MN Lake Superior Watershed Stream Science Symposium II
January 6-7, 2016

Presentation Abstracts
(Alphabetically by Presenter*)

PRESENTATION TITLE, A perspective on forest stream ecosystem services

Ted Angradi, US EPA

Research on ecosystem services (ES) increased greatly following publication of the Millennium Ecosystem Assessment in 2005. Application of the approach for practical decision making has lagged far behind. Definitions of ES vary. I prefer "the outputs of natural ecosystems that are directly enjoyed, consumed, or used, to yield human wellbeing." Federal agencies will soon be directed to explicitly consider ES in planning and decision-making. A simple conceptual framework for using in ES in local decision-making includes policies, the biophysical state of the environment, ecosystem-mediated processes, ecosystem outputs, social welfare functions, benefits, and feedbacks in the form of monitoring and stakeholder expectations. ES is highly interdisciplinary, which is one reason it has been slow to be adopted for operational application. Recommendations for moving forward with applications are provided.

PRESENTATION TITLE, Sustaining Healthy Aquatic Ecosystems in a Changing Climate: Understanding ecological relationships with flow

Dr. Kristen Blann, The Nature Conservancy

Climate change threatens to significantly alter stream ecosystems along the North Shore of Lake Superior, especially when coupled with land use changes and other human activities. Understanding and anticipating responses of stream communities to streamflow and temperature changes (projected to occur over the next few decades in response to changing patterns of precipitation, snowmelt, temperature, storm intensity, etc) is necessary to develop adaptation and mitigation strategies to maximize stream resilience and to inform fisheries management priorities. Based on both literature review and empirical analysis, we are exploring regional flow-ecology relationships based on existing biological monitoring datasets to identify critical stream flow conditions needed to maintain native fish species such as brook trout. The overall goal is to assess the relative vulnerability and resilience of streams under likely future climate and land use conditions, and identify strategies to enhance stream resilience through land and water management. This presentation will describe how North Shore stream communities relate to current flow regimes, as well as our approach to understanding and predicting how stream communities may respond to future flow, temperature, and land use changes.

PRESENTATION TITLE, Implementation of a Tiered Aquatic Life Uses Framework for Lake Superior Basin Streams

R. William Bouchard, Jr.

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The Minnesota Pollution Control Agency (MPCA) is developing a Tiered Aquatic Life Uses (TALU) framework for streams and rivers. Adoption of a TALU framework will move Minnesota from a "one-size-fits-all" system for setting aquatic life protection and restoration goals, to a more refined system that better recognizes the *biological potential* of Minnesota's streams. The TALU framework classifies streams into Exceptional, General, or Modified Use tiers. Designation of these tiers is based on an assessment of a stream's biological condition and habitat quality. The ability to identify and protect high quality streams is particularly important in the Lake Superior Basin which likely has the greatest number of biologically exceptional streams in the state. The technical tools needed to support the TALU framework (i.e., Indices of Biological Integrity, biological criteria, Use Attainability Analysis procedures) are completed with formal rulemaking scheduled to start in March 2016. Final adoption of the TALU framework into rule is expected in late 2016. The presentation will provide an overview of the TALU framework and its integration into the Intensive Watershed Monitoring Plan with a focus on the implications for streams in the Lake Superior Basin.

PRESENTATION TITLE How much sediment is too much, according to stream macroinvertebrates?

Dr. Valerie Brady*, Natural Resources Research Institute, University of Minnesota Duluth;
Larissa Herrera, Water Resources Science, University of Minnesota Duluth (current affiliation: GZA GeoEnvironmental, Inc.)

Excess fine sediments (sand, silt, and clay) may be a problem for stream macroinvertebrates when they embed rocky substrates. Certain traits, such as clinging to rocks, having fragile gills, or having a hard exoskeleton, may make macroinvertebrates more or less vulnerable to high stream sediment loads. Western Lake Superior streams have a wide range of fine sediment amounts due to their varied surficial geology and soils, but low amounts of other stressors (e.g., agriculture) and thus are a good region to investigate relationships between macroinvertebrates and fine sediments. We created a combined sediment index comprised of embeddedness, depth of fine sediments, and total proportion fine sediments. We found strong relationships for various traits and taxa with percent embeddedness and the combined sediment index. These metrics may help diagnose whether stream invertebrate assemblages in poor condition are or are not due to excess sediments. We also found that, in at least some years, many north shore

streams have sediment amounts that seem to be below those that would trigger obvious changes in the macroinvertebrate assemblage. We hypothesize that sediment build-up in the substrate over long periods of the summer is more detrimental than sediments that are continually washed downstream.

PRESENTATION TITLE, Geomorphic Characteristics, Processes, and Responses of Duluth-Area Streams to the June 2012 Flood, Minnesota

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On June 19 – 20, 2012, heavy rainfall produced severe flooding in tributaries to Lake Superior near the city of Duluth, Minnesota. In 2013, the U.S. Geological Survey (USGS) revisited 48 streams that had previously (2003) been included in a USGS geomorphic assessment of Duluth-area streams. Channel bed material, woody debris, bank erosion, depositional bars, pools, and bank stability measurements were collected and compared to measurements from the 2003 study to document their response to the 2012 flood. Changes in channel bed material indicated that larger (cobble) sizes had been replaced by smaller (gravel) sizes and large wood in streams had declined by more than 70 percent. Aggradation of the streambed, loss of pool habitat, scouring, and widening of channels also were observed in the 2013 study. These data provided important insight on stream and ecosystem responses to flood events and offered valuable information for future stream restoration and ecosystem management.

PRESENTATION TITLE, The Science(s) Behind Managing Stream Fishery Resources

Cory Goldsworthy Lake Superior Area Supervisor
Minnesota DNR Section of Fisheries

Managing fish populations in the Great Lakes is a complex task involving factors such as Sea Lamprey mortality, status of the prey base, “in-lake” predation, exploitation, and environmental effects. This complexity is further exacerbated in a stream based fishery due to in-stream environmental conditions, habitat degradation, climate change, and limited habitat suitable for rearing of young fish. This presentation attempts to explain these challenges and provide insight into how Stream and Fisheries Science helps guide management decisions all while taking into consideration the even more complex nature of Social Science.

PRESENTATION TITLE, Stream resiliency in a changing climate

Karen B. Gran
Department of Earth & Environmental Sciences
University of Minnesota Duluth

Resiliency measures a system's ability to sustain desired ecological functions under changing environmental stress. Climate change is becoming an ever-increasing stress on North Shore streams as both annual mean precipitation and temperature increase in northeastern Minnesota. Predictions from GCMs of future conditions indicate continued warming and changes to precipitation regimes that may include more extreme events. Increasingly episodic delivery of precipitation has consequences for both high and low magnitude flows. How will the ecological systems respond? This talk explores the potential effects on the physical stream environment and implications for stream ecology.
Rivers along the North Shore are adapted to their current energy and sediment regimes, moving the imposed loads of water, sediment, and wood downstream over time under a given disturbance regime. Streams that are most mobile tend to be the most resilient, able to adapt to changing conditions, even though these same streams may have the most detrimental impact on infrastructure when the two intersect. Ecologically, studies have generally found rapid recovery following major flood events. The main challenge to ecosystem response to climate change thus comes from warming temperatures and impacts to low flows, not high flows. Ultimately, the most resilient streams are likely to be the most thermally-resilient, not the most geomorphically-stable.

PRESENTATION TITLE, Trout Unlimited's Conservation Success Index, Land Management and Climate Impacts

Carl Haensel, Minnesota Trout Unlimited

Trout Unlimited developed the Conservation Success Index (CSI) in order to become more strategic and effective in conservation efforts. Using the CSI, it is possible to quantify and map the conservation status of all native coldwater fishes so that comparisons of existing condition, threats, future security, and management opportunities can be made across watersheds, river basins, and entire species. This enables the delivery of conservation in context. The CSI integrates population data from various assessments completed by state and federal agencies with spatial data on habitat and threats gathered by TU scientists to create a common analytical framework applicable to all coldwater fishes. The basic components of the CSI include 20 indicator variables that describe the range-wide condition, habitat integrity, population integrity, and future security for all subwatersheds that historically or currently contain native trout. The variables can be modified slightly

to accommodate analysis of anadromous species as well as rivers and upstream contributing watersheds containing wild, non-native trout populations. In Minnesota, the CSI has been applied to Great Lakes brook trout, including those within the Lake Superior basin. CSI derived outputs are available for discussion and use in formulating management options in addressing challenges including land use and climate change.

PRESENTATION TITLE, <u>Sediment Investigation of Lake Superior Watersheds</u>

Brad Hansen
Department of Bioproducts and Biosystems Engineering
University of Minnesota

The two main objectives of this project were to: Identify critical pathways and areas on the landscape that contribute a disproportionate amount of sediment to selected streams located in LS South and to develop a management prioritization framework to address areas of high erosion potential. The three watersheds investigated were the Sucker, Knife and Beaver Rivers.

An existing erosion hotspot model was used to identify in stream areas of high erosion potential which correlated well with eroding bluff locations. Bluff scans with ground based Lidar were conducted and combined with 4 years of previous scan data to provide an estimate of bluff erosion. Critical shear and soil strength data was also collected from eroding bluffs to help determine which bluffs may have the highest erosion potential. The number of ravines in each watershed was as also documented. An estimate of sediment load from ravines is being calculated.

LIDAR images were used to identify upland areas of highest erosion potential which correlated to lake plain clays soils. Infiltration rates were measured on lake plain soils on both openlands and forested areas. Infiltration rates were ten times faster in forested areas versus openlands but infiltration was limited in both areas by a dense clay layer present at a depth of 6 to 12 inches. Passive sediment samplers where used to try and document differences in sediment loads on paired watersheds.

A method to prioritize erosion hotspots in the channel and on the upland areas is being proposed.

PRESENTATION TITLE, Managing climate change in the Superior North Shore Tributaries: Can we maintain the flow?

William Herb*, Lucinda Johnson*, Ralph Garono, Meijun Cai, Kristen Blann, and John Jereczek.

Climate change is a serious threat to the freshwater ecosystems in Minnesota's Lake Superior tributary streams. To develop long-term strategies to address these threats, a project is underway to develop tools for classifying these ecosystems, and to predict their hydrologic and ecological responses to climate and land use changes. Based on the projected flow conditions and corresponding ecological responses, the relative vulnerability and resilience of each stream class will be determined. Land and water management opportunities will be identified in cooperation with local, regional, and state-level managers. The results of this project are targeted at management professionals for use in climate change adaptation planning.

This presentation will describe progress on hydrologic classifications of the Lake Superior tributary streams, and the hydrologic and land cover models being used to characterize past and future streamflow conditions. A regional stream classification was developed using catchment and reach physical characteristics, based on the NHDplus hydrography layers. Empirical and deterministic hydrologic models are being used to characterize current streamflow conditions in gaged and ungaged watersheds, based on historical climate data, and future streamflow conditions, based on the outputs from several global climate models. The future change scenarios also include the response of forest cover to climate change, and corresponding changes in water budget components such as canopy interception and transpiration. Preliminary results suggest that future changes in climate, particularly changes in seasonal precipitation patterns, will have a stronger influence on streamflow regimes than land cover changes.

PRESENTATION TITLE, New Methods for Modeling Stream Temperature Using High Resolution LiDAR, Solar Radiation Analysis and Flow Accumulated Values

Tom Hollenhorst*
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John Jereczek
Lake Superior Habitat Coordinator
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In-stream temperature directly effects a variety of biotic organisms, communities and processes. Changes in stream temperature can render formally suitable habitat unsuitable for aquatic organisms, particularly native cold water species that are not able to adjust. In order to anticipate changes in stream temperature we need a better understanding of riparian attributes (amount and height of vegetation, bank

and gully shading), and watershed attributes (amount of impervious cover, open lands, ground water interactions, etc.) that might have the greatest effect on thermal "insolation" (i.e. the amount of solar radiation energy received at a given location) and the subsequent in-stream temperature downstream from those locations. To add to that understanding we analyzed high resolution LiDAR data, results from Solar Radiation Analyses and flow accumulated values compared to locations of measured stream temperature to predict stream temperature in unmeasured areas.

PRESENTATION TITLE, Cutting Climate Change Down to Size Through Crowd sourcing, Collaborations, and Better Monitoring and Models

Dan Isaak, U.S. Forest Service, Rocky Mountain Research Station

Concerns about the effects of climate change on aquatic ecosystems have motivated extensive research, vulnerability assessments, and modeling efforts for decades. Despite those efforts, most of the knowledge we possess is general in nature and rarely provides "actionable intelligence" about where to prioritize conservation and restoration efforts most effectively. Inexpensive digital temperature and flow sensors, combined with biological survey techniques based on sensitive genomic assays, now provide the means of developing large datasets for research to use in next-generation models for hydrology, stream temperature, and species abundance. Moreover, because standard protocols exist for many data collection activities they can often be "crowd-sourced" among collaborating professionals from different agencies and even the private citizenry. These new datasets and models engage a broader cross-section of society, enable more precise measurements of climate change effects on aquatic systems, and facilitate climate-smart prioritization strategies. As better information is developed, climate effects are sometimes found to be less ominous than previously feared, but the information capacities yielded by better data and models prove useful for a wide range of additional applications to traditional conservation and management issues. Examples from streams and rivers across the western U.S. will be used to illustrate these concepts.

PRESENTATION TITLE, The Surface Water – Groundwater Connection: Amity Creek Watershed, Duluth, MN

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Excellent brook trout habitat can be found in segments of many Lake Superior South watershed streams. Optimal riverine brook trout habitat includes clear, cold spring-fed water and studies have shown that areas of groundwater upwelling in streams tend to be more important than other site selection variables. Observations of historical brook trout and temperature data in the Amity Creek subwatershed of Lake Superior South led us to hypothesize that reaches with healthy and stable brook trout communities are likely connected to groundwater storage, exchange, and upwelling. Climate trend models for the Midwest predict future changes in temperature, annual precipitation, and storm event frequency for Northern Minnesota. Streams along the North Shore of Lake Superior are susceptible to increased temperatures and insufficient late summer to early winter flows due to climate change and the unique regional geology. Understanding groundwater-surface water hydrology interactions, watershed connectivity, and related flood-induced geomorphic and hydrologic changes is important because they relate to the overall stability and aquatic health of the stream and the biological communities that inhabit it. The objectives of this study were to identify groundwater storage zones, upwelling zones and seasonal variations; and assessing how these relationships change as result of a major flood. A study reach on the East Branch Amity Creek is incising through clay-rich glacial tills overlying bedrock, and has avulsed multiple times in the past, stranding discrete remnant channels cut into till. A 500-year storm hit Duluth, MN on June 19-20th 2012, producing 8-inches of rain in a 24-hour duration which resulted in mass flooding across the region. Pre-flood and post-flood groundwater and surface water level data were collected through a series of piezometers with pressure transducers and an in-channel stream gage. Stable isotope analyses of Deuterium and Oxygen-18 were conducted on water samples with varying temporal and spatial variability to provide information on watershed and reach scale source hydrology and evaluate flood-induced changes. Results show groundwater upwelling variability within the greater watershed and identify two discrete groundwater storage zones within a smaller study reach. Pre- and post-flood analysis shows a correlation between incision in main stem and remnant channels and a lowered water table, following the flood. Isotope analysis indicates a temporary post-flood change in subsurface source water. Because much of the greater North Shore of Lake Superior has the same geology as the study area,

the results of this study may provide insight to hydrology studies of other North Shore of Lake Superior streams.

PRESENTATION TITLE, How cold is cold enough? Stream temperatures of Minnesota's North Shore streams today and in the future.

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1 - Natural Resources Research Institute, UMD
2- St Anthony Falls Lab, UM
3- Minnesota Trout Unlimited

Brook trout are an iconic species associated with streams along Minnesota's North Shore of Lake Superior. Due to their reliance on cold water habitat, brook trout are considered vulnerable to the effects of a warming climate. To help inform climate adaptation strategies and help prioritize management and restoration activities in North Shore watersheds our team has been studying the effects of land use and climate on stream temperatures. Past work has focused on the development of models predicting stream flow and temperatures from existing data, and application of those models to streams under future climate scenarios. While models were found to accurately predict presence/absence of trout about 75% of the time, key data gaps were noted. In particular, locations of groundwater inflows to streams are poorly mapped in this region. A new project will help understand the locations of groundwater inputs to high-value trout streams, and is expected to improve model predictions. The objectives of the new project are to utilize volunteers to map coldwater refuges, to characterize key landscape variables that influence groundwater potential, improve stream temperature models based on improved landscape data, and predict distributions of coldwater refuges and brook trout under future climate scenarios. This presentation will review past work on stream temperature and flow modeling, and will discuss the new project objectives and progress to date.

PRESENTATION TITLE, Removing Roadblocks: Experiments on Culvert Design for Fish Passage

Jessica Kozarek
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University of Minnesota

Culverts can act as barriers to fish and other aquatic organism movement in streams due to insufficient water depth, excess velocity, excess turbulence, or insufficient

roughness. In addition, aquatic organisms may encounter a behavioral barrier due to different conditions (such as light) within the culvert. This presentation will cover a series of experiments conducted in the field and at St. Anthony Falls Laboratory (SAFL) to examine the physical performance of fish passage culvert designs and fish behavior in dark culverts. While significant research efforts have been made to understand individual fish swimming abilities, our projects examine other aspects of fish and aquatic organism passage through culverts: a) culvert performance in terms of sediment transport into and through embedded culverts (a key component to predict habitat conditions within the culvert), b) potential behavioral barriers (light), and c) novel methods to add roughness along the boundaries of concrete box culverts. These experiments provide guidance to culvert designers on a) the need for sediment placement within embedded culverts to maintain natural stream bed roughness, b) the necessity for light mitigation strategies in long, dark culverts, and c) the ability to utilize inexpensive methods to retrofit culverts with additional boundary roughness.

PRESENTATION TITLE, <u>Interplays of nutrients and light: effects of river & stream inputs in Western Lake Superior during the 2012 flood</u>

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On June 19-20, 2012, the western Lake Superior watershed experienced an extreme storm event with extensive flooding. This caused intense coupling of the landscape and lake; with extensive sediment loading (including phosphorus) and riverine colored dissolved organic matter reaching open lake waters. The massive input of P (estimated to be 40% of the typical annual load to the entire lake) might be expected to create large, local algal blooms. However, chl in the plume was similar to or only slightly higher than in the lake itself. Response to nutrient loading appeared to be moderated by reduced light penetration and changed depth of the mixed layer. Timescales of biological response to nutrients might also have been long compared to residence time of P in the water column. Extreme storms such as the June 2012 event are projected to become more common in North America as our climate changes; understanding the implications of such storms to coastal ecosystems will be critical.

PRESENTATION TITLE, The Forests of the Lake Superior Watershed and Climate Change: In Transition to What and When?

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The forests of the Lake Superior watershed will probably undergo the greatest changes in productivity and species composition with global warming in the coming century than any other place in the lower 48 states. The ranges of most boreal species will likely contract northward out of Minnesota, Wisconsin, and Michigan, but will likely remain intact in Ontario along the north shore. What will replace them will depend on soil type. On clay soils that can hold water, sugar maple and other northern hardwoods will expand their range northward, so long as drought does not become prohibitive. On sandy or rocky soils of low water holding capacity, oak-jack pine savannas will likely become dominant. What this means for streams in the watershed and the delivery of nutrients, dissolved organic matter, and sediment to Lake Superior remains an open question that needs to be the focus of future research. The changes in the delivery of dissolved organic matter, nutrients, and sediments will likely be greatest during the transition from the current landscape to the new landscape, but will stabilize thereafter. Most of the changes in forest composition will happen in the southern part of the Lake Superior watershed, which is quite narrow, while the forests in the northern half of the watershed, which is considerably wider, will not change as much. This configuration of the watershed around the Lake may buffer the effects of the expected changes in forest composition on the Lake itself.

PRESENTATION TITLE, Mercury in Aquatic Food Webs of Six National Parks in the Western Great Lakes Region

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The western Great Lakes region has several national park units that provide potential pathways for exposure of humans and wildlife to methylmercury (MeHg). The parks exhibit a wide variety of aquatic ecosystems, and relatively little is known about the extent of Hg contamination in aquatic resources within these units. During 2010-12, we quantified total Hg and MeHg in aquatic food webs from 23 water bodies within six national park units, including samples of sediment, water, seston, zooplankton, larval dragonflies, prey fish, and predatory fish. Our results show that aqueous MeHg levels are largely driving trophic transfer through the food web. A screening-level risk assessment indicates that a significant proportion of fish from the parks exceed the US EPA criterion concentration for human consumption, as well as published threshold concentrations for adverse effects to sensitive wildlife. Our results indicate a regional trend where the parks in northern Michigan

and Minnesota exhibit higher food web MeHg concentrations than the parks in lower Michigan and northern Indiana, which are closer to Hg point sources and urban centers. Despite recent regional decreases in Hg emissions, contemporary Hg continues to pose a threat to humans and wildlife in these mercury-sensitive landscapes.

PRESENTATION TITLE, Use and Evaluation of New Genome Techniques to Understand Microbes in Waterways

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The emergence of metagenomics-based approaches at the end of the 20th century overcame the historical culture bias in microbiological studies enabling a more comprehensive assessment of microbial ecology in environmental samples, especially waterways and soils. The subsequent development of second-generation sequencing technologies, able to produce millions of sequence reads at improved cost and speed, quickly necessitated a computational shift from user-supervised alignment and analysis pipelines. Current computational advances have massively expanded the scope of microbial biogeography studies and offered novel insights into microbial responses to environmental variation and anthropogenic pollution. However, new biostatistical and computational approaches were required to handle the large volume and complexity of these new multivariate datasets. While new bioinformatics and biostatistical tools have allowed more complete characterization of taxonomic, phylogenetic, and functional microbial diversity, these tools are still limited by methodological biases, incomplete databases, and the high cost of fully characterizing environmental biodiversity. Here I discuss the pros and cons of methods to monitor surface waters and characterize environmental samples in the Lake Superior Watershed through the recent computational advances in metagenomics, with an emphasis on the study of surface waters and public health. These new methods have provided an abundance of opportunities to expand our understanding of the interaction between microbial communities and public health. Specifically, they have allowed for comprehensive monitoring of bacterial communities in surface waters for changes in community structure associated with fecal contamination and the presence of human pathogens, rather than relying on only a few indicator bacteria.

PRESENTATION TITLE, Monitoring and Assessing Water Quality in Lake Superior Basin Streams

John Sandberg
MN Pollution Control Agency

The Minnesota Pollution Control Agency conducts biomonitoring surveys on rivers and streams across the state, and uses this information to assess the quality and biological integrity of these waters. Since inception of Minnesota's Intensive Watershed Monitoring approach in 2008, the MPCA has monitored stream fish and aquatic macroinvertebrates at more than 300 locations within the Lake Superior Basin, encompassing all five major watersheds (St. Louis River, Cloquet River, Nemadji River, Lake Superior – South, Lake Superior – North). These biological surveys are used to identify both impaired and high quality waters, inform restoration efforts and protection strategies, provide broad-scale estimates of condition, and track long-term changes. The presentation will provide an overview of MPCA's biomonitoring and assessment approach, including monitoring design, assessment tools, and methodology.

PRESENTATION TITLE, Carbon Storage and Cycling in Riparian Environments: Considerations for Lake Superior's Watershed

Dr. Kathryn Schreiner, Large Lakes Observatory, University of Minnesota Duluth

The North Shore of Lake Superior and the Lake's Minnesota watershed is characterized by a series of relatively high-elevation, mountainous headwater streams. The watersheds of these streams tend to originate in forested and/or wetland areas characterized by low flow regimes and then flow relatively rapidly over rock faces and cliffs as they near the terrestrial-aquatic interface. These watersheds have the potential to store large amounts of organic carbon both in forested soils and wetland soils (the latter is commonly known as "blue carbon"). Management of this potentially large store of organic carbon is important for the future health of these watershed ecosystems, their streams, and Lake Superior.

Generally, streams and rivers of this mountainous, high-flow type are often thought to promote rapid downstream delivery of organic carbon, sediments, and nutrients, with little in-stream processing due to the short transit times for sediment and carbon delivery. However, relatively little is known about the carbon dynamics of mountainous headwater streams. Here, I will summarize the current state of knowledge about carbon processing, delivery, and dynamics in these types of watersheds and make connections to the Lake Superior watershed environment specifically, focusing on carbon storage and management in the North Shore watershed ecosystems.

PRESENTATION TITLE, MN DNR Fisheries Easements

Anna Varian* MN DNR, Jamie Juenemann, MN DNR

The Minnesota DNR has over 1,380 fishing easements in the state. A portion of these easements also provide riparian protection by restricting landowner activities within sensitive riparian areas. These easements not only allow fisherman to use private property to access fishing spots but also allow the DNR and partnering agencies to complete research and restoration work. Public use of these easements is limited to angling only (other recreational activities require the landowners permission); Because these easements allow public access, partnering agencies are able to acquire funding for habitat improvement and other critical work that is contingent on a project having a direct benefit to the public. Easement locations were last printed in a series of trout angling booklets in 2007. Updated easements maps are now viewable online using the Recreation Compass feature on the Minnesota DNR's website. A Recreation Compass app is also available for mobile use and a GIS shapefile can be downloaded from the Minnesota Geospatial commons webpage.