissance-level scoping for approximately 65 small dam removal projects in New England for which the target species for upstream passage are anadromous species. He is a member of the ASCE-EWRI/AFS-BES Ad Hoc Committee on Fish Passage, a fisherman, has a MS in engineering from Utah State University and a BS in engineering from the University of Connecticut, and is a licensed professional engineer.

Design Challenges using Reference Reaches in Manipulated Watersheds

First Author Name:
Steven Allen

First Author Affiliation:
GHD

Other Authors:
2. Travis James
3. Jeremy Svehla

Other Authors Affilliations:
2. GHD
3. GHD

Abstract Body:

Manipulated watersheds present additional challenges to restoration efforts. A single manipulation, such as one road crossing in an otherwise pristine watershed, would not pose significant difficulty in identifying and using a reference reach as a basis for restoration design. But what happens when a watershed is manipulated at several locations? What happens where there are less than ideal reference reaches available? In these situations standard guidelines may not be applicable and professional judgment and adaptation is necessary. This presentation will focus on US West Coast anadromous restoration projects that highlight the challenges of identifying reference reaches in manipulated watersheds. The California Department of Fish and Game Salmonid Stream Habitat Restoration Manual will be used as an example of a helpful guideline for developing restoration projects, with or without a viable reference reach. No guideline is intended to address every situation encountered and so professional judgment is required to determine what an ideal reference reach may be for a particular system and how to find solutions when they do not exist.

Presenting Author Bio:
Mr. Allen is a licensed civil engineer with experience in a variety of civil and environmental engineering projects. He earned a degree in Environmental Resources Engineering from Humboldt State University after working in the construction industry operating heavy equipment. Mr. Allen currently serves as the Managing Principal of GHD's Eureka office, as well as serving on the Board of Directors of the Salmonid Restoration Federation. Mr. Allen has extensive training and experience in the design of restoration and fish passage projects, including project permitting, preparation of construction plans, bid documents, project management, construction management, and regulatory compliance in sensitive environments in California, Oregon, Nevada, and the Commonwealth of the Northern Marianas Islands.

Reference Reaches; Opportunities and Limitations

First Author Name:
James MacBroom

First Author Affiliation:
Milone & MacBroom Inc

Abstract Body:
Many tools are available for the planning and design of open channels that simulate or rehabilitate naturalistic streams. Current tools include reference reaches, regime concepts and equations, empirical hydraulic geometry relations, analytical techniques, and sediment transport models. But none of these insure ecological success, so increasingly one assesses entire watershed processes and trends.

Stream management based upon reference reaches has been common practice since the dawn of the environmental movement. Stream reference reaches reflect past land use and hydrology, not the future, and are challenged by climate change. However, one example of where reference reaches are still very useful has been in the post flood emergency river recovery efforts after recent flooding, when rapid field designs for channel modifications have been necessary to re-open roads and protect infrastructure.

Presenting Author Bio:
Jim MacBroom is a registered Professional Engineer with 40 years experience in stream restoration, geomorphic based flood control, modeling, and dam removal. He is also a lecturer of applied geomorphology at Yale University.

Channel Restoration during Dam Removal – Letting the River do the Work. Lessons from the Brown Bridge Dam Removal

First Author Name:
Andy Selle

First Author Affiliation:
Inter-Fluve Inc.

Other Authors:
Frank Dituri, Brett Fessell, Steve Largent, Nate Winkler

Other Authors Affilliations:
Frank Dituri Brett Fessell - Grand Traverse Band of Ottawa and Chippewa Indians
Steve Largent - Grand Traverse Conservation District
Nate Winkler - Conservation Resource Alliance

Abstract Body:
The Brown Bridge Dam was removed in 2012-2013. The largest dam removal in Michigan, it occurred on one of the most pristine trout streams, the Boardman River, home of the original Adams Fly. Well over 200,000 CY of sediment were deposited within the 200 acre impoundment, covering the pre-dam channel and floodplain. Channel restoration was guided in large part by locating the pre-dam channel below the sediment and using existing analog elements in the channel outside of the impoundment to illustrate expected development of a post removal channel and attendant habitat features. Decisions between active and passive restoration approaches were informed by engineering and geomorphic principles, detailed field data collection on patterns of sediment deposition, and the reality of finite construction funds. The end goal was the removal of major impediments to the natural process of restoration that would be accomplished by the river following dam removal.

Presenting Author Bio:

Andy has a BS in Fisheries and Aquatic Science and an MS in Hydraulic Engineering, both from Purdue University. He worked for several years as a stream biologist in Indiana with the Indiana Department of Environmental Management before returning to Purdue to pursue studies in fluvial geomorphology, hydraulics, and hydrology. Andy has worked in streams over the last 14 years, the last 10 with Inter-Fluve, a stream restoration firm. His mixed background allows him to “speak” a number of languages that develop among stakeholders on stream projects. To date Andy has worked on over 30 dams from feasibility to removal, ranging in size from a few feet to over 40 feet.

C2

Emergency Pumping Plant Fish Protection Screens at California's Red Bluff Diversion Dam

First Author Name:
Darryl Hayes, P.E.

First Author Affiliation:
Intake Screens, Inc.

Other Authors:
Jeff Sutton

Other Authors Affilliations:
Tehama Colusa Canal Authority

Abstract Body:
The Red Bluff Diversion Dam (RBDD), located on California's Sacramento River, was a large, seasonally operated, gated barrier whose primary purpose was to gravity divert up to 2500 cfs into the Tehama-Colusa and Corning Canal systems. Although the RBDD was initially operated to provide year round diversions, the annual “gates-in” period was reduced to less than a three month period to improve juvenile and adult fish passage of several endangered salmonid species and green sturgeon through the area. In 2009, the National Marine Fisheries Service mandated that the gates could only be operated between June 15 and August 31, forcing the Canal Authority to construct a 500 cfs emergency pumping plant to provide critical agricultural deliveries to their users during the Spring and Fall “gates-out” period. The emergency pumping plant (EPP) consists of 10, 350 Hp vertical turbine pumps spaced on 15-foot centers and located in a shallow area along an existing sheetpile wall area downstream of the RBDD. Each pump intake was adapted to draw its water through a 14-foot diameter brush-cleaned cone-shaped fish screen. Each screen’s large surface area allowed the pumping plant to operate at full capacity in as little as three feet of water. The majority of the facility components were built off-site and then installed on driven piles to reduce construction related impacts. The entire EPP and fish screen system was designed, fabricated, constructed, and operational within a three month period in Spring 2009. The cone-shaped fish screens successfully protected fish while allowing critical water deliveries and fish passage to continue until the permanent fish screen and pumping facility was completed in 2013. This presentation will describe the facility design and construction details as well as some of the fisheries monitoring and screen testing completed at the EPP site.

Presenting Author Bio:
Darryl Hayes has been working as the Engineering Manager at Intake Screens, Inc. in Sacramento, CA, for the past 7 years and working on fish protection and passage systems for the past 20 years. He was previously a Senior consultant at CH2M HILL and the Fish Facility Chief at the California Department of Water Resources. Darryl is a Past President of the American Fisheries Society's Bioengineering Section.

Installation of a pilot plant for fish protection an bypass systems

First Author Name:
Uli Dumont

First Author Affiliation:
Floecksmuehle Consultants

Abstract Body:
According to the European Water Framework Directive, all hydropower plants in Germany have to be modified within a certain period so that they do not cause damage to the fish populations in the waters in the future. The necessary technical solutions such as fish protection systems and fish-friendly turbines are not yet available and are currently being developed.
Therefore, the Government of the State of North Rhine-Westphalia has built a pilot plant with a 10mm bar screen and various bypass systems for salmon, eel and potamodromous

fish species. The plant has a design flow of 28 m^3/s. The screens are equipped with three different bar profiles as well as special cleaning systems. Furthermore, extensive facilities for monitoring downstream migrating fish have been installed. A biological and technical monitoring will be performed to examine the use of the system to other locations.

Presenting Author Bio:
Civil engineer and directing manager of Floecksmuehle Consultants who are working as designers and experts for up- and downstream migration facilities, fish protection systems and hydro power stations. Member of the German committee on design of fish passes and fish protection systems. Scientific work on fish migration and passability of rivers. Adviser for state and federal government.

North Battle Creek Feeder Fish Screen and Fishway Model

First Author Name:
Dale Lentz

First Author Affiliation:
Bureau of Reclamation

Other Authors:
2. Brent Mefford

Other Authors Affilliations:
2. Wild Fish Engineering LLC

Abstract Body:
The North Battle Creek Feeder (NBCF) diversion is located in Shasta County on the North Fork of Battle Creek near Manton, California. The facility is owned and operated by Pacific Gas and Electric Company (PG&E). As part of the Battle Creek restoration project a new fish screen and ladder was built in 2011. The fish screen, ladder and diversion have not been performing as designed. Field studies indicate flow velocities through the fish screen are not uniform and are too high. This could cause juvenile fish to become impinged on the screen. In addition, the facility is physically unable to divert the full water right for power generation. In the fish ladder, the water surface drop between pools may be too large to facilitate adult salmonid fish passage.

The unique hydraulic characteristics involved in this project are most thoroughly analyzed with a physical model. A 1:4-scale physical hydraulic model of the NBCF facility was constructed in Reclamation's hydraulics laboratory in Denver, Colorado in 2012. The purpose of the model was to investigate the performance issues and evaluate modifications and/or operating procedures that will allow the facility to perform within acceptable criteria for fish while meeting the full diversion for PG&E.

The study identified a number of modifications to both the fish screen and the fish ladder that will improve performance. Fish screen enhancements include blanking panels, guide vanes, and guide walls to improve screen uniformity, reduce approach velocities, and allow a full diversion. Recommended modifications to the fish ladder include three additional pool bays (one upstream and two downstream of the original ladder) and smaller orifices throughout the fishway. The physical model was an invaluable tool in identifying and evaluating alternatives that will greatly improve the performance of the NBCF facility.

Presenting Author Bio:
Dale Lentz, P.E. (Utah), B.S. and M.S., Utah State University. 5 years working in Reclamation's hydraulic laboratory modeling numerous hydraulic phenomena, including: fish passage, fish screens, fish refuge, spillway performance, and canal embankment breach. 4.5 years working for USACE, designing and modeling fish passage, flood plain mapping, and sedimentation studies.

Design, Construction, Installation and Operation of Three Large Scale Netting Fish Barrier Projects

First Author Name:
Dave Erickson

First Author Affiliation:
Pacific Netting Products, Inc.

Abstract Body:
Currently in North America, there are several significant large scale netting fish barriers successfully protecting various species of fish and wildlife in the aquatic and marine environments. These systems allow major hydroelectric dams, pump storage facilities and nuclear power plants to continue operations while protecting fragile species within their habitat.
Barrier design entails a thorough site assessment inclusive of species conservation goals, flow rates, forebay bathymetry, period of deployment, potential for debris entrainment, barrier loading and anchoring methods. Additional operational requirements, such as controlled netting barrier submergence during high flow periods and variations of forebay elevations, are considered. Following this initial assessment, actual net design commences with respect to netting mesh size, yarn type and gauge, rope supporting methods and material selections. In the past decade, significant advancements in high strength, lightweight and highly abrasion resistant synthetic yarns have allowed the development of substantially lower drag netting membranes with far less resistance to water flow. Dyneema twine is as strong as steel wire of equivalent diameter with one tenth of the weight. This allows for a much smaller diameter netting twine that is much stronger than more common nylon netting material. Dyneema netting offers a 20-50% drag reduction, resulting in a substantial reduction in anchoring requirements and costs. The most successful barrier net applications are constructed using Dyneema netting. The additional costs of Dyneema netting are offset by superior properties, inclusive of higher strength, greatly reduced drag, low elongation and excellent abrasion resistance. Dyneema netting is also easier to clean with simple pressure washing methods. With recent advancements in engineering and design using modern materials, several barrier nets have been successfully operating continuously for more than five years in a variety of environmental conditions. Three active, successful large scale netting fish barriers are discussed, along with their environmental advantages.

Presenting Author Bio:
Dave Erickson-Vice President/ Co-Owner Pacific Netting Products, Inc. - Dave has co-owned and operated Pacific Netting Products for the past 17 years, with an emphasis on designing and manufacturing high tech barrier nets for the power industry as well as for other challenging industrial applications. He spent his early years commercial fishing in Alaska, then traveled all over the world from Alaska to Africa as a net technician, installing and testing commercial fishing gear systems aboard fishing vessels. He has 33 years' experience in designing, manufacturing and installing application-oriented netting systems.

D2

An Overview Of The New German Fishway Standard For Upstream Fish Passage

First Author Name:
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First Author Affiliation:
ARCADIS Germany

Abstract Body:
The totally revised German Fishway Standard DWA-M 509 “Fishways and Fish-Passable Hydraulic Structures - Design, Calculation, Quality Management” will replace the Guideline DVWK-M 232, initially published in 1996 and translated into English by the FAO of the United Nations in 2002. The new Standard will be published in April 2014 and represent the compulsory technical norm for upstream fish passage (restoration) in Germany.

The presentation provides an overview of the following new and updated elements of the Standard:
• New fishway design philosophy based on the region-specific fish fauna and/or target species.
• Revised classification of fishway facilities based on their hydraulic design, function and location at a barrier. The former categorization "nature-like fishways" and "technical fishways” is repealed as nature-like structures do not function better per se than technical fishways. The building materials used, landscaping and aesthetic aspects are not decisive for the efficiency of a fishway.
• Geometric and hydraulic design criteria based on the body size and shape, and (riverine zones oriented) swimming performance of fish.
• New design concept including safety factors for calculations. Limitation of fishway efficiency is to be expected when threshold values are exceeded. Design values and safety factors have been introduced to take account of hydraulic, structural and operational imponderabilia.
• Appraisal of new types of fishways, e.g. vertical slot fishway with round pools and bristle-type fishway.
• Review of hydraulic structures passable for fish, e.g. culverts, flood retention basins, gauging stations, ship locks etc.
• Introduction of a quality management and assurance process encompassing all project phases (design, construction, commissioning and operation) in order to support the design and licensing process, ensure compliance with the Standard, and reduce the need for monitoring. Henceforth fishway monitoring is only required when deviating from the recommenced design criteria.
• Assessment of monitoring techniques.
• Costs of fishways, including operation and maintenance requirements.

Presenting Author Bio:
Marq is a specialist in river restoration, hydraulic & dam engineering, integrated catchment management and hydropower. His work experience of 18 years comprises policy and feasibility studies, project management, and technical designs including hydraulic modeling, economic assessments, and construction supervision.
Marq is the chairman of the Expert Committee on Fishways of the German Water Association (DWA), and a member of the “EIFAAC Group on Fish Passage Best Practices” of the European Inland Fisheries and Aquaculture Advisory Commission.

The Legal Status of Fish Passage and Challenges In Turkey

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Abstract Body:
Dams and hydropower plants is significantly promoted, to reduce carbon dioxide released into the environment from fossil energy sources, to increase share of indigenous and renewable energy resources as too many country.
However, these structures prevent ecological connectivity in rivers and migratory behavior of some fish species is prevented. Migratory fish species can not adapt to the new conditions, are faced with the danger of extinction.
To protection river ecosystems and migratory fish species in Turkey, In all dam and regulator, it is necessary to construct fish passage, the size and species of fish found in rivers is no exception.
Height, stands out against us as the biggest problem in the construction of fish passage. Turkey's average height is more than European countries and the United States. Technical problems, has made difficult to building fish passages, at some bigger dam. Fish passage must be made in all of the dam has been questioned by investors and academics.
In this study, important migratory fish species and the number and height of the dam, examples of some of the fish passage, the legal status of fish passages, technical difficulties encountered in the construction of fish passage is provided to the subject.

Green Infrastructure and Blue Habitat-making the connection in Massachusetts

First Author Name:
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First Author Affiliation:
The Nature Conservancy

Abstract Body:
In Massachusetts, The Nature Conservancy and our partners are restoring passage for river herring, American eel, and other species by removing dams and improving road-stream crossings. We are also improving the reopened aquatic habitat and the habitat downstream to give fish populations the best chance to thrive in their new environment. While green infrastructure is gaining popularity as a method to manage stormwater, it also has important impacts on fish habitat. Research shows that watershed impervious cover has an impact on stream macroinvertebrate communities even at low levels, and that it is a strong indicator of fluvial fish community health. Green infrastructure disconnects effective impervious surface, and benefits aquatic habitat by infiltrating runoff, reducing the risk of erosive flooding and low flow events, moderating air and water temperature, and improving water quality. We are encouraging implementation of green infrastructure, including both site-specific best management practices and landscape level conservation of natural lands, through demonstration projects, outreach, and support of legislation and policy.

Presenting Author Bio:
Cathy is an aquatic ecologist at The Nature Conservancy in Massachusetts. Her work focuses on dam removal projects, green infrastructure and stormwater management, and partnership-based watershed restoration and management. Cathy has a M.S. in Water Resource Management from the University of New Hampshire and a B.A. in Geology from Colgate University.

Developing Habitat for the Wild & Rare

First Author Name:
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Abstract Body:
Each year private, county, state and federal agencies spend millions of dollars to stabilize stream banks and create habitat for trout. However, past stream restoration projects in the upper Midwest have often failed to incorporate habitat for non-game species such as snakes, frogs, turtles, and birds, primarily because of a lack of knowledge about those species' habitat needs. Trout Unlimited, working with a host of partners, developed a variety of habitat practices for non-game species utilizing the riparian corridor and produced a non-game habitat guide in 2009. The guide provided information about the habitat needs of a variety of upland, riparian and wetland/aquatic non-game species and described specific habitat features that can benefit them. Since the development of the first guide there has been great acceptance by practicing stream restoration managers to include habitat practices for non-game species into their projects. Developing habitat for non-game species at the same time that construction equipment is being used for trout stream restoration projects is efficient and cost-effective. Not combining habitat needs for a multitude of species is a missed opportunity.

Then, in 2013, Trout Unlimited once again worked with its partners and created a second edition of this Habitat Guide to help project planners better determine whether a particular habitat feature is likely to accomplish its intended purpose within the immediate habitat and within the surrounding landscapes. This guide "Non-game Wildlife Habitat Guide: Complementary Opportunities for Stream Restoration Projects" is now ready for distribution and will help project proponents develop plans that incorporate habitat features which that are likely to succeed at accomplishing their intended purposes.

Presenting Author Bio:
Jeff Hastings has been the Project Manager for the Trout Unlimited -Driftless Area Restoration Effort for the past eight years. Jeff attended the College of Natural Resources at the University of Wisconsin – Stevens Point where he majored in Wildlife Management and Biology. Prior to working for Trout Unlimited Jeff spent over 25 years managing county land and water conservation departments. Designing and installation of trout habitat work has been an important element of his career, along with pursuing grants and partners to implement projects.

A3

Great Lakes Fishery Commission Policy on Sea Lamprey Barriers and Dam Removals

First Author Name:
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Abstract Body:
The Great Lakes Fishery Commission (commission) deploys a sea lamprey barrier program as an effective alternative to the use of pesticides to control the invasive, parasitic sea lamprey (Petromyzon marinus) in the Great Lakes basin. Decades of use and research have demonstrated that pre-existing and purpose-built physical barriers successfully deny sea lamprey access to spawning habitat in Great Lakes tributaries. Nevertheless, these barriers can also reduce the passage of non-target fishes and growing interest in removing dams is presenting new management and policy challenges due to the potential for unintended consequences and for trade-offs between the native lake fishes affected by sea lamprey parasitism and the native and desirable non-native fishes affected by sea lamprey barriers. Better decision support systems for selecting barriers for removal could help reconcile these trade-offs in ways benefitting lake and riverine populations of valued fishes. The commission's policy on sea lamprey barriers and dam removals will be discussed.

Fixed-crest sea lamprey barrier design and operation

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Abstract Body:
The Great Lakes Fishery Commission (commission) deploys a sea lamprey barrier program (Program) to control the invasive, parasitic sea lamprey (Petromyzon marinus) in the Great Lakes basin. Fixed-crest sea lamprey barriers have been used in the Program as an alternative control technique for decades and have reduced the number of stream miles requiring lampricide treatment. There are many variations of the fixed-crest barrier deployed throughout the Great Lakes, some of which include trap and sort technology to pass desired fishes. Operational characteristics may also be adjusted to meet multiple objectives. The commission's standard barrier design and operation will be discussed.

Presenting Author Bio:
Jessica Barber is a fish biologist with the U.S. Fish and Wildlife Service. She currently serves as the Barrier and Trapping Team Leader with the Sea Lamprey Control Program. She has a Master of Science Degree in Fisheries from the University of Wisconsin - Stevens Point.

Passage options for walleye and lake sturgeon at the dam site on the Black Sturgeon River, Lake Superior, Canada

First Author Name:
Rob McLaughlin

First Author Affiliation:
University of Guelph

Abstract Body:
This talk will summarize the conclusions reached at a two-day workshop addressing passage options for native fishes, including walleye (Sander vitreus) and lake sturgeon (Acipenser fulvescens), at the Black Sturgeon Dam, Lake Superior, ON, which also serves as a sea lamprey barrier. The workshop was needed because (i) local stakeholders consider the dam to be an impediment to rehabilitation of a once productive walleye population in Black Bay, Lake Superior, (ii) lake sturgeon occurs in the river and has been assessed as threatened in the Great Lakes, which is creating momentum to re-establish connectivity between the Great Lakes and their tributaries for remnant lake sturgeon populations, and (iii) Fisheries and Oceans Canada and the Great Lakes Fishery Commission consider the Black Sturgeon Dam to be key aspect of sea lamprey (Petromyzon marinus) control in Lake Superior. Selective passage of walleye and other fishes of concern, such as lake sturgeon, could reconcile the benefits of increased connectivity between Black Bay and the Black Sturgeon River with the control benefits of denying spawning phase sea lamprey access to the Black Sturgeon River. Workshop participants believed that selective passage of walleye and other desirable fishes would be possible at the Black Sturgeon Dam. They identified a variety of features that make the Black Sturgeon Dam site suitable to fish passage. Components of an ideal passage facility were identified and used to specify uncertainties that could affect overall success at passing fishes. An experimental approach was recommended; uncertainties with the fishway components will likely require fine-tuning before effective passage rates are achieved. Any passage facility at the Black Sturgeon Dam could be part of larger, experimental fish passage collaboratory encompassing multiple strategic locations from across the basin.

Presenting Author Bio:
Dr. Robert McLaughlin is an Associate Professor in the Department of Integrative Biology at the University of Guelph in Ontario, Canada. His research program is diverse, but the overarching theme involves using the movements of animals to assess the significance that individual behaviour has for the biology of populations and communities and, ultimately, biodiversity. In one main component, his students are using studies at the assemblage, population, and individual levels to examine changes in the biodiversity of stream fishes caused by in-stream barriers used to control sea lamprey in the Laurentian Great Lakes, the role of restrictions on movement in bringing about these changes, and methods of minimizing any change (e.g. improved trapping of sea lamprey and passage of other fishes). His position and this research are supported by the Great Lakes Fishery Commission to increase its science capacity. In a second main component, his students are using smaller scale approaches focused on diversification in the foraging and migratory movements of brook charr (Salvelinus fontinalis) to understand the role that individual differences in behaviour have in facilitating population divergence in physiology, morphology, and life history (resource polymorphism), and the creation of new biodiversity.

His research program has two, additional minor components. Several students have been and continue to conduct studies assessing the effects of agricultural practices on stream fishes. They continue to examine basic research questions related to animal movement. Differences in the nature,

approach, and subject matter of these components creates a unique and interesting combination of research opportunities that is rich biologically and intellectually, and creates a productive synergy in terms of addressing the overarching theme of his program.

The efficacy of seasonally operated barriers for sea lamprey control and passage of non-target fishes

First Author Name:
Rob McLaughlin

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University of Guelph

Abstract Body:
Tools restricting the movements of invasive species (e.g. barriers) and reducing habitat fragmentation for native species (e.g. corridors, fishways) provide examples where actions taken to address one environ- mental concern can hinder efforts to address another environmental concern. We used perturbation analysis of stage-structured projection matrices to evaluate the efficacy of seasonally operated barriers and fishways for controlling non-native sea lamprey (Petromyzon marinus) in the Laurentian Great Lakes while minimizing effects on non-target fishes. For non-jumping fishes migrating in spring, seasonally operated barriers without a fishway will not balance the management objectives satisfactorily. Migration phenologies of the seven common non-target fishes considered in our analyses overlapped considerably with the migration phenology of sea lamprey, with peaks in migration typically being 7–43 days (median 12) from the peak in the sea lamprey migration. Consequently, across species, years, and tributaries, 44–100% of the migratory runs of non-target fishes would be blocked under the 75-day operation period required to block 99% of the sea lamprey spawning run, on average. Reductions in the production of non- target fishes due to blocking were also projected to be similar in magnitude to reductions projected in the production of sea lamprey, unless density-dependent compensation was strong or overlap in migration phenologies between a non-target species and sea lamprey was low. Even under density-dependent compensation, providing a fishway is advisable and passage of non-target fishes may have to be highly effective to avoid population declines in non-jumping species that migrate between a Great Lake and its tributaries.

Presenting Author Bio:
Dr. Robert McLaughlin is an Associate Professor in the Department of Integrative Biology at the University of Guelph in Ontario, Canada. His research program is diverse, but the overarching theme involves using the movements of animals to assess the significance that individual behaviour has for the biology of populations and communities and, ultimately, biodiversity. In one main component, his students are using studies at the assemblage, population, and individual levels to examine changes in the biodiversity of stream fishes caused by in-stream barriers used to control sea lamprey in the Laurentian Great Lakes, the role of restrictions on movement in bringing about these changes, and methods of minimizing any change (e.g. improved trapping of sea lamprey and passage of other fishes). His position and this research are supported by the Great Lakes Fishery Commission to increase its science capacity. In a second main component, his students are using smaller scale approaches focused on diversification in the foraging and migratory movements of brook charr (Salvelinus fontinalis) to understand the role that individual differences in behaviour have in facilitating population divergence in physiology, morphology, and life history (resource polymorphism), and the creation of new biodiversity.

His research program has two, additional minor components. Several students have been and continue to conduct studies

assessing the effects of agricultural practices on stream fishes. They continue to examine basic research questions related to animal movement. Differences in the nature, approach, and subject matter of these components creates a unique and interesting combination of research opportunities that is rich biologically and intellectually, and creates a productive synergy in terms of addressing the overarching theme of his program.

The quest for an effective non-physical migration barrier for invasive sea lamprey

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4. Jessica Barber
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5. Department of Integrative Biology, University of Guelph

Abstract Body:
Here, we describe non-physical stimuli tested as sea lamprey migration barriers and what lessons have been learned. Sea lamprey (Petromyzon marinus) control is essential to biodiversity and a sustainable fishery in the Laurentian Great Lakes and relies on an integrated approach that uses selective pesticides to kill larval sea lampreys in natal streams and barriers to limit access to spawning habitat. Migration barriers were the first sea lamprey control tactic deployed during the 1950s and remain a critical component of the program. Non-physical stimuli to block sea lamprey migration have been investigated because they can deter fish without affecting water flow or navigation and can be seasonally operated to allow some non-target fish passage (in contrast to physical structures). Sea lamprey migration has been minimally deterred by light, sound, and bubbles in experiments conducted to date. Electrical barriers have been used since the 1950s with limited success, but new pulsator technology and electrode configurations are still being investigated and have shown promise. Recent research into species-specific chemical barriers has also shown promise. Migratory sea lampreys are attracted by the odor of larval sea lampreys (pheromone) and are repelled by the odor of dead sea lampreys (alarm substance). A push-pull approach, where the simultaneous use of repellents (the push) and attractants (the pull), may be effective at guiding sea lampreys away from productive spawning streams and into areas that can be effectively treated with lampricides. Combinations of non-physical stimuli targeting multiple sensory modalities will likely prove most effective for blocking sea lamprey migration.

Presenting Author Bio:
I study fisheries with an emphasis on fish behavior and physiology. My research has focused on control of invasive sea lamprey and restoration of native lake trout in the Great Lakes. Specifically, I study the chemical ecology of sea lamprey and lake trout to advance the development of innovative techniques to manage these species. My research also has focused on whether low voltage electric fields can be used to block and or guide sea lamprey migration.

A New Tool to Trap and Sort Migrating Adult Sea Lamprey

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Abstract Body:
An eel-ladder-style trap (ELST) consists of a wetted inclined ramp with bristles or vertical pegs arranged in a regular pattern (designed to facilitate passage of anguilliform fishes) that leads to a vertical drop into a collection box. Recent research has shown that adult sea lamprey capture rates of ELSTs are similar to traditional sea lamprey traps (funnel traps), but without the fin-fish by-catch typical of funnel traps. ELSTs were also shown to be 100% effective at retaining captured sea lampreys; funnel traps are known to allow escapement. Importantly, ELSTs used in conjunction with trap and sort fishways have been shown to be effective at automatically sorting sea lampreys from fin-fish and thus have the potential to greatly reduce the operating costs of fishways. Based on these results, ELSTs could be a valuable asset to the sea lamprey control program.

B3

Acushnet River Fish Passage (*Joint ASCE-EWRI & AFS-BES Committee Project Award Winners*)

Nominated by:
Steve Block (steve.block@noaa.gov)
NOAA Restoration Center

Presented to:
NOAA Restoration Center
EA Engineering, Science and Technology, Inc.
US Fish and Wildlife Service
Massachusetts Division of Marine Fisheries
Buzzards Bay Coalition
US Geological Survey
The New Bedford Harbor Trustee Council
Town of Acushnet

Project Description:
The Acushnet River Fish Passage Restoration project in Acushnet, Massachusetts, improved diadromous fish passage from the head-of-tide to more than 200 acres of prime freshwater spawning ponds 3.8 miles upstream. The project's innovative approach to fish passage was successful and has resulted in a more than 1800% increase of river herring (Alosa pseudoharengus and A. aestivalis) being able to access the spawning ponds over preconstruction conditions. Prior to the project, diadromous fish in the Acushnet River negotiated three dams fitted with failing fishways on their journey to the spawning ponds.

Due to multiple uses of the headponds supported by each of the dams (including water intakes for agriculture), and associated critical wetland habitats, dam removal was not feasible. Working with numerous stakeholders, including dam owners, head-pond abutters and users, citizens, and regulators, a plan was developed to use unique, nature-like designs to improve fish passage and river function at each dam while preserving the headponds. The project team, consisting of a local, state, federal and nonprofit partnership, developed and used a hydrologic model of the watershed to design fish passage at the three dams.

The design for the lowermost dam on the river included partial breach of the spillway, shortening the spillway, and installing a nature-like stone flow-constrictor/step-pool fishway the width of the river channel. Each of the eleven steps (stone weirs) was designed with five notches at different elevations to promote fish passage at various base flows. The design for the second dam on the river included the installation of a nature-like stone step-weir fishway. The design at the dam that impounded the 220-acre spawning ponds consisted of a 240-foot long Denil technical fishway. The $1.8M project, funded entirely with natural resource damages settlement funds by the New Bedford Harbor Trustee Council, was completed in 2007. Pre and post-construction monitoring shows the project has achieved success in meeting short-term fish passage goals and that fish passage on the Acushnet River is on an upward trajectory. This project and the monitoring results have been presented at numerous conferences and DMF published a paper describing the monitoring results as well.

Cumulative delay and passage performance of sea lamprey ascending four fishways.

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Abstract Body:
Sea lamprey (Petromyzon marinus) is an important species in both its native and invasive range. Preventing access to habitat is a driving factor in control efforts, while fishways are generally assumed to pass them effectively in their native range. Despite the importance of barriers to movement of this species, there are very few data describing passage performance through actual fishways. We addressed this data gap by tagging 97 sea lampreys at Holyoke Dam, the first dam on the Connecticut River, and tracking their movements upstream through 4 additional fishways. Sixty percent of tagged lampreys bypassed extensive available habitat to arrive and enter the next fishway on the river, 54.5 km upstream. Movement was rapid, with most fish entering the second dam in less than 2 days, indicating a migration speed >0.45 m s-1. Passage through the fishways was poor, however, requiring multiple attempts. Delays were extensive, with total time to pass the second dam requiring >11 d for most fish. Fewer than half of entrants passed most fishways, and cumulative delays may have restricted further migratory success—only 4% of tagged lamprey arrived at the third dam.

Presenting Author Bio:
Dr. Castro-Santos is a Research Ecologist at the USGS Conte Lab and is one of the organizers and originators of this meeting.

Unintended Fishway Passage and Transport of Native and Non-Native Lampreys (Petromyzontidae)

First Author Name:
Chris Bunt

First Author Affiliation:
Biotactic Inc.

Abstract Body:
A video-based fishway monitoring system was used to count migrating salmonids that inadvertently transported Silver Lampreys *Ichthyomyzon unicuspis* and Sea Lampreys *Petromyzon marinus* upstream through a nature-like fishway that maintains connectivity between Lake Huron and the Beaver River, Ontario. Rainbow Trout *Oncorhynchus mykiss* transported only Silver Lampreys from March to May with mean monthly water temperatures ranging from 6.8 – 15.6 ^{o}C. Chinook Salmon *Oncorhynchus tshawytscha* transported both Silver Lampreys and Sea Lampreys upstream from August (mean temp = 22.6 ^{o}C) to October (mean Temp = 9.0 ^{o}C). Transportation rates were low and ranged from 0.08 % for Rainbow Trout with Silver Lampreys and 0.27 % and 0.61 % for Chinook Salmon that transported Silver Lampreys and Sea Lampreys, respectively. Rainbow Trout with Silver Lampreys and Rainbow Trout with scars took significantly longer to pass compared with Rainbow Trout with no lampreys attached or scars. Chinook Salmon with Sea Lampreys had reduced swimming performance and took significantly longer to pass upstream than fish that transported Silver Lampreys and fish with no lampreys or lamprey scars. This was likely related to bioenergetic consequences of parasitism coupled with increased drag coefficients and increased hydrodynamic resistance; however, this did not preclude successful fishway use.

Presenting Author Bio:
Dr. Chris Bunt founded Biotactic Inc. in 1998 in Ontario, Canada. Biotactic specializes in fisheries conservation, fish passage and remote fish monitoring. Unlike most environmental consulting companies, Biotactic regularly publishes results from their research in peer-reviewed scientific journals.

Evaluation of Fish Passage Following Installation of a Rock Arch Rapids at Lock and Dam #1, Cape Fear River, North Carolina

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Abstract Body:
Previous studies have documented varying degrees of impediment of migratory fishes at each of three lock and dams on the Cape Fear River, North Carolina. With the goal of improving fish passage, a rock arch rapids fishway at the first lock and dam (LD-1, river kilometer (rkm) 97) was completed in November 2012. This is the first known test of this fishway design along the Atlantic coast or for anadromous species. Our objective is to evaluate the passage of fish through the rock arch rapids and at the other two lock and dams (LD-2, rkm 149; LD-3, rkm 186) in 2013 and 2014. Fish passage only occurs via the rock arch rapids at LD-1 but through locking procedures at the other lock and dams. We implanted striped bass Morone saxatilis, American shad Alosa sapidissima, and flathead catfish Pylodictis olivaris with sonic transmitters. At each LD, stationary telemetry receivers were located downstream, in the lock chamber, and upstream to determine when tagged fish arrived and if they passed each dam. For analyses, we excluded individuals that never migrated to LD-1 or never returned to LD-1 after tagging. In 2013, 21% of striped bass (n=43), 50% of American shad (n=32) and 80% of flathead catfish (n=20) passed upstream of LD-1 through the fishway. Mean duration downstream of LD-1 prior to passage ranged from 4.1 days for striped bass to 18.4 days for American shad. Passage rates were variable at the other two lock and dams, ranging from a low of 36% for American shad at LD-2 (n=9) to 100% at LD-3 for both striped bass (n=7) and American shad (n=5). For 2013, the rock arch rapids fishway passed all three species, but did not meet pre-determined success criteria (80%) for striped bass and American shad.

Analysis of Multiyear Acoustic Telemetry Data to Assist in Determining Operations at Bonneville Dam on the Columbia River

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Abstract Body:
To improve survival and passage of juvenile salmonids migrating through the Federal Columbia River Power System (FCRPS), the US Army Corp of Engineers (USACE) has been using physical and numeric hydraulic models of the dams to test structural and hydraulic changes, and consequently prioritize modifications. Acoustic telemetry is one such

tool that the USACE, Portland District has used to address 1) the evaluation of structural and hydraulic improvements, and 2) quantify passage and survival of juvenile salmonids on the lower Columbia River hydroelectric dams between 2008 and 2012. During this period, a total of 73,549 juvenile Chinook salmon and steelhead were surgically implanted with Juvenile Salmon Acoustic Telemetry System acoustic transmitters and passive integrated transponders, which after release were monitored on dam mounted and autonomous receivers deployed in river reaches.

Although the primary purpose of these studies was to estimate passage survival within years, additional processing and analysis of these large datasets across years can be used to verify the models and “ask the fish” which operating conditions are best for survival. Using these multi-year datasets, we were able to evaluate survival of juvenile salmon passing through the turbines at Bonneville Dam powerhouse 1 and powerhouse 2 over the entire turbine operating ranges to identify the best operating conditions of the turbine units that provide juvenile salmonids with the safest and most efficient passage conditions. We also evaluated spillway survival to determine if survival was reduced in certain regions of the spillway due to erosion and if survival varied across the range of spill conditions.

Presenting Author Bio:
Mark Weiland is a senior research scientist at PNNL. His main focus is evaluating passage of juvenile salmon through the Columbia and Snake River hydropower system using Juvenile Acoustic Telemetry System (JSATS), hydroacoustics and acoustic imaging to provide support for decisions to improve hydropower facilities for fish passage survival. He has been a key player in the development and implementation of the JSATS for the US Army Corp of Engineers and managed the research and development of the JSATS dam-face cabled array. In addition to acoustic telemetry, he uses hydroacoustics and acoustic imaging technologies as part of fish passage research. Mark is also experienced in installation and monitoring of sensors in harsh environments.

Fishway use and movements of giant migratory catfishes downstream of a large hydropower dam in the Brazilian Amazon

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Abstract Body:
Large tributaries of the Amazon River have recently become the last frontier for the construction of large hydropower projects to supply the growing demands for electricity in Brazil. In the Madeira River, the major tributary of the Amazon River, two hydropower dams (Santo Antônio: 3,568 MW; Jirau: 3,750 MW) are currently at the final stages of construction. These dams may represent a barrier to the long-distance migrations of giant catfishes (e.g., genera Brachyplatystoma, Pseudoplatystoma and Zungaro). In this study, commissioned by Santo Antonio Energia, we investigated the movements of six species of giant catfish (B. rouseauxii, B. platynemum, B. filamentosum, P. tigrinum, P. punctifer, and Z. zungaro) downstream of the Santo Antônio dam and within its 900-m-long fishway. Fish were captured, radio-tagged and released downstream of the dam and monitored by fixed stations and mobile

tracking from January to July 2013. Twelve (4.5%) individuals out of 266 tagged and released were recorded by fixed stations along the dam. Five fish moved between different zones of the dam with the mean time of residence ranging from 18 seconds to 24 days. Residence time was greater near the main spillway. None of the tagged fish passed through the fishway. Only one individual moved into the fishway but left through its downstream end shortly after (3 minutes). Mobile tracking detected 45 fish up to 10 km downstream of the dam, including eight fish that were also detected by fixed stations. In the upcoming migration season (flood season of 2014−2015), we will conduct experiments to investigate the role of flows on attraction and passage of giant catfishes into the Santo Antonio fishway.

Presenting Author Bio:
Biologist and technical director of Neotropical Environmental Consulting and specialized on migration of Brazilian fish.

C3

Barrier Nets for Fish Guidance and Reduction of Entrainment at Water Intakes

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Abstract Body:
Barrier nets have been used successfully at several sites to protect both resident and anadromous fish populations. Two primary applications have been developed. The first is a fish guidance application used to improve collection and transport of outmigrating Pacific salmon (Onchorhynchus spp.). Floating Surface Collectors (FSCs) are being installed behind many high-head dams to collect juvenile Pacific salmon so they can be transported downstream to continue their outmigration. The fish attraction currents generated by the FSCs are quite localized. Many installations, therefore, incorporate large guidance nets to improve fish collection. Guidance nets are composed of 3/32" to ¼" Dyneema netting and currently range in size up to 2,400 feet in length and 300 feet in depth. The anticipated lifespan of the guidance nets are 8 to 10 years with proper maintenance. The second application is as a physical barrier to reduce fish entrainment at spillways and water intakes. The conservation requirements of Section 316(b) of the Clean Water Act will necessitate permits for facilities with cooling water intake structures to reduce impingement of fish and other aquatic populations. Barrier nets provide an economical and effective physical solution to significantly reduce fish entrainment. Barrier nets at existing installations are composed of Dyneema netting in sizes down to 1" stretch mesh. Water velocities at several installations exceed 3.0 fps. The anticipated lifespan of the barrier nets are 3 to 10 years depending upon the site conditions and proper maintenance. Studies at several barrier net installations indicate that conservation requirements are being met, with fish impingement being reduced by up to 96%. With proper engineering, installation and maintenance, barrier nets have even been successfully deployed in harsh environments such as the Great Lakes.

Presenting Author Bio:
Shane Scott is a fisheries biologist and owner of S. Scott & Associates, LLC in Vancouver, WA. He currently works with utilities and other river-oriented industries to develop facility operations and projects to improve fish survival at hydroelectric dams and related facilities. He also works with manufacturers to develop fish protection systems for dams and water intakes. Previously, Mr. Scott worked with the Washington Department of Fish and Wildlife and Tacoma Power, where he developed and implemented fish protection and mitigation projects.

Evaluation of Bar Rack Spacing and Approach Velocity for Preventing Entrainment of Silver American Eels at Hydropower Projects

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Abstract Body:
State and federal resource agencies have been prescribing restrictive intake bar spacing

and approach velocities for downstream passage of silver American eels at hydropower projects in the U.S. These criteria could result in significant costs and lost generation at many projects. To determine the applicability of eel-specific criteria versus those used for other species, we conducted a laboratory evaluation of bypass efficiency for silver eels exposed to a bar rack oriented 90o to the flow with clear spacings of 19 and 25 mm, approach velocities of 0.46 and 0.61 m/s, and a full-depth bypass. Bypass efficiencies were higher for the smaller bar spacing and decreased slightly with increasing approach velocity for both spacings. An analysis of morphometric measurements indicated that eels with lengths greater than 930 mm would be physically excluded from entrainment through 19-mm clear bar openings and eels greater than 1,135 mm would be excluded by 25-mm spacing. The results of this study can be used to assess the relative effectiveness of various bar rack spacing and approach velocity criteria to develop site-specific designs for silver eels that balance biological effectiveness and impacts to project operation.

Presenting Author Bio:
Mr. Amaral is a Principal Fisheries Biologist with Alden Research Laboratory, Inc., located in Holden, Massachusetts. He has B.S. and M.S. degrees in fisheries biology, both from the University of Massachusetts. For the past 22 years, Mr. Amaral has been extensively involved in the design, evaluation, and application of fish passage and protection technologies at water intakes and in the development of biocriteria for improving the survival of fish passing through hydro turbines. Recently, his research has focused on the mechanics of turbine blade strike and the use of theoretical models for predicting blade strike probability and mortality of fish passing through conventional and hydrokinetic turbines.

Modeling of a non-physical fish barrier

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Abstract Body:
The migration of salmonids in the San Joaquin and Sacramento Rivers is of great environmental interest due to decline of native species. Juvenile salmonids encounter alternative pathways during migration to the Pacific Ocean. Passage through the interior Delta decreased the survival of juvenile Chinook salmon. Fish diversion into the Delta may result in delayed migration, elevated risk of predation, exposure to poor water quality conditions, and mortality in pumping facilities. Non-physical barriers (NPBs) can deter fish from entering an undesirable pathway without restricting flow. NPBs may be comprised of a bubble curtain, low-frequency sound, and hi-intensity light-emitting diode (LED) Modulated Intense Lights (MILs).
The goal of this study is to develop numerical modules to be incorporated into a computational fluid dynamics (CFD) code to predict bubble, sound and light fields in the vicinity of an NPB for Chinook salmon. The modules were developed in the open source code, OpenFoam, which provides an efficient mechanism for research, collaboration, and

technology transfer by removing proprietary software issues. A Boussinesq approach is used to account for the reduction of density in the zones where bubbles are present. A simplified diffusive model of sound intensity is presented as the base of the sound module. The proposed method for light is based on the superposition of analytical solutions for elementary one-dimensional cases, written as a transport equation. To validate the solvers, several well-known experiments were simulated. Model application to the NPB located at the intersection of the Old and San Joaquin Rivers will be presented and discussed.

Presenting Author Bio:
Marcela Politano is an Associate Research Engineer at IIHR-Hydroscience & Engineering, The University of Iowa. She holds a PhD from Instituto Balseiro, Argentina. Her background includes modeling of multiphase flows, total dissolved gas, and heat and mass transfer. She has expertise in numerical modeling of the hydrodynamics and water quality in rivers, tailraces, reservoirs and fish passage structures. During the past 10 years, she had supervised over thirty projects for the power industry.

Increased Downriver Passage of Juvenile Blueback Herring after Reconfiguring an Ultrasonic Field

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Abstract Body:
Populations of blueback herring, Alosa aestivalis, an important anadromous forage fish in northeastern USA, have been depleted from historic levels. Measures to reduce mortality from many sources, including entrainment by hydroelectric turbines, are considered to be important to restore populations back to sustainable levels. At Crescent Hydroelectric Project (Crescent) on the Mohawk River, New York, ultrasound (122-128 kHz) was produced to deter out-migrating blueback herring adults and juveniles to sea from entering the intake channel to the Crescent headrace and turbines where mortality may occur. To increase the deterrence rate observed in 2008, the sound field was extended further upriver to expose juvenile blueback herring to an increasing sound gradient as they migrate downriver and allow them more time to avoid the intake channel. When juvenile blueback herring were present upstream of Crescent from 8 September through 10 October, 2012 and exposed to an ultrasonic field, catch per unit effort (CPUE) by pelagic trawling in the main channel downriver of the ultrasound was 94% of the CPUE in the upriver trawl region and 250% of the CPUE in the intake channel. Repeated mobile acoustic surveys revealed total abundance of juvenile blueback herring averaged 35 times higher in the downriver main channel region than in the intake channel region. During the peak migration period of 20 September through 14 October, continuous monitoring by fixed-location horizontal transducers revealed that 76% of the cumulative net downstream passage of juvenile blueback herring at the upriver site occurred through the downriver site in the main channel, thus bypassing the turbines. This was significantly higher than expected

assuming that entrainment is proportional to river flow and higher than the proportion observed in presence of the previous ultrasound field. These results demonstrate significantly improved downstream passage at Crescent for the majority of out-migrating juvenile blueback herring.

Presenting Author Bio:
Ben Lenz has worked as a hydroelectric utility representative since 2005; the Columbia River basin for five years and currently for the state of New York. He has also worked for federal and state resource management agencies, including the National Park Service and the state of Wisconsin. He's a graduate of West Virginia and Wisconsin-Madison Universities.

Use of Electric Fish Guidance Technology to Deter Salmonids from Entering Hydro Tailraces and Intake Canals: Two Case Studies

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Abstract Body:
The global hydropower community faces constant challenges in protecting and preventing various fish species and life stages from entering hydropower and dam-related tailraces and intake canals. Many different technologies have been attempted with varying degrees of success. Of the more than 50 Graduated-Field Fish Barriers (GFFBs) already in operation around the world, we review two case studies from projects designed to prevent fish from entering hydropower tailraces and intakes with electric gradients. In both deployments mild, non-lethal fields of pulsed-DC electricity were successfully used to prevent entry into hydro-related facilities at levels far lower than those biologists use to non-lethally sample fish with electrofishing technology. At Vessy Hydroelectrique Station near Geneva, Switzerland, a bottom-mounted GFFB was constructed in the tailrace just above its confluence with the River Arve. The goal was to prevent upstream movement of fish into the tailrace. Of 339 radio-tagged brown trout released below the electric barrier in the tailrace, none were found upstream (and none could access the powerhouse, thus achieving the desired goal). In the case of the array used at Gunnison Diversion Tunnel near Montrose, Colorado, a series of vertically suspended electrodes were deployed to create the electric deterrence fields. The goal was to prevent downstream-moving, adult rainbow trout from entering this intake canal. Preliminary observations suggest deterrence success at Gunnison. More robust results will follow from surveys by government agencies when the structure is de-watered during spring to assess whether fish entered the canal and/or became stranded in Diversion Tunnel pools. GFFB technology provides innovative approaches for deterring or blocking fish migrations near or into hydropower facilities such as intakes and tailraces. Other conceptual fish deterrence models (and electric deterrence arrays in hydropower draft tubes in Beeston, U.K.) will also be discussed.

Presenting Author Bio:
Martin O’Farrell is a fisheries scientist with PhD from the National University of Ireland in Galway (and Post-Doctoral Fellowship at Trinity College in Dublin). During the early part of his fisheries career, he focused on assessment and management of Atlantic salmon and migratory trout stocks that supported important commercial and recreational fisheries in Europe. He then spent

a decade as full-time fisheries consultant with Ireland's national Electricity Supply Board, designing and executing fisheries management programmes for Atlantic salmon and European eel on river systems fuelling hydroelectric generating stations. He has widespread international experience in fisheries management issues associated with hydroelectric development and has participated in turbine passage survival assessments for Atlantic salmon smolt in Ireland, Scotland and Russia, and for American eel and steelhead in the USA. For 15 years Martin owned and managed an Irish company involved in the manufacture of electrofishing equipment and electric fish barriers. He now runs the European office of Smith-Root and routinely participates in research and development projects throughout the U.S. to develop and test innovative fish guidance and marine mammal deterrence technologies.

D3

Stream Simulation Design in High Gradient Channels

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Abstract Body:
High gradient channels (>3%) need to be treated differently than low gradient channels (<3%) from a stream simulation design perspective. High gradient streams are composed of natural grade controls (steps, cascades, and large roughness elements) that mobilize infrequently (Q30 to Q80) and control bed elevation with finer grain materials mobilizing on a more frequent basis (Qbf). In comparison low gradient channel bed materials mobilize more frequently (Qbf or less) and do not contain rigid grade controls. These differences cause high gradient channels to be more rigid and static and low gradient channels more flexible and responsive, which in turn pose different site and risk consideration during the design process.

During the last 15 years of stream simulation design and implementation, continual improvements in methodology and construction techniques have led to greater success in higher gradient channels. This presentation will focus on design methodology and lessons learned from construction and monitoring of these higher gradient structures. Assessment and design methodology will be discussed along with construction techniques.

Presenting Author Bio:
Robert Gubernick is the watershed restoration geologist for the eastern region of the USDA FOrest Service. He is also one of the national cadre of the washington office virtual AOP design team providing training and design support for the national forest system for aquatic organism passage design. He has 29 years of design and construction experience of aquatic organism passage structures

Stream Simulation in Very Low Gradient Channels

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Abstract Body:
Very low gradient channels (<0.5%) have several common characteristics that require consideration during stream simulation culvert design. They have predominantly sand channel materials, tend to be located in wetlands with broad floodplains, have moderate sinuosity, may lack pool-riffle morphology and frequently do not transport sediment sizes larger than sand. When the natural tailwater will provide suitable depth

and velocity to allow for aquatic organism passage and the natural transport of sediment and organic material, a bankfull width culvert set at the proper elevation will frequently provide adequate stream simulation. The invert elevation must be based on analysis of the stream profile. Culvert capacity is checked with traditional hydrology and hydraulics to ensure the culvert will pass Q100 with a HW/D <1. Depending on length, the invert is often set flat and material may or may not be placed in the culvert. Many existing stream crossings have culverts that are undersized and set too high. This causes several common problems including: (1) stagnant backwaters with aggradation that extends long distances upstream; (2) large plunge pools with high tailwater controls and braided outlets; and (3) large downstream sediment deposits from frequent failures. Recognizing and accounting for these problems during survey and design can restore streams and dramatically improve road infrastructure.

Presenting Author Bio:
Dale Higgins is a hydrologist for the Chequamegon-Nicolet National Forest in northern Wisconsin. He has 34 years of experience in wildland hydrology. Over the past 16 years he has been involved in the replacement of over 200 stream crossings to provide aquatic organism passage, restore channel morphology and improve infrastructure. His work has included FERC hydropower relicensing, stream restoration, riparian management, forestry best management practices, lake and reservoir management, aquatic ecological classification and water resource monitoring.

Do Stream Simulation Culvert Designs Improve Ecosystem Function? A Case Study in Northern Wisconsin

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Abstract Body:
The stream simulation culvert design was developed to restore aquatic organism passage with the assumption that ecosystem function would also be better maintained. Our objective was to investigate whether full stream simulation culverts, where culverts are replaced to accommodate bankfull widths and stream bottoms are rebuilt, maintain ecosystem functions better than partial stream simulation designs, where culverts are replaced but stream bottoms are left to fill naturally, by evaluating three measures of ecosystem function: hydrologic exchange, CPOM (coarse particulate organic matter) retention, and nutrient cycling. Three full stream simulations were paired with partial stream simulation culverts and processes were measured in reaches above, through and below replaced culverts. We also measured hydrologic exchange and CPOM retention above and through culverts at nine additional sites including 2 full stream simulations, 3 partial stream simulations, and 4 non-replaced culverts.
Nutrient uptake velocities ranged from 0.027 to 0.187 mm/sec, with no statistical differences between above and below culverts

or among culvert designs. The mean stream velocity decreased 33.8 % through partial stream simulation culverts compared to upstream reaches, but increased 16.7% and 66.1% through non-replaced and full stream simulation culverts, respectively. CPOM retention decreased 74% through full stream simulation culverts compared to upstream reaches, but decreased 98.1% and 99.5 % for partial stream simulation and non-replaced culverts. The main and interaction effects between reach and culvert design were all significant (two-way ANOVA, $p<0.05$) for both average velocity and CPOM retention. Full stream simulation culverts better maintain CPOM retention rates through culverts compared to non-replaced and partial stream-simulation designs. However, we observed no significant differences in stream ecosystem functions upstream or downstream of road crossings due to differences in replacement culvert design.

Benefits of Stream Simulation Design Culverts on Biological Productivity

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Abstract Body:
Typical goals of aquatic organism passage projects include providing adequate passage of targeted fish species, or occasionally passage of all fish, aquatic organisms, sediment, and debris. Most project objectives do not consider whether in-stream biological productivity or other ecological functions are improved. We examined differences in habitat and food web responses (periphyton, organic matter, and invertebrates) in upstream, downstream, and culvert reaches at paired road-stream crossings of similar gradient in northern Wisconsin streams. One culvert of each pair was constructed using the full Stream Simulation Design (full-SSD) which mimics natural channel slope, width (bankfull), and structure (filled with natural bed materials) of reference reaches, while the other was designed for bankfull discharge, but left to fill on its own (partial-SSD). Habitat characteristics within full-SSD culverts included shallower depths, faster velocities, and substrate dominated by cobble, pebble, and gravel, while silt dominated partial-SSD culverts. Periphyton standing crop was greater in full-SSD culverts than partial-SSD culverts. Fine benthic organic matter was significantly greater in partial-SSD culverts than at all other reaches. Standing crops of coarse organic matter food resources (leaves and wood) and invertebrate biomass were significantly lower in partial-SSD culverts compared to upstream and downstream reaches. Collector-gatherer chironomids dominated invertebrate communities in partial-SSD culverts, while mayflies, stoneflies, and caddisflies dominated reaches at full-SSD sites. Food webs at full-SSD road-stream crossings more closely reflected reference reaches demonstrating

that full-SSD can provide ecological functions beyond aquatic organism passage.

Presenting Author Bio:
Sue Eggert is a research aquatic ecologist with the Forest Service's Northern Research Station. Her research interests include the influence of riparian habitat and culvert design on the ecology of aquatic food webs and ecosystem processes.

Stream Simulation Lessons Learned – Case Studies from Here and There

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Abstract Body:
Stream Simulation is the design of a road-stream crossing that contains a stream channel that has the same profile, shape, and bed material characteristics as a nearby representative reach. While the concept of creating a dynamically stable stream channel through a pipe seems straight forward, there are many typical problems that seem to be repeated over and over. In this presentation, case studies from around the country are discussed that showcase typical preventable problems that occur in the survey, design and construction of stream simulation projects.

Presenting Author Bio:
Mark is the forest hydrologist and Watershed/Fisheries Program Manager on the White River National Forest in western Colorado. He is heavily involved in the Forest Service's aquatic organism passage (AOP) program as a member of the national teaching cadre, through development a computer-based e-learning tool for road-stream crossing design, and through development of implementation and effectiveness monitoring protocols for AOP projects. He has also assisted the Forest Service International Program with a climate change needs assessments in Vietnam and spatial planning training in West Kalimantan, Indonesia. His past and current graduate work in civil engineering have largely focused on open-channel hydraulics and modeling sediment transport in gravel-bed rivers. His favorite movie is Princess Bride, his first car was a 1968 Volkswagen bug and he is particularly fond of dark chocolate.

Factors to Consider When Selecting a Structure for an AOP Design

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Abstract Body:
Over the last decade, federal and state agencies have made a significant investment in the development of stream simulation design methodology for Aquatic Organism Passage projects. This process has focused primarily on the stream and while it has provided guidelines for structure size, there are many other factors to consider in determining the best type and shape of structure to use. Proper structure selection ultimately affects cost, efficiency, durability, and length of construction of the project.
A brief overview of the types of structures available and in-depth discussion of the many factors that can affect the choice of the structure itself at any given site will be

provided. These factors can include, but are not limited to: structure to stream alignment, fill height, depth of embedment, depth to bedrock, types and condition of geologic materials, road access, site terrain configuration, maintenance and service level of the road, environmental factors (pH), , and availability of construction materials and equipment.

Presenting Author Bio:
Holly has been a civil engineer with the Forest Service for over 20 years. For the past 10 years she has focused primarily on culvert replacements for aquatic organism passage using stream simulation designs. In this time, Holly has completed designs and installations at over 40 sites, providing access to more than 100 miles of mountain streams.

A4

Alternatives to sea lamprey barriers: pheromones and trapping

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Abstract Body:
Upstream migration barriers remain a critical component of the sea lamprey control program. However, sea lamprey barriers limit passage of non-target species and many are degrading. Therefore, fishery managers would likely opt to remove barriers if alternatives were available. Recently, progress has been made in the understanding of chemosensory communication in the sea lamprey, which may be exploitable for sea lamprey control purposes. Specifically, reproductive pheromones have been characterized including; a migratory pheromone released by larval sea lamprey that signals the suitability of a stream for spawning, and a mating pheromone released by sexually mature male sea lampreys that signals to sexually mature females a males readiness to mate. More recently, a sea lamprey alarm cue has been discovered that is released from dead and decaying sea lampreys and may signal to adult sea lampreys that an area is not suitable for inhabitation. Both reproductive pheromones and the alarm cue likely play a critical role in the successful reproduction of a species that dies shortly after spawning. Therefore, these chemical cues may be useful for manipulating sea lamprey behaviors to enhance trapping or disrupt reproduction. Because chemical cues are naturally present in the environment they could be environmentally benign and species-specific.

Presenting Author Bio:
I study fisheries with an emphasis on fish behavior and physiology. My research has focused on control of invasive sea lamprey and restoration of native lake trout in the Great Lakes. Specifically, I study the chemical ecology of sea lamprey and lake trout to advance the development of innovative techniques to manage these species. My research also has focused on whether low voltage electric fields can be used to block and or guide sea lamprey migration.

Accounting for sea lampreys in a Great Lakes barrier removal decision support tool

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Abstract Body:
Tributaries to the Great Lakes are highly fragmented by dams and road crossings that act as potential barriers to migratory fishes, restricting their access to historical riverine spawning grounds. There is growing investment in removing or modifying these barriers to restore native fish migrations and ecosystem function, but these efforts may also increase available habitat for invasive species like sea lampreys (Petromyzon marinus). In the Great Lakes basin, the restoration community lacks a systematic method for comparing these costs and benefits to assess which barrier removal projects would offer the greatest return on investment. To address this problem, we developed a basin-scale mathematical optimization model to prioritize barriers for repair/removal on the basis of upstream breeding habitat for both lampreys and native fishes. We parameterized this model using a recently developed database of dams (n=7,091) and road crossings (n=268,818); economic models of projected barrier removal costs; and historical field survey data describing the distributions of both native and invasive species. Using this model, we delineated Pareto curves that describe, for a given budget, optimal trade-offs between native migratory fishes and sea lampreys that would accompany numerous barrier removal scenarios. These curves are highly nonlinear, indicating that there are locations where barrier removals can be expected to substantially increase habitat available to native fishes without a corresponding increase in preferred lamprey habitat. In other locations, barrier removals would likely substantially increase the amount of accessible sea lamprey habitat while offering little benefit to native fishes. We will discuss the sensitivity of the model to uncertainty in our estimates of the suitability of tributaries for native and invasive species.

Lamprey Barrier Design and Fish Passage in Great Lakes Tributaries

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Abstract Body:
Exotic sea lamprey control has been an issue in the Great Lakes since the crash of lake trout populations in the mid to late 20th century. Keeping lamprey out of tributary streams conflicts with efforts to remove dams to improve stream connectivity and passage for a variety of native and game species. This talk examines the regulatory and design challenges associated with lamprey barriers and dam removal. Examples of recent projects will present hydrologic and hydraulic analysis used, regulatory issues discussed and implementation strategies adopted.

Presenting Author Bio:
Jason Carey - Jason has 15 years of experience managing over 70 major projects involving river restoration, river recreation, master planning, geomorphic assessment, natural channel design, wetlands restoration, river stability analysis, bio-stabilization, sediment transport, floodplain determination, reservoir capacity analyses, dam removal planning, hydraulic design of structures in the river environment, design of erosion control measures, design of irrigation canals, hydraulic bridge design, diversion structure design, design of aquatic habitats, and whitewater park design.

B4

Fish numerical model based on fish behavior in flumes

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Abstract Body:
The efficiency of engineering solution, which focuses on the environmental integrity in freshwater, depends on the predictability of fish behavior in such facilities. Hydraulic flow features are especially important aspects that impact fish behavior. During the last years, numerical tools have been developed and contributed to detailed knowledge about hydraulic parameters in different flow regimes. Nowadays, Computational Fluid Dynamics (CFD) can provide flow features in three dimensions. On the order hand, fish behavior studies have been conducted and information about how the hydraulic flow drives fish is being collected in laboratory facilities. The aim of this study was to combine hydrodynamic information with fish behavior in a numerical model. Flume experiments described in the literature (Castro-Santos, 2005; Castro-Santos et al., 2013) were used as base for this work. The model was developed in two different codes: in the commercial code Fluent (Ansys package) and in the open source OpenFoam. The discrete Reynolds-averaged Navier-Stokes (RANS) equations were solved for a flume -using a rigid-lid approach for the free-surface. Hydrodynamic parameters were the bases for numerical representation of fish movement. A Lagrangian model that takes into account the drag force and fish thrust for developing the optimum velocities was used. Comparison of model results with both codes and the movement of three fish species (American shad, Blueback herring and Walleye) will be presented.

Presenting Author Bio:
Hersília is professor at Civil Engineering Department of Centro Federal de Educação Tecnológica de Minas Gerais (Brazil) since 2007. Her scientific expertise are on ecohydraulic issues, acting on fish passages models (numerical and scale models); fish swimming capability (voluntary and non-voluntary tests); river models (2D and 3D numerical models) and fish habitat suitability.

Three dimensional multiphase CFD model for studies of fish behavior: an application to Três Marias dam (Brazil)

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Abstract Body:
Most of hydraulic studies related to fish migration are related to the flow characteristics inside fish passages. However, the flow also influences the fish behavior in

downstream areas of dams. Stream features in these areas are especially important to analyze the location of fish passage entrance as well as the operation of the dam, such as spillways and turbines flows, in order to maximize the fish survival. In Brazil, there are concerns about fish populations in downstream areas of hydropower plants because of dams operation might produce important environmental impacts. In 2007, approximately seven fish tons were killed during a turbine shutdown operation. Most fish were concentrated close to the downstream spillway area and the first turbine unit. The aim of this work was to create a three dimension multiphase model of hydraulic flow which occurs downstream Três Marias dam. The geometry of the tailrace and some parts of downstream reach were built in CAD software. Unsteady RANS equations were solved using the commercial software Fluent (Ansys package). The model k-ε was applied for the turbulence closure. In the simulated scenario, three of six turbines were used and they had a discharge 10.96m3/s, 10.96m3/s and 10.8m3/s. For this turbine layout, field data were collected by Acoustic Doppler Current Profiler (ADCP). Results indicated that the flow in the tailrace may is highly turbulent with presence of a big vortex. The comparison between numerical results and field information indicated good approach. Numerical results indicate that some structures such as a wall on the right river bank affect the general flow pattern in the tailrace. The absolute velocities in the area nearby the dam (2 to 3 m/s), proved the existence of a region where native species can access.

Presenting Author Bio:
Hersília is professor at Civil Engineering Department of Centro Federal de Educação Tecnológica de Minas Gerais (Brazil) since 2007. Her scientific expertise are on ecohydraulic issues, acting on fish passages models (numerical and scale models); fish swimming capability (voluntary and non-voluntary tests); river models (2D and 3D numerical models) and fish habitat suitability.

The 3-Dimensional Design of Midwestern Grade Control Structures for Karman Gait Fish Passage Characteristics

First Author Name:
Alan Schlindwein

First Author Affiliation:
U.S. Army Corps of Engineers

Abstract Body:
The Blue River Channel Improvements Project was finished in 2011 with the construction of in-channel structures in the transition reach from the flood conveyance channel to the up-river natural channel. The primary transition structures were six rock-based grade control structures that controlled the hydraulic drop that naturally occurs at the upriver terminus of flood conveyance channels. These six structures were located in plan-view at the exit of river bends so that they supported pools in these bends while centering the river flow into the downriver riffles. The centering of river flow below these structures prevents the direct attack of the channel banks by storm flows. This flow centering was created on these grade control structures by establishing flow separations on both sides of the entrance crest. Combining matching flow separations on these crests utilizes LaGrangian Fluid Dynamics concepts to create a 3-dimensional flow environment over each grade control structure that inherently has fish passage characteristics.

LaGrangian Flow Dynamics allows for the Conservation of Identity in the flow environment. Conveyance is provided in a core flow zone, while secondary flow circulation cells are allowed as ineffectual flow zones along both banks. The interface between these two zones is a shear surface along the flow separation that transfers momentum between these flow zones through turbulence. As a result the primary energy

dissipation in the flow column is along this water-to-water interface. If this flow separation is set up correctly, it can result in a consistently repeating series of turbulence cells called a vonKarman Vortex Street. Lauder and others have shown that most fish can efficiently swim upstream in such repeating flow cells using the Karman Gait.

The designer has used exposed boulder on similar grade control structures to create these vortex streets. The boulder acts much like the bow of a ship in creating a shock wave that transition to trailing flow separations on each side of the disturbance. In a flashy urban river, the number of exposed boulders needed for fish passage in a narrow transition structure is totally impractical. However in a narrow structure, if the entrance condition along each bank is a blunt surface, a matching shock wave can be created from opposing banks that casts two matching flow separations into the center of the grade control structure. This approach inverses the exposed boulder strategy while strongly centering the flow into the downriver channel.

In practice, the blunt surface is simply a stacked layer of boulders on the channel banks. One of the characteristics of natural grade controls, called geologic nick points, is a constriction at the crest composed of exposed boulders. This constructed, blunt constriction creates the shock wave that initiates the flow separations into the crest. These flow separations quickly create secondary flow circulations, which leads to the formation of the vortex streets. After some distance the flow deepens and each vortex street degenerate into general turbulence cells. The general turbulence cells eventually expand to the center of the channel and meet. This causes a turbulent central flow that enters the downstream channel and this turbulence quickly subsides. Both the vortex street and the general turbulence cells will maintain a secondary flow circulation along the edge of the rock-lined channel bank. The amazing characteristic of these secondary flow cells is that the flow against these rock-lined banks is actually in the upstream direction.

This repeating turbulent surface along the flow separation, along with the upstream flow along the banks, allows fish to migrate easily up to the crest. Coincidently this situation should also allow kayakers to move up these grade control structures in a similar manner. At the crest, the fish can utilize their burst speed gait to transition the entrance shock wave and enter the upriver pool environment. Kayakers may be more interest in riding the turbulent core back downriver.

Presenting Author Bio:
Alan Schlindwein, PE, D.WRE is a Senior Hydraulic Engineer with the Hydrology & Hydraulics Section of the US Army Corps of Engineers' Albuquerque District. He obtained his Masters of Engineering in Civil Engineering from the University of Louisville in 2003 and obtained his Post-Masters in Environmental Engineering from the Johns Hopkins University in 2005. He has been working in the water resources field since obtaining his Bachelors in 1982 and specialized in 1998 on natural channel design. His major accomplishments include the 1995 Agency River Champion Award from the Friends of the Chicago River for Leadership on the Prairie Wolf Slough Wetlands Project; the award winning fish passage project for the Woodrow Wilson Bridge Environmental Mitigation Project; and the successful analysis & remediation of the failed Red Ramp stream and wetlands mitigation project on Pope Air Force Base. For the US Army Corps of Engineers, he has been recognized the design of nature-like riffle grade controls to stabilize the Blue River flood control channel, the subject of this abstract. This Project received the 2012 Alphonse J. Dell'Isola Award for Outstanding Achievement in Construction and a 2012 Kansas City Environmental Achievement Award; and was

the subject of the “The Greening of the Blue River,” printed in Civil Engineering, ASCE, December 2012.

An approach to model swimming behavior of smolts in the forebay of hydro dams

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2. Marcela Politano
3. Larry Weber
4. Mark Timko

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Abstract Body:
Effective design of fish bypass structures and reduction of forebay residence time are important to facilitate fish downstream migration. These goals can be better achieved understanding the interplay between fish behavior and hydrodynamics. This paper presents a numerical model that simulates Chinook salmon, sockeye salmon, and steelhead migratory behavior in the forebay of hydropower dams. Chinook swim paths were measured in the forebay of Rocky Reach Dam and sockeye and steelhead swim paths were measured in the forebay of Priest Rapids Dam. Model parameters were developed by analyzing flow conditions from CFD simulations and the three dimensional measured swim paths. Probability distributions that represent swimming characteristics such as fish orientation and swimming thrust were developed and implemented in a particle tracking algorithm. Predictive capabilities of the model were tested for flow conditions recorded in Priest Rapids Dam. Relative differences between model results for forebay residence time and fish final exit are on average below 20% and 12%, respectively. Agreement between model predictions and measured final exit for Chinook indicates that the methodology presented in this paper could be used to simulate fish behavior in locations different from those where swim paths were measured. This is true only if fish are in a similar life stage. This methodology also has the potential to be used to simulate fish reactions to other stimuli like temperature, total dissolved gas, light, and sound.

Presenting Author Bio:
Antonio Arenas holds a Ph.D. on Civil and Environmental Engineering from The University of Iowa. For his dissertation he developed a numerical model to simulate the behavior of smolts in a dam reservoir. In the last five years he has worked in several CFD studies related to water quality and fish passage design including Total Dissolved Gas (TDG) simulations at Wells Dam and Hells Canyon Dam, temperature dynamics at Brownlee Dam, spillway deflector design at Hells Canyon Dam, and downstream fish passage design at Cowlitz Falls Dam. He has also applied physically-based models to examine the hydrologic budget of a HUC 12 watershed. Numerical results will be used to identify regions within the watershed where modifications can be made to mitigate flood-related damages.

Fish Passage Design Using CFD Modeling

First Author Name:
Navid Nekouee

First Author Affiliation:
Tetra Tech

Other Authors:
Hugo Rodriguez, Steven Davie

Other Authors Affilliations:
Tetra Tech

Abstract Body:
A fish passage structure was studied to determine the hydraulic efficiency for passing the desired flow and meeting the required design criteria. The fish passage was designed to resemble a natural environment by creating nature-like rapids and pools. A CFD model (Flow3D) assisted the design to study the small scale hydraulic features between the rocks and over the weirs and pools and changes in velocity and water surface elevation. Flow3D was a useful tool in predicting the details of the hydraulic process in and out of the channel. Coarse model runs provided useful information about the combined dam and channel hydraulic efficiency. The nested model predicted the detail of the flow, velocities and depth around the rocks and at different sections of the channel. The design showed a flow capacity of up to 8,000 cfs through the fish passage. This was in agreement with the design requirement of the structure and the future operation mechanism of the nearby dam and the raised spillways. The minimum depth for the fish movement was maintained in studied scenarios and the velocities were below maximum velocities through the cross section.

Presenting Author Bio:
Dr. Nekouee has over 10 years of experience in environmental and water resources engineering. His specific environmental engineering experience includes physical models of mixing water tanks for municipalities, design of wastewater lift stations, bulk sodium hypochlorite feeders for water treatment systems, waste management and remedial studies of tailings dams, environmental testing for communities around superfund sites, and systematic studies for irrigation channels. He also has supported regulation through environmental assessments, environmental impact statements (EIS), evaluations to meet regulatory compliance, and stormwater monitoring. His water resources engineering experience includes coastal engineering, hydraulics, hydrology, computational fluid dynamics (CFD), sediment transport and water quality modeling. He has also developed comprehensive three-dimensional beach bacterial forecasting hydrodynamic and fate-transport models for Great Lakes Coastal Forecasting Systems (GLCFS), developed hydrodynamic and water quality models for nutrient criteria and total maximum daily loads (TMDLs), and performed modeling to determine wave run-up heights for FEMA (Federal Emergency Management Agency) flood certification.

C4

Social and Political considerations for Fish Passage at Hydro Dams in the Age of Asian Carp and Other AIS

First Author Name:
Denny Caneff

First Author Affiliation:
River Alliance of Wisconsin

Abstract Body:
While getting the engineering and biological aspects of fish passage right are obviously important, perhaps more important is a good educational strategy for the public and clarity of intentions with utilities, especially if Asian carp are knocking at the door. A public utility in Wisconsin had fish passage prescribed (required) in its operating license for its dam on the Wisconsin River in 2002. After years of delay (caused by utility recalcitrance and agency passivity), there was finally a plan to move forward on fish passage at this dam in 2012. But due to a misunderstanding between the utility and the agencies about responsibility for fish handling, the utility panicked, contending it would be liable for spreading Asian carp throughout Wisconsin River basin. The utility went on a full-court public relations offensive, turning public and political opinion against fish passage, causing the resource agencies to retreat, and possibly bringing down the project. This is a case study of how not to handle a fish passage project, with suggestions for how controversies around it could be managed.

Don't Forget the Natives!

First Author Name:
Nick Frohnauer

First Author Affiliation:
Minnesota DNR

Abstract Body:
The Minnesota Department of Natural Resources (DNR) believes Asian carp pose a serious threat to the Upper Mississippi River basin in Minnesota. Asian carp are advancing northward in the Mississippi River and are poised to enter southern Minnesota from Iowa lakes and streams. The Minnesota DNR has taken a proactive approach to the threat of Asian carp expansion into Minnesota. One of the actions is constructing barriers to prevent Asian carp from entering new areas. While simple in theory, potential implementation comes with controversy and concern. This presentation will discuss Minnesota DNR's experiences with barriers: effectiveness, cost, benefits, impacts, and let's not forget about the natives.

Presenting Author Bio:
Nick Frohnauer graduated from the University of Wisconsin-Madison with a B.S. in Conservation Biology and from Iowa State University with a M.S. in Fisheries Biology. He has worked from Maine to Idaho and from Missouri to Minnesota. He has had the honor of getting smacked by a 20 plus pound silver carp and is currently the Invasive Fish Coordinator for the Minnesota Department of Natural Resources.

Natal environment and movement of Asian carps in the upper Mississippi River inferred from otolith chemistry

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Southern Illinois University

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2. Jacob Norman
3. Quinton Phelps

Other Authors Affilliations:
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3. Missouri Department of Conservation

Abstract Body:
Knowledge of the principle natal environments, immigration rates, and movement patterns of bighead carp (Hypopthalmichthys nobilis) and silver carp (H. molitrix) in the upper Mississippi River would be valuable for developing control strategies to limit further population expansion and impacts of these species, particularly upstream from Lock and Dam 19 where they are currently less abundant. However, the relative contributions of the upper Mississippi River itself, its principle tributaries, and the middle Mississippi (downstream of the Missouri River confluence) and Missouri rivers to Asian carp stocks in the upper Mississippi River is unknown. The objectives of this study were to identify natal environment and characterize lifetime inter-river movement patterns of adult Asian carps in pools 20-26 of the upper Mississippi River using stable isotope and trace elemental signatures in otoliths. Results indicated that the majority of adult Asian carp in this section of the Mississippi River were immigrants that originated in the middle Mississippi River and have moved between the upper and middle Mississippi Rivers multiple times during their lifetimes. Efforts to suppress further increases in abundance of Asian carps in the upper Mississippi River should account for the importance of downstream river reaches to Asian carp recruitment.

Asian carp expansion in the Mississippi River: Focusing on the leading edge of the stronghold

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Missouri Department of Conservation

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2. Kevin Haupt
3. Quinton Phelps

Other Authors Affilliations:
2. &3. Missouri Department of Conservation and Southeast Missouri State University

Abstract Body:
Asian carp have been expanding their range up the Mississippi River; however abundance is thought to be higher in the lower reaches which are in closer proximity to the Illinois River. However the Asian carp population has a stronghold in the Upper Mississippi River, with Lock and Dam 19 at Keokuk, IA being the only barrier to slow the expansion further up the Mississippi River. As Asian carp abundance increases below Lock and Dam 19, it is important to investigate potential means of control that will prevent or delay the complete invasion of the Mississippi River above Lock and Dam 19. In the summer of 2013, silver and bighead carp were collected below Lock and Dam 19 to determine size structure, condition, age, growth, and mortality of the population at the leading edge of the invasion. We can then use this information to model the population and determine potential ways to control the Asian carp population and prevent continued expansion. During this time period 20 Asian carp were also implanted with ultrasonic transmitters to evaluate rate of passage through the lock chamber at Lock and Dam 19. Stationary receivers were placed strategically below the entrance of the lock chamber and above the lock and dam, as well as with in the lock chamber. This information could be used to determine whether potential barriers need to be placed at the entrance of the lock chamber entrance to prevent Asian carp passage upstream into pool 19.

Fish passage at hydropower dams in Wisconsin and concerns with invasive species, disease, and contaminants

First Author Name:
Nick Utrup

First Author Affiliation:
U.S. Fish and Wildlife Service

Abstract Body:
Historically, many Midwestern migratory fish species, such as lake sturgeon (Acipenser fulvescens) and paddlefish (Polyodon spathula), had free and unobstructed access to feeding and spawning areas in rivers and tributaries throughout their range in the Midwest, including the Great Lakes. Major river systems, such as the Menominee River in northern Wisconsin and the Wisconsin River in central Wisconsin, at one time supported vast spawning migrations. Within the past 100 years, however, construction and operation of hydroelectric dams on these river systems has interrupted much of these great migrations. This fragmentation and loss of habitat has contributed to the decline of the lake sturgeon and paddlefish populations throughout the Midwest. One method for reestablishing this lost connection is to create an artificial pathway such as a fish passage facility (i.e., fishway). The U.S. Fish and Wildlife Service (FWS) has been working with state and local partners in Wisconsin and Michigan to design and build fishways to reestablish migratory corridors on rivers historically important to lake sturgeon and paddlefish. In particular, the FWS has been working on two fish passage projects, one on the Wisconsin River near Prairie du Sac, WI (a hydroelectric dam licensed by the Federal Energy Regulatory Commission; FERC) and another at a FERC dam on the Menominee River, a tributary to Lake Michigan near Menominee, MI. At both of these locations, fish passage is complicated by the occurrence of invasive species and disease downstream of the dam, one of which has the added concern of heavy metal contaminants. Of particular concern to fisheries agencies is the emergence of aquatic threats such as Asian carp (e.g., sliver carp and bighead carp) and fish diseases (e.g., Viral Hemorahgic Septicemia). As these projects move toward completion, the agencies need to take great care in how long term project operation may impact the health of the aquatic ecosystem upstream of the proposed fishway. One solution may be to impose a restriction on numbers and species of fishes to be passed upstream. In addition, fishes allowed to be passed upstream may need to be manually sorted and selected based on strict guidelines as approved by the appropriate state agency with jurisdiction. We will explore fish passage projects at FERC dams in Wisconsin and Michigan and discuss how emerging concerns with invasive species, disease, and contaminants are impacting project planning, design, and long term operation.

Presenting Author Bio:
Nick Utrup is a biologist with the U.S. Fish and Wildlife Service, currently stationed in Bloomington, MN. Nick uses his hydropower experience and fisheries background to develop productive partnerships for the purpose of establishing appropriate and effective hydropower license terms and conditions, which includes fish passage in some cases. Nick currently participates in several Implementation and Technical Advisory Teams working on fish passage issues, including the Menominee River Fish Passage Partnership in the Lake Michigan Basin and the Prairie Du Sac Fish Passage Project on the Wisconsin River. Nick is currently working with partners on groundbreaking work to design passage facilities for sturgeon and paddlefish in the Midwest while also working under the constraints and challenges of invasive species and disease. Nick received a B.S. in Zoology from The Ohio State University and an M.S. in Wildlife and Fisheries Ecology from Oklahoma State University.

D4

Fish Passage Enhancement at York Haven Dam – Reconnecting the Lower Susquehanna River

First Author Name:
Stephen Arnold

First Author Affiliation:
HDR Engineering, Inc.

Abstract Body:
On January 30, 2014, York Haven Power Company (YHPC) entered into a comprehensive agreement with resource agencies resolving all issues, including fish passage concerns, associated with relicensing the York Haven Hydroelectric Project (FERC No. 1888). The Project is located on the Susquehanna River, the largest U.S. river east of the Mississippi, near Harrisburg, Pennsylvania, where major efforts to restore anadromous fish populations and construction of upstream fish passage facilities have occurred over the last three decades. In addition to YHPC, the comprehensive agreement included the U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, and Susquehanna River Basin Commission. The parties reached agreement on six core fish passage issues: (1) upstream passage of American shad and river herring, (2) upstream passage of American eel, (3) downstream passage of post-spawning American shad and river herring, (4) downstream passage of juvenile American shad and river herring, (5) downstream passage of silver stage American eel, and (6) resident fish passage. The centerpiece of the fish passage agreement is the planned construction of a new nature-like fishway at York Haven Dam that will allow year-round upstream and downstream passage of all fish species in the lower Susquehanna River and serve to reconnect upstream and downstream aquatic communities at York Haven Dam. This presentation will provide an overview of the various fish passage elements that will be implemented at the York Haven Project under the new FERC operating license; some of the fish passage alternatives that were considered but not adopted; and the studies, data, and analyses that supported the comprehensive agreement.

Presenting Author Bio:
Steve Arnold is a Senior Aquatic Scientist and Professional Associate at HDR Engineering, Inc. in Portland, Maine. He obtained an M.S. in Biology from Michigan Technological University in 1981 and has worked as a fisheries consultant for 31 years, providing services exclusively to the hydropower industry for 25 years. Steve's professional interests include upstream and downstream passage of migratory fish, stream ecology, fish population dynamics, instream flow and associated habitat for aquatic organisms, and multiple-use resource conservation principles.

Installation of Successful Combined Denil Fishway and Eelway at Upper Mystic Lake, MA

First Author Name:
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First Author Affiliation:
The Louis Berger Group, Inc.

Other Authors:
2. Chad Cox
3. Mike Galvin

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2. GZA GeoEnvironmental Inc.
3. Massachusetts Department of Conservation and Recreation

Abstract Body:
Upper Mystic Lake Dam is a low-head dam maintained by the Massachusetts Department of Conservation and Recreation (MADCR) on the Mystic River, in Arlington and Medford, MA. The dam was rehabilitated to meet dam safety requirements, and a new fishway was

constructed to facilitate the upstream passage of diadromous species in the Mystic River, a largely urban watershed. Prior to dam rehabilitation, large numbers of river herring accumulated at the base of the dam and were transported upstream by a “bucket brigade” organized by the Mystic River Watershed Association (MyRWA). After evaluation of alternative designs, and consultations with state and federal fisheries agencies, a standard 4-foot-wide Denil fishway was chosen as the preferred option for upstream passage of alewife, blueback herring, and American shad. Options were also evaluated for upstream American eel passage. Because of MADCR operational concerns about annual installation and removal of a temporary eelway, potential flood effects on a temporary eelway, and aesthetics at this site, a unique design was selected, incorporating a separate 18-inch-wide concrete eelway channel within the overall Denil fishway structure. The fishway construction was completed in 2010 as Phase I, the dam rehabilitation was completed in 2011 as Phase II, and both fishways have since been operating successfully. This paper will provide additional details of the fishway design, and the results of river herring and American eel monitoring in 2012 and 2013, the first two years of monitoring. River herring counts indicate a healthy run in the Mystic River, at a time when other rivers in the Northeast have experienced significant declines in river herring populations.

Presenting Author Bio:
Senior fisheries scientist with the Louis Berger Group, with about 40 years of experience with fish passage design and operations and other environmental studies related to licensing and operation of hydro and other energy projects throughout the US.

Process for Selecting the Optimum Location for a Juvenile Fish Bypass Outfall at Lower Granite Lock and Dam

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Gresham, Smith & Partners

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2. U.S. Army Corps of Engineers, Walla Walla District

Presenting Author:
Sean C. Milligan, P.E.

Presenting Author Affiliation:
U.S. Army Corps of Engineers, Walla Walla District

Abstract Body:
The Walla Walla District of the U.S. Army Corps of Engineers owns and operates several large lock and dams on the lower Snake and Columbia Rivers in Washington and Oregon. Each of these dams has fish collection and bypass facilities for both upstream-migrating adult fish and downstream-migrating juvenile fish, primarily several species of salmon and steelhead, but also including shad, lamprey, bull trout and other resident species.

Currently, the Walla Walla District is designing a major upgrade for the juvenile fish collection and bypass system at Lower Granite Lock and Dam on the Snake River. One of the major features of the new facility will be a new primary bypass, a pipe and flume system that diverts fish around the dam to an outfall location in the tailrace. This presentation will describe the process used to select the optimum bypass outfall location, which has significant influence on the survival of migrating juvenile fish.

The tailrace at Lower Granite Dam is a complex hydraulic environment. The Corps collected extensive visual (video) and Acoustic Doppler Current Profiler (ADCP) velocity data over a wide range of operating conditions, and then combined that with the latest bathymetric surveys to create a GIS model of the tailrace. This model was used to analyze and evaluate the data in relation to desired outfall criteria. A 1:55 scale physical hydraulic model was also constructed at the Engineering Research and Development Center laboratory in Vicksburg, MS to evaluate the tailrace environment. In addition to hydraulic conditions, other considerations in selecting the bypass outfall included impacts to and from barge transportation and both avian and piscine predation concerns. Close coordination with federal, state, and tribal fishery agencies in the region was maintained throughout the process.

Presenting Author Bio:
Sean C. Milligan has over 20 years experience in hydraulic and fish passage engineering at the Walla Walla District of the U.S. Army Corps of Engineers. He is currenlty the Chief of the Hydraulics and Water Quality Section. Mr. Milligan recieved both Bachelor's and Master's degrees in Civil Engineering from the University of Idaho in Moscow, ID. He is registered as a Professional Engineer in the State of Washington.

Fish Passage Facilities as Part of the Penobscot River Restoration Project

First Author Name:
Keith Martin, P.E.

First Author Affiliation:
Kleinschmidt

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Scott Hall

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Manager Evironmental Service - Black Bear Hydro Partners

Abstract Body:
The Penobscot River Restoration Project is a landmark basin-wide, multi-dam, ecosystem restoration project. This system-wide endeavor involves several different large hydro projects including two dam removals, the decommissioning of and bypass around a third dam, generation increases at four other sites, and improvements to fish passage at three sites.
Although Kleinschmidt has been involved with all phases of this endeavor for well over a decade, involving multiple specialties, our discussion here is limited to the fish passage improvements constructed in 2013. The removal of Veazie and Great Works dams was an important step in the restoration project; however, the key to success for this endeavor is the installation of state-of-the-art fish passage facilities.
This involved four separate and simultaneous design and construction projects at three different dams: an upstream fish elevator and downstream passage expansion at Milford and Orono, and new installation and expansion of downstream passage at two Stillwater powerhouses.
One of the challenges of the Project was the sheer size of the Milford fish elevator and the complexity of the Milford site. As the current lowest dam on the main stem of the Penobscot, Milford required a new high capacity fish elevator to efficiently move fish over the dam. The system is designed to pass a population of 12,500 Atlantic salmon, 3.8M river herring, and 633,000 American shad. Milford also required a trap and sort facility in order to support Maine Department of Marine Resources (MDMR) stocking and hatchery programs, since trapping capability has been lost with the removal of the Veazie fish ladder.

This paper will highlight the broader Penobscot River Restoration Project, discuss some of the challenges and benefits of the Project, and describe the fish passage facilities which will ensure its success.

Presenting Author Bio:
Keith Martin is a Structural Engineer in the Fish Passage Team at Kleinschmidt Associates, and a licensed Professional Engineer in the State of Maine. A Senior Engineer and Project Manager, Mr. Martin works on the design of fish passage facilities and other hydropower infrastructure. While at Kleinschmidt, he has performed inspection, analysis, feasibility assessments and designfor fish passage, hydropower capacity upgrades, minimum flow units, inflatable flashboard systems, and other capital improvements.

Prototype modifications within a flood control channel to improve fish passage in Mill Creek near Walla Walla, WA

First Author Name:
Jon Renholds

First Author Affiliation:
USACE Walla Walla District

Abstract Body:
Mill Creek is a tributary to the Walla Walla River, and flows through the city of Walla Walla, Washington. The Mill Creek flood control projects were initially built in the early 1940's following several large floods in the 1930's. The Mill Creek project includes a diversion dam that can send water to an off stream storage reservoir. Approximately the first mile of the flood channel downstream of this diversion is still owned and operated by the USACE Walla Walla District and is designed to safely pass up to 3500 cfs. The federal reach portion of the Mill Creek channel consists of concrete covered gabion sills spanning the channel with levees on both sides of the channel. The sills provide the necessary energy dissipation and grade control during flood discharges within the channel constricted on both sides by levees. While the channel works well for its intended purpose of flood control, the sills make it difficult for fish to pass through the reach to the upper portion of Mill Creek which has good habitat for salmon and bull trout. The sills create both low flow depth and high water surface differentials over a range of flows but low flows present the largest difficulty for fish passage. USACE has considered a number of alternatives to improve fish passage within this reach. In 2012 a prototype modifications were constructed on 3 of the 84 sills within the federal reach. A hydraulic assessment following construction indicated that the prototype modifications met the design objectives. This presentation focuses on the selection, analysis and assessment of the prototype design. Design of the modifications to the remaining 81 sills is ongoing in 2014 with construction to follow as funding is available.

Presenting Author Bio:
Jon Renholds is a P.E hydraulic engineer for the Hydraulic Engineering and Water Quality section of the US Army Corp of Engineers Walla Walla District. He has 11 years of engineering experience with the last 4 years spent at the Walla Walla District primarily with fish passage design issues. He has a BS in Environmental Engineering from Oregon State University and a Masters in Civil Engineering with a Hydraulic Engineering and Stream Restoration emphasis from Colorado State University.

A5

History of the Menominee River multi-partner fish passage initiative

First Author Name:
James Fossum

First Author Affiliation:
U.S. Fish and Wildlife Service (Retired)

Abstract Body:
The early partnership concerning fish passage on the Menominee River began in the late 1980s. The Scott Paper Company, owner and operator of the Park Mill Hydroelectric Dam (the second dam upstream on the river), applied for a Federal Energy Regulatory Commission (FERC) amendment to their license to add generating capacity to the plant. The resource agencies reviewed the amendment and recommended a fish entrainment study. Numerous fish movement studies in Midwest rivers showed that many fish species move many miles seasonally to spawning, foraging, and wintering habitat. The Agencies were concerned that fish moving through the Park Mill Dam had only one way for downstream fish passage when the tainter gates were closed, through the powerhouse. Potential turbine mortality to entrained fish was a big concern. A 1990 - 1991 study estimated an annual entrainment rate of approximately 46,138 fish and an average mortality rate of about 26%. Many fish species (e.g., lake sturgeon, walleye, largemouth bass, smallmouth bass, and black crappie) of various sizes were found to move through the dam annually. The River Alliance of Wisconsin and Michigan Hydro Relicensing Coalition joined the partnership and we embarked on a fish passage initiative at the Park Mill Dam to design a safe route downstream around the powerhouse. Ultimately, this initiative spread throughout all five dams on the lower Menominee River, eventually involving partners from We Energies, North American Hydro (NAH) and Wisconsin Public Service. A FERC brokered settlement with NAH and the other partners, at the lower two dams, provided the means to develop a downstream fish passage plan. The partnership agreed to expand planning for upstream passage at the lowermost dam (Menominee Hydro Dam), and eventually, upstream and downstream passage at all five dams. Grants awarded by the EPA and National Fish and Wildlife Foundation, with cost sharing from NAH, are paying for installation of a fish bypass and fish lift at the lower two dams, with work ongoing to complete upstream and downstream passage at the upper three dams.

Presenting Author Bio:
James Fossum is a hydropower consultant for the River Alliance of Wisconsin (RAW) and Michigan Hydro Relicensing Coalition (MHRC). In 1969, he received a B.A. degree in Biology at Winona State University in Winona, MN and in 1975, received a M.S. degree in Biology from St. Mary's College in Winona, MN. He retired from the U.S. Fish and Wildlife Service in 2002 after 26 years of service. Jim was a fish and wildlife biologist with the Service and worked most of his career in the Green Bay, Wisconsin field office on numerous hydropower projects on many rivers in Wisconsin and Michigan. He worked with the resource agencies to develop terms and conditions for inclusion in new hydropower licenses issued by the FERC that restore, protect, enhance, and mitigate hydro project operational affects on fish and wildlife species and the habitats upon which they depend. Jim has been active in the Menominee River fish passage initiative since the team was assembled in 1993. Since retiring from the Service, Jim has represented the RAW and MHRC on the Menominee River fish passage Implementation Team guiding the design of fishways to be installed at the Park Mill and Menominee Hydro Projects. Jim's role is to bring his fisheries biology expertise and career experience to the project, especially in the context of

hydropower operations and fish passage planning.

Habitat and population based rational for lake sturgeon passage on the Menominee River

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Abstract Body:
Lake Michigan supports at least 8 viable populations of lake sturgeon that migrate up major rivers to spawn. These rivers then provide important rearing habitat for young sturgeon during their first summer of life before they move into Lake Michigan. The largest of these populations spawns in the Menominee River, tributary to Green Bay. Historically, sturgeon could migrate 132 kilometers up the Menominee River and spawned at several major rapids throughout the river. Today, this migration is blocked by 5 hydroelectric dams, the first located 4.3 Km from the river mouth. Upstream of the first dam, landlocked populations of sturgeon reside in 3 river sections segmented by the 4 additional dams. Limited downstream movement of fish through these dams contributes to the population of sturgeon in the lower river but is a loss to the upstream populations since there is no upstream movement. Habitat inventories conducted in 2004-5 quantified contemporary spawning, juvenile rearing and adult staging habitat throughout the Menominee River and in 5 other Lake Michigan sturgeon rivers. Comparison across rivers and within river sections shows that spawning and juvenile rearing habitat in the Menominee River is abundant upstream of the lower two dams. However, juvenile rearing habitat in the lower Menominee River is less abundant than in other Lake Michigan rivers and river sections that support sturgeon. This lack of juvenile rearing habitat and lack of access to upriver habitats is believed to be limiting the successful reproduction and growth of the Menominee River sturgeon population. Reestablishing an effective migration route around the lower two dams on the Menominee River would provide potential for increased reproduction and a significant increase in abundance of lake sturgeon in Lake Michigan.

Green Bay Lake Sturgeon Spawning Fidelity

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Abstract Body:
Spawning river fidelity of lake sturgeon is difficult to assign considering the relatively long inter-spawning intervals and the complexity of conducting assessments on large waterbodies with multiple spawning rivers, like Green Bay. In addition, movement patterns of adult sturgeon are likely impacted due to a relatively small population size compared to historic estimates (< 1%) and

hydroelectric dams on most rivers which have altered spawning behavior. Green Bay lake sturgeon have been genotyped (N=907) and indirectly assigned to assumed spawning river groups (Menominee, Lower Michigan, Peshtigo-Oconto, and Fox-Wolf); but direct tagging studies have indicated mixing of adult sturgeon between genetically assigned spawning rivers. Using acoustic telemetry, we observed the movements of adult lake sturgeon (N=83) into four Green Bay rivers (Menominee, Peshtigo, Oconto, and Fox). Acoustic receivers allowed us to identify seasonal and directional movement patterns of these sturgeon for multiple years. In most cases, we are not able to confirm that upstream movements in April and May of each year was associated with spawning activity, since acoustic receivers were located downstream of known spawning sites. Movements were routinely detected during both spawning and non-spawning seasons; but most fish were only detected for a few days to weeks in the subject rivers and occupied the greater Green Bay waters for the remainder of the year. Genotypic assignments can corroborate that implanted fish originated from the rivers where they were tagged; but it appears from our acoustic telemetry data that mixing of these spawning stocks occurred during spring spawning periods.

Presenting Author Bio:
Michael obtained a BS from Iowa State University and a MS from Southern Illinois University. He has been employed with Wisconsin DNR since 2004. His management responsibilities include the Menominee River and Green Bay Lake Sturgeon Populations

Can we attract lake sturgeon to a fishway?

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Abstract Body:
Lake sturgeon (Acipenser fulvescens) were once abundant in Lake Michigan and had unobstructed access to feeding and spawning areas within its many tributaries. Hydroelectric dams now impede much of this access, contributing to a more than 99% decline in the population. One method for re-establishing this lost connection is to create an artificial pathway around the dams (i.e., fishway). Working in collaboration with two of the dam's owners, WE Energies and North American Hydro, we conducted two experiments to test efficacy of attraction flows on lake sturgeon in the Menominee River, a major tributary to Lake Michigan. The Menominee River forms the border between northern Wisconsin and Michigan's Upper Peninsula. Our first experiment tested how well sturgeon attract to various flow rates within an empty turbine bay of an existing hydroelectric dam. Results show that even with a modest attraction flow (approximately 2% of river flow) sturgeon would enter the turbine bay within minutes of flow application. In our second experiment, we used a prototype fishway channel, suspended downstream of the discharge from a

hydroelectric dam, to test whether we could attract sturgeon into an enclosed trap. The trap was 1.5 m wide and 1.5 m deep and was suspended approximately 1.83 m from the river bottom with a ramping screen leading from the river bottom to the fishway channel. Video and Passive Integrated Transponder (PIT) telemetry results show nearly 20% of the sturgeon population were attracted up into the fishway channel and passed through a 45.7 cm wide V-trap opening without hesitation. Overall, results from our studies indicate that sturgeon can be successfully attracted into a fishway using a designed flow and show the ability to be trapped.

Presenting Author Bio:
Nick Utrup is a biologist with the U.S. Fish and Wildlife Service, currently stationed in Bloomington, MN. Nick uses his hydropower experience and fisheries background to develop productive partnerships for the purpose of establishing appropriate and effective hydropower license terms and conditions, which includes fish passage in some cases. Nick currently participates in several Implementation and Technical Advisory Teams working on fish passage issues, including the Menominee River Fish Passage Partnership in the Lake Michigan Basin and the Prairie Du Sac Fish Passage Project on the Wisconsin River. Nick is currently working with partners on groundbreaking work to design passage facilities for sturgeon and paddlefish in the Midwest while also working under the constraints and challenges of invasive species and disease. Nick received a B.S. in Zoology from The Ohio State University and an M.S. in Wildlife and Fisheries Ecology from Oklahoma State University.

B5

Barrier Removal Prioritization for Stream Resident Species on the Westfield River in Western Massachusetts

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Abstract Body:
The removal and repair of road-stream crossings and other barriers to fish passage has been recognized as an integral step in restoring fish populations. Budget limitations require the prioritization of repair and removal decisions on stream networks that may contain hundreds or thousands of barriers. We approach the barrier removal prioritization problem using a budget-limited optimization formulation that maximizes habitat for riverine species. A case study is being carried out on the Westfield River in western Massachusetts. Stream network data comes from the Critical Linkages Project (http://www.umasscaps.org/applications/critical-linkages.html), which has assessed habitats and road-stream crossings throughout Massachusetts and parts of New England. The project provides both an Index of Ecological Integrity indicating habitat quality values for the landscape, and aquatic passability values for road-stream crossings. While past prioritization projects have used species-specific metrics to assess habitat value and connectivity, the metrics used here are intended to be holistic representations of the value and connectedness of an ecosystem. Using a problem formulation similar to that implemented by O'Hanley et al. (2013), we maximize total connected habitat for resident aquatic organisms, taking into account habitat quality and organism dispersal. Budget constraints are accounted for using realistic barrier removal costs. A genetic algorithm is used to solve the resulting non-linear binary optimization problem. We present the results of the analysis here and discuss the role of this analysis in facilitating the decision-making process associated with barrier removal.

Presenting Author Bio:
Rachael Weiter is a graduate research assistant in the Environmental and Water Resources Engineering program at the University of Massachusetts Amherst. Her academic and research interests include fish passage engineering and optimization programming. Off campus, she enjoys hiking and fly-fishing.

Metrics to identify fishway passage bottlenecks in the multi-species Columbia River

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Abstract Body:
We have conducted a long series of fishway passage evaluations for upstream-migrating adult salmonids (Oncorhynchus spp) and Pacific lamprey (Entosphenus tridentatus) at hydroelectric dams in the Columbia River basin. The fishways at these projects are large and often complex, with multiple entry locations, dendritic passage routes, and a variety of hydraulic challenges that vary seasonally. Consequently, many fish make

multiple passage attempts and a wide range of behaviors are observed. Efforts to optimize upstream fish passage efficiency at the dams require that problem areas are correctly identified and that mechanisms of passage failure are understood. Structural or operational solutions must be effective for all species present – or at least not detrimental to any groups. We have primarily used radiotelemetry to monitor fish at the Columbia and Snake River dams (n > 20,000 tagged fish) and have developed a variety of metrics to help identify and prioritize passage problem areas. Some passage challenges – such as transition areas between collection channels and overflow ladder weirs ¬– slow fish from all species at most dams. Confusing attraction cues in these areas result in up to ~70% of the fish falling out of the fishway to the tailrace, requiring additional passage attempts and extending passage times. Other fishway features present more critical bottlenecks for individual species. For example, high-velocity vertical slot fishway sections strongly inhibit Pacific lamprey passage, many of which fail to pass the dams. Passage solutions for these types of problems have been incremental and adaptive, and have included innovative design features. Our integration of spatially-intensive monitoring with quantitative analytical techniques has been critical to understanding the complex relationships between fishway features, environmental variation and fish behavior. The general research framework and analytical tools we have used in the Columbia basom can be applied to a wide range of passage assessments.

Presenting Author Bio:
Keefer is a UW-Madison alum who has worked at the University of Idaho for 16 years studying anadromous fish ecology and behavior. His research group advises the US Army Corps of Engineers on ways to improve adult fish passage at hydro dams and, more broadly, investigates the environmental and management-related factors that affect fish migration success.

Dam removal and freshwater mussels: effective restoration and prioritization through case studies

First Author Name:
Erin Singer McCombs

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American Rivers

Abstract Body:
Dam removal is gaining momentum as a restoration tool to increase aquatic connectivity, public safety, and recreational opportunities. With limited resources and thousands of small and medium sized dams to prioritize for removal, information to guide the process is of principal importance. Freshwater mussels are an imperiled group of aquatic organisms found across the country with frequently high richness and density below small dams. I will attempt to guide resource managers to the best practices for prioritizing and removing dams where freshwater mussels are present and offer case studies from completed projects in North Carolina as well as elsewhere in the Southeast and Midwest. The first step when approaching a dam for removal is to determine if the project will achieve effective restoration. American Rivers has assembled a suite of standards a project manager can use to determine whether the project achieves effective restoration. Within the framework of these restoration standards management options exist to address the presence of freshwater mussels at a dam removal which may include sediment management, mussel relocation, and equipment location management. While large information gaps in understanding dam removal effects on freshwater mussel populations exist, case studies have shown that adverse short term impacts to freshwater mussels can be reduced with proper planning, timing, and removal techniques. Additionally, a need remains for collaboration between resource managers and academics to get a better grasp of the complex ecological impacts of dam removal.

Presenting Author Bio:
Erin works in American Rivers' Southeast Region, largely in the Carolinas and Tennessee, to provide technical assistance, project management, and general guidance in the planning, development and implementation of projects like dam removals for the River Restoration program. Prior to joining American Rivers, Erin worked for other area nonprofits like the Western North Carolina Alliance with the French Broad Riverkeeper program, Audubon North Carolina, and the Southern Alliance for Clean Energy. Erin has a Master's degree in Biology from Appalachian State University where she studied the effects of small dams on freshwater mussels.

A Screening Method for Identifying Fish Passage Barriers at Road Crossings Using LiDAR-Derived Elevation Data

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Abstract Body:
The passability of road crossings by fish varies widely, from fully passable structures such as open-bottom bridges to fully impassable structures such as culverts with large outlet drops. Field surveys can accurately document these characteristics, but are not feasible to implement over very large regions, such as entire states. We are developing a method for using LiDAR-derived bare-earth digital elevation models (DEMs) to identify potential fish passage barriers at road crossings based on the difference in water surface elevation between the inlet and outlet of a culvert. While a large elevation difference can be caused by either a high slope or an outlet drop, both conditions impede fish passage and require remedial action. The LiDAR-based assessment provides several other pieces of information that are useful in prioritizing fish passage barrier remediation, including 1) the locations and characteristics of crossings on unmapped roads, 2) whether or not a defined stream channel is present upstream of each crossing, and 3) culvert length and depth of road fill, which are used to estimate replacement cost. With a high-quality LiDAR DEM (5 ft horizontal resolution, 0.3 ft RMSE vertical accuracy), the method is efficient (50 sites/hour) and accurate (R2=0.73 between field and LiDAR-derived elevation differences at 35 surveyed culverts). This presentation will describe our experience with the development and testing of the method in southern Wisconsin, and discuss the feasibility of implementing the method elsewhere.

Presenting Author Bio:
Matt Diebel is a fisheries and aquatic research scientist at the Wisconsin Department of Natural Resources. He has an MS in water resources management and a PhD in limnology from the University of Wisconsin-Madison. His research focuses on landscape-scale patterns in aquatic ecosystems and on methods for restoration and protection of these resources.

C5

Whitewater Park Hydraulics: Implications for Fish

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Abstract Body:
Whitewater Parks (WWPs) have become a popular recreational amenity in the United States, with Colorado being the epicenter for WWP design and development. WWPs consist of one or more instream structures that have the primary purpose of creating a hydraulic wave for recreational activities such as kayaking and tubing. Little information exists describing how hydraulics formed by WWP structures influence fish habitat and passage. Recent fish population sampling from pools located within a WWP and a reference stream reach have indicated lower fish biomass and densities within the deeper, larger-volume WWP pools. Pool hydraulic characteristics were assessed within the WWP and the reference reach, and velocity profile data indicate that flows are more spatially and temporally variable in the WWP reach. Movements across WWP structures and native stream bottom were compared using multiple PIT tag antenna arrays and 2,500 resident fishes (Salmo trutta, Oncorhynchus mykiss, Catostomus catostomus and Rhinichthys cataractae). Tagging study results indicate that passage rates through the WWP reach are lower than passage rates through the reference reach. Taken together, population estimates, hydraulic studies, and movement studies indicate that the WWP provides suboptimal habitat and restricts upstream fish movement of resident fishes in the study stream.

Presenting Author Bio:
Matt Kondratieff works as an aquatic research scientist for Colorado Parks and Wildlife in Fort Collins, CO. He completed his undergraduate work at U.C. Davis, received his Master's from Colorado State University and he worked for three years as a fisheries biologist for Wyoming Game and Fish in Pinedale, WY. He has 7 years experience involving the design, construction, and monitoring of stream restoration projects in Colorado. He also provides technical assistance on aquatic habitat issues with the goal of aiding or preventing upstream fish passage on streams.

Are whitewater parks movement barriers to Great Plains fishes?

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Abstract Body:
Hydraulic data from a Colorado whitewater park indicate that it provides suboptimal habitat and restricts fish passage for resident fishes, most of which are large, strong swimmers with a high tolerance for turbulence. But what would happen if a similar whitewater park were installed in a lower elevation Great Plains stream? Many Great Plains native fishes are small and have

maximum sprinting abilities of < 1 m/s, and some studies have shown that they have a low tolerance of turbulent conditions. Furthermore, swimming behaviors of these fishes may also be incompatible with the bed profile seen in many whitewater parks. Unpredictable flow changes, hydraulic jumps, and an unusual bed profile come together to create unsuitable habitat and the potential for a major movement barrier for native Great Plains fishes. As a result, creative approaches are necessary to ensure that whitewater parks are fun but also accommodate native fish movement.

Presenting Author Bio:
Ashley received her B.S. in Wildlife and Fisheries Biology at UC Davis in 1996. She received her M.S. in Fish, Wildlife, and Conservation Biology at Colorado State University in 2006 and is just completing her PhD, also at Colorado State University. She currently works as a fisheries ecologist at GEI Consultants, Inc., because she really enjoys talking to engineers about fish. Her primary research interest involves improving habitat for native fishes within the current constraints provided by our road and water infrastructure.

Spatially explicit hydraulic analysis of the effects of whitewater parks on fish passage

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Abstract Body:
Whitewater parks (WWPs) provide a valuable recreational and economic resource that is rapidly growing in popularity throughout the United States. WWP structures are primarily constructed to create a hydraulic jump that is desirable to boaters. WWPs were originally thought to enhance aquatic habitat; however, recent studies have shown that the hydraulic conditions required to meet recreational needs can act as a partial barrier to upstream migrating trout and that WWP pools may contain lower densities of fish compared to natural pools. There is limited knowledge of the direct effects of WWPs on fish passage. Managers and policy makers are forced to review WWP designs and make permit decisions without sound scientific evidence. It is also difficult to make design recommendations for future WWPs and possibly retrofitting existing WWPs to allow for successful fish passage without improved understanding of the factors contributing to suppression of movement in WWPs. We describe novel approaches combining fish movement data and hydraulic results from a 3-D computational fluid dynamics model to examine the physical processes that limit upstream movement of trout in an actual WWP in Lyons, CO. These methods provide a continuous and spatially explicit description of velocity, vorticity, and turbulent kinetic energy (TKE) along potential fish swimming paths in the flow field. A spatially continuous analysis of flow paths provides insight on interactions among velocity, vorticity, and TKE and likely causes of suppressed movement of upstream migrating fishes, at each WWP structure relative to its design and configuration. The results of these analyses have implications for WWPs of various sizes and fishes with lesser swimming abilities.

Presenting Author Bio:
Tim received his undergraduate degree in Civil and Environmental Engineering from the University of Tennessee at Knoxville. Shortly after he was accepted into the graduate

degree program in Civil and Environmental Engineering at Colorado State University. Tim studies hydraulic engineering, stream restoration, and river mechanics at CSU while conducting research on whitewater parks.

Recreational Amenities as Unintended Passage Barriers: Hydraulic Characterization of a Whitewater Play Wave

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Abstract Body:
Various structures have the potential to act as partial or total barriers to fish passage. Irrigation headgates, utility crossings, and various habitat structures are a few examples. This presentation addresses whitewater play waves, which are increasingly common in the American West and can be found in smaller numbers in other regions. Hydraulic data from a constructed kayak/surfing wave and its surrounding reach on the Clark Fork in Missoula, Montana will be presented. Implications for fish passage, new directions in playwave design, and potential design alterations for improved passage characteristics at structures will be presented.

Presenting Author Bio:
Jock Conyngham is a Research Ecologist in the Environmental Laboratory of the Engineer Research and Development Center (ERDC), US Army Corps of Engineers. His specialties include multiscaled assessment, restoration, and monitoring of watersheds, streams and rivers, riparian zones, and aquatic populations. Jock has provided technical (including field, modeling, design, and review) support for dam removals, fish passage projects, restoration initiatives, monitoring efforts, and environmental benefits assessments for multiple agencies and clients across North America. He has published numerous peer-reviewed articles, book chapters, and proceedings papers, presents regularly at national and international conferences, and has served on multiple national committees. Prior to joining ERDC in 2002, Jock was Director of Watershed Assessment and Geomorphic Restoration for the national office of Trout Unlimited, where he worked for nine years. He is based in Missoula, Montana.

D5

Hydraulic analysis and risk assessment of a proposed fish barrier for Johnson Creek, Utah.

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Abstract Body:
Historically, Yellowstone cutthroat trout occupied large portions of the Raft River drainage in Utah. Currently, their range in Utah is restricted to isolated patches of headwater tributary streams in this drainage, including the upper reaches of the Lefthand Fork of Johnson Creek. Johnson Creek is a remote, small, ungaged tributary that is mostly diverted once it leaves public land. It's desired to establish a population of Yellowstone cutthroat trout in the mainstem of Johnson Creek and to construct a fish barrier in the lower extent of the drainage basin that will prevent the reinvasion of brook trout. The proposed site is on private land and includes current irrigation diversion headworks and the remnants of a small dam and reservoir, headgate, and perched ditch. Some years back the dam failed and the Johnson Creek channel captured the irrigation ditch. We evaluated the effectiveness of seven alternatives for a fish barrier with a hydraulic basis. To feasibly create a barrier, some increase in head is required to increase free overfall or velocity to create an effective fish barrier. The site configuration basically requires installing a spillway on a failed dam in order to create the fish barrier. Risk was considered in re-impounding the dam and potential for the dam or barrier to geotechnically fail a second time. It's recommended that a complete fish barrier be installed, with the highest relative performance value being a velocity barrier with a 3-foot upstream wall.

Presenting Author Bio:
Steve Hunter civil engineer for the White River National Forest in Western Colorado and a member of the US Forest Services National Aquatic Organism Passage (AOP) Virtual Design Team. Professional interests include fluvial processes & stream geomorphology, fish passage & barriers, fish habitat, and river hydraulics. Steve is a licensed professional engineer, professional hydrologist, & certified fisheries professional.

Design and Management of a Multifaceted Fish Passage Improvement Project

First Author Name:
Jonathon Mann

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HDR Engineering, Inc.

Abstract Body:
The study and design for the Mirabel Fish Screen and Fish Ladder Replacement project in Sonoma County in northern California has been underway since 1999 with the last three years in final engineering. Along the way, many challenges of the project site have been investigated and designs put into place for remediation. Ground improvements construction to address geotechnical concerns at the site is now underway as site challenges continue to evolve. The evolution of the ground and fish passage improvements designs, along with the many facets of the project site and challenges of managing the project, will be presented. The project includes a new contemporary fish screen system at the intake for the 11 foot high bladder dam, increased bypass flow control and capacity,

and a bypass fishway in the form of a vertical slot fish ladder for significantly improved fish migration past the dam. The fish ladder also includes a large public viewing gallery with windows to the ladder for enhanced public education and a more intimate experience with fish. The expected fish passage performance and challenges of public access design will be highlighted.

Presenting Author Bio:
Jon is a Professional Engineer with extensive experience in hydraulic engineering and a special focus on fish passage and stream channel restoration. During the course of his career, Jon has worked with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service where he provided technical expertise on many fisheries projects throughout California. For the last 9 years Jon has been in private practice involved with many diverse fisheries-related projects on both coasts of North America as well as projects in the mid west of the United States. He has conducted several feasibility studies and prepared detailed designs of complex fish passage projects for a wide variety of fish species in addition to having supporting roles on habitat restoration projects. He is based out of Santa Rosa, California.

Presentation the history of fish ladder construction in România and one concrete frontal solution that can achieve longitudinal connectivity of the Crişul Repede River. A case study.

First Author Name:
Răzvan George Voicu

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National Institute of Hydrology and Water Management in Bucharest, Romania

Abstract Body:
Hydrologic connectivity is globally recognized as a fundamental requirement of all healthy ecosystems and sustainability of fisheries. In 2011 România, according to available data, there are 100 fish ladders located in eight river basin districts (Someş-Tisa, Criş, Mureş, Banat, Jiu, Argeş-Vedea, Buzău, Ialomiţa, Siret). Many other obstacles to fish passage exist on the watercourses in throughout România. Thus, there are more than 750 dams and about 250 reservoirs in total requiring connectivity. România has a proper experience when it comes about dam construction, as there are lots of built dams built by România all around the world, but in terms of building passable migration systems for fish upstream-downstream, it can be considered a beginner.
After the EU accession, Romanian legislation (Water Framework Directive 60/2000) has come into agreement with the EU legislation and has transposed EU environmental directives.
Due to fiscal constraints and lack of perceived cost/benefit Fish passage construction in Romania has been slow even though much design and analysis has been done to date in many of the river districts for various species of migratory fish. A fish passage design for the Işalniţa dam will be constructed during dam reconditioning.

The history fish ladder construction in România I will presented along with one concrete frontal solution (system dimensioning) for fish migration upstream of the discharge sill near Ferdinand Bridge in the town of Oradea. Novelty is that some components of this frontal solution touches the discharge sill and has a great advantage of being placed anywhere in the water course.

Presenting Author Bio:
In 2002 Răzvan received his doctorate from the Technical University of Civil Engineering (UTCB) in Bucharest in the department of Sanitary Engineering and Environmental Protection. His thesis is titled ‘’Rivers pollution and Ecological Restoration’’. Since 2003 he has been an Engineer at the National Institute of Hydrology and Water Management

in the Laboratory of Water Management and Ecohydrology.

Hydraulic impact on fish migration in a Sariakandhi fish pass of Bangladesh.

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Abstract Body:
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.

Presenting Author Bio:
Bijoy Ghosh is the Deputy Director in the Education Engineering Department for the Ministry of Education in Bangladesh. His key responsibilities are overall supervision of functions performed by the planning & development wing, monitoring of all development works and disposal of funds respective institutions and preparations of economic review of different schemes.

A6

Lake Sturgeon Passage at Five Hydroelectric Dams on the Menominee River

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Abstract Body:
The Menominee River forms the border between Wisconsin and the southwestern end of the Upper Peninsula of Michigan. The Menominee River is a major tributary of Lake Michigan and historically one of the largest spawning and rearing rivers for lake sturgeon. The long term goal for lake sturgeon management in the Menominee River has been to provide free passage of lake sturgeon throughout their historical range.

The USACE initiated a study to investigate the feasibility of safely conveying sturgeon upstream and downstream of the first five hydroelectric dams on the Menominee River to restore connectivity of historical spawning and rearing habitat. This feasibility study was undertaken for USACE (Detroit District) by a Joint Venture involving URS Corporation and Baird and Associates. Kleisnschmidt Associates served as the principal subconsultant for the study. The project team consisted of engineers, fishery biologists, and regulatory specialists, all working together to analyze numerous upstream and downstream fish passage measures. Some of the fish passage measures that were considered are fish elevators, nature-like fishways, vertical slot fishways, close spaced trashracks, angled bar racks, louver structures, exclusion nets, induced flow devices, surface bypasses, submerged bypasses, pipeline bypass, and truck and transport methods. To determine the preferred fish passage alternative at each dam site, the project team reviewed a number of screening criteria including: potential fish passage effectiveness, potential impact on existing hydro operations, estimated construction cost, estimated operations and maintenance cost, potential flood impacts, potential impact on water quality, potential impact on aquatic and terrestrial habitat, potential for issues with hazardous waste, and potential for historical/cultural resource issues.

Each site provided unique challenges that were evaluated by the project team. This presentation will highlight the engineering analysis, biological analysis, economic analysis, regulatory review, and stakeholder engagement that went into this large scale multi-project fish passage feasibility study.

Presenting Author Bio:
Jesse Waldrip has a background in civil engineering and structural design. He serves as the fish passage team leader at Kleinschmidt Associates and has more than ten years of experience in the planning and design of fish passage facilities. His responsibilities include study, costing, design, inspection, and testing of all types of fishway projects. Mr. Waldrip routinely works closely with hydro licensees and state and federal fishery agencies on all stages of fish passage projects from conceptual design to construction and testing.

Estimating Downstream Passage Efficiencies for Sturgeon Under Different Scenarios

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Abstract Body:
The long term goal for lake sturgeon management in the Menominee River is to provide for passage at five hydroelectric dams. Restoration of access to historic sturgeon spawning and rearing habitat will provide sturgeon with a significant gain in habitat, thus increasing the sturgeon populations in the Great Lakes. Passage efficiency is a critical metric which quantifies the ability of a facility to effectively pass sturgeon. Fish pass through a facility may be subjected to either impingement (fish colliding with and getting stuck at the trash rack) or entrainment (fish passing through the trash rack and turbine penstock). Passage efficiency at a structure is defined as the percentage of the number of fish that successfully pass a structure and its immediate environment.

Smaller migrants have higher entrainment mortality than their larger counterparts because larger fish are excluded due to their size. Exclusion is length dependent, and is also dependent on the size of the trash rack spacing in relation to fish length. For the Menominee River dams, fish passage efficiency was calculated for rack spacing of 2.5-inches, 2-inches, 1.5-inches and 1-inch. These efficiencies ranged from 85 to 96 percent at the Menominee and Park Mills Dams, 91 to 98 percent at Grand Rapids Dam and 84 to 98 percent at White Rapids and Chalk Hill Dams. The general trend was that smaller rack spacing configurations lead to greater passage efficiencies. However operational limitations such as frazzle ice, and debris loading also need to be considered when determining final rack spacing requirements.

Fish passage efficiencies are important to understand when examining multiple projects. When dependencies with other dams are taken into account small changes can create a ripple effect throughout the system. Alternatives must be chosen which optimize multiple operational and fish passage efficiency criteria and maximize the system wide benefit.

Presenting Author Bio:
Chris Tomichek is a fisheries biologist and is currently the Senior Manager of the Fisheries and Aquatic Resources group at Kleinschmidt Associates. She has over 30 years of experience in planning and implementing fisheries assessment studies. Ms. Tomichek has been involved in fish assessments and FERC hydro relicensing work for many years. She specializes in fish passage assessments and has worked closely with engineering staff to design upstream and downstream fish passage for migrating fish, including American shad, river herring, American eels, shortnose and lake sturgeon, at East Coast and Midwest hydro facilities.

A Hydro Owner's Perspective on Planning, Consultation, and Implementation of Lake Sturgeon Passage on the Menominee River

First Author Name:
Rory Alsberg

First Author Affiliation:
North American Hydro

Abstract Body:
Rory Alsberg (Project Manager, North American Hydro) will discuss the hydro owner’s perspective and experiences about working with multiple agencies to install Sturgeon Passage on the Menominee River, located on the border of Wisconsin and Michigan’s Upper Peninsula.
North American Hydro has worked closely with multiple state, federal, and nongovernmental agencies for almost a decade on this project. Tasks have included creating an Implementation Team, engineering a plan to complete necessary construction work, creating a conceptual report specifically explaining the entire process of the project, and applying/receiving grants needed to fund the project. Learn about the challenges faced in keeping both the

owner's and agency's best interests in mind while discussing flow requirements, invasive species, and the design and operations of fish passage.

Multi-stakeholder partnership: keys to successful planning and implementation of fish passage from the NGO perspective

First Author Name:
Denny Caneff

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River Alliance of Wisconsin

Abstract Body:
Government agencies, private dam owners and nonprofit organizations all have different interests in making fish passage happen. How each entity meets its own interests while achieving mutual goals requires careful diplomacy, clear intentions and simple, unambiguous language. The Menominee River fish passage project, the planning for which stated 10 years ago, is a complex one involving two dams at which three discrete passage devices will be built. Unclear language about who is actually responsible for passing the fish – and confusion about what those words literally mean – delayed construction of the passage devices for over a year. I will offer my perspective on why this happened and offer it as a cautionary tale for others entering multi-stakeholder projects with public money hanging in the balance.

B6

Towards a Healthy Danube - Fish migration at the Iron Gate dams

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ARCADIS

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Abstract Body:
The presentation is not about a published article but about a currently ongoing project (june 2013-june 2104) about the design of the largest fish passes in Europe. The fish passes will be suitable for sturgeon in the lower Danube region and will be constructed near the largest hydropower facilities in Europe at the Iron Gate 1 and 2 dams in Romania.

Project objectives
Extend the opportunities for different sturgeon species to migrate 800 km upstream in the Danube river system. Project result will be a report providing a continuation of the 2011 FAO study. The following activities are carried out and reported:

Tagging and monitoring of sturgeons in order to observe sturgeon behaviour and to determine the correct location for a fish passage at the Iron gates II.

Preliminary design of fish way at Iron gates I and II for upstream fish migration, including a cost estimate.

Preliminary study to downstream fish migration possibilities;

Presenting Author Bio:
Ir. W.J.J. (Wilco) de Bruijne is consultant aquatic ecology at ARCADIS. Wilco graduated at Wageningen University as an aquatic ecologist and water quality specialist specialized in fish ecology. In his current position Wilco works for more than five years on fish migration projects throughout Europe. His work includes feasibility studies for fish passes, design and constructions of fish passes, fish stock research, monitoring and evaluation of fish passes and fish stocks.

Using network theory to formulate behavioral inferences from the movement patterns of Chinook salmon and Pacific lamprey

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Abstract Body:
Fishways at large hydropower dams can be complex spatial systems rather than linear passage structures and traditional fish passage metrics such as ‘efficiency’ may not capture important elements of behavior within these environments. Network theory provides a novel perspective on interpreting telemetry data by evaluating the relationships between the detection locations (nodes) and movements (links) of fish in spatially complex environments. We compared the network structure of 290 individual Pacific lamprey and 240 Chinook salmon migration histories through a large, multi-fishway hydroelectric project (Bonneville Dam, WA, USA) and examined the utility of network metrics to describe different elements of passage behavior within and between species.

Interspecific differences in global network properties suggested that lamprey had a higher level of connectivity among sites within the fishway environment and made more movements between sites compared with salmon. Network structure was associated with lamprey body size and run timing in that metrics of connectivity and density were lower for smaller and late-season run lamprey. Similar intraspecific differences were observed between Spring-run and Summer-run Chinook salmon, with Summer-run fish exhibiting overall lower connectivity and fewer movements between fishway sites. Local network properties allowed us to evaluate how behavior differed among fishway locations, particularly at fishway entrances. For example, metrics of connectivity and betweenness differed based upon whether fish approached the spillway entrances compared with powerhouse entrances. Many of these behavioral insights are concordant to what we hypothesized based upon the biological characteristics of these species, but network analyses provided a new quantitative and comparative approach to evaluating those differences. In particular, network analyses provided a quantitative framework for making inferences about patterns of route selection, path length, and milling behaviors both within and across species. Similar analyses have the potential to be applied for a wide range of fish movement and passage data.

Movements of dourado (Salminus brasiliensis) transported upstream of a dam in a subtropical river in southern Brazil: implicatio

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Abstract Body:
The movements of migratory fishes in South American large rivers are poorly known, preventing the identification of effective strategies to mitigate the impacts of hydropower facilities. In this study, we investigated whether dourado (Salminus brasiliensis) – a migratory characin – transported upstream of a dam with no fishway would migrate to potential spawning streams located around the reservoir. Twenty two dourado were captured downstream of Monjolinho dam (Passo Fundo River, South Brazil), radio-tagged and released 900 m upstream of the dam in May 2010 (n=2) and January/February 2011 (n=20). Fish movements were monitored by radio telemetry fixed stations located downstream and upstream of the dam and by mobile tracking throughout the reservoir and potential spawning streams from May 2010 to April 2012. No dourado was detected on the potential spawning streams. Fifteen (68%) dourado were detected downstream of the dam; six (27%) were always detected in the main pool of the reservoir during the study; and one (5%) was never detected. Fish detections downstream of the dam occurred 0–576 days after release, with five (23%) dourado being detected downstream for the first time only 5–25 hours after release. Four (18%) dourado moved downstream or were entrained (i.e. accidentally displaced downstream) through the spillway. Two (9%) dourado were recaptured by fishers 74–90

rkm downstream 11–12 months after release. Because tagged dourado were never detected near potential spawning streams around the reservoir, this research suggests that a fishway (whose construction is under discussion since 2010) and translocation approaches would provide limited benefits for dourado in accessing additional spawning grounds upstream of the Monjolinho dam.

Homestream Detection by Pink and Sockeye Salmon in a Regulated River System

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Abstract Body:
Fish that migrate through regulated rivers often face the well-documented challenge of dam passage. They can also face, however, alterations to the location or concentration of their natal water. While the effects of these alterations on the detection of natal water can be difficult to detect, and have received relatively little attention, their impact on the homing ability of migrating fish can have potential consequences on population persistence. In the Seton River, a tributary of the Fraser River in British Columbia, hydroelectric development has caused the dilution of natal water as it flows into the Fraser mainstem. Past tracking studies on populations of Pacific salmon (Oncorhynchus spp.) that spawn in this region have detected erratic migratory behaviors and difficulty in locating the Seton River. We used a series of behavioral choice experiments to explore the effects of homestream dilution on wild pink salmon (O. gorbuscha), as well as an endangered population of sockeye salmon (O. nerka). In addition to furthering our understanding of the effects of altered river systems on homing behaviors, the results of these experiments will be implemented in future operational changes in the Seton River system.

Effects of daily varying natal olfactory cues on Pacific salmon migration success in a river regulated by hydropower generation

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Abstract Body:
Olfaction is the primary sensory mechanism used to guide the homing of adult Pacific salmon (Oncorhynchus spp.) in their freshwater spawning migrations to natal streams. These migrations require complex decision-making and are reliant on odours of natal areas remaining unique and constant from year to year. Increasingly, rivers are physically transformed and regulated by diversion and impoundment, modifying natural flow regimes and hence potentially altering amounts or types of natal odors. To date, few studies have examined how hydropower systems can affect the composition of homestream cues and the compounding

effects this can have on olfactory-guided migratory behavior and survival. We used radio telemetry to monitor upstream migration rates and survival of adult sockeye (O. nerka) and pink (O. gorbuscha) salmon in southwestern British Columbia as they passed from the Fraser River into the Seton River and through the Seton fishway enroute to spawning grounds. Natal odours in the Seton River are likely altered by inputs from an adjacent stream (Cayoosh Creek) whose flows are regulated through hydropower operations. We examined daily changes to the migratory corridor and the relative contribution of Cayoosh Creek water to Seton River water and found that when Cayoosh contribution exceeded 30%, sockeye survival to spawning grounds was impaired, though migration rates were not affected. Females incurred the highest rates of mortality. Our results will be discussed in the context of evaluating broader fisheries impacts of the current hydro operations and whether operational changes can improve fish passage to spawning grounds.

Downstream Migration of Landlocked Atlantic Salmon Kelts and smolts in the River Klarälven, Sweden

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Abstract Body:
Downstream migration of kelts and smolts through eight hydropower dams was studied in a landlocked population of Atlantic salmon in the River Klarälven in south central Sweden. About 49% of the kelts survived spawning and initiated downstream migration. The kelt migrated both in autumn and spring and remained relatively inactive in the river during winter. Most kelts passed the first hydropower station via upward-opening spill gates after a median delay of 25 min. No tagged fish survived passage of all eight hydropower stations in the system to reach the lake. For the smolts, the downstream migration survival through the eight dams was 16% when all water passed through the turbines and 20-25% when there was surface spill. Remedial measures such as guidance and bypass systems, organized spill and trap and trucking are potential solutions that need to be tested.

C6

Go with the Flow: Scoping, Design, and Implementation of a Downstream Fish Passage System at a FERC-Licensed Hydroelectric Facilities

First Author Name:
Michael Chelminski

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Stantec Consulting Services Inc.

Abstract Body:
This presentation presents scoping, design, and implementation of a downstream fish passage system at a FERC-licensed hydroelectric facility on a tributary to the St. Lawrence River in northern New York. Components of the downstream fish passage facility include a flume located on the crest of the project dam, a stilling basin weir that maintains minimum plunge pool depths, and alteration of bedrock in the bypassed reach of the river to facilitate downstream passage of the target fish species. A specific feature of the downstream fish passage system is that it was designed to provide the negotiated minimum bypass reach flow of 20 cubic feet per second (cfs).
Existing provisions for downstream fish passage were limited to passage through horizontal weir set between the flashboards on the crest of the dam at the upstream end of the bypass reach or passage over the flashboards at higher flows. Both of the existing pathways may have resulted on fish impinging on the downstream face of the dam, which has a steep but pronounced slope, and in some areas, discharged onto bedrock protrusions.
Initial study components included identification of 1) minimum bypass reach flow, and 2) means to provide downstream fish passage. Identification of the minimum bypass reach flow was performed using a blend of demonstration flow and desktop studies. The downstream fish passage system included replacement of the horizontal weir with a flume that achieves sufficient velocity to provide a discharge trajectory that clears the downstream face of the dam and provides for the minimum bypass reach flow at the normal pool elevation. Sufficient plunge pool depths were achieved by constructing an approximately 4-ft-heigh weir across the bypass reach approximately 75 ft downstream from the dam. Additional project work included removal of bedrock protrusions in the bypass reach.

Presenting Author Bio:
Michael Chelminski is an environmental consultant and Principal at Stantec Consulting Services Inc. The focus of his work is on fisheries habitat restoration through improved upstream fish passage. The current focus of his work is decommissioning of legacy infrastructure (i.e., dam removal) as a means to improve access for indigenous fish to their historic habitats. Michael also scopes, evaluates, and designs upstream and downstream fish passage projects in the United States and Canada. He is a member of the ASCE-EWRI/AFS-BES Ad Hoc Committee on Fish Passage, a fisherman, has a MS in engineering from Utah State University and a BS in engineering from the University of Connecticut, and is a licensed professional engineer.

Conservation of Anguilla anguilla in Ireland by trap and transport of silver-phase eels from sites upstream of hydropower dams

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Abstract Body:
European eel (Anguilla anguilla) population decline has lead to an increased interest in stock conservation and in the implementation of Eel Management Plans (EMP's) at river basin district, national and EU levels. In Ireland, the national EMP has resulted in closure of commercial and recreational fisheries and has focused attention on the need to mitigate adverse effects of hydropower generation on eels. Effects of hydropower include barriers to upstream migrating juvenile eels, as well as delayed downstream migration and mortality in potential spawners (i.e. silver-phase eels) departing impacted river systems. In Ireland, a pilot scale silver eel trap and transport (T & T) programme initiated in 1993 has been greatly expanded since Ireland's EMP was implemented in 2009. In this presentation we will describe the protocols developed for upstream capture, transport and downstream release of eels on three Irish rivers (Rivers Lee, Shannon and Erne) used for hydropower generation. The methods used to determine if EMP targets are met will be outlined and discussed. The T & T conservation fishing has been gradually improved by adaptations of the fishing gear and increased fishing effort at the most productive sites. Technical improvements have also been made to the transport and release protocols. The catch and release activities are closely monitored and used in analyses of silver eel population dynamics and calculation of escapement biomass of potential spawners. A total of over 250t of silver-phase eels have been released, for safe seaward spawning migration, since EMP conservation activities began in 2009. A cost-benefit analysis suggests that this expensive and logistically complex conservation action might be avoided by development and use of effective eel guidance technologies.

Presenting Author Bio:
Dr T. Kieran McCartny, is an Emeritus staff member in the National University of Ireland, where he directs the research work of a team that is investigating Irish populations of European eels. He has a particular interest in problems encountered by migrating eels at hydropower dams. Much of his recent research involves estimation of silver-phase eel production and spawner escapement biomass in Irish rivers.

Downstream Passage Survival Analysis for a Proposed Hydro Project in Estonia

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Stephen

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Amaral

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2. Celeste Fay

Other Authors Affilliations:
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Abstract Body:
An evaluation of downstream passage survival of several potomadromous and diadromous fish species was conducted for a proposed hydro project at a dam on the Parnu River in Estonia. The survival analysis included estimates of the proportion of fish using available downstream passage routes (spillway, bypasses, and turbines) and the expected survival rates for each route. Turbine entrainment was based on fish size and bypass efficiency estimates developed from available literature. Spillway and bypass survival were also developed using data from published studies of passage survival conducted with similar species. Turbine

survival of entrained fish was estimated using a theoretical blade strike probability and mortality model. Average direct survival rates, which accounted for morality from lethal injuries suffered during downstream passage, exceeded 97% for all species and life stages. Total project survival estimates, which accounted for direct and indirect mortality, were generally high (greater than 90%) for all species and life stages at three levels of indirect survival that were included in the analysis. To maintain high total project survival rates for the primary species and life stages of interest, it will be important to for the Sindi Project to have a properly designed downstream bypass and spillway conditions that minimize the probability of injury and mortality.

Presenting Author Bio:
Mr. Amaral is a Principal Fisheries Biologist with Alden Research Laboratory, Inc., located in Holden, Massachusetts. He has B.S. and M.S. degrees in fisheries biology, both from the University of Massachusetts. For the past 22 years, Mr. Amaral has been extensively involved in the design, evaluation, and application of fish passage and protection technologies at water intakes and in the development of biocriteria for improving the survival of fish passing through hydro turbines. Recently, his research has focused on the mechanics of turbine blade strike and the use of theoretical models for predicting blade strike probability and mortality of fish passing through conventional and hydrokinetic turbines.

Alden Fish-Friendly Hydropower Turbine Development Status

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2. Greg Allen
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Abstract Body:
The Alden turbine is designed to allow the safe passage of downstream migrating fish through the turbine eliminating the need for expensive screens and bypasses and loss generation via spillage for fish passage. Following initial proof-of-concept testing that demonstrated fish passage survival, when scaled to a full-size field installation, at 98% or greater for several species of migratory fish and further development of an optimized conceptual design, EPRI and the U.S. Department of Energy funded research to further enhance the turbine's mechanical performance through modification of the hydraulic passageways (spiral case, distributor, runner and draft tube). Each design modification was also evaluated for fish passage in order to ensure that the original fish-friendly characteristics of the turbine were maintained. The final stage of the Alden turbine design effort included a physical model test and an updated mechanical and balance of plant equipment sizing necessary for actual field installation. Model testing indicated a maximum prototype efficiency of almost 94% at conditions corresponding to a net head and flow of 92.0 ft and 1,504 cfs, respectively. To further enhance the design studies, the relative costs of the Alden turbine compared to conventional turbine designs was completed. Total project costs and energy generation under varying inflow conditions were estimated for a prototype field installation. This analysis determined that the total project costs for an Alden turbine installation versus conventional units are comparable and not as significantly different as found when comparing turbine and associated equipment costs alone. The next stage in developing the Alden turbine is a field demonstration project. EPRI is now seeking a demonstration site. EPRI is also in the preliminary stages of developing an Alden

turbine design that can be retrofit at existing developments.

Presenting Author Bio:
Douglas Dixon manages power plant fish protection research for the Electric Power Research Institute. Dr. Dixon has over 40 years of prefosessional experience in fisheries sciences with a specific focus on fish passage and protection at all types of power plants. He received his BA at the State Unversity of New York at Geneseo and his PhD at the College of William & Mary, Virginia Insitute of Marine Science.

Employing the TSP Design Process to Design Replacement Turbine Runners for the Ice Harbor Lock and Dam

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Abstract Body:
The US Army Corps of Engineers' (USACE) Turbine Survival Program (TSP) was established to evaluate and enhance survival of juvenile salmonids passing through large Kaplan turbine runners within the Lower Snake and Columbia River hydropower dams. As a part of a broader USACE Columbia River Fish Mitigation (CRFM) effort, and with support from the US Department of Energy, the TSP team has developed new design guidelines and criteria for replacement turbines. The TSP design process relies on the interactive use of physical hydraulic models at the USACE Engineering Research and Development Center, the turbine industry's standard performance test models and computational fluid dynamic (CFD) models to identify, develop and test design alternatives to meet biological criteria and achieve design goals. USACE has applied this collaborative process through a contract with Voith Hydro to design and supply a fixed blade turbine runner (with options to supply an adjustable blade runner) to be installed at Ice Harbor Dam on the lower Snake River, Washington. Currently, the fixed blade runner design is complete and is in fabrication; the adjustable blade runner design is in the final stages of evaluation. The replacement runners for Ice Harbor Dam have been designed to improve the turbine passage environment for juvenile salmonids while improving turbine efficiency and once installed they will serve as the "proof of concept" for the USACE recommended design process.

Presenting Author Bio:
Martin Ahmann is a Senior Hydraulic Engineer for the US Army Corps of Engineers' Walla-Walla District. He is a registered professional engineer and has been involved with the hydraulic design of fish passage improvements at the USACE hydropower projects for 22 years. Martin is the senior technical lead for the USACE Turbine Survival Program, which was established to improve turbine operations and design for safer fish passage throughout the Federal Columbia River Hydropower System (FCRPS). He is also the Walla Walla District's lead hydraulic engineer for the Ice Harbor turbine design and replacement project.

Helix Design for Downstream Fish Passage

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Abstract Body:
Providing downstream fish passage at large storage reservoirs is an important issue throughout the Pacific Northwest. Storage reservoirs present many unique challenges to fish passage including dam height, and large fluctuations in water surface. To date most high dams where downstream fish passage has been established consist of manned surface collectors that require high operation and maintenance costs.
Reclamation is actively pursuing the development and construction of downstream passage on a number of its storage reservoirs using a new concept that will allow fish to self-guide into a structure that carries them around the dam and into the downstream river channel; thus, significantly reducing associated O&M costs.
NOAA's criteria for facility design [1], for providing safe juvenile downstream passage, limits the maximum vertical drop to 10 ft and maximum flow velocity to 25 ft/s. However there is some evidence to suggest that under certain conditions fish survival may be good at higher velocities, as long as fish passing through the system are contained within the body of flow so they are not exposed to high shear stresses as they enter the downstream river channel. As a result, new downstream passage criteria and a concept using a helix configured design is now being considered.
A mathematical model was used to conduct a sensitivity analysis to determine the overall diameter, slope, and geometry for the proposed helix design. Initial results from this analysis showed the potential for flow rollover and also rotational secondary flows that may cause injury to fish. The sensitivity analysis was used to determine parameter combinations that would eliminate rollover and reduce secondary flows to produce a significant "sweet spot" within the body of flow where fish can ride out relatively high velocities without injury. Next, a physical model of the structure was constructed and tested in Reclamation's Denver laboratory. Results will be presented.
[1] National Marine Fisheries Service Northwest Region, "Anadromous Salmonid Passage Facility Design, July2008

Presenting Author Bio:
Leslie Hanna is a hydraulic engineer with the U.S. Bureau of Reclamation in Denver, with more than 20 years' experience as principle investigator in conducting and coordinating physical hydraulic model studies. She has been involved in the evaluation and development of fish barrier, fish passage, and fish screening concepts for more than 10 years. Leslie has a B.S. in Mechanical Engineering from Arizona State University.

A7

The situational context for fish passage issues in the Upper Mississippi River System

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First Author Affiliation:
UMRR-Long Term Resource Monitoring Program

Abstract Body:
The Mississippi River has often been regarded as a “highway for invasive species”; a conduit between areas as geographically disparate as the Atlantic Gulf coast, the Laurentian Great Lakes, and the eastern slopes of the Rocky Mountains. Within the northern reaches of the Mississippi River, a series of 29 navigation locks and dams is used to manage water levels (St. Louis, MO to Minneapolis, MN) in support of commercial navigation. These locks and dams both potentially limit the distribution of native fish fauna as well as active invasions of nonnative fish species. Some dams are more impermeable to fish passage than others. However, where permeability exists, strategic opportunities for managing these dams as more complete barriers may be possible using non-structural behavioral modification technologies.
The navigation dams on the Upper Mississippi River (UMR) have a novel design, and they are unlike most dams with which people are familiar. To provide the situational context for the rest of the papers being delivered in this session, I will describe the engineering features of these locks and dams, evaluate their permeability, identify native migratory species that may also be affected by non-structural behavioral technologies, and assess the degree to which the UMR lock and dam system presently constrain the distribution of native migratory species across the UMR.

The effects of visual and acoustic deterrents to prevent the upstream movement of Asian carps

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Abstract Body:
Bighead (Hypophthalmichthys nobilis) and silver (Hypophthalmichthys molitrix) carps have invaded the Mississippi River Basin and have successfully established populations in the La Grange reach of the Illinois River. The invasion of Asian carps in the Illinois River has negatively influenced native fish populations and they now pose an imminent threat to invading Lake Michigan through the Chicago Sanitary and Ship Canal (CSSC). Sound Projector Array Bio-Acoustic Fish Fence (ie. sound-bubble-strobe light barrier) technologies may have the ability to slow or eliminate Asian carp range expansions. In 2005, sound-bubble barrier technologies were shown to be 95% effective at deterring adult bighead carp passage in hatchery raceways. However, in order to use this technology for Asian carps management, barrier effectiveness trials must be conducted at an ecosystem-scale. We tested the effectiveness of sound-bubble-strobe light barriers at repelling Asian carps and native fish passage in the fall of 2009 within Quiver Creek, a tributary to the Illinois River. To test barrier effectiveness, Asian carps and native fishes were removed from upstream of the barrier. The upstream portion of Quiver Creek above the barrier is pooled by a lowhead dam preventing fishes from moving further upstream. All captured fishes were measured for length, weight, and received a floy-tag prior to being released downstream of the barrier.

Barrier effectiveness was determined by upstream recaptures. Our preliminary results suggest 100% effectiveness at repelling silver carp passage and 97% effectiveness against passage by native fishes. If further testing concludes that this system is effective at repelling Asian carps passage, sound-bubble-strobe light technologies could be used as a redundant technology in the CSSC in addition to the current electric barriers and in locations where Asian carps have not yet invaded, but pose a threat.

Presenting Author Bio:
Dr. Greg Sass earned his B.S. with Honors in Biology from the University of South Florida in 1999. He earned his M.S. and Ph.D. in Zoology at the Center for Limnology, University of Wisconsin-Madison in 2001 and 2004, respectively. He was the Director of the Illinois Natural History Survey's, Illinois River Biological Station from 2006-2011. Greg has been a fisheries research scientist with the Wisconsin Department of Natural Resources since 2011.

Lock and Dam #1, Asian carp barrier alternatives analysis; the known unknowns

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Abstract Body:
USACE Lock and Dam 1 located on the Mississippi River in the greater Minneapolis-St.Paul area was identified as one location for construction of a behavioral deterrence barrier. The goal of the barrier is to slow the spread and minimize the impacts to the Upper Mississippi River basin from upstream invasions of Asian carp, specifically bighead and sliver carp. A barrier alternatives analysis was conducted to provide recommendations for a safe and effective deterrence barrier for all life stages of Asian carp at the lock. The evaluation utilized peer reviewed literature as well as collaboration with MNDNR, USACE, technology vendors, and Asian carp researchers to establish a pool of potential alternatives that were more than 90% effective. The initial pool of potential alternatives were further evaluated for construction impacts, potential long-term infrastructure impacts, ice and cold weather operations, flood flows, vessel damage, scour, fish behavior and human safety. The evaluation process was substantially constrained by the limited amount of peer reviewed literature and studies on barrier effectiveness for all life stage of Asian carp. The lack of field or large scale longer-term studies to evaluate deterrence effectiveness currently provides little guidance for management agencies to make decisions on approaches to slow the spread of Asian carp at lock and dam structures on the Mississippi River.

Presenting Author Bio:
Ron Koth is a fisheries biologist at Barr Engineering Company. His expertise is in fluvial fish habitat enhancement and improvement, fish passage, and low head dam repurposing. Prior to his career with Barr Engineering he served for over 20 years as the statewide fish habitat development biologist for the State of SD.

Differences in the spring time upstream migrations of invasive common carp (Cyprinus carpio) and native northern pike

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Mary Haedrick University of Minnesota

Presenting Author:
Peter Sorensen

Presenting Author Affiliation:
University of Minneesota

Abstract Body:
Inundated flood plains, backwaters, and wetlands are critical spawning habitats for many freshwater lacustrine fish in North America including the invasive common carp and native northern pike. In this study, spring-time movement patterns of adult pike and adult common carp were systematically monitored from several lakes into two wetlands in Minnesota, USA across a five-year period. Pike migrated over a 2-4 week period in early spring when temperatures were approximately 4C and then returned much later during the course of the summer. In contrast, common carp migrated about a month later and then in distinct several-day pulses when temperatures were above 16ºC and water levels were rising after rain. Overlap in the spring-time movements was thus minimal and we were able to block and block remove carp using simple, temporary fish screens without interfering with the pike. These results suggest that exploiting subtleties in the biology of fish migration / passage can allow for targeted and inexpensive management control strategies that favor native fishes while controlling invasives. (Funded by the Riley Purgatory Bluff Creek Watershed District)

Presenting Author Bio:
Dr. Sorensen is a professor in fisheries at the University of Minnesota and director of the Minnesota Aquatic Invasive Species research Center. He is an expert in fish behavior and physiology, carp and lamprey in particular. Dr. Sorensen has over 125 peer-reviewed publications and approximately two dozen book chapters.

Engineering a bubble curtain deterrent system to deter the movement of common carp through shallow streams

First Author Name:
Daniel Zielinski

First Author Affiliation:
University of Minnesota

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3. J. Svendsen
4. M. Hondzo
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6. University of Minnesota

Abstract Body:
Bubble curtains are a low cost behavioral deterrent, which produce aversive acoustic and hydrodynamic fields, that have frequently been suggested for use to limit the movement of invasive fishes in situations where physical screens are too expensive or impractical to maintain, but whose properties have not yet been fully described or optimized. We explored the theory and application of this

technology in two studies using common carp (Cyprinus carpio L.), a highly invasive migratory fish from Eurasia, that is very sensitive to sound and responsible for destroying millions of acres of wetlands across the globe. In the case of this widely distributed invasive, even partial blockage of movement would be of great value if the solution was of low cost. A laboratory investigation identified two different bubble curtain systems which reduced common carp passage by 75-80% in both up- and down-stream directions. Complimentary sound and fluid motion measurements along with speaker array and alternative lighting tests demonstrated that avoidance behaviors were the direct result of sound and fluid motion stimuli, rather than visual cues. Field tests of an optimized bubble curtain design in a shallow Midwestern stream that drains common carp spawning and nursery habitat provided proof of concept by blocking 57±12% of downstream swimming common carp. This result would be helpful in this case due to the low cost of the barrier. In this talk I will discuss the theory behind this technology, past and ongoing results, and its potential as a tool for managing invasive fish. (Funded by the Environmental and Natural Resources Trust Fund and Ramsey-Washington Metro Watershed District)

B7

Ecological Structures for the Waller Creek Tunnel Project

First Author Name:
Keith Moody, P.E., CFM

First Author Affiliation:
RPS

Abstract Body:
The Waller Creek Tunnel Project consists of a one-mile long, 22-foot diameter bypass tunnel, inlet to direct the upper watershed, outlet structure in Lady Bird Lake, and two creek side inlet diversion systems. The creek side inlet systems will divert stormwater flow from the lower portion of the watershed to the main flood control tunnel by way of two in-channel backwater structures located just upstream of 4th and 8th Streets. The backwater structures themselves are dams that create the hydraulic conditions in the creek necessary to divert floodwaters to a lateral side weir that connects to the main tunnel. An ecological weir structure (EWS) was developed for implementation across the backwater structure so that ecological connectivity within the creek system could be maintained. The EWS consist of strategically placed natural limestone rock boulders' creating a switchback of fish runs with intermediate submerged wetland planting pockets. The aquatic constraints used to design the fish run were provided with the help of biologist at the City of Austin. The implementation of an ecological structure is also being developed at the main inlet structure for the Waller Creek Tunnel Project to establish an ecological connection for the main pool with lower Waller Creek. This presentation will demonstrate that the ecology of a stream can be maintained across a hydraulic flood control structure.

Presenting Author Bio:
Mr. Moody is a Principal Engineer with RPS and manages the Civil Design/Stormwater Management Department. He has a Bachelors of Science Degree from Texas A&M University and has over 16 years of experience in water resources engineering on projects located throughout the state of Texas. His experience includes engineering, design and project management in water resources engineering that generally include the areas of hydrology, hydraulics, flood control, water quality treatment facilities/systems, erosion and sedimentation control planning and management, and natural channel/stream restoration design. He is Certified Floodplain Manager and a member of the Texas Floodplain Management Association.

Re-plumbing roadside ditch networks to reduce flooding, dry-outs and water pollution for healthier streams.

First Author Name:
Rebecca Schneider

First Author Affiliation:
Cornell University

Abstract Body:
Networks of roadside ditches criss-cross every watershed. Although highway staff routinely connect ditches directly to streams, the impacts on streams have largely been overlooked. For the past nine years, our team has been investigating the impact of roadside ditch networks on stream flooding, drawdowns, and water pollution. Research conducted in 7 watersheds in central New York included: mapping ditch networks using Trimble TM GPS units and ARC-GIS TM, monitoring flows using Tru-trak TM gauges, collecting water samples using ISCO TM automated samplers, and modeling. This research indicates that ditch networks increase the effective stream channel density by 2-4 fold or greater, capture ~20% of the incoming rainfall and shunt it rapidly to the nearest stream, and deliver it as a high-velocity faucet at 94 locations within each ~40 km2 watershed. This discharge contributes to a significant increase in the magnitude of peak flows and contributes to dry-outs in 1st-3rd

order streams. Ditches are both a source and a conduit of suspended sediment to streams, especially where scraped by highway staff or when incised by high flows and significantly contribute to water pollution. They are also rapid conduits for fecal coliforms and other contaminants moving as stormwater runoff from manure spread on ag fields to downstream drinking water supplies. All of these impacts directly impair both the health of the stream channel ecosystem and its capacity to support safe fish passage. This presentation will present alternative ditch management options for re-plumbing our nation's watersheds.

Presenting Author Bio:
Dr. Rebecca Schneider is an Associate Professor at Cornell University with expertise in the area of sustainable, ecologically-based water resource management. She leads an integrated research-extension program on watershed processes to reduce floods, droughts and water pollution to buffer the impacts of climate change. Specific research topics include re-plumbing roadside ditches, restoring desertified grassland soils, measuring groundwater seepage along lakeshores, and understanding linkages between marsh evapo-transpiration and glacial-fed groundwater.

Complex effects of partial barriers on a simulated watershed trout population

First Author Name:
Steven F. Railsback

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Lang Railsback & Associates

Other Authors:
2. Bret C. Harvey
3. Margaret M. Lang

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Abstract Body:
Watershed-scale and population-level effects of passage barriers are important to understand but difficult to evaluate via field studies alone. We therefore simulated effects of partial barriers in an individual-based stream trout model. The inSTREAM model includes virtual stream reaches made up of habitat cells, and virtual trout that move among cells and reaches to select good foraging habitat. Each simulated day, each fish evaluates cells within a radius that increases with fish size and moves to the cell providing the best tradeoff between growth and predation risk. We simulated barriers typical of traditionally designed culverts: fish can move upstream past a barrier only if flow is above a minimum (determined by depth) and below a maximum (limited by velocity), with separate passage ranges for small, medium, and large trout. Input was from a 26 square km watershed on Little Jones Creek in northwestern California. We simulated a mainstem, two forks, and six small tributaries, totalling 2544 m length, over 78 years with exaggerated frequency of extreme low and high flows. Twenty simulated barriers were placed throughout the fork and tributary reaches, with passage ranges estimated using FishXing. Simulated effects of barriers were not simple. The model predicted higher adult trout abundance with the barriers than without, apparently because barriers kept trout out of small tributaries where habitat conditions gradually worsen over a summer. In sensitivity experiments the number of reaches with local extinction increased as the minimum fish length for upstream passage increased but only when this length exceeded 18 cm. As the maximum passage flow was decreased below the median flow, adult abundance decreased and local extinction increased. Together, the results indicate that providing passage only for large adults may be nearly as beneficial as completely removing barriers.

Presenting Author Bio:
Steve Railsback is a consulting environmental scientist, adjunct professor in Humboldt State University's Environmental Modeling Graduate Program, and co-author of two books on individual-based ecological modeling. He and colleagues have pioneered the use of individual-based simulation models for river fisheries management; see http://www.humboldt.edu/ecomodel.

Stream and vegetative habitat restoration in a spring-fed stream to augment endangered species habitat

First Author Name:
Ed Oborny

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2. Tim Osting
3. Zac Martin

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2. RPS Espey
3. City of New Braunfels, TX

Presenting Author:
Tim Osting

Presenting Author Affiliation:
RPS Espey

Abstract Body:
As part of the recently-approved Edwards Aquifer Habitat Conservation Plan to protect endangered species in spring-fed areas of central Texas, restoration efforts were conducted in 2013 in the Old Channel Comal River in New Braunfels, TX. The restoration efforts are to benefit the endangered fountain darter during drought by augmenting total area of available suitable habitat under low flow conditions. Restoration included excavation work in the stream bed, turbidity controls, removal of non-native invasive vegetation species, and re-vegetation with native vegetation. In-channel excavation focused on removing a sediment island covered in non-native donax and resulting in a bed profile that maintains water surface slope at low flows and creates two different types of aquatic habitat. The habitat areas within the excavation zone, and in other more extensive areas downstream, were revegetated using native submerged aquatic species including Ludwigia, Sagittaria and Cabomba. Over 10,000 native aquatic plants were sourced from a natural waters nursery developed specifically for this project.

Presenting Author Bio:
Tim is a water resources engineer with public and private experience collaborating with biologists and scientists on environmental flows, aquatic and riparian habitat, water quality and modeling projects. He specializes in effectively linking field and modeling studies to quantify site-specific variables, and he has developed water quality, H&H and morphology approaches for regional agencies evaluating instream flows conditions on water permits. Tim has a M.S.E. in Environmental and Water Resources Engineering from the University of Texas at Austin and is a Senior Consultant/Managing Engineer with RPS Espey in Austin, TX.

Presentation a technical solution that can achieve longitudinal connectivity (upstream-downstream) of the Crişul Repede River.

First Author Name:
Răzvan George Voicu

First Author Affiliation:
National Institute of Hydrology and Water Management in Bucharest, România

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Abstract Body:
The paper presents a case study that proposes a technical solution(system

dimensioning) to facilitate Fish Migration past the restrictive weir located on Crisul Repede River, near the Ferdinand Bridge in the Oradea township.
Discharge sills, small dams and the water intake for power plants (CET Oradea) on the Crisul Repede River stops migration process of various fish species, common nase (Chondrostoma nasus), barbell (Barbus barbus) and freshwater bream (Abramis brama). and blocks the energy exchanges in anthropogenic lotic ecosystems in the same time. Such constructions shall be equipped with systems for fish migration according to the Water Framework Directive (60/2000/CE). The fish passage structures are to be placed on the left bank, downstream of the weir and will take into account the annual natural rise and fall of the river water levels.
The structures would restore longitudinal passage connectivity to facilitate the passage of migratory fish species to approximately 4 Km of upstream breeding habitats and would contribute to ensuring of optimal conditions for the developing migratory fish species present in the area. If there are no longer migratory fish in the area, due to the same conditions or after minor modifications, the whole system can be attached to another discharge sill.

Presenting Author Bio:
In 2002 Răzvan received his doctorate from the Technical University of Civil Engineering (UTCB) in Bucharest in the department of Sanitary Engineering and Environmental Protection. His thesis is titled ‘’Rivers pollution and Ecological Restoration’’. Since 2003 he has been an Engineer at the National Institute of Hydrology and Water Management in the Laboratory of Water Management and Ecohydrology.

C7

Fish Passage Program - Making Connections Across Our Watersheds: Active restoration of riparian migratory corridors in the Lake Michigan Basin in Ozaukee County

First Author Name:
Andrew T. Struck

First Author Affiliation:
Director, Ozaukee County Planning and Parks Department

Abstract Body:
The Ozaukee County Planning and Parks Department has implemented a comprehensive effort to restore aquatic habitat connectivity and improve the ecological function of existing riparian habitats throughout the Ozaukee County portion of the Milwaukee River Watershed and Lake Michigan Basin. The watershed downstream of Ozaukee County is highly urbanized, with little of the formerly-abundant wetland and riparian habitat remaining in its natural state, resulting in reduced native species abundance and diversity. Ozaukee County has significant contiguous tracts of relatively intact, high quality, and/or protected, suitable spawning and rearing habitat, if hydrologically connected and, in some cases, improved. Enhancing the ecological productivity of aquatic and terrestrial riparian habitat directly supports sustainability and/or population recovery for remnant desirable, native, and/or imperiled species.

Since 2009, the Department's Fish Passage Program and partners have identified and removed/remediated over 233 impediments to aquatic organism passage, reconnecting over 125 stream miles and thousands of wetland and floodplain acres. These activities include large-scale dam removals, nature-like fishway design and construction, road/stream crossing replacements/remediation and habitat restoration projects. The Program is also developing a GIS-based fish and wildlife decision-support tool to prioritize in-stream and riparian habitat restoration projects for the maximum benefit of multiple target species. Tool outputs are guiding ongoing, large-scale habitat projects that include stream remeandering, floodplain and wetland reconnection, native plantings and invasive vegetation control. Together, these activities constitute a landscape scale effort to restore the ecological productivity of fragmented and/or formerly degraded riparian habitat to benefit several native, remnant and/or imperiled fish, wildlife, herptiles and bird species.

Advancing Fish Passage in the Menomonee River Watershed

First Author Name:
Cheryl Nenn

First Author Affiliation:
Milwaukee Riverkeeper

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2. Beth Wentzel
3. Dave Fowler

Other Authors Affilliations:
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2. Interfluve
3. MMSD

Abstract Body:
The goal of the Menomonee River Fish Passage Program is to identify, prioritize, and address fish passage impediments as well as opportunities to improve aquatic habitat fragmentation in the Menomonee River Watershed. Milwaukee Riverkeeper has identified and assessed over 382 different potential stream impediments along the natural mainstem and tributary reaches that could provide access to high quality natural areas that could be used for fish spawning or rearing. Removing artificial barriers to aquatic life passage will increase access for Lake Michigan and other native fish to pass to

upstream spawning habitats (e.g., vegetated wetlands, etc.), thus improving fish productivity, enhancing recreational opportunities, and providing a cheaper alternative to restoring degraded habitats or creating new habitats further downstream.

As a local non-profit, Milwaukee Riverkeeper is working to educate local municipalities and counties as well as private landowners about fish passage impediments and restoration opportunities. We are fundraising for design and engineering services to address the top priority passage impediments (e.g. perched culverts, pipe crossings, drop structures, etc.). We are also working with volunteers to address massive woody debris jams and rock fill areas that are impeding flow. Barriers have been prioritized for removal from downstream to upstream on the mainstem to enhance connection with Lake Michigan. Work on the tributaries has been prioritized by evaluating stream miles reconnected and access to critical spawning habitats. Projects selected to move on to design/engineering will be further prioritized based on landowner willingness and likelihood of funding.

The project is a collaborative effort to: 1) educate municipalities, counties, MMSD, and private landowners regarding fish passage impediments; 2) advocate for allocation of capital improvement funds and assist in grant writing to address impediments; 3) contract out design/engineering and cost estimates for top priority impediments; 4) educate and involve the public; and 5) document watershed improvements.

Presenting Author Bio:
Cheryl Nenn is the Riverkeeper with Milwaukee Riverkeeper. Cheryl has an M.S. in Natural Resource Ecology and Management from the University of Michigan and a B.S. in Biology from University of Illinois at Urbana-Champaign. Cheryl oversees multiple projects for Riverkeeper including the Menomonee River Fish Passage Program and the Citizen Stream Monitoring Program for the Milwaukee River Basin. She also co-leads the Menomonee River Watershed Action Team and Science Committee for the Southeastern Wisconsin Watershed Trust.

Thinking Outside the Box Culvert, Floodplain Management and Urban Stream Rehabilitation

First Author Name:
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Abstract Body:
Many communities are now facing the rapid urbanization that the Milwaukee area underwent the middle of the last century. Increased urbanization generally leads to more impervious watersheds and increased localized flooding. In Milwaukee, the Milwaukee Metropolitan Sewerage District (MMSD) was charged with the management of sewage and watercourses for the area and developed a program of widening and/or lining watercourses with concrete to reduce the flooding problems. Nearly 25 miles of streams were widened and concrete lined in short segments between 1950 and 1985. The cost of the reduced localized flooding were a parallel reduction in ecological health of the streams, as well as new flooding problems downstream. An aggressive and environmentally responsible system-wide plan is currently being implemented that not only remediates and prevents future flooding problems but also reverses previous flood relief techniques found to be ineffective or ecologically detrimental. This change in approach to flood control is the basis for this presentation.

During the 1990s, the MMSD embraced stream corridor concepts and watershed planning. A watercourse system plan was developed for the entire service area based on a watershed approach. Over 2,000 structures were identified within the 100-year floodplain and a $250 million comprehensive system-wide solution was begun. The solution is environmentally friendly and even provides for removal of over 10% of the concrete channels. The goal is to complete this work by 2005.

Ineffective solutions of the past are often difficult to reverse. The MMSD has reevaluated their flood relief program and begun the process of stream corridor rehabilitation with multiple benefits from an interdisciplinary perspective. Our presentation will include an historical analysis of past approaches to flood control, recent policy decisions revising that approach, pilot stream rehabilitation projects, tools developed to evaluate the pilots and to monitor planned projects, and an.

Presenting Author Bio:
Dave is a Senior Project Manager with the Metropolitan Sewerage District. He has a Master of Science degree in Stream Ecology and is a certified floodplain manger (CFM). Dave is a member of the Association of State Floodplain Managers and serves ASFPM as the Natural Floodplain Function Alliance Coordinator and Watershed POD Facilitator. Dave is also assists the Non Profit Earth Economics Team as a flood management advisor.

Habitat Enhancement in Conjunction with Fish Passage in Southeastern Wisconsin

First Author Name:
Beth Wentzel

First Author Affiliation:
Inter-Fluve

Abstract Body:
In addition to reconnecting stream reaches longitudinally by removing barriers to passage, the Ozaukee County Fish Passage Program is implementing projects to improve lateral connectivity and improve habitat in streams. One such project is the Ulao Creek Habitat Enhancement project, which included investigation into floodplain connectivity and habitat limitations in over a mile of channelized stream in Southeastern Wisconsin. This presentation will include a description of the Ulao Creek Habitat Enhancement Project with emphasis on evaluation of floodplain connectivity, the project's connection to fish passage barrier removal projects in the watershed, incorporation of installed large woody debris to increase habitat complexity, and provision for long term woody debris recruitment.

Presenting Author Bio:
Beth Wentzel is a project manager and engineer with Inter-Fluve. She has over 16 years of experience in river and wetland restoration research, advocacy, and engineering. She has contributed to development of several stream enhancement designs, including dam removal, fish passage, and channel reconstruction projects.

Oxbows and Sloughs: Wisconsin's Forgotten Lakes

First Author Name:
David W. Marshall

First Author Affiliation:
Underwater Habitat Investigations LLC

Abstract Body:
Despite decades of progressive lake research, monitoring and management in Wisconsin, an entire class of lakes remain hidden from mainstream management. Sloughs and oxbows, perhaps overshadowed by the scores of glacial lakes in the state, are poorly understood and rarely investigated. Yet these mysterious off-channel habitats are essential for river ecosystems and biodiversity. These diverse habitats sustain some of the most unusual fish species and assemblages in the state. Fates of many rare species depend on these crucial floodplain habitats. While floodplain lakes typically lack the types of problems associated with larger glacial lakes, they are nonetheless threatened and in many cases are significantly degraded due to floodplain aggradation and groundwater pollution. Presented are several years of findings that include near shore fish population survey results along with floodplain lake habitat and water quality information. The findings suggest that floodplain lakes, perhaps the most threatened class of lakes in Wisconsin, are in dire need of protection and restoration. In some cases, restoration can take the form of slough construction that coincides with dam removal.

Presenting Author Bio:
Dave Marshall received a Bachelor's degree in Biological Aspects of Conservation from UW Milwaukee in 1975. He worked as a water resources species at Wisconsin DNR from 1976 - 2006. He started his environmental consulting company, Underwater Habitat Investigations LLC, when he retired from Wisconsin DNR in 2006.

A8

Effects of a sweeping low frequency pulsed DC electrical field on Asian carp behavior in a zero flow environment

First Author Name:
Jackson Gross

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2. Alecia Stewart-Malone
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Abstract Body:
The goal of this research was to evaluate the efficacy of various electric field settings to successfully direct movement of bighead (Hypophthalmichthys nobilis) and silver (Hypophthalmichthys molitrix) carp. The ability to control the movement and passage of fish has valuable utility from preventing fish moving into river reaches through locks and dams to labor reduction and efficacy of fish collection in aquaculture and hatchery settings. Traditional graduated field fish barriers utilize electrical settings that immobilize fish as they swim upstream through the graduated electric field, and then are subsequently returned downstream from the barrier via downstream flow. In low to no-flow environments such as a lock chamber, however, there exists no flow capable of returning fish downstream of the barrier. The effectiveness of a sweeping electric field requires fish to be moved away from a targeted area in a controlled manner and with little detriment to fish swimming. This study characterized behavioral responses of varying sizes of bighead (5 – 100 cm) and silver (5-8 cm) carp to a low voltage, low frequency pulsed DC sweeping field necessary to systematically move fish in a 24m long X 2.5m wide X 1m water height raceway. Fish movement was recorded by video surveillance and PIT tag array equipment. A positive result was defined by the ability to direct one hundred percent of the fish into a predefined area. This presentation describes the efficacy study and discusses findings and their implications.

Response of fishes to the operation of water guns

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Abstract Body:
Bighead carp (Hypophthalmichthys nobilis) and silver carp (H. molotrix) have expanded their range into northern Illinois and Indiana and threaten to enter the Great Lakes through at least two potential connections. We examined responses of these species to discharge of seismic waterguns in 0.5-ha ponds to test whether waterguns might act as a deterrent for eventual use in natural environments to augment electrical barriers as deterrents to upstream migration. We conducted experiments in which a known number juvenile silver carp, bighead carp and four native species (bigmouth buffalo, channel catfish, paddlefish and yellow perch) were allowed to acclimate in the pond setting, then subjected to several periods of firing of water guns. Hydroacoustic transducers and an acoustic telemetry system were deployed to detect movement of fish before, during, and after firing periods. Detection rates are compared between detection gears, among firing periods, and between diel periods . Results suggest greater activity during

darkness and directed movement during firing periods to move away from operating water guns.

Presenting Author Bio:
Gaikowski is a supervisory biologist at the U.S. Geological Survey's Upper Midwest Environmental Sciences Center. He leads a research team focused on the development of tools for the surveillance and management of aquatic invasive species.

Impaired waterbody restoration utilizing electric fish barrier technology to exclude invasive carp

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Abstract Body:
This presentation will offer new perspectives on how an established technology (electric fish barriers) can be used to help restore water quality in carp-damaged ecosystems and watersheds. Various species of invasive Asian carp are extending (or have extended) their foothold in North American waters. Whereas the common carp was brought to the U.S. for food production purposes in the mid-1800's, invasive Asian varieties were introduced in the 1970's (for aquaculture uses and vegetative control). However, major flood events in the southern U.S. contributed to the escapes of Asian varieties from environments thought to have provided sufficient containment. These bottom-feeding, highly adaptable and prodigious reproducers quickly began to establish new ranges and wreak havoc on aquatic ecosystems throughout the Midwest. The effects of these invasions have turned once-clear reservoirs and lakes into muddy quagmires (that adversely affect other species) following the premature releases of bottom nutrients by these voracious feeders. Graduated Field Fish Barriers (GFFBs) were developed in the late 1980's for fish guidance and deterrence purposes. By the mid-1990's, this technology was being deployed to either contain sterile Asian varieties (i.e. triploid grass carp) or to prevent the movements of Asian carp escapees into new rivers and watersheds. There are numerous GFFBs installed for carp control located throughout the Midwest and southern U.S. Virtually all of these deployments have addressed needs to stop the movements and spread of invasive Asian carp. This presentation will examine the deployment of a GFFB in Mud Lake, MN, a water body invaded by common carp and the "before and after" effects on the lake's total phosphorous, chlorophyll a, and water clarity following rotenone treatment and barrier placement to eliminate carp. This case study thus offers new perspectives on how electric fish barrier technology can help restore water quality in carp-damaged watersheds.

Presenting Author Bio:
Aaron Murphy, P.E. is a civil engineer with a specialty in water resources and the environment. He spent the first 9 years of his career working on projects in Australia, South East Asia, United Arab Emirates and Afghanistan. This included work associated to flood/hazard management, dam break assessment, hydrological assessment, mining, urban/commercial development, irrigation/watershed assessment and management.
In 2010 he relocated to the USA and began working for Smith-Root, Inc. He was hired to develop a unique section of the company which entails using electricity to block, direct and guide fish in waterways. This opening has given him the opportunity to work on projects

in the USA, Canada, Europe, Russia and South America.
He is currently hired as the Director of E-Barrier Development | Principal Civil Engineer. He utilizes his experience, market knowledge and engineering ability to develop and strengthen the electric fish barrier business worldwide. He also provides high level of input associated to the design and installation of electrical fish and mammal barrier systems.

Use of carbon dioxide as a non-physical barrier to deter fish movement

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Abstract Body:
Upon arrival in a novel environment, invasive species have the potential to cause negative consequences at their new location. Rather than try to eliminate invasive species after introduction, preventing their spread is a more efficient strategy to mitigate impact. The current presentation will summarize work our group has been performing to quantify the potential of carbon dioxide gas (CO2) to act as a non-physical fish deterrent, with a particular emphasis on invasive Asian carp. Work has been performed in both the laboratory and the field, and has ranged from gene expression to pond-scale telemetry work. Results have demonstrated that exposure to elevated (CO2) induces a suite of physiological and behavioral disturbances across a range of fish species. More importantly, fish voluntarily choose to swim away from zones of elevated CO2, with all sizes of fishes (ranging from 2 inches to adults) avoiding areas of high carbon dioxide. Despite this potential, the use of CO2 in a natural setting has a number of challenges or obstacles, including potential impacts on the receiving environment and non-target organisms. Together, results indicate that zones of elevated CO2 have great potential to influence or impair the movement of fishes.

B8

Mapping Dam Removal Success: Lessons from United States Dam Removals

First Author Name:
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American Rivers

Other Authors:
Laura Craig

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American Rivers

Abstract Body:
Dam Removal is arguably the most effective tool we have for restoring river habitat and fish passage. While some of the more than 80,000 dams in the United States provide important water supply, flood control and recreation functions, most no longer serve the original purpose for which they were built. Many dams are relics of old mills and the industrial revolution and are no longer maintained and in need of repair. The benefits of other larger dams may no longer outweigh the significant impacts to fisheries and river habitat. Dam removal restores river function as sediment, water, nutrients and fish are able to move again unimpeded. Dam removal also eliminates maintenance requirements for owners and the potential danger of failure at unmaintained dams during floods. As the rate of dam removal has increased we are seeing positive results to fish and river habitat, and we are learning just what it takes to make projects successful.

American Rivers released an online map of over 1,150 dam removals across the United States in 2014. The interactive map provides both a tool for river advocates and a lens through which to view the success of dam removal. Using this map as a baseline for information, this presentation will 1.) Review patterns of dam removal rates and geography over time; 2.) Discuss what these changes mean for river restoration and fisheries management; and, 3.) Identify issues and geographies ripe for engagement in order to facilitate more dam removal.

Presenting Author Bio:
Amy works for American Rivers' River Restoration Program and The Nature Conservancy's Connecticut River Program managing dam removal projects and promoting efforts to improve river restoration in New England. She also leads regional efforts for both programs on culvert and stream crossing policy and implementation. Amy has a M.S. in Water Resources Management from the University of Wisconsin, Madison, and a B.S. Ecology and Evolutionary Biology from the University of Rochester.

The Biggest Barriers to Barrier Removal

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Princeton Hydro

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Abstract Body:
Dams are removed for a wide variety of reasons including issues relating to economics, dam safety, liability, and environmental concerns. However, even when a dam has outlived its initially intended use there may still be significant barriers to dam removal. The most common of these barriers include issues relating to funding (i.e. lack of available grants and the high cost of impounded sediment management); historic, aesthetics, and recreational values; impacts to infrastructure and water diversions; lack of

owner buy-in; community politics; invasive species management; and the scale of the effort involved. This paper will look at a wide variety of projects where dam removal was being considered and discuss the key barriers that made dam removal infeasible. We will then compare these projects with successful dam removal projects where similar issues arose and were addressed with creative solutions. Approximately 40 barrier removal projects will be discussed, including a dam in Vermont in poor condition that was retained due to aesthetic and recreation value; a dam in North Carolina that was retained due to future water diversion needs; a dam in Maine that was removed after a 20 years effort that led to the first FERC ordered decommissioning of an active hydro-electric dam; and a dam in California with a significant amount of impounded sediment that was removed only after a highly creative cost effective method for sediment management was developed. Identifying key barriers to dam removal early on in a project, and understanding which of these barriers might have potential solutions versus remain an impediment, is critical to prioritizing limited ecological restoration resources.

Presenting Author Bio:
Laura Wildman has worked since 1989 as a professional water resource/fisheries engineer focusing on fish passage, barrier removal and river restoration. She has been involved in hundreds of fish passage and river restoration projects throughout the United States, working on all aspects of the projects from inception through design and construction. Ms. Wildman is considered one of the foremost national experts on dam removal and nature-like fishways, speaking regularly around the country on these subjects, publishing papers and books, and developing and assisting with the instruction of courses at the University of Wisconsin and Yale in dam removal, fish passage, and river processes/restoration for over 10 years. Ms. Wildman is currently the President for the Bioengineering Section of the American Fisheries Society(AFS) and servers on the AFS Governing Board. In 2011, Ms. Wildman initiated a join ad hoc committee under both AFS-BES and ASCE-EWRI leadership to further the strategic goals of both organizations with the objective of developing a partnering relationship between the two organizations on the topic of fish passage, by establishing a reoccurring international fish passage conference and developing a repository for fish passage information. In 2010 she developed and now leads the Dam Removal and Fish Passage Network on LinkedIn with over 1,700 members internationally.

Restoring Minnesota Falls after a Century of Submergence

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Abstract Body:
The Minnesota Falls dam was constructed in 1905 as a hydroelectric power project, and was purchased by Northern States Power Company (now Xcel Energy) in 1917. In 1961, the facility was retired as a hydropower generating facility, but the dam was left intact; its reservoir provided cooling water for Xcel's Minnesota Valley Generating Plant until the plant was retired in 2009. By that time, the dam was in need of significant maintenance and repairs. Because the dam no longer served a beneficial use for Xcel Energy, they began exploring alternatives for removing the dam. Barr Engineering Co. assisted Xcel with

exploring options ranging from complete removal to repair and maintain, including the “in-between” option of removal and replacement with rock rapids in order to maintain the pool yet provide fish passage.

Complete removal was the selected option, which offered the greatest ecological benefit while fully eliminating the dam ownership liability. It was also the cheapest option. After completing extensive data collection, a feasibility study, an EAW, and securing numerous permits over a two year period, the dam removal finally took place during the winter of 2012-2013 over about a two month period, and final site restoration occurred in the summer of 2013.

Removal of the dam has restored Minnesota Falls to natural, bedrock-controlled rapids. Although the river environment is still adapting to the dam removal (a large flood has not yet occurred), several fish species that are either threatened or of special concern have been found above the former dam site where none were previously identified.

Presenting Author Bio:
Tom MacDonald is a Water Resources Engineer at Barr Engineering Company. His expertise is in fluvial geomorphology, sediment transport, hydraulic modeling and dam removal. His graduate work at the University of Minnesota’s St Anthony Falls Laboratory (long, long ago) emphasized evaluation of channel migration prediction for Minnesota streams.

Opportunistic vs Strategic: Raising the Bar for Stream Barrier Removals in Western PA

First Author Name:
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Abstract Body:
For the past 15 years, dam removal partners have attempted to resolve the question of opportunistic versus strategic approaches to stream barrier removal projects that provide maximum ecological gain with limited resources. Investing in a single watershed multiplies conservation benefits, but follows a number of critical path factors including project cost, access to funding, specific ecological benefit, the dam’s current use, and most importantly, the willingness of the dam owner to allow dam removal. To build momentum for the practice of dam removal, American Rivers and others have commonly followed an opportunistic path for stream barrier removal projects, with the results generally being dispersed projects over the landscape without significant measurable cumulative impact in a single watershed. In 2011, American Rivers was challenged by a funder to raise the bar for the practice of dam removal in western PA by developing and applying a strategic model. Utilizing two iterations of geospatial analyses, we first focused solely on ecological factors that defined the bookends of the water quality spectrum (HUC-12 watersheds most in need of conservation and most in need of restoration). This narrow scope produced limited opportunities due to lack of available projects in high-priority HUC-12s. Our subsequent geospatial analyses compiled additional datasets including an inventory of existing permitted dams (not available during the first analysis), ranges of iconic and ESA species, opportunities for funding, and watersheds in which stream barrier removals have already been completed. The addition of

a weighting process allowed us to compare the relative importance of watershed prioritization criteria, and revealed significant opportunities for cumulative restoration work within high-priority watersheds. Opportunities for strategic stream barrier removal are built on the momentum of multiple projects within a single watershed. Previous local success, albeit opportunistic in nature, is a strategic resource for new project recruitment and development.

Presenting Author Bio:
Hollingsworth-Segedy is a river restoration program manager in the Western Pennsylvania field office of American Rivers. A geologist and environmental planner, she has been involved in more than 60 dam removal projects since joining American Rivers in 2008.

C8

A Sensitivity Analysis of How Regional Climate Differences and Fish Passage Criteria Affect Steelhead Migration Opportunity

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Abstract Body:
This study evaluated whether differences in California's coastal climatic regions should be accounted for when defining high fish passage design flows for adult anadromous steelhead (Oncorhynchus mykiss). Current adult steelhead passage design flow criteria for California are defined by the National Marine Fisheries Service and the California Department of Fish and Wildlife. The criteria use the 1 percent annual exceedance flow, obtained from mean daily flow data, or, alternatively, 50 percent of the 2-year peak flow. The 1-percent annual exceedance flow criterion was based primarily on hydrologic data and observations of fish migration timing in north-coastal California streams.

Climatic differences between northern and southern regions of California have generated concerns regarding the impacts of high-flow migration delay imposed on coastal central and southern California steelhead by the current criteria. Generally, mean annual precipitation decreases moving from north to south, as does the frequency of rainfall and runoff events that adult steelhead utilize to migrate inland. Annual and inter-annual rainfall variability also increases from north to south, further influencing the frequency and time steelhead have access to their spawning grounds during a migration season. The relative importance of the passage delay created by adopting different passage criteria to the number and duration of fish passage flow events and total time which steelhead have access to spawning grounds within different climatic regions during wet, average, and dry migration seasons is described and provides a basis for assessing passage criteria.

While this study focuses on the impacts of fish passage design flow criteria on adult steelhead migration within different climatic regions along the Pacific Coast, the methods developed to assess and compare design flow criteria are broadly applicable. These methods can be applied to migratory fish species in any climatic region to better inform the criteria setting process and passage mitigation strategies.

Presenting Author Bio:
David Crowder received his Ph.D. in civil engineering from Virginia Tech where he conducted research in using 2-D hydraulic models to reproduce and quantify ecologically important flows. After working at the Illinois State Water Survey for 7 years studying sediment load and effective discharge computations, David took a position in 2008 with the National Marine Fisheries Service, where he works on fish passage issues.

Conserving riverine lake sturgeon in Wisconsin under a warming climate: the importance of connectivity

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Abstract Body:
Climate change is warming North American rivers and will have major effects on fishes. The lake sturgeon (Acipenser fulvescens), an uncommon and iconic species, prefers cooler waters, and climate projections indicate that much of its riverine habitat in Wisconsin could become too warm in the future. Lake sturgeon currently occupy about 2,280 km of river in the state, fragmented into 48 reaches isolated by impassable dams, of which 1,924 km (84.4%) are estimated to be thermally suitable, 350 km (15.4%) thermally marginal, and 6 km (0.3%) thermally stressful. All reaches with marginal or stressful habitats have cooler areas or large tributaries that could act as thermal refugia. Thirteen downscaled global climate models predict that by mid-century thermally marginal habitats will increase to 865-2,144 km (30.0-94.0%) and stressful habitats to 33-1,034 km (1.4-45.4%). Fourteen short reaches expected to have marginal or stressful conditions will no longer have any thermal refugia, and several longer reaches will have only one or two small refugia. For all of these reaches, provision of safe and effective upstream passage through dams could permit access to multiple large refugia further upstream. At present, Wisconsin has only two dams with functioning upstream passage facilities for lake sturgeon, Eureka Dam on the Fox River and Winter Hydro Dam on the East Fork Chippewa River. Two additional facilities may be built by 2020. However, more upstream passage will be required if lake sturgeon are not to be trapped in thermally challenging river reaches as the climate warms.

Presenting Author Bio:
John Lyons is a fisheries research scientist at the WDNR in Madison and also adjunct curator of fishes at the University of Wisconsin Zoological Museum, positions he has held for over 29 years. His research focuses on the conservation of fishes and their habitats in Wisconsin and in Mexico. One of his current projects is to forecast climate change impacts on Wisconsin fishes and develop adapatation strategies.

Using a Climate Change Vulnerability Assessment to Prioritize Aquatic Organism Passage Projects

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Abstract Body:
The White River National Forest developed a course screening methodology to rate the relative risk of aquatic resources in 6th-level subwatersheds to the anticipated impacts from climate change. Values such as aquatic habitat, water supply, and road/floodplain infrastructure were analyzed in 166 subwatersheds, totaling 2.3 million acres. The final product was a high/medium/low rating system for each subwatershed based on inherent subwatershed characteristics (e.g. aspect, precipitation type/amount, geology, etc.) and the extent of anthropogenic impacts. The rating system helps the forest to prioritize the location fish passage projects and road-stream crossing upgrades that might mitigate

expected changes in streamflow and temperature.

Presenting Author Bio:
Mark is the forest hydrologist and Watershed/Fisheries Program Manager on the White River National Forest in western Colorado. He is heavily involved in the Forest Service's aquatic organism passage (AOP) program as a member of the national teaching cadre, through development a computer-based e-learning tool for road-stream crossing design, and through development of implementation and effectiveness monitoring protocols for AOP projects. He has also assisted the Forest Service International Program with a climate change needs assessments in Vietnam and spatial planning training in West Kalimantan, Indonesia. His past and current graduate work in civil engineering have largely focused on open-channel hydraulics and modeling sediment transport in gravel-bed rivers. His favorite movie is Princess Bride, his first car was a 1968 Volkswagen bug and he is particularly fond of dark chocolate.

Indirect Effects of Impoundment on Migrating Fish: Temperature Gradients in Fish Ladders Slow Dam Passage by Adult Chinook Salmon

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Abstract Body:
Thermal layering in reservoirs upstream from hydroelectric dams can create temperature gradients in fishways used by upstream migrating adults. In the Snake River, Washington, federally-protected adult salmonids (Oncorhynchus spp.) often encounter relatively cool water in dam tailraces and lower ladder sections and warmer water in the upstream portions of ladders. Using radiotelemetry, we examined relationships between fish passage behavior and the temperature difference between the top and bottom of ladders (ΔT) at four dams over four years. Some spring Chinook salmon (O. tshawytscha) experienced $\Delta T \geq 0.5$ °C. Many summer and fall Chinook salmon and summer steelhead (O. mykiss) experienced $\Delta T \geq 1.0$ °C, and some individuals encountered $\Delta T > 4.0$°C. As ΔT increased, migrants were consistently more likely to move down fish ladders and exit into dam tailraces, resulting in upstream passage delays that ranged from hours to days. Fish body temperatures equilibrated to ladder temperatures and often exceeded 20°C, indicating potential negative physiological and fitness effects. Collectively, the results suggest that gradients in fishway water temperatures present a migration obstacle to many anadromous migrants. Unfavorable temperature gradients may be common at reservoir-fed fish passage facilities, especially those with seasonal thermal layering or stratification. Understanding and managing thermal heterogeneity at such sites may be important for ensuring efficient upstream passage and minimizing stress for migratory, temperature-sensitive species.

Presenting Author Bio:
Chris Caudill is an Assistant Professor in the Department of Fish and Wildlife Sciences at the University of Idaho. His research interests are in the ecology and evolution of animal

movement and the conservation of aquatic resources. He holds a MS from the University of New Hampshire (1995) and Ph.D. from Cornell University (2002). He conducted postdoctoral research at Georgia Tech before joining the Fish Ecology Research Lab at the University of Idaho in 2003 for a second post-doc. He has directed the FERL program since 2008, largely focusing on the migration ecology of adult salmon, Pacific lamprey, and American shad in the Columbia, Snake, and Willamette rivers.