2014 UMSRS Oral Abstract Guide (arranged by session number)

Session 1: Biology of Stream Restoration: Bugs, Plants and Fish

Moderator: Jeff Weiss (Barr Engineering)

Shoreline and Stream Bank Restoration – A Growing Trend: Managing for Invasive Plant Species on Public and Private Land with an Integrated Approach.

Patrick Kelly *Prairie Restorations, Inc.*

Over the last few years, one of the biggest growth areas for Prairie Restorations, Inc. has been with shoreline and stream bank restoration. From urban streams to lake homes, there are more incentives to eliminate traditional turf-based shorelines and replace them with native buffers. Restorations after installation often require vegetation management for initial establishment and long term success. Whether the project is large or small, it is important to assess the management needs of a restoration and develop an Integrated Pest Management Plan (IPM) that works as best practice within the budgetary constraints of a landowner. IPM may consist of mechanical/chemical/biological control of unwanted species, monitoring, and at times simply education. Managing shoreline and stream bank restorations post-installation can sometimes provide different challenges than those of upland restorations. The issues which need to be addressed on a particular site are based on previous site history, age of the restoration, and neighboring plant community composition. At Prairie Restorations, some of the major undesirable plant species which often need to be addressed on these types of restorations include: reed canary grass, narrow-leaved cattail, buckthorn, Canada thistle, and crown vetch. Because many shoreline and stream bank restorations also serve a stabilization function, an important consideration when controlling for exotic species are the consequences of control. Ensuring that desirables are in place to prevent new erosion issues is often a key step for management of these areas. Follow-up through landowner communication and post-treatment monitoring will lead the IPM process full circle to planning for the next step in one's management strategy.

Reach-scale Stream Restoration in Agricultural Streams of Southern Minnesota Alters Functional Responses of Macroinvertebrates

Christy Dolph *University of Minnesota;* Susan L. Eggert, Joe Magner, Leonard C. Ferrington, Jr., and Bruce Vondracek*, University of Minnesota*

Recent studies suggest that stream restoration at the reach scale may not increase stream biodiversity, raising concerns about the utility of this conservation practice. This study examined whether reach-scale restoration in disturbed agricultural streams was associated with changes in either macroinvertebrate taxa richness or secondary production (i.e., macroinvertebrate biomass over time). We collected macroinvertebrate samples over the course of one year from restored and unrestored reaches of three streams in southern Minnesota. We found no significant difference in richness between restored and unrestored reaches. Secondary production was 2 to 3 times higher in restored reaches relative to unrestored reaches, suggesting that reach-scale restoration may have ecological effects beyond influences on diversity. Higher productivity in the restored reaches was due largely to the disproportionate success of a small number of dominant taxa, most of which were collector-filtering clingers. Secondary production estimates for the streams in this study were considerably lower ($\leq$ 10 g/m2/yr) than those reported for other similar-sized agricultural streams; these low values may be indicative of stressful conditions for biotic life. Our findings highlight the benefits of considering functional, as well as structural, indicators of stream condition.

Restoration of Degraded Fish and Wildlife Habitat and Populations in the Milwaukee Estuary AOC

Andrew Struck *Ozaukee County Planning and Parks Department*

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 County portion of the Milwaukee Estuary AOC, 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 fish and wildlife species in the AOC.

Since 2006, the Department's Fish Passage Program and partners have identified and removed/remediated over 200 impediments to aquatic organism passage, reconnecting over 100 stream miles and thousands of wetland and floodplain acres. These activities include large-scale dam removal and restoration projects. The Program is also developing a GIS-based fish and wildlife decision-support tool to prioritize in-stream and riparian habitat improvement and restoration projects for the maximum benefit of multiple target and keystone species. Tool outputs are guiding ongoing, large-scale habitat projects that include stream remeandering, floodplain and wetland reconnection, 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.

Capturing Geomorphic and Ecological Diversity of Lowland Spring-Fed Creeks for Trout Habitat Restoration and Protection

Faith Fitzpatrick *USGS-Wisconsin Water Science Center;* Ray White*, Montana State University (retired)*

Lowland spring-fed creeks in the Midwest support survival, growth, and reproduction of trout. Reconfiguring stream channels and adding structural complexity are commonly done to enhance trout habitat and improve biodiversity, yet little evidence exists that these approaches restore or enhance healthy stream ecosystems. More suitable results may come from working in closer concert with natural physical and biological processes. That calls for better knowledge about those processes. Applying "natural channel design" based on bankfull regional curves may be inappropriate for these streams because it overly narrows and deepens channels (and creates flume-like conditions), has other adverse hydro-geomorphologic effects, and blocks dynamic processes that generate the habitat diversity on which trout and other organisms depend. Lowland spring-fed creeks have important hydrologic connections to riparian wetlands. These hydrologic connections are important for sustaining naturally reproducing trout populations and maintaining and healthy and resilient streamside and aquatic biological communities.

In an attempt to better understand natural physical processes in these special systems, we have initiated a study to measure and document the complexity and diversity of geomorphic, ecological, and habitat characteristics of springfed creeks with minimal land-use-impairment of watersheds and channels. We selected 25 streams across five ecoregions in the Upper Mississippi River and Great Lakes Basins for detailed mapping and measurement of channel morphology, substrate, banks, and riparian vegetation. These streams cover a range of glaciated and unglaciated geomorphic settings with channel slopes ranging from less than 0.3 to 2 percent. Watershed sizes are generally less than 50 km2. We will summarize field measurements into geospatial statistics that describe abundance and diversity of a range of characteristics important for resilient streams that sustain wild trout.

The study's results will form the basis of a practical guidebook co-authored by several geomorphologists and biologists to provide improved practices to protect, rehabilitate, and enhance lowland trout creeks. The guide will include concepts and techniques to foster natural rates of erosion, deposition, flooding and channel migration to which stream organisms are adapted. It will incorporate adaptive management approaches needed to cope with effects of expected climate change on stream temperature and hydrology. This presentation will discuss the methods of field measurement and data analyses and will seek input from the audience on how the results can best be transferred to stream restoration practitioners.

Session 2: Models and GIS Applications in Stream Restoration

Moderator: John Thomas (Hungry Canyons Alliance)

Basin-scale Geomorphology using GIS for Preliminary Stream Classification and Impact Analysis

Amy Mikus *Barr Engineering;* Peter Hinck, Benjamin Sheets, Miguel Wong*, Barr Engineering*

Understanding the basin-scale geomorphology of any river system is an important first step when evaluating the potential impacts of large civil works projects. This paper focuses on the study of the Mouse/Souris River watershed in north-central North Dakota, conducted as part of the Mouse/Souris River Enhanced Flood Protection Plan. Due to the size of the basin and the scope of the study, it was not feasible to complete a detailed survey of the river corridor and floodplains that would have allowed for application of a standard stream classification methodology. Instead, the study focused on three tasks: using GIS techniques to understand the driving geomorphic forces at work in the Mouse/Souris River basin, classifying river reaches based on valley and channel characteristics that were identified from GIS analysis, and developing a preliminary qualitative evaluation of the proposed project's potential to change the erosion and sedimentation behaviors of the Mouse/Souris River.

The present-day characteristics which shape the watershed of the Mouse/Souris River are highly constrained by the area's glacial history, and these characteristics can be studied and delineated using spatial analysis in GIS. The results of this analysis are distinct river segments delineated by major geomorphologic features such as valley and channel width, dominant valley soils, surrounding land use, sinuosity, amplitude of curvature and radius of curvature, as well as the influence of past and existing public works projects. Stream classification using basin-scale data affords a foundational understanding of the natural tendencies of the river with respect to erosion and sedimentation that is essential in order to adequately evaluate the potential impacts associated with the proposed project. Findings from this study are being used to minimize adverse impacts resulting from installation of flood risk reduction works for the City of Minot and neighboring areas.

Understanding the Extent of Stream Channel Alterations in Minnesota

Benjamin Lundeen *Minnesota Pollution Control Agency;* Scott Niemela*, Minnesota Pollution Control Agency;* Jim Krumrie*, Minnesota Geospatial Information Office*

Physical alteration of stream channels across the United States has been occurring since the late 1800s. These alterations have both direct and indirect effects on instream habitat and biological communities found within these ecosystems. Minnesota has a long history of channelizing natural streams and creating ditch networks. These alterations began in the early 1900s and have continued as a result of the growing population and need for increased agricultural capacities. There have been dramatic changes to the landscape as a result of these changes. Until now the extent of physical alterations to stream channels in Minnesota has been relatively unknown. There are a few datasets which provide some information regarding the extent of these alterations but have often been limited in coverage or inaccurate. The National Hydrography Dataset (NHD) is a GIS layer that provides stream networks across the United States. Many states utilize these data for monitoring and assessment applications. Unfortunately the conditions of stream channels in this dataset are largely inaccurate and underrepresented. The Minnesota Pollution Control Agency

(MPCA) and other Minnesota based agencies and companies rely on this dataset for myriad reasons. To better understand the extent of stream channel alterations across Minnesota, the MPCA in conjunction with the Minnesota Geospatial Information Office (MNGeo) designed a methodology to visually interpret changes in stream channel complexity and to identify if stream alterations have ever occurred. This effort was conducted using a GIS and many reference layers, which included historic aerial imagery (dating back to the 1930s), contemporary imagery, LiDAR (3m resolution) and other topographic GIS layers. The project entailed digitization of Geographic Information System (GIS) 'events' on to the United States Geological Survey's National Hydrography Dataset (NHD) stream linework. The events were then categorized as one of four types: Altered, Natural, Impounded or No definable channel based upon a standardized methodology and criteria.

The results of this project provide the first comprehensive baseline understanding of stream channel alteration in Minnesota. Our findings suggest that forty-nine percent of the streams throughout Minnesota have at one time been altered. The methodology that was developed as part of this project could be utilized by others interested in conducting similar analyses to better understand critical areas of habitat restoration and to better guide stream restoration management activities.

Modeling to Estimate the Migration Potential of a Constructed, Meandering Low-Flow Channel

Cory Anderson *Barr Engineering;* Miguel Wong*, Barr Engineering;* Jorge Abad, Christian Frias, Ronald Gutierrez*, University of Pittsburgh;* Eddy Longendoen*, USDA-Agricultural Research Service;* Aaron Buesing, Alex Nelson*, US Army Corps of Engineers*

For decades Fargo, ND, and Moorhead, MN, 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 flood risk reduction. This diversion project includes a meandering low-flow channel that would be constructed within the main diversion channel to facilitate drainage and sediment conveyance during non-flooding times. Miguel Wong presented at the 2013 UMSRS on the formation and migration history, sediment transport characteristics, and natural river planform characteristics of the Red River of the North and its tributaries. This presentation will focus on the modeling to estimate the low-flow channel meandering pattern that would develop given what was learned about the regional geology and the local flow and sediment characteristics.

The modeling tool used was RVR Meander, a two-dimensional, depth-averaged, linearized hydrodynamic model that estimates migration by both fluvial shear erosion and gravitational mass failure processes. First we will show the initial migration modeling of multiple reaches of the RRN and two tributaries. This modeling was performed to calibrate selected model parameters and demonstrate the model's ability to simulate observed migration patterns of local rivers in the long-term.

Second, we will show the probabilistic RVR Meander modeling performed for two reaches of the proposed low-flow channel. This modeling was performed specifically to answer the question "what is the likelihood that the constructed sinuous low-flow channel will migrate into the banks of the main diversion channel, increasing failure risks and O&M costs". This modeling resulted in the development of a step-by-step process, not strictly applicable to this geographic region alone, which can be used for the design of a stable, sinuous planform.

Finally, we will demonstrate the step-by-step process used on the actual low-flow channel centerline as designed for the most downstream reach of the main diversion channel, referred to as Design Reach 1. This modeling of the low-flow channel is different than the initial modeling because the centerline of Design Reach 1 includes variability in the centerline amplitude, wavelength, and curvature along the reach; the initial modeling assumed sine waves of one frequency or period. Overall, the modeling showed that the planform of Design Reach 1 will not likely promote migration of the meander bends into the banks of the diversion channel over the design life of the project.

Session 3: Lessons Learned in Stream Restoration Projects

Moderator: Ed Matthiesen (Wenck Associates)

Duck Creek Engineered Rock Riffle: Success, Failure, Success

Brian Stineman *City of Davenport, Iowa*

In the fall of 2012, the City of Davenport began construction of an engineered rock riffle to create a grade control structure over an abandoned sanitary sewer crossing that was functioning as a low-head dam. The work was constructed by city staff, and a hands-on stream stabilization workshop was conducted for local engineering and design professionals during the construction. Everything went very well and a presentation of this topic was given at the Iowa Stormwater Conference in 2013, and an article was published in the APWA Iowa Chapter 2013 Spring Newsletter describing the project. Shortly following, intense rainfall events on multiple days over several weeks wreaked havoc on the riffle and the left descending bank.

This presentation will cover a brief history of Duck Creek and the multiple sewer lines that cross it, design of the rock riffle by Dave Derrick, Vice-President and potomologist with River Research and Design, Inc., discussion of the construction of the “original” riffle and streambank stabilization, and the events that caused the downstream bank to fail. In addition, a description of the re-construction of the riffle and streambank stabilization and the lessons learned will be presented.

The Social Function and Lessons Learned from Urban Stream Resotration in Ankeny and Norwalk

Ivo Lopez *Synder & Associates*

The social function of streams is often undervalued, particularly related to stream restoration in urban settings. Urban streams are often affected by increased imperviousness, but also by prolonged wet periods. Stream channel erosion in the Des Moines Metro area was exacerbated by extremely wet years in 2008 and 2010. The importance of the social function in stream restoration will be illustrated with projects from Ankeny and Norwalk, Iowa to address safety concerns and impact to infrastructure with an integrated approach to also enhance stream quality of stream reaches. Over 1,300 feet and 500 feet of bioengineering stream restoration were completed in 2011 in Ankeny and Norwalk, respectively. Another 1,800 feet of stream restoration are being completed in 2013 in Ankeny, as the first phase of over 5,100 feet of restoration of a tributary to Fourmile Creek. Lessons learned that will be discussed include the magnitude of the need, funding challenges and phasing, site constraints, easement acquisition, the permitting process, individual versus collective visions, optimum social design and flexibility, construction in “my backyard,” establishing buffers with native species, and other related issues.

Busy as a Stream Ecologist: Can Restoration Do a Beaver’s Job?

Suzanne Hoehne *Biohabitats, Inc.*

Various studies have concluded that streams in the eastern half of the US were historically dominated by multichannel systems that were heavily influenced by beaver. These systems were modified by human activity during European settlement, mainly through the deforestation of surrounding hill slopes. Deforestation and subsequent poor farming practices led to severe erosion, with the eroded sediment ending up on the valley floor. With the existing stream unable to efficiently mobilize this sediment and with the desire of the surrounding populace to put as much land as possible into production, the streams evolved into single-threaded channels disconnected from the surrounding floodplain. These changes led to spiraling effects of decreased water quality and reduced ecological benefits. Urban streams have been further degraded due to effects of urbanization such as flashy storm flows, less riparian habitat, and increased incision and entrenchment of stream channels.

In the past 20 years, the field of stream restoration has had mixed success in addressing these impacts through "restoring" the stream's capacity to cycle nutrients, reduce water temperatures, decrease erosion rates, and provide wildlife habitat. Three common approaches for such restorations are often utilized: Natural Channel Design, Regenerative Stream Conveyance, and Valley Restoration. Natural Channel Design refers to the approach pioneered by Dave Rosgen, and uses reference reaches and bankfull flows to drive the design. Gaining ground in the Mid-Atlantic region, Regenerative Stream Conveyance is an approach that involves reconnecting the stream bed to the existing floodplain by constructing a series of riffles/pools, sometimes with sand seepage berms, across the floodplain. Valley Restoration has been simultaneously developed in several places in Wisconsin, Kentucky and Pennsylvania. This approach involves reconnecting the stream to its historic floodplain by designing for a larger storm event, such as a 100-year storm. Drawing on more than 10 years of stream restoration experience, this presentation will examine urban stream restoration projects representing each approach and explore their benefits, drawbacks, constraints and opportunities.

Session 4: Considerations in Stream Restoration Design

Moderator: Suzanne Hoehne (Biohabitats, Inc.)

Tough Invasives-Tough Questions From Design to Installation

Tory Christensen *Wetland Habitat Restorations, LLC*

Designs for large river restoration projects are often a beautiful and impressive set of documents to behold. They are impressive because they convey a pathway to transform a system locked in a state of degradation. This presentation will outline best practices for restoration design documents from the perspective of a sub contractor doing invasive species management.

We will make recommendations about how to develop specifications to control the tough invasive species that often accompany degraded aquatic environments. Management plans are effective at capturing the nuances of invasive species management, and the presentation will outline management plan basics that apply to writing specs for restoration projects. It will emphasize the importance of specs based on specific aquatic or upland habitat conditions and timing. In certain areas of the ecological restoration field, there are management plans written to ensure that issues with timing and location are clearly defined. Outlining timing in specifications will set the parameters for a successful vegetation establishment plan. We will outline case studies involving invasive species management, the basics of how to use a management plan template to develop specs suitable for invasive species management that support effective restoration techniques and facilitate clear communication between designers, engineers, prime contractors, and sub contractors.

Successfully managing invasive vegetation on river restoration projects is often complicated by several factors that are driven by the elements and natural conditions. Timing and sequencing are the most critical factors in getting control on tough invasives like reed canary and cattails. Subcontractors involved in managing invasive species and doing so within tight windows of time and weather conditions have to operate in specific parameters to attain successful results. The adaptability in timing and weather conditions is hard for many larger prime contractors to understand. And specs that outline the nuances of timing for large prime contractors to follow, will ensure a high quality end product.

Stream Restoration at Road Crossings in Northern Wisconsin

Dale Higgins *USDA Forest Service*

Poorly designed and constructed road crossings can have multiple impacts to stream ecology and morphology. These impacts typically result from culverts that are undersized and set too high. They include disruption of aquatic organism passage (AOP); impacts to channel profile, dimension and pattern; and water quality impacts from sedimentation and water temperature increases. Culverts with steep slopes or drops at the outlet can prevent the movement of many species and life stages of aquatic organisms. Undersized culverts set too high can cause both downstream scour and upstream aggradation. Those that fail frequently also cause downstream aggradation and an adverse profile on low gradient streams. The Chequamegon-Nicolet National Forest in northern Wisconsin has replaced over 200 road and trail stream crossings in the past 15 years to restore streams while also providing a safe, efficient, low maintenance transportation network. The primary solutions to these problems are design of adequately sized culverts, set at the proper elevation, with good permanent erosion control, sound construction practices and in-stream restoration where appropriate. Culvert sizing is based on a combination of bankfull width and hydraulic modeling to ensure the 100-yr flood has a HW/D<1. Culvert invert elevations are specified based on an analysis of the longitudinal profile of the stream taking into account impacts to channel morphology from the existing crossing. For low gradient streams (typically <0.5%), a no slope, tailwater control design approach is commonly used where the tailwater will provide sufficient depth and velocity in the structure to allow AOP. In these situations the culvert is frequently set flat at an elevation that will restore or maintain channel morphology and the natural transport of sediment and organic matter. For high gradient streams (typically >1.0%), a stream simulation approach is used where a reference reach is used to design and construct a channel through the structure that will pass aquatic organisms, sediment and organic matter at the same rate as the channel upstream and down. This technique requires a structure greater than bankfull width to accommodate stream banks and with sufficient height to allow for an adjustable bed and enough clearance that the 100-yr flood will have a HW/D<0.8. In some cases, in-stream work is necessary to restore a channel profile, braiding, an abandoned meander or alignment.

Stream and Floodplain Restoration Design Using Hydrologic and Sediment Transport Monitoring and Modeling in Lower Michigan

Scott Dierks *CardnoJF New;* Stu Kogge, Scott Isenberg, Andrew McDowell, Brandon Kulhanek, and Jeff Guerrero, *CardnoJF New*

Due to an existing landfill expansion, almost a mile of the Brent Run channel near Flint, Michigan is being relocated. In a novel permit for the State of Michigan, the Department of Environmental Quality is requiring suspended and bed load sampling to support sediment transport modeling of the existing and proposed channels. In addition, hydrology and geomorphology assessments were conducted at Brent Run and at the closest approximation of a reference reach in the region (Little Cedar River). Brent Run at the site of the relocation, has about a 21 square mile watershed. The channel is between five to six feet deep largely as a consequence of floodplain accretion of turn of the century legacy sediment from deforestation. The design sets back the geomorphology clock so the banks will have an average height of about 2.5-feet along a new valley that provides about 19-acre-feet of additional floodplain storage. Total excavation for the new valley and channel is estimated to be approximately 1.6 MCY. Suspended and bed load grab sampling per USGS protocol was conducted in the Spring, 2013 and captured several bankfull and near bankfull events in both Brent Run and the reference reach. The data were used to establish a reasonable sediment transport calibration for a HEC-RAS model of Brent Run. The calibrated model was then applied to our design reach. By balancing channel dimensions and bed slope, adequate sediment transport capacity was achieved while also providing for more frequent floodplain innundation. The hydrologic and sediment transport model was run for a ten-year period and showed almost a net balance of erosion and deposition in the channel. As expected, the floodplain is net depositional. Floodplain wetland hydrology was satisfied with frequent flooding near channel , on average four times a year, and less frequent flooding at the valley edge, combined with upslope runoff draining into the new valley. Clearing and excavation for the new valley is set to begin Spring, 2014, with the new channel coming on line the summer of 2015.

Swift Slough Restoration Feasibility and Design Alternative Analysis

John Stofleth *cbec, Inc.*

A study to evaluate the feasibility and development of design alternatives to enhance the hydrologic connectivity of Swift Slough on the Apalachicola River has been conducted.

Swift Slough has been established as being the primary habitat on the Apalachicola River System for several threatened and endangered (T&E) mussel species and its hydrologic connectivity to the mainstem of the river during low flows periods is essential to the long-term viability of these species.

The hydrologic connectivity of Swift Slough has been reduced by the incision of the main channel generally as a result of decreased sediment supply from the Jim Woodruff Dam and locally by historic navigation and maintenance activities (dredging and spoil disposal) that have been conducted by the U.S. Army Corps of Engineers. Since the mouth of Swift Slough is located 1.3 miles downstream of the Chipola Cutoff (a natural area for sediment deposition) and is in the vicinity of significant dredge disposal sites that serve as a local sediment source, the deposition of sediment into the slough during high flow events has further reduced its hydrologic connectivity during low flow periods.

The objective of this project is to conduct a feasibility study that investigates the dynamics of sediment transport / deposition in the main channel of the Apalachicola River, Swift Slough and the Chipola Cutoff. The study involved the collection of water surface elevation data, sediment transport data and bathymetric survey data that was used to develop a 2-dimensional hydrodynamic sediment transport model. This model was used to test the feasibility of restoration design alternatives and to determine how long a given alternative would promote a hydrologic connection to Swift Slough through an improved understanding of sediment dynamics within the project reach. The results of this study have been used to select a preferred design alternative that improves the hydrologic connectivity of Swift Slough during low-flow periods while minimizing future maintenance needs and maintaining the habitat characteristics essential to the viability of T&E mussel species that inhabit Swift Slough

Session 5: Planning Frameworks for Stream Restoration Projects

Moderator: Ben Lee (Inter-Fluve, Inc.)

Making Stream Restoration Decisions

Peter Wilcock *Johns Hopkins University*

When a stream is evaluated for restoration opportunities, the goals of all stakeholders should be determined, translated into actionable objectives, and evaluated in a way that allows a transparent comparison of the extent to which different alternatives can meet the various objectives. But the regulatory, political, and financial context varies from one case to another, and between regions, in some cases making it difficult to consider the suite of benefits that stream projects may provide. This talk is intended to provoke a conversation about how and when any and all stream project objectives, from ecological to social, can be incorporated into the development of stream project designs. The discussion is organized using Stream Project, the outcome of a collaboration among university and federal scientists and engineers. Stream Project explicitly links well-defined objectives to design choices in a manner that supports tradeoff analysis, adaptive management, and effective learning by doing. Stream Project is implemented as a web-based tool for specifying objectives and evaluating alternatives in a transparent framework. Although any and all objectives are encouraged at the start of the process, the Stream Project tool provides a guide to identify objectives that are appropriate, relevant, and achievable. It then allows different objectives to be weighted, allowing for a transparent evaluation of alternatives that explicitly specifies both values and weights for different stakeholders. Because the tool can accommodate and weight the input of many stakeholders with different objectives, it raises the question of when, whether, and how all stakeholders may have a say in the design of a project.

Stream Restoration as a Cost Effective Technique to Meet TMDL Water Quality Goals

Vince Sortman *Biohabitats, Inc.,* Joe Berg, *Biohabitats, Inc*

Local, regional, state, and federal organizations are looking to stream restoration as a cost-effective means to meet sediment and nutrient reduction goals associated with MS4 permits and regional TMDL goals. Concerns with this approach include the potential for conflicting resource management values, uncertainty with how to credit sediment and nutrient reduction, and the nature of regulatory oversight. Recently, an Environmental Protection Administration sponsored white paper (Schueler and Stack, 2013) addressed these issues and has received final approval by the Chesapeake Bay Program's water quality goal implementation team. This clears the way for regulated entities to use stream restoration to receive a range of water quality credits. At the same time, another study of various means to improve water quality (Center for Watershed Protection, 2013) has documented the relative cost and benefits of many water quality practices, and stream restoration is often an order of magnitude less costly per unit of nutrient removed. Together, these results are stimulating an increased interest in, and reliance on, stream restoration as a preferred approach for permit and water quality goal compliance. As presented in the EPA Bay Program white paper (Schueler and Stack, 2013), not all types of stream restoration are created equal, and as a result the greatest water quality benefits are associated with stream restoration projects that incorporate floodplain reconnection. This conclusion was supported by a range of monitoring studies, including streams restored using the 'base flow' channel design technique described in this presentation.

This presentation will summarize the EPA study and describe an integrated approach to stream restoration, which includes: 1) restoration of eroded ephemeral headwater reaches to hyporheic seepage flow dominated systems; 2) storage of pulsed runoff in sand-seepage systems which uses 'surplus' surface water to support the seepage hydrology of created wetlands in the riparian zone/floodplain of the stream as well as hyporheic flows to support stream baseflow; and 3) base flow channel design, which has as a goal to reconnect the stream's riparian zone/floodplain to yield a more sustainable channel form for runoff from precipitation events of any appreciable stage increase. Photos of typical conditions for pre-restoration, typical construction phase, and representative post-restoration conditions will be included in the presentation. In addition, monitoring results will be presented, including impacts of restoration on peak attenuation, increased time of concentration, temperature, and water quality benefits.

In-Lieu Fees, Perspectives from the Southeast

George Anthanasakes *Stantec Consulting Services*

In-Lieu-Fee (ILF) Stream Mitigation programs have been used for well over a decade throughout the southeast to meet compensatory mitigation needs. ILF mitigation provides a means to pool mitigation dollars together so that larger more comprehensive stream mitigation can be completed on a larger watershed scale. The author has personally been involved with implementing projects for ILF programs associated with the states of North Carolina, Kentucky and Tennessee. These programs utilize significantly different approaches to provide compensatory stream mitigation. North Carolina was one of the first states to implement an ILF program through the North Carolina Ecosystem Enhancement Program (NCEEP). This program has evolved over the years from a traditional Design/Bid/Build program to a Full Delivery model of turn-key project implementation through a single contract. The state of Kentucky administers an ILF program through the Kentucky Department of Fish and Wildlife. The Kentucky program follows a more traditional Design/Bid/Build approach and has recently experimented with Design/Build projects. Tennessee implements ILF projects through the Tennessee Stream Mitigation Program (TSMP) and follows a modified Design/Build approach to implement stream mitigation. This talk will provide an overview of the approaches utilized by each state to implement

ILF projects, will include the author's perspective of the advantages/disadvantages of each program, and will discuss key considerations for implementing new ILF programs.

Session 6: Know Your Landscape: Assessments and Tools for Understanding Midwest Rivers

Moderator: Jessica Kozarek (St. Anthony Falls Lab, University of Minnesota)

Habitat Improvement in a Degraded Driftless Area Stream

Ben Lee *Inter-Fluve, Inc.*

Mill Creek is a tributary to the Root River in the Driftless Area of southeastern Minnesota. The stream is similar to other streams flowing through lower main valleys within the Driftless Area in that extensive sediment aggradation has occurred on the floodplain, and meander migration rates are relatively fast. Due to these conditions, salmonid habitat is poor in many areas of Mill Creek. In 2012, Minnesota Trout Unlimited obtained funds for the design and construction of a habitat improvement project along one mile of the stream. Unlike many other habitat improvement projects in the Driftless Area, we completed a geomorphic assessment to better understand the fluvial processes governing the stream form prior to design. The results of this analysis suggested using a much different approach to enhancement from other Driftless Area projects that have altered stream form and utilized hard engineering techniques. Specifically, we determined that the existing morphology of Mill Creek was in a state of equilibrium with the supply of sediment and water to the reach, and significant departures from the existing form would be unsustainable.

Given the geomorphic conditions at Mill Creek, we developed some unique approaches for improving aquatic and riparian habitat including large woody debris crib walls and habitat structures. These innovative techniques will be presented along with some preliminary results of their effectiveness. In addition, the usefulness of geomorphic assessments in restoring Driftless Area streams will be discussed.

Knickpoint Migration in Western Iowa Streams

John Thomas *Hungry Canyons Alliance;* A.N. Papanicolaou, C.G. Wilson, E.A. Bettis*, University of Iowa;* M. Elhakeem*, Abu Dhabi University*

Knowledge of knickpoint migration rates would allow prevention of further channel bed incision in western Iowa streams. Most studies of knickpoints are laboratory, and not field, studies, limiting their usefulness for migration rate information. A few past field studies in western Iowa have reported knickpoint migration rates in alluvial loess deposits at average rates as high as 1,780 m/yr and maximum rates as high as 68.6 m/day.

For over four years, the upstream migration of a knickpoint on Mud Creek in Mills County, IA was monitored. The knickpoint migrated a total of 45.8 m, at a rate of 10.8 m/yr; the most rapid retreat of nearly 31.9 m occurred over a six-month period in February-August 2010. The knickpoint maintained a fairly constant height of 1.5-2.2 m, approximately at the same elevation of a stratigraphic discontinuity between silty, stronger soils above and sandy, weaker soils below. Approximately 0.2 m was visible above the downstream water surface.

The discrepancy between the available hydraulic shear stress and the shear strength and erodibility of the knickpoint indicate that fluvial erosion is not responsible for most or all of the observed knickpoint migration. A cyclic process is probably responsible, similar to that of previous authors where: 1) a pressure differential exists on the vertical knickpoint face due to increased flow velocity as water plunges over the knickpoint; 2) the upper part of the knickpoint is undercut by erosion of less resistant strata below; 3) the undercut sediment fails; 4) the failed material is deposited in the scour hole; 5) the debris is removed, and the vertical knickpoint face is reestablished.

Formation of ice over the knickpoint surface may cause pipe-like flow under the ice or, if the ice attaches to the knickpoint, the plucking and removal of large blocks of sediment, but ice formation does not directly cause knickpoint retreat. Past field studies in western Iowa reporting higher knickpoint migration rates were probably eroding through the weaker Roberts Creek Member, whereas this knickpoint is eroding through the upper Gunder Member. Jet erosion tests show the knickpoint bed material (Gunder) is an-order-of-magnitude more resistant to fluvial erosion than the bank soil (Roberts Creek). The presence and propagation of multiple knickpoints in series caused the erosional topography observed at the current knickpoint; in other words, in highly unstable streams, the current knickpoint is likely the bed scar of past knickpoints.

Investigating River Conditions in Minnesota

April Lueck *Minnesota Pollution Control Agency;* Scott Niemela*, Minnesota Pollution Control Agency*

What are the conditions of Minnesota's rivers? Have they improved or degraded over time? Since 1996 the MPCA has used probabilistic surveys as part of their biological monitoring efforts on rivers and streams. The survey design allowed data from a few sites to represent the population of Minnesota's rivers. Landuse, water chemistry, aquatic habitat, fish and macroinvertebrate data were used to explore conditions from multiple perspectives. Data were collected from two surveys utilizing MPCA biological monitoring protocol. Estimates from these surveys lay the foundation for where Minnesota's rivers are today and provides indication of the parameters that are most closely tied to the health of aquatic communities. In addition, comparisons made between the two surveys revealed preliminary information on temporal changes. Despite being simple questions to ask, the answers are often nuanced and complex; however, the results are laying a critical foundation for understanding one of Minnesota's most vital resources.