2013 UMSRS Oral Abstract Guide (arranged by session number)

Invited Talk: River Restoration: 45 Years of Lessons Learned
Dave Rosgen, *Wildland Hydrology*
Sunday February 24, 7:00pm

Invited Talk: Evaluating the Success of Urban Stream Restoration in an Ecosystem Services and Watershed Context
Anne Jefferson, *Kent State University*
Monday, February 25, 8:30am

Session 1: Stream Restoration in the Built Environment

Streambank Restoration and Stabilization to Mitigate Exposure of Three Natural Gas Pipelines

Aaron Steber, *Cardno JFNew*

Energy delivery infrastructure is a critical component of North America's energy transportation system. According to 2003 figures, 2.3 million miles (3.7 million kilometers) of pipelines transport trillions of cubic feet (or meters) of natural gas and hundreds of billions of tons of petroleum products each year (PHMSA 2007). With millions of miles of rivers and streams adjacent to or crossed by millions of miles of infrastructure, the points of intersection become an area of concern for utility and environmental managers as natural shifts in streambeds can lead to streambank erosion, potentially exposing pipelines or other infrastructure. Exposure subjects pipelines and other infrastructure to threats such as hydraulic pressure, buoyancy, or impact from debris. High flow events within streams and rivers have the potential to damage exposed pipelines possibly causing a release event, inhibiting product delivery, creating expensive repair and clean-up expenses, as well as extensive regulatory follow up.

Cardno JFNew was approached by a national pipeline company to provide the stream corridor stabilization and restoration necessary to mitigate pipeline exposure issues for three large gas pipelines (36 inch (2) and 26 inch diameter). In the center of the streambed, erosion from down-cutting had exposed one section of buried pipeline and threatened exposure of a two others. In a second location, approximately 500 feet (152 meters) upstream, severe lateral erosion of the streambanks threatened to expose all three pipelines. Using time-trend aerial photograph analysis, Cardno determined that the streambanks at the second site were eroding at a rate of 1 to 2 feet (0.3 to 0.6 meters) per year. Cardno JFNew developed a stabilization plan to provide an ecologically sound restoration of the streambanks and provide enough depth of cover to protect the pipelines therefore provide long-term stabilization at the stream crossings.

Construction of the restoration design was completed in September 2009. As a result of the structures altering the local channel morphology and the high sediment load carried by the stream, streambanks previously eroding 1 to 2 feet (0.3 to 0.6 meters) per year are currently rebuilding and accumulating sediment, providing additional protection to the pipeline in this location. As of May 2012, portions of streambank at the meander bend laterally accumulated 10 to 25 feet (3 to 7.6 meters) of sediment. With the solutions designed and implemented the streambanks have now been successfully restored, reducing the risk of exposed pipelines for the client.

Golf, Trains, and Highways - Addressing Three Unique Impairments to Brown's Creek

Kevin Biehn*, EOR*

The Brown's Creek Watershed District (BCWD) has recently completed two stream rehabilitation projects in their effort to improve the cold-water fishery of their namesake in Stillwater, MN. A third stream project in partnership with the Department of Natural Resources (MNDNR) is also currently underway. Each of these projects addresses a distinctly different but common impairment of Midwestern streams. The presentation will touch on the impairments, solutions vetted, funding, cost, metrics of success and lessons learned along the way.

Project #1: Improved fish passage [completed] Modifications of two box culverts under two state highway were designed to raise the critical water depth and maintain critical connectivity during low stream flow. Project provides fish habitat and refuge within the 80' long crossings.

Project #2: Coldwater stream restoration [completed] Restoration addresses a highly manicured reach through a public golf course, which had become excessively wide and shallow. The newly established stream buffer contributes to habitat creation, helps reduce instream warming, and improves course aesthetics while still meeting the strict playability standards of the golf course.

Project #3: Restoring floodplain connectivity [underway] As part of the MN/DNR rails to trails development of the Brown's Creek Trail, this project will serve to alleviate a century-old entrenchment caused by the rail line. A constructed two-stage channel will provide a flood release thereby reducing bank erosion and stabling the trail's cross section.

Sheboygan River Area of Concern Habitat Restoration Projects

Thomas Sear, *Short Elliott Hendrickson, Inc.;* Marty Melchior*, Inter-Fluve, Inc.;* Scott Isaacs*, City of Sheboygan;* Stacy Hron*, Wisconsin Department of Natural Resources;* Aaron Brault*, Sheboygan County*

The Sheboygan River flows 81 miles through eastern Wisconsin and discharges into Lake Michigan at the City of Sheboygan. In 1985, the lower Sheboygan River and Harbor was designated an Area of Concern (AOC) by the U.S. Environmental Protection Agency because of water quality and habitat degradation that occurred due to urbanization and the historical discharge of pollutants into the AOC. The City of Sheboygan, Sheboygan County and the Wisconsin Department of Natural Resources (WDNR) are currently implementing the three habitat restoration projects along the lower Sheboygan River that address the elimination of habitat related Beneficial Use Impairments (BUIs) associated with the AOC designation. Between October 2011 and April 2012, a Short Elliott Hendrickson (SEH) project team that includes Inter-Fluve developed related conceptual, preliminary and final habitat restoration designs, while working with a variety of local stakeholders and participating in public information meeting.

Three sites, encompassing 73 acres and nearly 2 miles of shoreline, were targeted for restoration along the lower Sheboygan River, which include the: (1) Kiwanis Park Shoreline Site, (2) Wildwood Island Area Site, and (3) Taylor Drive/Indiana Avenue Site. Although degradation issues vary by location, the causes of the BUIs include stream bank erosion, sedimentation, habitat fragmentation, invasive plants, urban land use, and urban storm water impacts. Restorative measures include shoreline stabilization and development of habitat using woody debris (anchored log jams); bioeningeered bank stabilization; removal of invasive plants and replacement with native species; and strategic placement of boulders and gravel banks within the stream to provide fisheries habitat and address sediment issues. The improvements are designed to enhance migratory and shore bird stopover and breeding, herptile breeding, warm water fisheries, and fish and wildlife populations.

The Taylor Drive / Indiana Avenue Project Area includes the development of a restored wetland within an approximately 6 acre pond that was constructed as a wetland mitigation site for the Wisconsin Department of Transportation in the early 1990s. The specific restoration goals for this site include developing connectivity between the Sheboygan River and newly constructed riparian wetlands, and improving fish and wildlife habitat within the wetland complex.

Construction of improvements, which are being funded by the Great Lakes Restoration Initiative (GLRI), were initiated in June 2012 and are scheduled to be substantially complete in Spring 2013. SEH and Inter-Fluve are assisting the City of Sheboygan in overseeing the construction of the habitat restoration improvements.

Minnehaha Creek Restoration: The Renaissance of an Iconic Resource

James Wisker, *Minnehaha Creek Watershed District;* Michael Hayman*, Minnehaha Creek Watershed District*

Over the last century and a half, urbanization has degraded Minnehaha Creek by ditching the stream, eliminating riparian wetlands, and increasing nearby impervious surface. These impacts mean increased runoff volumes and pollutant loads; decreased infiltration/baseflow; and fragmentation and degradation of in-stream and bank habitat.

Minnehaha Creek is impaired for biota due to its chlorides, dissolved oxygen and limited baseflow, while downstream receiving Lake Hiawatha is impaired for nutrients.

The Minnehaha Creek Watershed District (MCWD) is in the midst of a comprehensive series of projects to restore the riparian corridor, which helps meet water resource goals (TMDL, baseflow, recreation, wetland restoration, flooding, etc.) as well as broader goals of cities, the county, the state and area businesses. The District is taking an integrated watershed management approach, with an emphasis on partnerships and innovative policy and engineering.

In 2009, the District partnered with Park Nicollet to restore the creek and wetlands at Methodist Hospital in St. Louis Park. The project re-meandered 2,000 feet of stream channel, improved in-stream habitat, created vernal ponds, and restored the riparian zone vegetation. A boardwalk trail was included in the construction, improving access to the regional amenity for hospital patients, guests, staff and the public.

More recently, the District has begun a project to enhance and restore Minnehaha Creek upstream of the Park Nicollet site. Using that site as a model, the District has partnered with the City of St. Louis Park to restore approximately 4,600 feet of stream channel, reconnect the channel with its historic floodplain, and manage approximately 100 acres of previously untreated urban stormwater runoff. Construction will begin during the winter of 2012-2013.

In addition to stream and wetland restoration, the MCWD incorporated a variety of elements designed to benefit surrounding communities and their water resources. Additional projects include urban land acquisitions, regional stormwater management, development partnerships, and the creation of new public access to a regional resource within the Metro area.

Combined, these projects will create more than two miles and 20 acres of linear parkland around one of the most recreationally-used creeks in the Twin Cities. They will treat up to 600 acres of regional stormwater runoff, reducing or eliminating municipal and private infrastructure costs to meet federal clean water TMDL mandates for Minnehaha Creek and Lake Hiawatha. Once completed, it will be one of the most significant marriages of the urban and natural environments in recent Twin Cities history.

Session 2: Designing for Change: Restoration under Changing Conditions

Flood Resiliency, Aquatic Organism Passage, Critical Infrastructure, and Economics: a case Stream Simulation Design and ERFO policy changes

Bob Gubernick, *USDA Forest Service;* Nat Gillespie, Amy Unthank, Lauren Campbell, Dan Cenderelli, Mark Weinhold, Paul Anderson, Dan McKinley, Brian Austin, Steve Roy*, USDA Forest Service;* Susan Wells, Jan Rowan, Madeleine Lyttle, Curt Orvis, *US Fish and Wildlife Service;* Rich Kirn*, Vermont Fish & Wildlife Service;* Alison Bowden, Jessica Levine*, The Nature Conservancy;* Amy Singler, Eileen Fritz, *American Rivers*

A retrospective case study was conducted in the Upper White River subbasin in Vermont (Unthank et al 2012) that examined persistence of traditional hydraulic and stream simulation designs following the record flood flows from Tropical Storm Irene that occurred in August 2011. Analysis indicated that extensive damage to road infrastructure in this study area was largely avoided in areas where the stream simulation design approach was implemented, as did several other localized case studies from across New England. Benefit/cost analyses suggest that a relatively modest increase in initial investment to implement stream simulation designs to provide aquatic organism passage yield substantial societal benefits. When considering the overall comparative economic, social and natural resource costs to communities caused by crossing and/or road failure due to undersized road-stream crossings, adoption of stream simulation design is comparatively inexpensive when examined over a multi-year time frame.

Hydraulic analysis results of stream simulation designed structures surviving Tropical Storm Irene will be presented along with a series of regulatory, policy and funding recommendations to help agencies, municipalities and communities make smart infrastructure and aquatic resource investments that reduce future road and stream crossing failures and associated impacts, and to help provide biological resilience and infrastructural persistence in the face of increased frequency and severity of flood events modeled under climate change.

Farm-Crossing Mitigation Design and Native Plant Tolerance & Function

Mimi Wagner, *Iowa State University;* Nate Hoogeveen*, Iowa Department of Natural Resources;* Angela Hettinger*, Iowa State University*

Native riparian plant communities are regionally and even sub-regionally distinct, responding to latitude, hydrology, and geology. Becoming a student of local plants helps one begin to understand submergence tolerance and moisture needs, scour and deposition tolerance, sun and shade tolerance, and root qualities including depth, density, fibrous matting, and hardness. All these factors have significant effects on project success, particularly with ongoing climate change stresses on rivers and restoration projects .This session reports on two Iowa stream restoration efforts in which native plants are being researched to better understand tolerances and function. A farm-crossing mitigation on the Yellow River included removing a dam-like structure and reconstructing at thalweg level, bankfull floodplain restoration, and diverse plantings that will be monitored long-term. Streambank restoration on three urban tributaries to the Skunk River included 17 native species and utilized pre- and post-construction BEHI calculations.

A Washload Dominated-Sediment Transport River with Limited Channel Migration, yet very Meandering

Miguel Wong, *Barr Engineering;* Cory Anderson, Brandon Barnes, Peter Hinck, Tom MacDonald, Ben Sheets, Jeff Weiss *,Barr Engineering;* Aaron Buesing, Michelle Larson, Alex Nelson*, Army Corps of Engineers*

For decades the cities of Fargo, North Dakota, and Moorhead, Minnesota, have been plagued by flooding from the Red River of the North and its tributaries. The goal of a relatively large and complex diversion project proposed by the U.S. Army Corps of Engineers is to provide permanent relief. This presentation will deal with two aspects of this proposal. The first is the evaluation of potential impacts from the project on the channel morphology and sediment transport characteristics of the rivers in the project area. The second is the design of a project feature that attempts to learn from the typical characteristic of the natural riverine systems and two existing diversions in the project area.

We will show that for the evaluation of project impacts, understanding of the surficial geology and channel network development in the Red River valley formerly covered by glacial Lake Agassiz is of particular relevance. This understanding of processes over a geologic time scale provides an appropriate framework for analyzing and interpreting what could happen in engineering time scales. In addition, the evaluation benefitted from an extensive set of channel morphology and sediment transport measurements during both low and high flow conditions, which portray the washload dominated-transport in suspension of primarily clays and silts typical of the rivers in the project area. One additional important finding that will be highlighted is the relatively uniform vertical profile of sediment concentrations, perhaps because of the very fine nature of the sediments being mobilized, and the implications of this in evaluating impacts.

We will also show the results of the analysis supporting the design of a meandering low flow channel that would be constructed within the main diversion channel to facilitate drainage and sediment conveyance during non-flooding times. The analysis included the estimation of channel migration rates since the last glaciation in rivers located in the project area. For this purpose, a combination of borehole transects along point bars, organic matter sampling and carbon dating techniques, and geologic interpretation of field and laboratory results were used. The preliminary conclusion is that the rivers in the project area, including the Red River of the North, have been migrating very slow (in the order of 0.1 to 0.2 feet per year), which is consistent with what was found by Brooks in Manitoba.

The analysis also included evaluation of planform characteristics (amplitude, sinuosity, and wavelength) for the rivers in the project area, and a comparison to channel configuration characteristics (top width, channel aspect ratio, channel slope, and valley slope). While it was anticipated that some correlations would be seen between these parameters, this was not the case. In general, relationships were both weak and inconsistent. A possible explanation for this is the unique soil characteristics of the region. Rather than being driven by river hydraulics, channel alignment may have been formed by the last glaciation, with minimal change since. Thus, there is no typical, ideal planform to target in the design of the meandering low flow channel.

Finally, the analysis included numerical modeling of different meandering configurations using the RVR Meander software in a probabilistic fashion (Monte Carlo simulations). Initial base models were developed and calibrated to match observed historical channel migration of rivers in the project area. These base models were then modified to determine the probability that the artificially constructed low flow channel would remain within a desired, prescribed meander belt width. More importantly, this last step of the analysis has led to proposing a methodology for assessing the "morphodynamic stability" of riverine-like systems.

Invited Talk: Understanding Environmental Economics in Agricultural Watersheds

Catherine Kling *Iowa State University*

Tuesday, February 26, 8:30 am

Session 3: A State of the Practice: Examining Stream Restoration

Efficacy of Stream Restoration as Currently Practiced

Doug Shields, cbec, inc. eco engineering; Martin W. Doyle, *Nicholas School of the Environment, Duke University*

Stream restoration is widely practiced in developed countries, with annual expenditures in the U.S. exceeding $1 billion. Economic justification for most projects is based on restoring functional attributes of lightly impacted streams including flood mitigation, channel stability, downstream water quality, and ecological integrity. However, few projects are monitored, and the assumption that development impacts to streams may be mitigated by restoration of degraded reaches is in question. Herein we synthesize the literature regarding effectiveness of stream restoration projects, with particular emphasis on large meta-analyses and long term studies with parallel reference sites allowing before-after-control-impact experimental designs. Preliminary findings include the following:

1. Geomorphic restoration (stream form) is not adequate to assure ecological recovery. In particular, restoring physical habitat characteristics is not in and of itself adequate to produce functional ecological restoration.
2. Success rates vary widely, with most efficient stream work occurring along salmonids streams with coarse beds.
3. Many projects fail to produce significant benefits because upstream watershed developments and impacts dominate reach-scale improvements.
4. Hydrologic and chemical water quality restoration is particularly difficult to achieve under current restoration approaches.

These findings support the concept that more rigorous science to support restoration planning and design standards is needed. Furthermore, training and professional certification for practitioners needs to become stronger and more widely required. Policy changes allowing greater flexibility in selecting stream restoration sites and allocation of resources to a wider array of restoration options when awarding mitigation credits is also worthy of further consideration.

Are We Certifiable? Defining the Body of Knowledge for Practicing Stream Restoration and National Certification

Sue Niezgoda, *Gonzaga University*

Should stream restoration professionals by registered? Certified? Are we indeed certifiable? What is the body of knowledge that defines the practice? Many projects require the stamp of a PE. Are professional engineering standards sufficient to ensure that stream restoration projects are appropriately specified, well designed, and adequately installed? Issues of responsibility and liability make these questions intensely relevant to engineers, but they also help to define the state of the practice. To help answer these questions and meet this ever-growing need for high quality restoration professional development, a stream restoration educational materials task committee of the River Restoration Committee of the ASCE-EWRI Hydraulics and Waterways Council was formed in 2009. With sights on advancing the quality of restoration planning, design, implementation, and monitoring, the TC set out to establish a common and consistent set of core principles and methods for the practice of stream restoration providing a formal stream restoration body of knowledge (SR-BOK) for the profession. This goal was met through the completion of three tasks. Task 1 was a selected review of existing guidance manuals and professional development courses to examine strengths and weaknesses, and to offer guidance on currently available educational opportunities. According to the survey results, course sequences and certificate programs offer both the most efficient means to learn the largest variety of restoration topics and expert instruction covering the widest variety of disciplines. Task 2 was a practitioner survey to compile a stream restoration body of knowledge (SR-BOK). The key findings indicate that a SR-BOK needs to be multidisciplinary and contain both foundation and application topics. Task 3 was to develop a standard SR-BOK that defines a suggested minimum level of competence for a general practitioner in the stream restoration profession (see attached). If adopted at a broad scale by a variety of disciplines, the standard SR-BOK will advance the profession and lay the groundwork and rationale for developing a national stream restoration professional certification.

A Fresh Look at Stream Restoration

Ray White, *Consulting Stream Ecologist*

The science underlying stream restoration has advanced tremendously in the last 20 years, and greatly improved practice has resulted in some regions and within some institutions. Knowledge of this, however, has not reached (or not been accepted by) various governmental, NGO, and private practitioners, who continue outmoded methods of the 1930s-1980s. Poor communication by scientists is part of the problem. Much of so-called "stream restoration" fails to deal with root causes; is conducted as piecemeal, highly artificial projects; restructures channels without restoring much, if anything; and causes ecological damage. Particularly harmful is hard over-stabilization of channels into simplified forms that prevent the dynamic natural stream processes that generate and regenerate the complex habitats to which fish and other organisms are adapted. Much can be done to make programs more truly restorative, but there is confusion about the concept of restoration and about objectives that are beneficial and attainable. For example, in the Midwest, we can restore toward but seldom reach the semi-natural, pre-Euro-American conditions that existed for thousands of years, a time of fire-driven landscape processes, often influenced by Native Americans. I will show common examples of false restoration, as well as of unneeded and overdone "habitat improvements," explain problems they cause, and then present alternatives that lead to self-healing processes in streams—and that could be more economical and aesthetic. Rather than the usual "architect mode," in which one person designs a project, it is essential to have a multi-profession team perform pre-project analyses of physical and ecological processes in the stream and its watershed, diagnose problems, design the project for action in concert with natural functions, and keep some oversight of treatments. Protecting and managing riparian vegetation will often accomplish most of what needs to be done.

Session 4: Managing Incised Systems

An Overview of Sediment TMDLs in the Minnesota River Basin

Larry Gunderson, *Minnesota Pollution Control Agency*

Excessive sediment disequilibrium is a pervasive problem in the Minnesota River and its tributaries. The Minnesota River contributes the largest amount of sediment to the Mississippi River and Lake Pepin. Turbidity impairments are among the most frequent water quality violation in the Minnesota River basin. Total maximum daily load (TMDL) projects are underway to establish targets and implementation strategies.

Near channel features such as stream banks, bluffs and ravines have been identified as primary sediment sources; caused in part by historic drop in base level to reach the Minnesota River. Nevertheless, tributaries in the Minnesota River basin show continuing and varying degrees of channel instability. Channel widening and incision continue to occur in selected locations of the basin; however, the problem is systemic and requires a holistic solution. Both upland and riparian areas undergoing the most rapid land use change need to be understood with respect to drivers; whether climatic, anthropogenic or both.

Estimates developed as part of TMDL studies indicate that large decreases in sediment are needed to meet the state's water quality standards. Possible implementation measures identified so far include upland best management practices, perennial vegetation and water storage. Stream channel restoration could be a part of an overall strategy to reduce sediment. Research, TMDL projects and modeling will be used to drive implementation strategies.

Understanding Ravine Growth using Physical Experiments

Stephanie Day, *North Dakota State University;* Karen Gran*, University of Minnesota-Duluth*

Ravines grow as head cuts propagate upstream in response to overland flow. Often these head cuts threaten infrastructure and cause land owners worry that their land will be dissected by the growing ravine. Typically methods used to slow ravine growth include stabilizing the head cut using rip rap or check dams. These methods are often initially successful, but do not offer long term solutions, and only partially address the cause of ravine propagation. In addition to sediment erodability, hydrology also plays a role in ravine growth. Using a set of small physical experiments we tested how changing overland flow rates for a fixed volume of water alters the total volume of erosion and the ravine morphology. These experiments showed that the volume of water entering a ravine through overland flow determines how quickly a ravine erodes. This response is not typical when compared to pre-existing channels where higher flow rates result in greater erosion.

Fish Passage and Abundance around Grade Control Structures on Incised Streams in Western Iowa

John Thomas, *Hungry Canyons Alliance;* Mary Culler, *Iowa State University / Missouri DNR;* Dimitri Dermisis; *IIHR at University of Iowa;* Clay Pierce*, USGS and Iowa State University;* Thanos Papanicolaou*, IIHR at University of Iowa;* Tim Stewart*, Iowa State University;* Chris Larson*, Iowa Department of Natural Resources*

Land use changes and channelization of streams in the deep loess region of western Iowa have led to stream channel incision, altered flow regimes, increased sediment inputs, decreased habitat diversity, and reduced lateral connectivity of streams and floodplains. Grade control structures (GCS) are built in streams to prevent further erosion, protect infrastructure, and reduce sediment loads. However, GCS may have a detrimental impact on fisheries and biological communities if they present a barrier to fish passage. Three complementary biological and hydraulic studies on the effects of GCS in these streams are reviewed. GCS with steep (≥ 1:4 rise:run) downstream slopes severely limited fish passage, but GCS with gentle slopes (≤ 1:15) allowed greater passage. Following modification of GCS to reduce slopes and permit increased passage, IBI scores increased and several species were detected further upstream than before modification. Total macroinvertebrate density, biomass, and taxonomic diversity, and abundance of ecologically sensitive taxa were greater at GCS than in reaches immediately upstream, downstream, or ≥ 1 km from GCS. A hydraulic study confirmed results from fish passage studies; minimum depths and maximum current velocities at GCS with gentle slopes (≤ 1:15) were more likely to meet minimum criteria for fish passage than GCS with steeper slopes.

Implications of Fish-habitat Relationships for Designing Restoration Projects within Channelized Agricultural Headwater Streams

Peter Smiley, *USDA ARS;* Robert B. Gillespie*, Indiana University-Purdue University;* Javier M. Gonzalez*, USDA Agricultural Research Service;* Kevin W. King, *USDA Agricultural Research Service;* Douglas R. Smith*, USDA Agricultural Research Service*

Channelized headwater streams are common throughout agricultural watersheds in the Midwestern United States. Management of these streams focuses on drainage without consideration of the other ecosystem services they are capable of providing. Restoration of channelized agricultural headwater streams is hindered by a lack of basic ecological information. Understanding fish-habitat relationships within channelized agricultural headwater streams will assist with designing restoration projects for these degraded streams. We have been conducting research involving fish community assessments, biomarker evaluations, and streamside bioassays from seven channelized agricultural headwater streams in central Ohio and three channelized agricultural headwater streams in northeastern Indiana since 2006. Our objective for this presentation is to synthesize seven years of research results to highlight how information on fish-habitat relationships can assist with designing restoration projects. Our fish community assessments have documented that community structure is more strongly correlated with instream habitat than either riparian habitat or water chemistry. These fish-habitat relationships occur across watersheds and within individual watersheds. However, examination of fish-habitat relationships within individual watersheds observed some within-watershed differences. Six of 21 fish community response variables were more strongly correlated with water chemistry in northeastern Indiana and only one of 20 response variables was more strongly correlated with water chemistry in central Ohio. Results from streamside bioassays suggest that long-term exposure to nutrients and herbicides may have caused negative impacts on growth in fathead minnows (Pimephales promelas). However, exposure to agricultural contaminants did not negatively affect survival, hepatosomatic index , or gonadosomatic index in fathead minnows. Overall, our results suggest that restoration projects within channelized agricultural headwater streams in the Midwestern United States need to address physical habitat degradation to induce changes in fish community structure and to address chemical habitat degradation to avoid sublethal responses in fish populations.

Session 5: Stream Restoration and Biotic Systems

Modeling Freshwater Mussel Habitat in a Large River: How Understanding Processes can aid Restoration Efforts

Teresa Newton, *USGS;* Steve J. Zigler*, USGS*

Large floodplain rivers are fundamentally different from smaller systems in their lateral complexity and hydrology. However, conditions that constitute habitat for freshwater mussels in large rivers are poorly understood, greatly limiting our understanding of the conditions that promote high quality mussel assemblages. Several conservation activities (e.g., placement of young mussels in streams for propagation efforts, relocation of adult mussels for bridge repair) require knowledge of those features that constitute quality mussel habitat in our rivers and streams. Over the past 10 years, we have modeled the abundance and distribution of mussels in the Upper Mississippi River (UMR) using physical and hydraulic variables. Analyses of data from small (0.4 km) to large (38 km) spatial scales indicated that computed hydraulic variables (e.g., shear stress, Froude number) were more predictive than measured physical variables (e.g., depth, substrate type). Models of mussel presence were largely driven by shear stress and substrate stability, but interactions with physical variables (e.g., slope) were important. Moreover, discharge-specific models suggested that episodic events such as droughts and floods were more important in structuring mussel distributions than conditions during average flows. Geospatial models predicted few mussels in poorly connected backwater areas and the navigation channel, whereas main channel border areas with high geomorphic complexity and small side channels were typically favorable to mussels. Overall, our studies indicate that the spatial distribution of mussels in large rivers is determined by a complex interaction of biotic and abiotic factors acting at various spatial scales. Our research suggests that the interaction of geomorphology and discharge produces a template of hydrophysical conditions that could be manipulated by managers to create quality mussel habitat to benefit restoration activities.

Quantifying Stream Reach Nutrient Processing: a Comparison of Experimental and Modeling Approaches used in Eagle Creek

Amy Hansen, *St Anthony Falls Laboratory, University of Minnesota;* Ali Khosronejad, Kris Guentzel, Jessica Kozarek, Fotis Sotiropoulos, Miki Hondzo*, St Anthony Falls Laboratory, University of Minnesota*

Stream restoration projects often include elements designed to improve nutrient processing in the reach. This goal may be explicitly included to address downstream TMDL requirements or as a response to the concept of “restoration” as an act to improve ecological functioning. Physical and biological processes that control nutrient cycling in streams are highly localized and uptake can vary greatly within a reach. Various methods and models can be used to quantify nutrient uptake in the stream reach as well as predict the water quality impacts of the restoration effort. Using nitrogen uptake in a small, spring fed stream as an example (Eagle Creek, Savage, MN), I compare results from; a one dimensional transport and storage model (OTIS), a fully resolved, three dimensional computational fluid dynamics model developed at St Anthony Falls Laboratory, U of MN (VSL), and parametric estimates from time series moment analysis. Model assessment is based on experimental time series measurements and spatially explicit cross sectional measurements taken during a nutrient addition experiment. I conclude with a comparison of the types of projects that each model is best suited for and the effort required to develop each model.

Moving Beyond InStream Structures: What can we learn about stream restoration from field-scale experiments

Jessica Kozarek, *St Anthony Falls Laboratory, University of Minnesota*

Rock vanes, cross vanes, bendway weirs and other similar flow control structures have been studied as part of a multifaceted research program to improve quantitative design guidelines for frequently used stream restoration structures. These structures are typically used in stream restoration projects with the intent of protecting unstable streambanks, preventing undesired lateral migration, or improving aquatic habitat. Despite their frequent use, extensive research-based quantitative design guidelines do not readily exist. A recent project combined small scale laboratory flume experiments, near field scale experiments in an instrumented meandering channel, and high resolution numerical modeling to evaluate structure installation in different stream channels. These experiments provide insight into the complex interactions between flow and sediment transport in the vicinity of instream structures to inform restoration design. In-stream structures are only one approach to stabilize banks and increase habitat complexity; this presentation will summarize what we have learned about in-stream structures so far, and will explore further opportunities for this research methodology to be applied to understanding stream ecogeomorphic response to softer engineering approaches such as streambank vegetation and wood structures.

Session 6: Managing River Connectivity

Stream Restoration Following the Paint Creek Dam Removal

Rob Myllyoja, *Hubbell, Roth & Clark, Inc.*

Paint Creek, located in the Clinton River Watershed, is one of the few remaining cold water trout streams left in southeast Michigan. This project provides an example of the benefits of stream restoration following small dam removal. A low head dam was removed in 2011 to improve fish passage for the local trout population. In spring 2012, work began to restore the incised channel below the dam. The channel had the capacity to contain a 40-year storm due to the bed erosion that had occurred since the dam was originally constructed in 1835. Meanders and gravel riffles were restored to provide floodplain connectivity and address the underlying causes of instability and poor habitat. Many design innovations were developed during the construction phase to use as much natural material as possible. Native sod mats were transplanted along the banks from disturbed areas. Woody material including dead ash logs, rootwads, brush bundles were incorporated into stream bank fill areas. Log “Rock and Roll” structures were used to transition into the downstream reach. These natural materials will stabilize the banks, but allow for subtle adjustments over time as the upstream watershed continues to change.

Reconnecting Fish Passage from Lake Erie to the River Raisin

Scott Dierks, *Cardno JFNew;* Michelle LaRose, Scott Isenberg, Andrew McDowell, Jeff Guerrero, Matt Gates, *Cardno JFNew*

In 2010 the City of Monroe received Great Lakes Restoration Initiative (GLRI) funds to facilitate fish and canoe/kayak passage over eight low head dams in an effort to mitigate habitat beneficial use impairments identified as part of the River Raisin area of concern (AOC). This project will reconnect 23 miles of river for fish migration to Lake Erie while simultaneously enhancing tourism for the region. Allowing for fish migration helps promote the health of existing small mouth bass, blue gill, perch, walleye, and northern pike populations. This project, in conjunction with other habitat restoration and sediment contamination control projects, has the potential to make the River Raisin the second AOC ever delisted within the United States.

Opening a river to fish migration for the first time in 80 years requires the creation of new pathways around or over each dam. Sanitary sewer lines running through four of the dams prevent these structures from being removed. At these locations rock arch ramps were designed to aid fish and recreational boaters to pass safely over the dams for a broad range of flows. The primary purpose of a rock arch ramp is to convey fish across structures through a nature-like pattern of loosely connected stone weirs. Rock arch ramp design must balance water velocity, depth, and impact to the 100-year flood elevation against, fish burst speeds and jumping ability.

Two more dams, which do not contain active sewer, will be removed. The final two obstacles, Waterloo and Grape dams, will utilize nature-like fish channels to bypass each structure. At the Waterloo dam a new 400+ foot riffle/pool pattern channel will be built at the city of Monroe's Veteran's Park. To bypass Grape dam an existing mill race will be modified by removing a concrete drop structure and a large woody debris jam at the millrace mouth.

Project construction will occur in two phases. Phase-1 will place a rock arch ramp below the two lowest dams and remove two other dams upstream. Construction for phase-1 should be complete by the end of 2012. The $1.1 million construction budget for this portion of the project will open 2.3 miles of river to Lake Erie upon competition. Phase-2 entails two more rock arch ramps and the bypass channels at Waterloo and Gape Dams. The construction cost for this phase is budgeted at 1.2 million dollars and provides passage for an additional 20.7 miles of river.

Sand Creek Meanders Inside Culvert

Bryan Ripp, *Mead & Hunt, Inc.*

The extension of the main runway at Southwest Michigan Regional Airport is intended for better and safer service to its users, and to provide another mechanism to stimulate economic growth for the area. The community of Benton Harbor, which encompasses the airport, currently has a struggling economic base and is actively making strides to improve its local economy through re-development, in which the airport plays a vital role.

The main runway for this general aviation airport requires routing Sand Creek through a 600-foot long culvert under the runway. The Michigan Department of Natural Resources required that the channel within the culvert must contain elements which allow fish passage or more specifically places for fish to rest.

This requirement eliminated the typical design of a flat-bottom, lined culvert, such as a typical box culvert. In order to meet the goals of the design, we conducted a process-based geomorphic assessment of the creek, including a longitudinal profile. Using Natural Channel Design, we designed a meandering, two-stage channel within a 24-foot-wide arch culvert. We used HEC-RAS to properly size the culvert to pass the 100-year recurrence flood as well as model the channel shears for choosing and sizing bank and channel treatments. In addition, we used FishXing software to verify fish could travel upstream in the pool/riffle structure planned.

The resulting design was a rock-lined two-stage channel with a pool/riffle structure within the culvert. In our design, we reconnected the new channel to the existing channel, as a two-stage channel with pre-vegetated coir log and rock bank treatments and Newbury rock weir grade controls in a sand-bottom channel. The culvert and channel inside, and the realigned channel with pre-vegetated coir logs were completed in late 2009. Live staking and bare-root planting in the reconstructed floodplain was completed during the spring 2010.

Mead & Hunt presented this design to the Michigan Department of Natural Resources, including a comprehensive understanding of the geomorphic setting as well as the science and engineering rationale behind the design. Had Mead & Hunt not proposed this design, the project would have been placed on indefinite hold and likely be in litigation and ultimately would have negatively impacted the airports users, including the areas major employers, to the point of potentially losing them and slowing the social and economic rebirth of the area.