MN Lake Superior Watershed Stream Science Symposium II

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Poster Abstracts
(Alphabetically by Primary Author*)

A Next-Generation Sequencing Approach for Determining Sources of Fecal Bacteria in the Lake Superior Watershed

Authors: Clairessa Brown*, Christopher Staley, Ping Wang, Chanlan Chun, Michael Sadowsky

Lake Superior, the second largest freshwater lake in the world, serves as a drinking water and recreational source for over 300,000 people. Contamination of the Lake Superior watershed by animal fecal material lowers water quality by introducing potentially pathogenic microorganisms detrimental to human health. Microbial source tracking (MST) are methodologies that aim to determine the source(s) of fecal contamination. Current MST methods use single indicator organisms (SIO) present in animal and human feces. However, SIO can be naturally present in the environment. Furthermore, the most common SIO detection method has high inter-lab variability in reported results. To circumvent these problems, a next-generation sequencing (NGS)-based MST method was developed that uses the total bacterial community to differentiate between source animals. Analysis from amplicon sequencing of ~500 fecal and environmental samples revealed that bacteria present in water and fecal samples are significantly different. While there are common fecal-associated phyla across fecal samples, there were animal-specific, or unique relative abundances of phyla allowing for differentiation between different animals. The statistical program SourceTracker, which calculates the amount that an animal source(s) contributed to fecal contamination in a particular environment, revealed that the predominant sources at environmental sites were from chickens and wastewater effluent.

Stream Simulation Design Road-Stream Crossings Benefit Habitat and Basal Food Resources in Food Webs of Lake Superior Tributary Streams

Sue L. Eggert, USDA Forest Service, Northern Research Station, Grand Rapids, MN

Increasing storm flow magnitudes associated with climate change and undersized/improperly designed culverts will result in more failed road-stream crossings, economic losses, and impaired aquatic organism passage. Stream simulation design is a new geomorphic and ecologically-based approach to designing road-stream crossings that mimic natural channel structure, sediment characteristics, water velocity, and depths. Research examining habitat and food web responses associated with road-stream crossing restorations using stream

simulation design in the Chequamegon-Nicolet National Forest demonstrates higher basal resources (periphyton, fine and very fine particulate organic matter, leaf, and small wood standing crops) are available to aquatic food webs within stream simulation culverts following restoration. Substrate types within the culvert area have shifted from no substrate or sand/silt substrate pre-restoration to predominantly cobble and pebble substrates post-restoration. Additional food resources along with improved habitat (i.e. more stable substrate) available to invertebrates will likely result in increased biological productivity of fish, amphibians, and mammals in aquatic and riparian ecosystems near road-stream crossings. Although aquatic organism passage and flood resiliency has been the primary design priorities of stream simulation design, our work in Lake Superior tributary streams has demonstrated additional benefits of improved food web function associated with stream simulation design road-stream crossings.

Food Availability for Wood Turtles (*Glyptemys insculpta*) in Managed and Natural Woodlands

Katelin M. Goebel*, University of Minnesota Duluth, 9 Howard Gnesen Rd, Duluth, MN 55811, goebe081@d.umn.edu, 320-583-7221

Madaline M. Cochrane, Integrated Biosciences Program, University of Minnesota Duluth, Biology Department, 1035 Kirby Dr, Swenson Science Building 207, Duluth, MN 55812, cochr081@umn.edu, 218-720-4294

Donald J. Brown, West Virginia University, School of Natural Resources, PO Box 6125, Morgantown, WV 26506, donald.brown1@mail.wvu.edu, 304-293-0021

Ronald A. Moen, University of Minnesota Duluth, 317 LSci, 1110 Kirby Dr, Duluth, MN 55812, rmoen@d.umn.edu, 218-726-7774

Wood turtles (*Glyptemys insculpta*) are listed as threatened by the state of Minnesota, and are a species of management concern. These animals are largely terrestrial during the summer months, and use forested areas for foraging. University of Minnesota Duluth scientists and the Minnesota Department of Natural Resources started a study on wood turtles in the spring of 2015 to assess habitat use and responses to management actions. This project compared food availability between known wood turtle locations from VHF telemetry and adjacent clear-cut jack pine (*Pinus banksiana*) regeneration areas. Data collection occurred during the summer and early fall of 2015. Turtles were found in areas with 77% (SD = 26, range 3 to 100) canopy cover, compared to 37% (SD = 37, range 0 to 99) in random locations in managed areas. Earthworm, slug, and berry densities did not differ between the two types of sites. Green plants and raspberry stems had higher densities in managed areas, while mushroom density was greater where turtles were present. Our results indicate the wood turtles could be selecting areas with higher mushroom densities. Alternately, other environmental factors, such as canopy cover, may be driving wood turtle habitat use patterns.

Behavioral Analysis of Western Blacknose Dace in a Turbulence Modified Flow Field

By: Michael T. Goettel*, Dr. Joseph Atkinson and Dr. Sean Bennett, State University of New York at Buffalo, Buffalo, New York.

Fish passage success rates have been historically low due to flow field conditions that exceed the physical or behavioral capabilities of a given species. Significant efforts to design and modify hydraulic structures for enhanced passage rates often fail to achieve the desired results, with a primary reason being a poor understanding of how fish respond to complex hydraulic conditions. Contemporary research efforts have targeted the relationship between hydraulics and fish behavior using live fish in the laboratory to better comprehend these interactions. In this study experiments were conducted to assess the behavioral responses along swimming trajectories of western blacknose dace (*Rhinichthys obtusus*) in turbulent flow conditions and to test the hypothesis that dace preferentially adjust their swim paths to avoid elevated turbulent conditions. Data were collected through digital imaging of dace trajectories for fish navigating a shallow flume with enhanced turbulence flow fields. Additionally, detailed flow measurements were collected with an acoustic Doppler velocimeter to compare dace trajectories to flow field conditions represented by average metrics of turbulent kinetic energy and Reynolds shear stresses. Analysis of the data consisted of quantifying the proportion of time a dace's swim path selected a direction toward a lower magnitude turbulence condition and the qualitative visual assessment of swim path preferences. Results indicate that dace did avoid turbulence under the conditions experienced but not nearly to the degree anticipated; instead, data suggest dace often used bursting strategies when faced with elevated turbulence zones. Qualitative observations suggest behavioral factors, such as the presence of conspecifics and light intensity, also influence the swim path trajectories.

Watershed Pollutant Load Monitoring Network

Stacia Grayson
Minnesota Pollution Control Agency - Duluth
525 Lake Ave, Duluth MN 55802
218-302-6631

The Watershed Pollutant Load Monitoring Network (WPLMN) is designed to obtain spatial and temporal pollutant load information from Minnesota's rivers and streams and track water quality trends. This long-term program utilizes state and federal agencies, universities, local partners, and Minnesota Pollution Control Agency (MPCA) staff to collect water quality and flow data to calculate pollutant loads.
Monitoring sites span three ranges of scale:

Basin –major river main stem sites along the Mississippi, Minnesota, Rainy, Red, Des Moines and St. Croix rivers.

Major Watershed – tributaries draining to major rivers with an average drainage area of 1,350 square miles (8-digit HUC scale).

Subwatershed – major branches or nodes within major watersheds with average drainage areas of approximately 300-500 square miles.
Establishment of basin and major watershed sites within the network began in 2007 following the passage of Minnesota's Clean Water Legacy Act with subsequent funding from the Clean Water Fund of the Minnesota Clean Water, Land and Legacy Amendment. Determination and establishment of subwatershed sites began in 2011 and all sites are in operation as of 2015.There are currently 20 major river main stem sites, 59 major watershed sites, and 126 proposed subwatershed sites within the network.

Enhancing the Lake Superior North and South Watershed Assessments – Red Clay Bank Analysis

John Jereczek* and Clint Little

Coastal Program staff and DNR staff worked in collaboration with DNR Division of Forestry Resources Assessment Program to provide critical data and tools useful in the development of watershed restoration and protection strategies (WRAPS) for the coastal zone's two major watersheds – Lake Superior North and Lake Superior South. The Red Clay Project was a research and demonstration project completed in 1980 and sponsored by five soil and water conservation districts from two states. The local district supervisors were committed to the task of seeking practical solutions to the many forms of red clay erosion and the resulting water quality problems. The overall objectives of this project were to demonstrate economically feasible methods of improving water quality, to assess the capabilities of existing institutions to cooperatively implement a pollution control program and to provide data and recommendations that could be used in future programs. Through our project we have mapped these areas and created a GIS layers hosted on the DNR's GDRS based on high resolution LIDAR derive topography and the new SSURGO soils data. This data can then be used for planning, water quality management and application of published Red Clay best management practices

LiDAR based Topographic Riparian Area Delineation

John Jereczek*, Tyler Kaebisch and Clint Little

Coastal Program staff and DNR staff worked in collaboration with DNR Division of Forestry Resources Assessment Program to provide critical data and tools useful in the development of watershed restoration and protection strategies (WRAPS) for the coastal zone's two major watersheds – Lake Superior North and Lake Superior South. Riparian areas are valuable ecotones that have unique functions and values. These include water quality and quantity, habitat for plants and animals, refuge for native plant and animals, recreation and aesthetics, natural filtering of sediment and connectivity with other landscapes. This project involves the creation of a GIS layer of topographic riparian areas. Next steps include a riparian ecological health assessment.

Enhancing the Lake Superior North and South Watershed Assessments – High Resolution Hydrography

Tyler Kaebisch*, Clint Little and John Jereczek

Coastal Program staff and DNR staff worked in collaboration with DNR Division of Forestry Resources Assessment Program to provide critical data and tools useful in the development of watershed restoration and protection strategies (WRAPS) for the coastal zone's two major watersheds – Lake Superior North and Lake Superior South. New innovative methods were developed utilizing remote sensing/GIS methods to update the existing 1:24,000 hydro-layer. Detailed stream lines were delineated from 1 meter LiDAR digital elevation models using flow accumulation routines. An inventory of digital dam break lines for digital elevation model hydro-modification was created. Data contains FGDC metadata for stream line and digital dam break line GIS layers. Information derived from this task will be instrumental in developing strategies and actions aimed at achieving and maintaining water quality in both watersheds.

TMDLs and Watershed Restoration and Protection Strategies in the St. Louis and Nemadji River Basins

Jennifer Olson*, Andrea Plevan, Tetra Tech
Mike Kennedy, Karen Evens, MPCA

Work is ongoing in both the St. Louis River and Nemadji River watersheds to develop Total Maximum Daily Load (TMDL) studies and Watershed Restoration and Protection Strategies (WRAPS). Both of these projects are expected to be completed in 2016.

These projects provide an assessment of important pollutant sources leading to water quality degradation and impairments and incorporate watershed-based HSPF modeling being completed basin-wide in Minnesota. TMDLs include the needed pollutant reductions to meet water quality standards in the rivers and lakes. Implementation strategies will also be developed to define priorities and focus implementation activities; this effort is being done in conjunction with stakeholder groups in both watersheds. In addition, waters that are of high quality in these watersheds will be targeted for protection strategies. The poster will provide a summary of the progress made to date on these projects and anticipated steps to completion.

Interactions of Estuary, Tributary, and Lake Flows in the St. Louis River Estuary – The Role of the Superior Entry Channel

Paul C. Reneau*, Joel T. Groten, Faith A. Fitzpatrick, and Richard L. Kiesling

A side-looking acoustic Doppler profiler was installed at the Superior Entry Channel in the fall of 2015 to continuously monitor flow and currents in and out of the Superior Bay portion of the St. Louis River Estuary, Wisconsin and Minnesota. This instrumentation was installed in support of a biophysical model being developed for the St. Louis River Estuary by the U.S. Geological Survey through a Great Lakes Restoration Initiative study. Simultaneous measurements of discharge in both the Superior Entry Channel and the Duluth Ship Canal serve a long-standing data gap to understand localized lake and estuary hydrodynamics in relation to the greater circulation patterns of the western arm of Lake Superior. This work can offer further insights into the effects of flood flows from the St. Louis River, Nemadji River, and other direct tributaries to the St. Louis River Estuary. Preliminary data from the Superior Entry Channel are highlighted in this poster, showing the simultaneous relation of current direction and magnitudes relative to the Duluth Ship Canal (http://waterdata.usgs.gov/mn/nwis/uv?site_no=464646092052900).

FIELD GUIDE FOR MAINTAINING RURAL ROADSIDE DITCHES

JESSE SCHOMBERG* – *UNIVERSITY OF MINNESOTA SEA GRANT*
31 W COLLEGE ST DULUTH, MN, 55812
218-726-8106
JSCHOMBE@D.UMN.EDU

DR. VALERIE BRADY – *NATURAL RESOURCES RESEARCH INTITUTE*
5013 MILLER TRUNK HIGHWAY, DULUTH, MN 55811
218-720-4294
VBRADY@D.UMN.EDU

In three rural NE Minnesota watersheds (Sucker, Knife, and Poplar Rivers), miles of ditch channel approximately equal the miles of stream channels (assuming a ditch on both sides of every road); thus essentially doubling the network of drainage channels. Discussions with road and conservation personnel about what could be done with roads and ditches to reduce the impacts of stormwater runoff on streams highlighted a need for a ditch maintenance guide specific to this region that could be used for training of road and ditch maintenance workers (Brady and Breneman 2008). Over the past 3 years we have developed a "Field Guide for Maintaining Rural Roadside Ditches". The guidebook focuses on proper routine maintenance of rural roadside ditches, with a major focus on helping maintenance workers identify what problems are serious enough that the advice of a supervisor or engineer is recommended. Out of 30 evaluations to-date, most thought the field guide would help improve water quality or reduce environmental impacts of ditch maintenance (86% = yes).

Open Land Analysis using LiDAR

Jamie Schultz* and John Jereczek

Elon S. Verry conducted a study that determined negative impacts could be seen on flooding in areas with greater than 60% of land cover disturbance. (Verry, 2001) Using LiDAR, areas were identified in major watersheds 1 and 2. When used along with other datasets, the open land analysis data can help identify areas to protect from disturbance. The data is being used to help with planning processes at both the DNR and outside organizations.

Morphological Variation in Four Minnesota Lymnaeid Snails

J. Trevor Vannatta*, Integrated Biosciences Program, University of Minnesota – Duluth, Biology Department, 1035 Kirby Drive, Swenson Science Building 207, Duluth, MN, 55812, vanna006@d.umn.edu, 218-788-2760

Ron Moen, Department of Biology and Natural Resources Research Institute, University of Minnesota – Duluth, rmoen@d.umn.edu, 218-788-2610

Lymnaeid snails are difficult to identify using current keys despite being important parasite vectors. Lymnaeid snails were collected across St. Louis and Lake Counties in Minnesota from June – September 2015. *Lymnaea megasoma*, *L. stagnalis*, *L. elodes*, and *L. catascopium* were found in the study area. For *L. megasoma,* the average length was 36.73 mm, but individuals <35 mm were often found. The width:length (W/L) ratio of *L. megasoma* averaged 0.61. *L. megasoma* was often brown-gray, but was almost black in some locations. The purple color inside the aperture is the most diagnostic feature for *L. megasoma. L. stagnalis* was the largest snail by length (mean = 44.68 mm) and had a W/L ratio of 0.45. Morphological variation was most obvious in the body whorl. The morphology of *L. elodes* was

conserved across locations. The prominent striping on these *L. elodes* shells is characteristic of the 'reflexa' subgroup. The shell is half the length of *L. megasoma* or *stagnalis* at 20.17 mm and has a W/L ratio of 0.39. We suggest the 35 mm length minimum for classifying *L. megasoma* be reevaluated and replaced with W/L ratios as the primary diagnostic feature which is more conserved across different locations.

How Much is Too Much: Establishing Baseline Monitoring for Cloud Lake Ontario

Nathan Wilson
Department of Geography and the Environment
Lakehead University

Cloud Lake is a head water lake for Lake Superior located approximately 45 km southwest of Thunder Bay, Ontario. Over the past decade residents and lake users report observing a substantial decline in the quality of fishing as well as diminishing aquatic vegetation. These observations coincide with complaints of increased pelagic and benthic algae, possible blue-green algae blooms, and overall concerns about the lake's health. The purpose of this study is to assess the current level of phosphorus in the lake and to characterize potential input sources. A water sampling protocol was employed for ice and ice-free periods during 2015 in order to capture trophic indicators such as temperature profiles, total phosphorus, secchi depth (clarity), chlorophyll content and vegetation/habitat surveys. The study also provides a baseline for long-term monitoring as a background for examining the human contributions to nutrient loading. The results of this study will be used to provide recommendations for remedial actions to residents concerned about the future of Cloud Lake. Initial analysis of data supports the hypothesis that the lake is experiencing eutrophication. The increasing total phosphorus levels within Cloud Lake may result in an increased phosphorus input to Lake Superior.