Poster Abstracts

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1. Rethinking the Red Clay Project: Restoration in the Nemadji

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The Red Clay Project was a 1970's era multi agency effort that encompassed watersheds in the Lake Superior Basin portion of North East Minnesota and Northern Wisconsin. Its goal was to reduce erosion in the Nemadji Watershed. In Minnesota, efforts focused on sediment retention structures called Red Clay Dams in two sub watersheds of the Nemadji River Basin: Skunk Creek and Deer Creek. Sixteen structures were constructed in the Skunk Creek Watershed and four structures were constructed in the Deer Creek Watershed. The design life of these structures was 10 – 25 years depending on the specific project, and they all have exceeded their designated lifespan. Many of these structures are failing or have already failed.
In 2014 and again in 2016, the Carlton SWCD worked with Technical Service Area III Engineers to complete two stream restorations using Rosgen methodology to address failing or failed dams that were contributing large amounts of sediment into the impaired Nemadji River Watershed. In 2018 we plan to start work on two more restorations. Our goal is to reduce sediment and improve connectivity. The results of these projects include an estimated reduction of over 2600 tons of sediment and almost 13 miles of stream connectivity restored.
River Restoration 2018 3

2. Biodiversity as an indicator of success

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How can we measure the success of our river restoration efforts? One very clear, tangible outcome is an increase in biodiversity. The diversity and abundance of fish and mussel communities in river ecosystems has decreased significantly over the years. Here are a few startling facts:

- The extinction rate f2 (or North American freshwater species is estimated to be 5 times the rate of terrestrial species, which is comparable to that for tropical rainforests. 1
- Of the remaining 700 species of fishes in North American, 39% are considered imperiled. 2
- Sturgeons are the most imperiled group of species overall with 85% of the 27 species at risk of extinction, most of which are critically endangered. 3

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- The current population of lake sturgeon is estimated to be at less than 1% of their historic abundance.
- Freshwater mussels are among the most endangered group of organisms on the planet with 74% of the known 300 species in North American considered imperiled. 4

With numerous dam-related projects to draw from, dam removal and modification have proven to have substantial benefits to biodiversity. An analysis of 32 dams throughout Minnesota watersheds found that fish species richness decreased, on average, by 43% upstream of the first complete barrier dam. The removal of 12 of these dams resulted in the return of an average of 67% of the absent species. Of these removal projects, the biological response at five are presented here. Channel restoration projects have also proven to have beneficial impacts to biodiversity and stream health. The two projects presented here, Lawndale Creek and Whitewater River, were large projects that replaced channelized reaches with meandering channels, designed using reference reach information. The result was a restoration of diverse substrates and habitats. The aquatic communities responded with increased diversity and abundance of fish, especially the less tolerant fish species.

1 Ricciardi and Rasmussen 1999
2 Jelks et al. 2008
3 International Union for Conservation of Nature 2010
4 Williams et al. 1993

3. Monitoring bluff erosion rates using terrestrial laser scanning and Structure-from-Motion photogrammetry on Minnesota's North Shore streams

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Excess turbidity from increased fine sediment can degrade water quality and be harmful to fish and other aquatic life. On Minnesota's North Shore of Lake Superior, there are several streams impaired by turbidity, often driven by erosion of stream bluffs. We have been quantifying rates of erosion on North Shore bluffs, starting in 2011, using terrestrial laser scanning (TLS). TLS allows for creation of 3D point cloud datasets that result in cm-scale resolution models of topographic surfaces, which can then be compared over time to quantify geomorphic change on bluffs. This project adds to earlier monitoring data, by providing bluff erosion rates on both natural and stabilized bluffs. We also use a new technique called Structure-from-Motion (SfM) to create point cloud datasets from photographs collected with an unmanned aerial vehicle (UAV). This method may provide a faster, more cost-effective way to collect high-resolution topographic data of bluff surfaces. Results

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will include quantitative analysis using CloudCompare, a 3D point cloud processing software, which will give volumes of sediment eroded. We will compare the TLS and UAV methods to determine if SfM is a viable alternative for monitoring bluff erosion rates. Work also includes a geotechnical assessment of slope stability with the goal of developing a predictive model for stable slope angle. The results from this work will assist in determining appropriate bluff stabilization structure geometry, and may better inform stream restoration activities along the North Shore.

4. Applied Methods for Targeting Fluvial Restoration Efforts

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Many areas of the Upper Midwest face issues associated with unstable fluvial systems which are often tied to increased runoff. This poster will highlight methods that have been applied across the state of Minnesota to assess the stability of fluvial systems and target upland and in-channel solutions for restoring fluvial systems. Examples will be highlighted from both urban and rural agricultural watersheds.

5. Application of Dimensionless Sediment Rating Curves in Minnesota

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Consistent and reliable sediment data are needed by Federal, State, and local government agencies responsible for monitoring water quality, planning river restoration, quantifying sediment budgets, and evaluating the effectiveness of sediment reduction strategies. Heightened concerns about excessive sediment in rivers and the challenge to reduce costs and eliminate data gaps has guided Federal and State interests in pursuing alternative methods for measuring suspended and bedload sediment. Simple and dependable data collection and estimation techniques are needed to generate hydraulic and water-quality information for areas where data are unavailable or difficult to collect.

The U.S. Geological Survey, in cooperation with the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources, completed a study to evaluate the use of dimensionless sediment rating curves (DSRCs) to accurately predict suspended-sediment concentrations (SSCs), bedload, and annual sediment loads for selected rivers and streams. This study included the application of DSRC models developed for a small group of streams located in Colorado to rivers in Minnesota. Regionally based DSRC models for Minnesota also were developed and

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compared to DSRC models from Colorado to evaluate which model provided more accurate predictions of SSCs and bedload in Minnesota.

Results of data analyses indicate that DSRC models developed using data collected in Minnesota were more effective at compensating for differences in individual stream characteristics across a variety of basin sizes and flow regimes than DSRC models developed using data collected for Colorado. Minnesota DSRC models retained a substantial portion of the unique sediment signatures for most rivers, although deviations were observed for streams with limited sediment supply and for rivers in southeastern Minnesota, which had markedly larger regression exponents. The results presented in this report indicate that regionally based DSRCs can be used to estimate reasonably accurate values of SSC and bedload.

6. Developing a High Resolution Eco-Hydrologic Watershed Model for Three Local Streams

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We are working to populate and calibrate an eco-hydrologic model developed by the EPA for three local watersheds (Keene, Kingsbury, and Talmadge. VELMA (Visualizing Ecosystem Land Management Assessments) is a spatially explicit ecohydrology model that links hydrological and biogeochemical processes within watersheds. VELMA has been used to assess the effects of forest harvest on streamflow, the effectiveness of riparian and watershed management strategies on salmon recovery and the effectiveness of alternative green infrastructure scenarios for protecting water quality. To support the modeling efforts, we began streamflow monitoring in 2017 for both Keene and Kingsbury with monitoring on Talmadge starting in 2018. Multiple water level recorders were deployed in each watershed and set to record at 15-minute intervals through the ice-free season. Flow is measured at different water flow levels to develop discharge at various parts of the watershed from upstream to downstream. Air and water temperature loggers have also been deployed in the upper and lower parts of each watershed. We also monitor stream water for nutrients (N and P), suspended solids, organic C, various anions and cations, and specific conductance monthly (April to October) and one time in winter (February). Next steps for us will involve rain event sampling. We are looking to find other data that identify and quantify vegetation composition and biomass for various parts of these watersheds as well as hydrologic data. The VELMA model can be used for environmental managers to provide alternative scenarios and effects testing for many types of single event to chronic changes at smaller sub-watershed and whole watershed scale. We'll develop model scenarios to compare the effects of land cover changes (e.g. loss of wetlands, or increased imperviousness) in context of changing weather and precipitation.

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7. A Nutrient's downstream spiral

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Indicators of a stream's ability to remove nutrients provide insights on watershed integrity and stream habitat characteristics that are needed to help managers to restore stream ecosystem services. We used the Tracer Addition Spiraling Characterization Curve (TASCC) to measure the uptake length, velocity and rate over a range of nutrient concentrations (max=1629 µg/L N-NO3, 1240 µg/L N-NH4, 2182 µg/L P-PO4) in eighteen Twin Port streams. We found that nutrient concentrations alone do not account for how in-stream nutrient removal functions respond to changes in habitat conditions (no significant correlations). Streams with relatively complex in-channel and riparian habitats and low discharge may have more capacity to remove nutrients than flashy streams with hardened banks. Phosphorus uptake velocity was correlated with riffle-run-pool habitat (r=0.99, p=0.02). Ammonium uptake length and areal rate were correlated with stream velocity and discharge (r=0.63-0.94). Nitrate areal uptake rate and velocity were also correlated with velocity and discharge (r=0.71-0.82). Understanding features that promote in-stream nutrient removal can guide land use and habitat restoration decisions. Functional assessments help resource managers connect the restoration of habitat with the restoration of ecosystem services such as clean water and fisheries. Our stream functional indicator research is helping identify and map streams in Twin Ports area for the types of in-stream habitat features needed to enhance processing and removing excessive loads of nutrients.

8. Stream Mitigation - Developing Reference Curves to Inform Calculations of Lift and Loss

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1 US Environmental Protection Agency Region 8, 2 Stream Mechanics, 3 Ecosystem Planning & Restoration

Stream assessments can be used to support project planning, document successful techniques, improve restoration designs, and inform stream permitting decisions. A major challenge in implementing the Clean Water Act Section 404 permitting program in stream systems lies in developing approaches to stream assessment and crediting/debiting that are repeatable, objective and accurately characterize stream function. Approaches need to be ecologically sound in characterizing functional lift at restoration sites and functional loss at sites with permitted impacts when used to inform crediting and debiting under the 2008 Mitigation Rule. The Wyoming Stream Quantification Tool (WSQT) was developed to characterize changes in aquatic

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functions using existing quantitative methods and is based on A Function-Based Framework for Stream Assessment and Restoration Projects. The WSQT and framework organize stream functions into categories (hydrology and hydraulics, geomorphology, physicochemical, and biology) and outline parameters, metrics, and reference curves that can be used to determine stream functional capacity within each category. Reference curves were developed for each metric to relate field measurements to a range of condition via index values of 0-1. These metric-level index values are then rolled up to provide parameter, category and overall condition scores that can serve as a basis for calculating debits and credits. Reference curves were developed using existing peer-reviewed literature values, regional datasets and best professional judgement. This poster will outline the general process for developing reference curves, as well as specific examples from the WSQT.

9. Minnesota's Culvert Assessment App and Database

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1 Minnesota Department of Natural Resources

Culverts are ubiquitous features on the landscape. There are almost 65,000 public road crossings over streams in Minnesota, and the majority utilize culverts to span streams. Culverts can have significant negative impacts to streams if improperly designed or installed. Fish passage can be impaired or blocked, sediment transport can be altered to cause aggradation or degradation of the stream bed, and transport of debris such as logs can be blocked. In Minnesota watersheds that have been assessed, approximately 70% of culvert crossings have at least one of these impacts. There is interest in addressing these impacts through replacement or retrofitting of problem culverts, but effective use of limited resources requires a prioritization of where investment will be most beneficial. The Minnesota Department of Natural Resources has created a mobile application and database for the collection and storage of culvert assessments. This will allow watershed-scale examination of problem culverts, both the severity of their impact and the length of stream that they are affecting. The application and database follow the protocol adopted by Minnesota's Stream Practitioners, a statewide multi-agency group of professionals working in the field of stream habitat. We hope that the protocol, application, and database become the state standard for assessing culverts, so that cooperative data collection can efficiently populate a database that allows comprehensive evaluation of culverts.

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10. Three Mile Creek Dam Failure and Site Restoration

Stuart Kogge1, Scott Dierks1, Brian Majka1, Todd Bowen1, and Sam Prentice1

1 GEI Consultants, Inc.

In the summer of 2013, an earthen berm dam on Three Mile Creek in the Millecoquins River Watershed failed, sending approximately 6,000 to 8,000 cubic yards of material of former impoundment and earthen berm material downstream. GEI Staff conducted wetland impact assessments and sediment depths within the creek channel. Sediment observations included notably black or anoxic sediment on banks, riffle features which appeared to be buried by unnatural amounts of unconsolidated material, and excessive amounts of sediment or sediment with nearly vertical sides along point bars or mid-channel bars. River cross-sections were collected at four locations, aerial reconnaissance was conducted with a Cessna aircraft, and depositional/erosional areas were noted along the entire stretch of the Millecoquins River downstream of the Three Mile Creek confluence.

After conducting a sediment transport study and assessing the biological impacts of the dam failure, GEI convinced the Michigan DEQ on behalf of the client that restoration work should be limited to habitat improvements solely on Three Mile Creek and no further restoration work would be necessary on the Millecoquins River given the river's ability to transport fine sediment throughout the year and minimal to no negative impacts on the habitat.

The approved habitat plan included sediment removal, plantings, seeding, live stake installation, grade control, bank stabilization, and creating fish habitat structures. Given the confined colluvial valley surrounding Three Mile Creek, all sediment removal was completed by hand and hauled out of the ravine via sleds 0.16 cubic yards of sediment at a time. Over the course of one month, GEI staff moved more than 205 cubic yards of sediment by hand, equivalent to nearly 1,290 sleds worth of sediment. Following the completion of sediment removal, newly exposed wetlands were seeded, blanketed and planted with more than 5,600 native species to restore plant diversity and create stable banks. Cedar and fir trees were harvested outside of the wetland areas and used to build 10 separate habitat structures spanning 500 lineal feet of the creek. The structures provided overhead cover, scoured any remaining fine sediment out of the existing pool, and stabilized the adjacent bank.

The outstanding technical and restoration expertise of the GEI team led the Michigan DEQ to approve the violation of the dam breach two years early given the effective design and implementation of all restoration efforts. This reduction in regulatory expenditures saved the client thousands of dollars and allowed them to use their members funds in other manners in the best interest of habitat conservation in Michigan's Upper Peninsula.

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11. Brent Run Creek Relocation and Wetland Creation

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1 GEI Consultants, Inc.

This project, located in Montrose, Michigan, is a combined stream, threatened and endangered species, wetland and floodplain impact and compensatory mitigation project associated with the expansion of Brent Run Landfill. The original concept for the project was developed in 2009 shortly after Waste Connections, Inc. (WCI) purchased the landfill. At the time of purchase, the landfill had approximately four to five years of waste storage volume remaining.

After several years of stream, wetland, woodland, and aquatic biota assessments, negotiations and collaboration with government agencies, the Michigan DEQ issued a final project approval in January 2014 to commence construction. The final approved design proposed the creation of approximately 4,090 linear feet of new stream channel, approximately 22.58 acres of wetland with a minimum of 15.74 acres of the total being forested wetland, and relocation of state-listed endangered freshwater mussel species.

Project construction was completed in September of 2015. Additional wetland acreage was created to ensure MDEQ compliance, the project is currently undergoing 10 years of monitoring until 2026. Initial monitoring results indicate a stable channel in dimension and profile, with adjustment to most outer bends and an increase in the radius of curvature. Fine sediment transported downstream through the project site has covered portions of the imported riffle stone, but has also led the inner berm formation through several riffles. There was substantial consistency in fish assemblages across survey periods with creek chub, common shiner, and rainbow darters as the most abundant species. Multiple fish species, such as blackside darters and fantail darters, which serve as hosts for the relocated state-listed mussel species (slippershell and ellipse) were observed in the relocated channel following construction. Benthic macroinvertebrates observed were more diverse during post-construction surveys than pre-construction surveys in 2011. Mussel communities assessed to date are similar between post- and pre-construction.

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12. Using stream temperature data to assess restoration in the Stewart River, MN

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Monitoring restoration projects to assess success and guide future efforts is critical. Stream temperature data are easy and inexpensive to collect and biologically relevant, making them valuable to assessing restoration. We compared water temperature in the Stewart River, MN, before and after a restoration project aimed at reconnecting the stream to its floodplain and promoting groundwater exchange in the channel, as groundwater inputs are limited but can be locally important to maintaining water temperatures that are suitable for trout. We compared the relationship of mean daily water and air temperature within the restored reach to the air temperature/water temperature relationship at a reference station upstream of the restoration project both pre- and post-restoration. We also compared temperature data longitudinally within the restored reach of the river using non-parameteric analyses. Stream temperature within the restored reach relative to a reference station varied spatially and temporally. Within the restored reach, there was a restoration effect (~1 °C increase in stream temperature post-restoration) at the upstream-most monitoring station but not further downstream. Within the restored reach, stream temperature increased from 0-0.2 °C from upstream to downstream during the study. Differences in the study were likely related to varying shortwave radiation, discharge, and sensible heat transfer and indicate that there was little change in stream temperature related to restoration activity, likely because canopy cover was impacted by lateral channel migration and exacerbated by flooding prior to restoration. Post-restoration temperatures may have been buffered by groundwater inputs. Efforts of future restoration projects should weigh the costs/benefits of tree removal, restoration (including increased groundwater capacity), and their effects on stream temperature in this region, given the limited input of cool groundwater. This study emphasizes the importance of long-term monitoring, thoughtful study design and collecting consistent data (pre- and post-) to understanding the success of projects.

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13. Slowing the flow: Setting priorities and defining success in Lake Superior's south shore watersheds

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For over 60 years, watershed conservation efforts to improve water quality have largely focused on restoring and protecting hydrology under the mantra "slow the flow". This approach seeks to reduce peak flows with landscape scale watershed restoration approaches that increase in-channel roughness, upland roughness, upland retention and infiltration. As the frequency of high intensity storms increases, we are compelled to improve methods to prioritize slow the flow efforts and measure success in the Lake Superior basin in Wisconsin. Relying on an extensive literature review, we identified metrics and associated thresholds for impacts to stream hydrology, and compiled the best available datasets to evaluate those metrics. Storage is one of the most important parameters in predicting peak flows. The recently-updated Wisconsin Wetland Inventory along with the Wetland Functional Assessment, which describes wetland functions like surface water detention based on geomorphological characteristics, allow enhanced evaluation of subwatershed storage and opportunities to increase storage. In addition, a Potentially Restorable Wetlands layer, available across the basin, identifies probable historic wetlands based on soils and topography. Along with basin-wide data on soils, stream slope, precipitation, and snowmelt; we can calculate subwatershed peak discharges and compare them to the threshold where impacts start to be observed. The availability of detailed land use data (NASS Cropland Data Layer, WiscLands2, etc.) allow us to evaluate subwatershed open lands compared to peak flow impact thresholds. With land use overlaid with land ownership data, we can identify actionable opportunities for conservation as well as identify priority actions tailored to the existing land use interests (agriculture, forestry, municipal, etc.) at the subwatershed scale. The increasing availability of high-resolution, spatially resolved datasets allows us to advance strategic efforts rooted in sound science to better implement and evaluate slow the flow efforts in the Lake Superior basin.

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