AMERICAN WATER RESOURCES ASSOCIATION - WISCONSIN SECTION

44th ANNUAL MEETING

March 3-4, 2021

Support From:

Freshwater Collaborative of Wisconsin

University of Wisconsin Water Resources Institute
Wisconsin Department of Natural Resources
Center for Watershed Science and Education, UW-Stevens Point
Wisconsin Geological and Natural History Survey
U.S. Geological Survey Upper Midwest Water Science Center

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The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management. The success of the section is due in part to the dedication of past and current members of our board of directors and conference planning committee. We heartily acknowledge the following individuals for their service, and we invite others to consider volunteering to ensure an ongoing dialogue among those committed to water resources research and management in the state of Wisconsin.

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Rada Sandheinrich
Rosalie Schnick
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AWRA BOARD OF DIRECTORS POSITION DUTIES

President (1-year term)

Shall preside at meetings, shall, in consultation with the Board of Directors, appoint all committees, and shall perform all other duties incident to the office. The President shall prepare, in collaboration with the Secretary and Treasurer, an annual report of the Section's activities to be presented to the annual meeting of the Section and to be forwarded by the Secretary to the President of the American Water Resources Association.

President-Elect (1-year term)

Shall perform the duties of the President when the latter is absent and shall succeed to the office of President in the following year. Historically has helped to recruit plenary and keynote speakers, has helped coordinate the nomination and election of officers, and performed other responsibilities related to the annual conference.

Vice President (1-year term)

Shall perform the duties of the President-Elect when the latter is absent. Some of the duties that the vice-president has helped with in the past include recruiting moderators for the general sessions, assisting with the technical program review, and performing other miscellaneous duties as assigned.

Secretary (2-year term, elected in odd years)

Shall keep the minutes of the Section's meetings, shall issue notices of meetings, and shall perform all other duties incident to the office.

Treasurer (2-year term, elected in even years)

Shall be responsible for all funds of the Section and the dues of the American Water Resources Association as agreed to between the Board of Directors and the American Water Resources Association. The Treasurer's accounts shall be audited at the close of each year as directed by the President. The Treasurer shall prepare an annual report and financial statement for presentation at the annual meeting.

Director-at-Large (2 positions, 2-year term, staggered appointments)

Shall serve on the Board of Directors to help manage the affairs of the Section including administration, program development and supervision of financial affairs.

BIOGRAPHIES OF CANDIDATES FOR THE AWRA WISCONSIN SECTION BOARD

Director-at-Large

Matt Diebel

Matt Diebel is watershed management coordinator for Dane County Land & Water Resources Department, where he develops watershed management tools, programs, and policies and evaluates water quality trends. He previously worked for the Wisconsin Department of Natural Resources in the water quality and research programs. He has a BA in biology from Colorado College, a MS in water resources management and a PhD in limnology from UW-Madison. He has experience with a wide variety of hydrologic and water quality models for streams and lakes, and is particularly interested in translating model results into formats for non-technical audiences. As a candidate for the AWRA-WI board, he is interested in recruiting and engaging student members.

Treasurer

Eric Booth

Eric Booth is an assistant research scientist at UW-Madison in the Departments of Agronomy and Civil & Environmental Engineering. He also collaborates with the North Temperate Lakes Long-Term Ecological Research site, Center for Limnology, UW Arboretum, Great Lakes Bioenergy Research Center, and Wisconsin Energy Institute. He holds a BS in environmental engineering from UW-Madison (2004), MS in hydrologic science from UC-Davis (2006), and PhD in limnology from UW-Madison (2011). His research interests cut across many disciplines with water as a centerpiece; these include hydroecology, impacts of climate and land-use change, urban stormwater management, wetland/stream restoration, water quality, groundwater hydrology, fluvial geomorphology, environmental history, agroecology, remote sensing, and numerical modeling.

President-Elect

Mitch Olds

Mitch received his bachelor's degree in watershed management and hydrogeology from the University of Wisconsin-Stevens Point in 2012. While attending UWSP, Mitch was an active member of the student chapter of AWRA serving as treasurer (2009-2010) and chapter president (2010-2012). Mitch is employed at the Milwaukee Metropolitan Sewerage District (MMSD) where he is involved in water quality monitoring in southeastern Wisconsin and is the captain of R/V Pelagos on Lake Michigan. Mitch received his master's degree in freshwater sciences and technology at the University of Wisconsin-Milwaukee. He has continued to attend AWRA Wisconsin Section Annual Meetings, serving as a judge for student presentations, and plans to continue to be involved in AWRA throughout his career.

Vice President

Michael Cardiff

Mike received his bachelor's degree in mathematics and geology from Oberlin College (2001). After his undergraduate degree, Mike worked in environmental consulting as a senior project associate at Project Performance Corporation (PPC) near Washington, DC (2001-2004). He then returned to graduate school, completing his MS (2005) and PhD (2010) at Stanford University in civil and environmental engineering, with a focus in environmental fluid mechanics and hydrology. He joined the faculty of UW-Madison in 2012 in the department of geoscience, where he is now a tenured associate professor. Mike has worked on a variety of hydrogeologic problems including aquifer characterization and imaging, groundwater modeling, and contaminant source identification. He is proud to be part of the vibrant water community in Wisconsin, and looks forward to supporting opportunities for researchers, consultants, and students at AWRA meetings in the future.

Aaron Pruitt

Aaron Pruitt has been a hydrogeologist at the DNR's Water Use Section since 2018, where he works on groundwater quantity issues throughout the state, including high capacity wells reviews, groundwater flooding issues, and the Central Sands Lake Study. Prior to the DNR, Mr. Pruitt worked for five years as an environmental consultant in Seattle, WA, working on prior appropriation water rights issues and groundwater contamination projects. He earned bachelor's degrees in English and geology from Appalachian State University in Boone, NC, and earned a master's degree in hydrogeology from UW-Madison under Jean Bahr and Ken Bradbury, where he worked on potential climate change impacts to groundwater/surface water interactions in the Chequamegon-Nicolet National Forest. Mr. Pruitt would be honored to contribute to AWRA's work of connecting water researchers across the state and building a community of hydroscientists.

PLENARY SPEAKERS

Sandra McLellan

Sandra McLellan is a professor in the School of Freshwater Sciences at the University of Wisconsin-Milwaukee. She earned her PhD in environmental health at School at the University of Cincinnati College of Medicine and has been working on water issues in the Great Lakes for the past 20 years. Her work focuses on understanding the linkages between the environment and human health, particularly in urban coast systems. Dr. McLellan's lab uses the microbiome signatures from animals and humans to identify pollution sources in water and had developed approaches to investigate contamination in stormwater outfalls, rivers, and the causes of beach closing. More recently, Dr. McLellan is analyzing wastewater samples to understand the trends of Covid-19 in Wisconsin communities and is partnering with researchers nationwide to implement surveillance programs that will provide data for a more informed public health response.

Anita Anderson

Anita Anderson has over 20 years of experience as a water supply engineer with the Minnesota Department of Health. Her primary area of expertise is surface water treatment, specializing in small systems. Currently she is also working on special projects to advance safe and sustainable water reuse in Minnesota and to predict the vulnerability of groundwater drinking water sources to microbial pathogens.

Adam Bechle

Adam Bechle is a coastal engineering specialist with Wisconsin Sea Grant. In this role Adam helps Great Lakes communities build resilience to coastal hazards by communicating the latest hazard research and data, developing education and outreach products on best management practices, and providing local governments guidance to identify opportunities to better plan and prepare for coastal hazards. Adam holds a PhD in civil and environmental engineering from the University of Wisconsin Madison.

Marissa Jablonski

Marissa Jablonski is the executive director of the Freshwater Collaborative of Wisconsin. The Freshwater Collaborative of Wisconsin (FCW) is a partnership of Wisconsin's 13 public universities, connecting with industry partners, local communities, policymakers, non-profits, and advocacy groups. Our mission is to train the next generation of water researchers and problem solvers and to establish Wisconsin as a global leader in water-related science, technology and economic growth. In addition to preparing future scientists and water managers, our work benefits everyone who uses or relies on water, from farmers to homeowners, outdoor enthusiasts to manufacturers.

Eric Olson

Abstract: Extension Lakes is collaborating with the Wisconsin DNR, UW Madison Division of Extension, Water Action Volunteers, Wisconsin Lakes, and others to produce a first of its kind, live and online statewide water outreach event: Wisconsin Water Week. It will be taking place the week following the 2021 AWRA conference, March 8-12. This project is looking to connect researchers, educators and managers with over 1,000 citizen water resource stakeholders. The core audience for the project consists of board members who govern hundreds of lake, river and watershed organizations in Wisconsin. We also plan to reach highly engaged stakeholders who may not be in leadership roles but are concerned about surface waters and groundwater. This presentation will summarize our plans for the event and highlight the metrics we will be using to gauge success. We are also looking to invite AWRA members and conference participants to assist us in spreading the word about Wisconsin Water Week and inviting their local and regional contacts to attend.

CONTENTS

PROGRAM SUMMARY

44th Annual Meeting of the
American Water Resources Association—Wisconsin Section
Wisconsin Dells, Wisconsin

WEDNESDAY, March 3, 2021

8:30 -- 8:40	**Welcome**
8:40 -- 10:20	**Opening Plenary**
8:40 -- 8:50	Marissa Jablonski Executive Director, Freshwater Collaborative of Wisconsin *The Freshwater Collaborative of Wisconsin: How It Benefits Teaching and Research in Wisconsin*
8:50 -- 9:00	Eric Olson UW - Stevens Point: Center for Watershed Science and Education *Wisconsin Water Week: An Experiment in Statewide Outreach and Education for 2021*
9:00 -- 9:30	Sandra McClellan UW - Milwaukee School of Freshwater Sciences *Tracking Community Trends in SARS-CoV-2 Burdens Using Wastewater Surveillance*
9:30 -- 10:00	Anita Anderson Minnesota Dept. of Health *Pathogens in Groundwater: Regulatory Perspective*
10:00 -- 10:20	Q&A with Sandra McClellan and Anita Anderson
10:20 -- 10:40	**Wisconsin AWRA Business meeting and Board Election**
10:45 -- 12:00 PM	**Concurrent Sessions 1A and 1B**
Session 1A	**Freshwater Collaborative of Wisconsin 1** Virtual Room A Moderators: Mike Rupiper and Greg Kleinheinz

10:45 AM	**Water Quality and Aquatic Invertebrate Communities Along an Agricultural-Urban Gradient in Southeastern Wisconsin Rivers** Nathan Elliott,* UW - Parkside, ellio019@rangers.uwp.edu
11:00 AM	**Monitoring Aquatic Invertebrate Biodiversity of Restored Coastal Wetlands** Gwendolyn Richardson,* UW - Parkside, richa082@rangers.uwp.edu
11:15 AM	**COVID-19 Wastewater Surveillance in a College Dormitory Setting** Greg Kleinheinz, UW - Oshkosh, kleinhei@uwosh.edu
11:30 AM	**Student Research Assistants: Cost-Effective Solution for High Quality Project Results** Greg Kleinheinz, UW - Oshkosh, kleinhei@uwosh.edu
Session 1B	**Isotopes - Stable and Unstable** Virtual Room B Moderators: John Luczaj and Nic Buer
10:45 AM	**Tracking Recharge and Sources of Sulfate Using $\delta^{34}S$ (Sulfate) and ^{14}C Age Dating in the Confined Sandstone Aquifer of Northeastern Wisconsin** John Luczaj, UW - Green Bay: Dept. of Natural and Applied Sciences, luczajj@uwgb.edu
11:00 AM	**Using Stable Lead Isotope to Identify Lead Sources in the Environment, Household and Drinking Water** Patrick Gorski, WI State Lab of Hygiene, patrick.gorski@wisconsin.gov
11:15 AM	**Using Isotopes to Investigate Radium Activities with Respect to Recharge History in the Wisconsin Cambrian-Ordovician Aquifer System** Amy Plechacek,* UW - Madison, Environmental Chemistry & Technology Program, Dept. of Civil & Environmental Engineering, plechacek@wisc.edu
11:30 AM	**A Regional Groundwater Isoscape for $\delta^{2}H$ and $\delta^{18}O$ in the Silurian Aquifer of Northeastern Wisconsin** Tyler Kunze,* UW - Green Bay: Dept. of Natural and Applied Sciences, kunzta18@uwgb.edu
12:00 -- 12:45	**Lunch Break**

* Student presentation.

12:45 -- 2:00 p.m.	**Concurrent Sessions 2A and 2B**
Session 2A	**Freshwater Collaborative of Wisconsin 2** Virtual Room A Moderators: Meg Haserodt and Brian Mahoney/Sarah Vitale
12:45 PM	**Surface Water and Groundwater Chemistry of Western Wisconsin: Establishing an Environmental Baseline** Retta Isaacson,* UW - Eau Claire, isaacsra8479@uwec.edu
1:00 PM	**Influence of Phosphorus Loading Through Lacustrine Groundwater Discharge on Lake Eutrophication in a Stratified Flow-Through Lake in Western Wisconsin** Madeline Palubicki,* UW - Eau Claire, palubimg1217@uwec.edu
1:15 PM	**Assessment of the Source and Mobility of Phosphorus in the Hydrologic System in Western Wisconsin** Maggie Callahan,* UW - Eau Claire, beranemr6501@uwec.edu
1:30 PM	**Successes and Obstacles While Organizing a Community Wide Well Sampling Effort** Carmen Thiel, UW - Oshkosh, thielc@uwosh.edu
Session 2B	**Surface Water Quality** Virtual Room B Moderators: Mitch Olds and Eric Booth
12:45 PM	**Stream and River Conditions in Wisconsin and the United States** Michael Miller, WI Dept. Natural Resources, michaela.miller@wisconsin.gov
1:00 PM	**Low-cost Turbidity Sensors for Field and Watershed Monitoring** Paul Baumgart, UW - Green Bay, Dept. of Natural and Applied Sciences, baumgarp@uwgb.edu
1:15 PM	**Climate Adaptation Strategies for Wisconsin Lakes** Madeline Magee, WI Dept. Natural Resources, madeline.magee@wisconsin.gov
1:30 PM	**Development and Assessment of Season-Ahead Water Quality Forecasts in Wisconsin Lakes** Max Beal,* UW - Madison, Dept. of Civil and Environmental Engineering, mrbeal@wisc.edu
1:38 PM	**Evaluating the Condition of Wisconsin's Surface Waters** Catherine Hein, WI Dept. Natural Resources, catherine.hein@wisconsin.gov

* Student presentation.

2:00 -- 2:15 PM	**Break**
2:15 -- 3:30 PM	**Concurrent Sessions 3A and 3B**
Session 3A	**Baseflow** Virtual Room A Moderators: Andy Leaf and Ian Anderson
2:15 PM	**Assessing Approaches to Quantify Hydrological Alteration on Wisconsin's Streams** Dana Lapides, UW - Madison & WI DNR, dana.lapides@wisconsin.gov
2:30 PM	**Insights from Instantaneous Measurements: 15 Years of Streamflow Data in the Central Sands** Jessica Haucke, UW - Stevens Point, Center for Watershed Science and Education, jhaucke@uwsp.edu
2:45 PM	**Geologic Influence on Stream Temperatures and Implications for Future Trout Habitat in the Marengo Headwaters** Anna Fehling, WI Geological and Natural History Survey, anna.fehling@wisc.edu
2:53 PM	**Measuring Stream Baseflow Conditions in West-Central Wisconsin** Katherine Langfield,* UW - Eau Claire, langfikm3250@uwec.edu
3:01 PM	**Using Hydrograph Separation to Improve a Statistical Water Quality Model** Matthew Diebel, Dane County Land & Water Resources Department, diebel.matthew@countyofdane.com
Session 3B	**Agriculture and Water Quality** Virtual Room B Moderators: Meg Haserodt and Tucker Burch
2:15 PM	**Tillage and Manure Timing Effect on Phosphorus Losses from a Dairy Agroecosystem** Laxmi Prasad,* UW - Madison, lprasad@wisc.edu
2:30 PM	**Treatment of Horizontal Silage Bunker Runoff Using Biochar Amended Vegetative Filter Strips** Joseph Sanford, UW - Platteville, sanfordj@uwplatt.edu
2:45 PM	**Continuous Load Estimation, Soup to Nuts: a Unique Design to Support a New Wisconsin TMDL** Aaron Fisch (Ruesch), WI Dept. Natural Resources, Aaron.Fisch@wi.gov

* Student presentation.

3:00 PM	**Big Acute P Losses Test an Ag Runoff Treatment System in 2019** Kevin Fermanich, UW - Green Bay & Wisconsin Extension, fermanik@uwgb.edu
3:08 PM	**Protecting Water Quality with Prairie Filter Strips** Craig Ficenec, Sand County Foundation, cficenec@sandcountyfoundation.org
3:30 -- 5:00 PM	**Concurrent Sessions 4A and 4B**
Session 4A	**Surface Water Dynamics & Climate Change** Virtual Room A Moderators: Mike Rupiper and Tim Asplund
3:30 PM	**Occurrences of Meteorologically-Induced Water Level Oscillations in Chequamegon Bay, Lake Superior** Hao-Chen Yan,* Civil and Environmental Engineering, UW - Madison, hyan76@wisc.edu
3:45 PM	**Flood Resiliency Planning in Wisconsin Municipalities** Margaret Thelen, WI Dept. of Health Services, margaret.thelen@dhs.wisconsin.gov
4:00 PM	**How Will Flood Hazard Change in a Warmer Future in Turkey River, Iowa?** Guo Yu,* Civil and Environmental Engineering, UW - Madison, yuguo365@gmail.com
4:15 PM	**Spatio-Temporal Patterns of Extreme Storms in the Mississippi Basin** Camila Abe,* Civil and Environmental Engineering, UW - Madison, cabe@wisc.edu
4:30 PM	**Updating Rainfall Statistics for Infrastructure Design in a Warming Climate** Daniel Wright, UW - Madison, Dept. of Civil and Environmental Engineering, danielb.wright@gmail.com
Session 4B	**Great Lakes Water Levels I** Virtual Room B Moderators: Mike Parsen and Maureen Muldoon
3:30 PM	**Coastal Morphological Changes in Southeastern Wisconsin** Boyuan Lu,* UW - Madison, Dept. of Civil and Environmental Engineering, blu38@wisc.edu
3:45 PM	**Flooding Vulnerability in the East River Watershed, Wisconsin** Yuan Liu,* UW - Madison, Dept. of Civil and Environmental Engineering, dlut_liuyuan@163.com

* Student presentation.

4:00 PM	**Rip Current Detection Using Deep Learning Approach** Wei Wang,* Civil and Environmental Engineering, UW - Madison, wwang487@wisc.edu
4:15 PM	**Multiscale Water Level Fluctuations in Lower Green Bay: A Compound Risk Perspective for Coastal Resilience** Yuli Liu, UW - Madison: Dept. of Civil and Environmental Engineering, yliu99@wisc.edu
4:30 PM	**Re-assessing the Importance of Groundwater to Lake Superior** Martha Nielsen, US Geological Survey: Upper Midwest Water Science Center, mnielsen@usgs.gov

THURSDAY, March 4, 2021

8:30 -- 9:45 AM	**Thursday Plenary**
8:30 -- 9:15	Adam Bechle University of Wisconsin Sea Grant *Vulnerability to Heightened Lake Levels on Wisconsin's Great Lakes*
9:15 -- 9:45	**Distinguished Service Awards**
10:00 -- 11:30 AM	**Concurrent Sessions 5A and 5B**
Session 5A	**Urban Hydrology** Virtual Room A Moderators: Mike Rupiper and Bill Selbig
10:00 AM	**Monitoring Tree Sway as an Indicator of Interception Processes Before, During, and After a Storm** Dominick Ciruzzi, UW - Madison, Dept. of Civil and Environmental Engineering, ciruzzi@wisc.edu
10:15 AM	**Scaling Investment in Distributed Green Infrastructure Solutions** Cynthia Koehler, WaterNow Alliance, cak@waternow.org
10:30 AM	**Relationships Between Land Use and Stream Temperature in the Yahara River Watershed** Yu Li,* UW - Madison, li728@wisc.edu
10:38 AM	**Incorporating the Hydrologic Impacts of Low Impact Development in a Large-Scale Land Surface Model** G. Aaron Alexander,* UW - Madison, Dept. of Civil and Environmental Engineering, gaalexander3@wisc.edu

* Student presentation.

10:46 AM	**Precipitation Throughfall Beneath Urban Tree Canopies: an Investigation of Precipitation Re-Direction** William Avery,* UW - Madison, Nelson Institute for Environmental Studies, waavery@wisc.edu
Session 5B	**Central Sands** Virtual Room B Moderators: Jeff Helmuth and Adam Freihoefer
10:00 AM	**Experimental Discharge Reduction Impacts Fish, But Not Invertebrates, in a Central Sands Trout Stream** Robert Stelzer, UW - Oshkosh, stelzer@uwosh.edu
10:15 AM	**The Groundwater Connection: Implementing the Central Sands Lakes Study** Jeff Helmuth, WI Dept. Natural Resources, jeffrey.helmuth@wisconsin.gov
10:30 AM	**Development of a Regional Groundwater Flow Model of the Central Sands** Megan Haserodt, US Geological Survey, Upper Midwest Water Science Center, mhaserodt@usgs.gov
10:45 AM	**Lake-Groundwater Interactions of Plainfield, Long, and Pleasant Lakes in the Central Sands of Wisconsin** Michael Parsen, Wisconsin Geological and Natural History Survey, UW - Madison Division of Extension, mike.parsen@wisc.edu
11:30 -- 12:15 PM	**Lunch**
12:15 -- 1:30 PM	**Concurrent Sessions 6A and 6B**
Session 6A	**Nitrate in Groundwater** Virtual Room A Moderators: Laurel Braatz and Gretchen Bohnhoff
12:15 PM	**Quantifying the Nitrate in Irrigation Water Across the Wisconsin Central Sands** Tracy Campbell,* UW - Madison, Dept. of Agronomy, tacampbell@wisc.edu
12:30 PM	**Development of a Dashboard for Nitrate Trends in Public Water Systems** Jennifer Dierauer, UW - Stevens Point & UW - Madison, Division of Extension, jbrand@uwsp.edu

* Student presentation.

12:45 PM	**Investigating Crop Rotational Effects on Water Quality Below a Central Wisconsin Agroecosystem** Kevin Masarik, UW - Stevens Point & UW - Madison, Division of Extension, kmasarik@uwsp.edu
1:00 PM	**Developing a Nitrate Decision Support Tool for Wisconsin -- Phase 1: Scenarios for Drinking Water Wells** Paul Juckem, US Geological Survey, Upper Midwest Water Science Center, pfjuckem@usgs.gov
Session 6B	**Great Lakes Water Levels 2** Virtual Room B Moderators: Mike Rupiper and Anna Fehling
12:15 PM	**New Characterization of Shoreline Changes Under Water Levels Fluctuations in Lake Michigan** Sarah Peterson,* UW - Madison, Dept. of Civil and Environmental Engineering, speterson26@wisc.edu
12:30 PM	**Vanishing Groundwater Seepage Along an Eroding Coastal Shoreline in Southern Lake Michigan** Benjamin Sieren,* UW - Madison, Geological Engineering, bsieren@wisc.edu
12:45 PM	**Cumulative Impacts of Coastal Structures on Bluff Erosion in Lake Michigan** Miles Tryon-Petith,* UW - Madison, Dept. of Civil and Environmental Engineering, tryonpetith@wisc.edu
1:00 PM	**Effects of High-Water Levels on Wave Climate, Sediment Resuspension, and Hab in Lower Green Bay, WI** Josh Anderson, UW - Madison, Dept. of Civil and Environmental Engineering, janderson1@wisc.edu
1:30 -- 1:45 PM	**Break**

* Student presentation.

1:45 -- 3:00 PM	Concurrent Sessions 7A and 7B
Session 7A	**Neonicotinoids** Virtual Room A Moderators: Mike Parsen and Matt Diebel
1:45 PM	**Acute and Chronic Toxicity of the Neonicotinoid Insecticides Thiamethoxam and Imidacloprid to Select Aquatic Invertebrates** Elisabeth Harrahy, UW - Whitewater, harrahye@uww.edu
2:00 PM	**Temporal and Spatial Dynamics and Predictors of Neonicotinoid Contamination in Groundwater Fed Streams in Central Wisconsin** Megan Lipke,* UW - Madison, mnlipke@wisc.edu
2:15 PM	**Use of Polar Organic Chemical Integrative Samplers (Pocis) to Monitor Neonicotinoid Insecticides in Streams and Ditches on the Central Wisconsin Sand Plain** Bill Devita, UW - Stevens Point, Center for Watershed Science and Education, wdevita@uwsp.edu
2:30 PM	**Widespread Detections of Neonicotinoid Contaminants in Central Wisconsin Groundwater** Russell Groves, UW - Madison, Dept. of Entomology, rgroves@wisc.edu
Session 7B	**Groundwater Modeling** Virtual Room B Moderators: Andy Leaf and Mike Fienen
1:45 PM	**Recharge or Runoff? Impacts of Changing Snow Cover and Frozen Ground Regimes on Groundwater Recharge in the Midwest** Katrina Hyman-Rabeler,* UW - Madison, Geological Engineering, rabeler@wisc.edu
2:00 PM	**Models Supporting Groundwater Availability Decisions: Approaches and Methods from the USGS Mississippi Alluvial Plain Project** Randall Hunt, US Geological Survey, Upper Midwest Water Science Center, rjhunt@usgs.gov
2:15 PM	**Monte Carlo Simulations to Evaluate Potential Outcomes of a Lake Drawdown Test** Andrew Leaf, US Geological Survey, Upper Midwest Water Science Center, aleaf@usgs.gov
2:30 PM	**Re-purposing Groundwater Flow Models for Age Assessments - Important Characteristics** Paul Juckem, US Geological Survey, Upper Midwest Water Science Center, pfjuckem@usgs.gov

* Student presentation.

3:00 -- 3:15 PM	**Break**
3:15 -- 4:30 PM	**Concurrent Sessions 8A and 8B**
Session 8A	**Aquatic Habitat** Virtual Room A Moderators: Mike Rupiper and Amanda Bell
3:15 PM	**Linking Fluvial and Sedimentation Characteristics to Larval Dragonfly Habitat** Amy Johnston,* UW - Parkside, johns262@rangers.uwp.edu
3:30 PM	**Chronic Exposure to Thiamethoxam Causes Neurotoxicity in Larval Fish** Tisha King-Heiden, UW - La Crosse, tking-heiden@uwlax.edu
3:45 PM	**Feasibility of Wetland Rehabilitation in the Upper Yahara River Estuary** Peter Torma, UW - Madison, Dept. of Civil and Environmental Engineering, torma.peter@epito.bme.hu
4:00 PM	**Boat Decontamination as AIS Prevention: Challenges and Successes in Vilas County** Becca Klemme, UW - Oshkosh, klemmer@uwosh.edu
4:08 PM	**Problems at the Intersection of Fluid Mechanics and Water Resources** Nimish Pujara, UW – Madison, Dept. of Civil and Environmental Engineering, npujara@wisc.edu
Session 8B	**Hydrogeology** Virtual Room B Moderators: Jeff Helmuth and Aaron Pruitt
3:15 PM	**Correlating Bedrock Folds to Higher Rates of Arsenic Detection in Groundwater, SE Wisconsin, USA** Eric Stewart, WI Geological and Natural History Survey, UW - Extension, eric.stewart@wisc.edu
3:30 PM	**An Updated Potentiometric Surface for the Confined Sandstone Aquifer in the Northeast Groundwater Management Area of Wisconsin (2019-2020)** John Luczaj, UW - Green Bay: Dept. of Natural and Applied Sciences, luczajj@uwgb.edu

* Student presentation.

3:45 PM	**Wisconsin Karst: Northeast Versus Southwest. What's the Same and What's Different?** Maureen Muldoon, WI Geological and Natural History Survey, muldoon@wisc.edu
4:00 PM	**Hydrologic and Geochemical Dynamics of the Karstic Aquifer Supplying Laguna Bacalar, Yucatan, Mexico** Tim Grundl, UW – Milwaukee, Dept. of Geosciences, grundl@uwm.edu
4:30 -- 5:30 PM	**Concurrent Sessions 9A and 9B**
Session 9A	**Groundwater Quality** Virtual Room A Moderators: Eric Booth and John Luczaj
4:30 PM	**Microbially-mediated Oxidation of Trace Element-Bearing Sulfide Minerals in Sandstones of Trempealeau County, WI** Lisa Haas,* UW - Madison, ldhaas@wisc.edu
4:45 PM	**Water Quality Indicators of Human Impacts to the Wetlands of Door Co., WI** David Hart, WI Geological and Natural History Survey, djhart@wisc.edu
5:00 PM	**Using Acesulfame to Determine Septic System Impact to Wisconsin Lakes** Hannah Lukasik,* UW - Stevens Point: Water and Environmental Analysis Lab, hluka093@uwsp.edu
Session 9B	**Contaminants** Virtual Room B Moderators: Mitch Olds and Pete Lenaker
4:30 PM	**Importance of Childhood Pb Exposure from Food Crops Grown in Contaminated Residential Soils Versus Exposure from Soil/Dust or from Drinking Water** Tim Grundl, UW - Milwaukee, Dept. of Geosciences, grundl@uwm.edu
4:45 PM	**Laboratory Contaminants in Microplastic Analysis** Becca Klemme, UW - Oshkosh, klemmer@uwosh.edu

* Student presentation.

5:00 PM	**From Rivers to Lakes - the Movement and Distribution of Microplastics from Tributaries to the Great Lakes** Peter Lenaker, US Geological Survey, Upper Midwest Water Science Center, plenaker@usgs.gov
5:15 PM	**Initial State-Wide Survey Results from the Wisconsin Department of Natural Resources Per- and Poly-Fluorinated Alkyl Substances (PFAS) Monitoring of Surface Water and Fish Tissue** Patrick Gorski, WI Dept. Natural Resources, patrick.gorski@wisconsin.gov

Program Summary

Session 1A: Freshwater Collaborative of Wisconsin 1
Wednesday, March 3, 2021
10:45 - 12:00
Moderators: Mike Rupiper and Greg Kleinheinz

Water Quality and Aquatic Invertebrate Communities Along an Agricultural-Urban Gradient in Southeastern Wisconsin Rivers

Nathan Elliott,[1*] University of Wisconsin - Parkside, ellio019@rangers.uwp.edu
Katie Loesl-Dunk, UW - Parkside
Christopher Tyrell, Milwaukee Public Museum
Jessica Orlofske, UW - Parkside

Anthropogenic impacts on freshwater systems require rigorous monitoring to inform responsible management practices. This study examines water quality and aquatic invertebrate communities along an agricultural-urban gradient in Southeastern Wisconsin rivers. Agriculture dominated reaches may show evidence of altered flows and excess sedimentation. Stormwater catchments in urban areas reduce the influence of stormwater runoff, yet the effects on adjacent instream communities remains uncertain. We expect differences in the invertebrate community concomitant with water impairment. Kick net samples were collected in fall of 2019 and 2020 in the Mukwonago and White Rivers (Fox River watershed) and the Oak Creek, Root, and Pike Rivers (Lake Michigan Watershed). A flow meter was used to assess depth, velocity, and discharge at each site. A multiparameter probe measured, temperature, turbidity, dissolved oxygen, conductivity and pH, with additional tests for nitrogen and phosphorous. Geographical information systems will be used to measure the area and proximity of agricultural land use, stormwater catchments, and impervious surface in the upstream subwatershed of each study site. Invertebrate data will be summarized using a suite of metrics and indices, including the Hilsenhoff Biotic Index, and associated to the anthropogenic gradient. Our study will evaluate the ability of such metrics to discriminate among multiple stressors for rivers in anthropogenically intensive landscapes.

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Monitoring Aquatic Invertebrate Biodiversity of Restored Coastal Wetlands

Gwendolyn Richardson,* University of Wisconsin - Parkside, richa082@rangers.uwp.edu
Eli Cortez, UW - Parkside
Hannah White, UW - Parkside
Katie Loesl-Dunk, UW - Parkside
Jessica Orlofske, UW - Parkside

Evaluating the health of wetland ecosystems has become critically important in recent years with land development, pollution, climate change, and other anthropocentric pressures threatening these valuable habitats. For this reason, urban wetland complexes, such as Samuel Myers Park (SMP) and North Beach Park (NBP) located on the Lake Michigan shoreline in Racine, Wisconsin, have been restored to improve fundamental ecosystem functions and ensure wetland integrity. In this

[1*]Student presentation.

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study, we used aquatic macroinvertebrates as bioindicators of ecological condition to evaluate these wetland ecosystems. We collected quantitative dip net samples of invertebrates and complementary water quality data (pH, temperature, dissolved oxygen, and conductivity) with a multiparameter probe at one natural and two constructed wetlands located at SMP twice during the summer of 2018, 2019, and 2020. Similar sampling was performed at the man-made, nine-chambered wetland and stormwater retention pond at NBP during the summer of 2019 and 2020. Invertebrate samples were preserved in 70% ethanol and processed in the laboratory using a dissecting microscope. Invertebrates were identified to the lowest taxonomic level possible, and the abundance was recorded. We observed an increase in invertebrate taxa richness and diversity for all wetlands sampled between 2018-2019. We anticipate a further increase in diversity and abundance of sensitive invertebrate taxa as colonization of the restored wetlands continues.

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COVID-19 Wastewater Surveillance in a College Dormitory Setting

Greg Kleinheinz, University of Wisconsin - Oshkosh, kleinhei@uwosh.edu
Marcel Dijkstra, UW - Oshkosh
Carmen Thiel, UW - Oshkosh
Leah Hujik, UW - Oshkosh

In the attempt to safely bring college students back to college campuses for fall 2020, a number of testing and monitoring techniques were employed across the United States. One early warning surveillance technique employed by a number of colleges was the monitoring of dormitory wastewater for COVID-19. Wastewater is a monitoring medium that has been used for a number of studies ranging from illicit drug and antibiotic use to usage rates of artificial sweetener use. Wastewater may be a good source of early detection for COVID-19 due to the fact that infected individuals shed virus in feces up to 48 hours before the onset of symptoms. Each dormitory at UW Oshkosh has centralized wastewater collection and discharge to the sanitary sewers facilitating the sampling of individual dorms. This allows the identification of infections prior to the onset of symptoms in individuals living in each dormitory. Observation of elevated concentrations of COVID-19 found in a wastewater stream allows for targeted testing of dormitory residents to identify infected individuals before they cause a wider outbreak. In compact living environments, early detection, quarantine, and isolation is key to preventing larger outbreaks. This talk will explore the wastewater sampling conducted at UW Oshkosh in the fall of 2020, the RT-qPCR results from that effort, and the corresponding student testing results.

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Student Research Assistants: Cost-Effective Solution for High Quality Project Results

Greg Kleinheinz, University of Wisconsin - Oshkosh, kleinhei@uwosh.edu
Carmen Thiel, UW - Oshkosh
Marisa Richter, UW - Oshkosh
Rebecca Klemme, UW - Oshkosh

As companies, municipal agencies, state agencies, non-profits, and non-governmental organizations search to complete water research they are often faced with making difficult choices due to budgetary constraints. Seasonal staff time, travel, analysis cost, and access to new methods and equipment all can lead to excess cost and efforts that are less than ideal when trying to address the significant questions of the day. Universities often struggle to pair students with internships and projects off campus that will enhance the student's learning experience, foster an inquisitive approach to science, and bring

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the good works of the university to the boarders of the state. Universities have limited discretionary financial capital, but they do have large quantities of human capital with boundless creativity and enthusiasm. Further, the availability of this abundant human resource is fortuitousness when one thinks of either field sampling seasons or availability during academic years when access to state-of-the-art equipment is most accessible. Thus, even a simple analysis can reveal how the very needs and limitations of each group directly complement each other. The goal of this talk is to explore the mutually-beneficial partnership opportunities that exist for student interns and off-campus partners. Challenges, opportunities, and success stories will be explored.

Program Summary

Session 1B:
Isotopes - Stable and Unstable
Wednesday, March 3, 2021
10:45 - 12:00
Moderators: John Luczaj and Nic Buer

Tracking Recharge and Sources of Sulfate Using δ34S (Sulfate) and ^{14}C age dating in the Confined Sandstone Aquifer of Northeastern Wisconsin

John Luczaj, University of Wisconsin - Green Bay, Dept. of Natural and Applied Sciences, luczajj@uwgb.edu
Olukayode Akinkuehinmi, UW - Green Bay
Amanda (Amy) Hamby, UW - Green Bay
Alex Hein, UW - Green Bay
Abby Shea, UW - Green Bay

Increasing concentrations of conservative ions (Cl-, Na+, Li+) and total dissolved solids (TDS) along flow paths in the confined Cambrian-Ordovician sandstone aquifer along the western Michigan basin result from residual brine dilution, with some contributions from locally sourced ions (SO42-, Sr2+, F-, As species). We compared the δ34S for dissolved sulfate with the δ34S of aquifer-hosted sulfur-bearing minerals to infer sources of dissolved sulfate along flow paths in the aquifer. Regional trends in dissolved sulfate concentrations, δ34S(SO4) in groundwater, and the 14C age of dissolved inorganic carbon help track eastward flow in the confined Cambrian-Ordovician sandstone aquifer of northeastern Wisconsin.

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Using Stable Lead Isotope to Identify Lead Sources in the Environment, Household and Drinking Water

Patrick Gorski, Wisconsin State Lab of Hygiene, patrick.gorski@wisconsin.gov
Sean Scott, WI State Laboratory of Hygiene
Martin Shafer, WI State Laboratory of Hygiene
Jonathan Meiman, WI Dept. of Health Services

It has been widely established that lead (Pb) has detrimental effects to the cognitive function of children at low blood Pb levels (<5 µg/dL), and adults at higher levels causing anemia, weakness, and kidney and brain damage. The Center for Disease Control (CDC) has more simply stated that no safe level of Pb has been identified. One of the many potential routes of exposure is drinking water, although there may be several sources of Pb that could contribute from the environment or households. In this work we use a multi-collector (MC) ICP-MS, which can precisely quantify the relative ratios of stable Pb isotopes (i.e., 204Pb, 206Pb, 207Pb, and 208Pb) in different potential environmental Pb sources, such as lateral line pipes, soil, groundwater, surface water, drinking water, precipitation, paint, house dust, coal, lead ore, and other miscellaneous lead sources. After identifying the Pb ratios of the sources, we then compare them to Pb ratios found in human blood to directly identify which sources most closely match and are the likely sources for Pb exposure. Using this approach of measuring Pb isotope data in a broad suite of samples and specific case studies could better inform policy decisions for reduction of Pb exposure in the general population.

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Using Isotopes to Investigate Radium Activities with Respect to Recharge History in the Wisconsin Cambrian-Ordovician Aquifer System

Amy Plechacek,* University of Wisconsin - Madison, Environmental Chemistry & Technology Program, Dept. of Civil & Environmental Engineering, plechacek@wisc.edu
Sean Scott, Wisconsin State Laboratory of Hygiene
Madeline Gotkowitz, Montana Bureau of Mines and Geology
Matthew Ginder-Vogel, UW - Madison, Environmental Chemistry & Technology, Dept. of Civil & Environmental Engineering

Radium (Ra) occurs above the EPA Maximum Contaminant Level at many locations in the Wisconsin Cambrian-Ordovician aquifer system (COAS). Radium activities are generally higher in the eastern part of the state, where the COAS is regionally confined and modern recharge is limited. However, elevated Ra activities can also occur in the regionally unconfined portion of the aquifer due to local hydrogeologic conditions. In this study, we use a suite of isotopes (δ18O, δD, δ34SSO4, 234U/238U) to examine Ra occurrence with respect to recharge along a local flow path where the COAS straddles the transition from regionally unconfined to regionally confined. Thirty-two groundwater samples were collected along a characterized cross section in Fond du Lac County to achieve a diverse spatial sampling with depth. Groundwater evolves from a mixed cation-bicarbonate type to calcium-sulfate and calcium-chloride types along the west-to-east flow path. Isotopic results confirm the presence of Pleistocene glacial recharge at the end of the flow path, where local hydrogeologic conditions limit modern recharge. Here, Ra activities rise as residence time increases and geochemical conditions become favorable for Ra mobility. Multiple mechanisms, including competitive sorption and the dissolution or absence of iron and manganese (hydr)oxides, contribute to Ra activities. Results demonstrate the importance of local hydrogeologic conditions and aquifer recharge history on Ra activities in groundwater.

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A Regional Groundwater Isoscape for δ2H and δ18O in the Silurian Aquifer of Northeastern Wisconsin

Tyler Kunze,* University of Wisconsin - Green Bay, Dept. of Natural and Applied Sciences, kunzta18@uwgb.edu
John Luczaj, UW - Green Bay

Isoscapes are geographic representations of the spatial variation in the stable isotope composition of elements that are produced through physical or biological fractionation processes. Our study has two main goals: 1) to construct the first regional groundwater isoscape for δ^{2}H and δ^{18}O in the Silurian aquifer of northeastern Wisconsin, and 2) to compare our results from those of Bowen et al. (2012) from the east side of Lake Michigan to compare how climate differences, such as lake effect snows, have influenced isotopic compositions.

Water samples from wells in Door, Kewaunee, Brown and other counties were collected by the authors and homeowners and analyzed at multiple stable isotope laboratories over the past 7 years. We compared the spatial variation of the stable isotopes and D-excess values to interpret trends relating to latitude and longitude. Despite a geographic spread of only 1.5° of latitude, we were able to detect a moderate correlation between δ^{2}H and δ^{18}O values vs. latitude. We did not detect d-excess variations with latitude or longitude, in contrast to lower Michigan. Calculated d-excess values ranged from 8.2 to 15.9 and were mostly similar to values observed outside of lake effect snow bands, suggesting little to no input from lake effect precipitation.

* Student presentation.

Program Summary

Session 2A:
Freshwater Collaborative of Wisconsin 2
Wednesday, March 3, 2021
12:45 - 2:00
Moderators: Meg Haserodt and Brian Mahoney/Sarah Vitale

Surface Water and Groundwater Chemistry of Western Wisconsin: Establishing an Environmental Baseline

Retta Isaacson,* University of Wisconsin - Eau Claire, isaacsra8479@uwec.edu
Madeline Palubicki, UW - Eau Claire
Jacob Erickson, UW - Eau Claire
Maggie Callahan, UW - Eau Claire
Laurel J. Mcellistrem, UW - Eau Claire
Sarah Vitale, UW - Eau Claire

The expansion of silica sand mining and concentrated animal feeding operations in western WI over the past decade has generated concerns about potential contamination of surface water and groundwater systems. However, the baseline chemical characteristics of the regional hydrologic system have never been documented. This investigation represents the first comprehensive analysis of surface water and groundwater chemistry throughout western WI, an area that encompasses sampling sites in the northeastern upper Mississippi River watershed between Barron and Tomah. The dissolved metal content of surface water sites (n=54) and municipal groundwater wells (n=13), has been quantified with each site sampled multiple times (2-4) over the past 4 years to evaluate temporal variations in water chemistry. Geochemical analysis of Paleozoic stratigraphy (n~50) constrains trace metal concentrations in regional aquifers.

Initial results demonstrate that surface water and groundwater in the region is very clean, with virtually all trace metals well below EPA drinking waters standards. The single exception is phosphorous, which exceeds applicable standards in both surface water and groundwater and is an important component of regional lake eutrophication events. This environmental baseline is vital to the development of reasonable and responsible environmental safeguards that will facilitate economic growth and sustainable development while protecting water resources in western WI.

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Influence of Phosphorus Loading Through Lacustrine Groundwater Discharge on Lake Eutrophication in a Stratified Flow-Through Lake in Western Wisconsin

Madeline Palubicki,* University of Wisconsin - Eau Claire, palubimg1217@uwec.edu
Jacob Erickson, UW - Eau Claire
Retta Isaacson, UW - Eau Claire
Sarah Vitale, UW - Eau Claire

* Student presentation.

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J. Brian Mahoney, UW - Eau Claire
Anna Baker, USGS Upper Midwest Water Science Center

Regional analysis in western WI demonstrates that phosphorous (P) concentrations are anomalously high in both surface water and groundwater. Lake eutrophication events are common in western WI and generally attributed to anthropomorphic nutrient loading from surface runoff. However, high levels of P detected in regional aquifers suggest that groundwater discharge may be a contributing factor in eutrophication events. The objective of this study is to understand the mobility of P in groundwater and its impact on Mud Lake.

Water quality was measured in Mud Lake from June-September in 2018, 2019, and 2020. Groundwater discharges into the lake throughout the entire field season. Surface water pH and dissolved oxygen (DO) rise into the late summer (pH ~10, DO >16 mg/L) before returning to “normal” levels in Fall (pH 6-7, DO 5-10 mg/L). These fluctuations are consistent with algal blooms in late summer. The pH (5.5-6.5) and DO (5-10 mg/L) in groundwater is essentially constant. P in surface water is relatively constant during the summer months (20-100 ppb), while groundwater P fluctuates with highest P occurring in mid-late Summer (>700 ppb). Nitrate in groundwater is variable.

Water quality indicators suggest that P mobility may be a combination of excessive P inputs as well as reducing conditions, which may vary throughout the groundwater flow path. Potential nonpoint sources of elevated P in the groundwater include agricultural land use and regional geology.

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Assessment of the Source and Mobility of Phosphorus in the Hydrologic System in Western Wisconsin

Jacob Erickson, University of Wisconsin - Eau Claire
Maggie Callahan,* UW - Eau Claire; presenting author; beranemr6501@uwec.edu
Madeline Marchiafava, UW - Eau Claire
J. Brian Mahoney, UW - Eau Claire
Sarah Vitale, UW - Eau Claire

Lake eutrophication due to nutrient loading from phosphorus (P) and nitrogen is a growing problem across the upper Midwest, causing a loss of aquatic biodiversity, damage to fisheries, and adverse impacts on human health. Although eutrophication is often blamed on anthropogenic sources, preliminary results suggest a notable amount of nutrient loading may be petrogenic. The objective of this investigation is to distinguish the source of P contamination in surface and groundwater systems in western Wisconsin, and to understand the mechanisms behind P mobility in the regional hydrologic system since P has been historically considered immobile in groundwater systems. The project includes a regional analysis of surface and municipal well groundwater samples in western WI, measured for P, iron, manganese, nitrate and basic water quality parameters, to obtain a baseline spatial P distribution and an understanding of the geochemical environment. Sequential extraction analyses of P-bearing geologic units help determine the natural conditions under which P may be mobilized. Results demonstrate groundwater P concentrations frequently exceed WI surface water regulatory limit (max 100 ppb), and that P is highly mobile along flow pathways into lakes and streams. This research is important in developing a comprehensive understanding of P migration in Wisconsin’s regional hydrologic systems to implement effective lake and waterway management.

* Student presentation.

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Successes and Obstacles while Organizing a Community Wide Well Sampling Effort

Carmen Thiel, University of Wisconsin - Oshkosh, thielc@uwosh.edu
Gregory Kleinheinz, UW - Oshkosh
Marisa Richter, UW - Oshkosh
Rebbeca Klemme, UW - Oshkosh

Community wide well sampling programs can be useful tools that can accomplish several goals for the area. They allow both residents and water quality specialists to gain more knowledge on the local geology and the status of the groundwater quality. These community wide sampling events can be used as leverage for other projects and funding sources to protect or improve groundwater quality. There are several factors that one must consider when organizing a community wide well sampling program including finding funding, working with a laboratory, obtaining volunteers, distribution of materials, partnerships, and how to deliver the program results to the community. This talk will also go over successes and obstacles that one may encounter while organizing a community wide well sampling effort.

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Program Summary

Session 2B:
Surface Water Quality
Wednesday, March 3, 2021
12:45 - 2:00
Moderators: Mitch Olds and Eric Booth

Stream and River Conditions in Wisconsin and the United States

Michael Miller, Wisconsin Department of Natural Resources, michaela.miller@wisconsin.gov

Wisconsin has an estimated 42,000 miles of perennial streams and rivers, enough to encircle the planet nearly 1.7 times. To adequately sample each of these waterbodies would take decades and be prohibitively expensive. Yet science-based management and an informed public requires accurate and current evaluation of resource conditions. The U.S. Environment Protection Agency's National Rivers and Streams Assessment (NRSA), is a collaborative effort among states, federal agencies, and tribes, designed to evaluate the ecological conditions of the nation's flowing waters on a recurring basis. Key findings of the 2013 – 2014 NRSA survey include: nutrient pollution is widespread; 60% of both WI and U.S. streams and rivers have high concentrations of phosphorus; 67% of WI and 43% of U.S. waters have high nitrogen concentrations. Degraded physical habitat and water quality significantly impact macroinvertebrates and fish both in Wisconsin and across the U.S. Less than 1/2 of WI and 1/3 of U.S. streams and rivers have healthy fish assemblages. Enterococci bacteria an indicator of fecal contamination is widely present in both WI and U.S. waters. Microcystin, toxins produced by cyanobacteria are present in a small proportion of both WI and U.S. streams and rivers, and usually at low concentrations. These findings can promote informed advocacy and documents the need for improved watershed management.

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Low-cost Turbidity Sensors for Field and Watershed Monitoring

Paul Baumgart, University of Wisconsin - Green Bay, Dept. of Natural and Applied Sciences, baumgarp@uwgb.edu
Andrew Schmitz, UW - Green Bay
Kevin Fermanich, UW - Green Bay

In-situ continuous turbidity monitoring can be used as a surrogate for tracking total suspended solids (TSS) concentrations in streams and other locations. It can be useful for tracking possible sources of TSS, and attached constituents, based on timing and multiple deployment schemes. Commercial turbidity sensors may be too costly for extensive deployments. The purpose of our study was to develop and test low-cost alternatives to off-the-shelf instruments. Four types of dishwasher-based turbidity sensors were successfully bench-tested. We found little difference once they were calibrated with dilutions of TSS mixtures composed of stream and field runoff samples (R-sq. > 0.99). 14 sensors were constructed. Pairs of low cost sensors and Campbell Scientific OBS-501 retractable head BS and SS turbidity sensors were deployed in two streams and two edge-of-field sites. All were equipped with automated samplers and Campbell data loggers. Eight sensors were matched with EnviroDIY Mayfly data loggers and deployed in streams and culverts for evaluation and source tracking. Low-

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cost sensors were combined with commercial loggers at a treatment pond study and a stream. Numerous runoff events were captured in 2020 and the record precipitation year of 2019 at Green Bay, Wisconsin. We will report our comparisons between low-cost and commercial sensors, with regards to TSS, phosphorus and turbidity relationships. The utility and limitations of the low-cost system will be discussed.

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Climate Adaptation Strategies for Wisconsin Lakes

Madeline Magee, Wisconsin Department of Natural Resources, madeline.magee@wisconsin.gov
Catherine Hein, WI Dept. Natural Resources

Wisconsin's 15,000 inland lakes are a vital economic and cultural natural resource statewide but are threatened greatly by climate change. Recent harmful algal blooms, flooding, and fish kills can all be attributed to a warmer, wetter climate. To evaluate and compile adaptation strategies, the Wisconsin Initiative on Climate Change Impacts gathered researchers and managers with expertise on Wisconsin's inland lakes. We identified climate change impacts and possible adaptations strategies for four thematic areas relevant to inland lakes: water levels, water quality, aquatic invasive species, and fisheries. While adaptation strategies for each theme differ, there is consensus around the need for a multifaceted approach that incorporates communication and outreach, policy and regulation changes, traditional resource conservation approaches, and novel engineering designs. This approach should focus on protecting high-quality lakes, building lake resilience, and retaining beneficial ecosystem services. Thoughtful, strategic interactions with stakeholders are key to implementing these strategies.

Development and Assessment of Season-Ahead Water Quality Forecasts in Wisconsin Lakes

Max Beal,* University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, mrbeal@wisc.edu
Bryan O'Reilly, UW - Madison
Kaitlynn Hietpas, UW - Madison
Paul Block, UW - Madison

For decades, cultural eutrophication has posed a threat to the water quality of Wisconsin lakes. In particular, the proliferation of algae in eutrophic lakes has caused concern to grow around potential threats to human health, ecosystems, and the economy. Recently, cyanobacteria blooms along the south shore of Lake Superior have raised new concerns about the status of Wisconsin's most pristine waters. Currently, little information regarding expected summertime water quality is available prior to the season. With sufficient lead time, communicating the likelihood of poor water quality may be informative for proactively managing potential threats to lake health and beach safety. Selecting Lake Mendota, Delavan Lake, and the Chequamegon Bay (Lake Superior) as case studies, models of summertime water quality indicators (e.g. chlorophyll, secchi depth, and cyanobacteria biomass) conditioned on season-ahead (spring) local and global scale predictors are constructed. Additionally, remote sensing methods are employed to enhance the observational record of water quality indicators. Preliminary results show promise in the application of season-ahead forecasts and remote sensing for water quality management of inland lakes. This warrants further investigation into the development of seasonal water quality forecast systems, and application to other waterbodies.

* Student presentation.

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Evaluating the Condition of Wisconsin's Surface Waters

Catherine Hein, Wisconsin Department of Natural Resources, catherine.hein@wisconsin.gov
Michael Miller, WI Dept. of Natural Resources
Tim Asplund, WI Dept. of Natural Resources
Sally Jarosz, WI Dept. of Natural Resources
Madeline Magee, WI Dept. of Natural Resources

The Wisconsin Department of Natural Resources evaluates the physical, chemical, and biological condition of lakes, streams, rivers, wetlands, and coastal areas on a 5-year rotation as part of the National Aquatic Resource Surveys with the Environmental Protection Agency. Although most lakes, streams, and rivers in Wisconsin are good in terms of a variety of indicators, most streams and rivers are poor in terms of nutrient pollution. Nutrients, sediments, and habitat degradation are the most widespread stressors of lakes, streams, and rivers in Wisconsin. Most wetlands across the Upper Midwest and Eastern Mountains are in good condition, but prevalent stressors include: surface hardening, ditching, vegetation removal, and high soil phosphorus. Coastal areas of the Great Lakes are in good condition when evaluated for eutrophication and sediment contamination, but fish are widely contaminated with selenium and mercury.

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Program Summary

Session 3A:
Baseflow
Wednesday, March 3, 2021
2:15 - 3:30
Moderators: Andy Leaf and Ian Anderson

Assessing Approaches to Quantify Hydrological Alteration on Wisconsin's Streams

Dana Lapides, University of Wisconsin - Madison & Wisconsin Department of Natural Resources, dana.lapides@wisconsin.gov
Bryan Maitland, UW - Madison & WI Dept. of Natural Resources
Aaron Pruitt, WI Dept. of Natural Resources
Rachel Greve, WI Dept. of Natural Resources

Wisconsin is home to abundant surface and groundwater resources that support both human needs and diverse aquatic ecosystems. However, the relationship between groundwater resources and stream ecology remains poorly quantified at the regional scale, particularly with respect to the relative importance of shifting precipitation patterns and increased groundwater reliance across the state. The Wisconsin Department of Natural Resources evaluates the effect of groundwater withdrawals on streamflow and associated depletion depending on a host of site-specific variables and tools. To conserve aquatic ecosystems and sustain human use, it is important that these calculations of the potential impacts of groundwater withdrawals on stream ecosystems are accurate and reliable. Numerous tools exist for this task, ranging from complex numerical models with high data and computation needs to machine learning emulators or analytical solutions with more built-in assumptions. But they all have one thing in common—they need data. Given variable data availability at the state-wide scale, we assess the utility of different approaches to quantify hydrological alteration in a management context, and explore how quantitative estimates of the effects of groundwater withdrawals on streams can be interpreted in terms of aquatic ecosystem health.

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Insights from Instantaneous Measurements: 15 Years of Streamflow Data in the Central Sands

Jessica Haucke, University of Wisconsin - Stevens Point, Center for Watershed Science and Education, jhaucke@uwsp.edu
Aaron Pruitt, WI Dept. of Natural Resources
Adam Freihoefer, WI Dept. of Natural Resources

The Wisconsin Department of Natural Resources (WDNR) relies on measured streamflow to assess natural flow variability and the impact of nearby groundwater pumping on classified trout streams. In order to assess stream impacts, an established record of measured flows is needed, and more importantly, an established record of groundwater contribution to those streams is needed. With over 13,000 miles of classified trout streams within the state, the existing network of real-time streamflow monitoring is spatially and temporally sparse.

Since 2005, UW-Stevens Point (UWSP), in partnership with the WDNR, has systematically collected over 5000 monthly baseflow measurements on 163 stream segments throughout the Central Sands region of Wisconsin. The development of a

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reliable, robust 15-year record of streamflow measurements has required consistent methodology, quality control and participation by UWSP staff and citizen volunteers.

The WDNR has incorporated the UWSP dataset into high capacity well reviews, groundwater flow model calibration, and the identification of longitudinal changes in flow regimes within a stream. This retrospective assessment shows how the UWSP dataset has improved our understanding of Central Sands hydrology and our water management decision making and discusses future improvements to the spatiotemporal collection of this important water budget component.

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Geologic Influence on Stream Temperatures and Implications for Future Trout Habitat in the Marengo Headwaters

Anna Fehling, Wisconsin Geological and Natural History Survey, anna.fehling@wisc.edu
David Hart, Wisconsin Geological and Natural History Survey
Jean Bahr, UW - Madison

Cold-water trout habitat in Wisconsin is projected to decrease as a result of climate change. The extent of habitat loss depends, in part, on groundwater discharge to streams, which can provide cool water refuges suitable for trout. In this study, we evaluated potential climate change impacts to groundwater discharge, stream temperatures, and trout in a small headwater stream in the Chequamegon-Nicolet National Forest in northern Wisconsin.

We used groundwater flow and stream temperature models to evaluate the sensitivity of stream temperature to climatic changes in baseflow and air temperature, as well as physical characteristics like shade and width. Impacts to baseflow were simulated by modifying recharge in a steady-state groundwater flow model. Thermal impacts from climate change were simulated by modifying baseflow, air temperature, and groundwater temperature in a mechanistic stream temperature model. Results were compared to trout thermal tolerance limits over a range of time periods to evaluate habitat impacts. Persistent higher temperatures over several months were projected to have a greater impact on trout than short-term increases in daily mean temperature. Projected increases in air temperature have the greatest influence on simulated stream temperatures, and overwhelm modest changes to width or shade. This improved understanding of system dynamics will help the U.S. Forest Service manage the watershed for trout.

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Measuring Stream Baseflow Conditions in West-Central Wisconsin

Katherine Langfield,[*] University of Wisconsin - Eau Claire, langfikm3250@uwec.edu
Angy Rafferty, UW - Eau Claire
Jacob Erickson, UW - Eau Claire
Mark Fiore, UW - Eau Claire
Sarah Vitale, UW - Eau Claire
Nicole Clayton, WI Dept. of Natural Resources

This study seeks to measure baseflow conditions in West-Central Wisconsin to aid in determining the impacts of groundwater withdrawals on local streams. Streamflow is measured monthly at fifteen (15) sites across eleven (11) streams

[*] Student presentation.

Program Summary

during baseflow conditions using an OTT MF ProWater Flow Meter. Baseflow conditions are determined by referencing recent rainfall totals and the USGS streamflow gage records. Streams with two or more sites are used to determine if streams are gaining or losing water. A stream gage and seasonal pressure transducer has been installed at one site to establish a relationship between the stream's stage and discharge. This study is conducted by the University of Wisconsin-Eau Claire in partnership with the Water Use Section at the Wisconsin Department of Natural Resources.

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Using Hydrograph Separation to Improve a Statistical Water Quality Model

Matthew Diebel, Dane County Land & Water Resources Department, diebel.matthew@countyofdane.com

Weighted Regression on Time, Discharge, and Season (WRTDS) has become a standard method for statistical modeling of river water quality dynamics. I developed an extension of this method, WRTDS-HS (for Hydrograph Separation), which separates discharge into base flow and quick flow. Based on total phosphorus data from 10 rivers in southern Wisconsin, WRTDS-HS consistently fits better than WRTDS and sometimes indicates different temporal trends in flow-normalized concentrations and fluxes. In particular, WRTDS-HS can fit to the different water quality signatures of periods with the same total flow but different fractions of base flow, which WRTDS can incorrectly attribute to a temporal trend. In general, WRTDS-HS should further improve our ability to differentiate the effects of weather and watershed management on river water quality trends.

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Program Summary

Session 3B:
Agriculture and Water Quality
Wednesday, March 3, 2021
2:15 - 3:30
Moderators: Meg Haserodt and Tucker Burch

Tillage and Manure Timing Effect on Phosphorus Losses from a Dairy Agroecosystem

Laxmi Prasad,* University of Wisconsin - Madison, lprasad@wisc.edu
Francisco J Arriaga
Anita M Thompson
K G Karthikeyan
Peter Vadas
Melanie N Stock

In Wisconsin, phosphorus (P) losses from dairy agroecosystems are a longstanding and recurring problem for the downstream water quality. Nutrient management in dairy agroecosystems has an array of opportunities. On-field management (tillage, manure application timing, and rate) is one of those. Often, on-field management is targeted seasonally without taking into consideration annual effects. Understanding both the seasonal and annual effects can inform long-term management practices and may reduce nutrient pollution. In a complete factorial design, event-wise surface runoff and its associated P losses were monitored from two tillage systems (chisel and no-tillage), each receiving liquid dairy manure as early winter (Dec) and late winter (Jan) application. The experimental site is located in Southcentral Wisconsin on a silt loam soil with a 5.8% slope, and the P loss data were analyzed both seasonally and annually. For the two years monitored (2015-16 & 2016-17), irrespective of manure timing, no-tillage produced significantly ($p<0.05$) higher annual runoff and P loads than chisel tillage. Late winter manure application appeared to lead to greater P losses since it has a greater chance for soil to be frozen and snow to be present on the ground. More than 70% of annual runoff and P loads in both years occurred during the non-growing season (Nov-Apr), making it a critical period for management. Winter manure application poses a risk to P losses, but tillage and timing of manure application can help reduce the risk in the dairy agroecosystems.

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Treatment of Horizontal Silage Bunker Runoff Using Biochar Amended Vegetative Filter Strips

Joseph Sanford, University of Wisconsin - Platteville, sanfordj@uwplatt.edu
Rebecca Larson, UW - Madison, Biological Systems Engineering

Horizontal silage bunkers produce leachate that contains contaminants that can be detrimental to the environment if released untreated. Vegetated filter strips are used to treat silage bunker runoff to prevent contamination of surface waters via infiltration, however increased infiltration poses risks to groundwater, particularly for nitrate (NO_3^-). In this study, vegetated filter strip plots were amended with biochar to assess the impact on nitrogen leaching. The total nitrogen leaching was reduced by 49 and 64% for control and biochar plots, respectively, which was significantly different between

* Student presentation.

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treatments. Biochar significantly reduced cumulative NO3--N leaching by 40% compared to the control. However, NO3--N concentrations in leachate remained high, with average mean flow weighted concentration of 23.40 mg NO3--N and maximum recorded concentration of 108.89 mg NO3--N L-1 in biochar amended plots. A mass balance suggests the primary mechanism for a decrease in nitrogen leaching from biochar amended plots was greater retention of NO3--N and ORG-N within the soil/biochar matrix. The development of oxygenated functional groups and/or formation of organomineral layer on the biochar surface likely enhanced N retention.

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Continuous Load Estimation, Soup to Nuts: A Unique Design to Support a New Wisconsin TMDL

Aaron Fisch (Ruesch), Wisconsin Department of Natural Resources, Aaron.Fisch@wi.gov
Matthew Diebel, Dane County Land and Water Resources
Mary Gansberg, WI Dept. of Natural Resources
Craig Helker, WI Dept. of Natural Resources
Eric Hettler, WI Dept. of Natural Resources
Kimberly Oldenborg, WI Dept. of Natural Resources

In 2017, the Wisconsin Legislature allocated funding for a TMDL for total phosphorus and total suspended solids in all Lake Michigan tributaries between Port Washington and Sturgeon Bay. An accurate understanding of loading conditions is required to calculate the TMDL, which is accomplished by building a SWAT model for the region. An accurate SWAT model should be calibrated to minimize error between the model output and site-specific pollutant load estimates. This region has many small, direct tributaries to Lake Michigan, requiring more monitoring stations than a typical TMDL monitoring design. However, the equipment for continuous discharge monitoring has become inexpensive enough to accomplish widespread monitoring on a project-specific basis without the need to install long-term infrastructure. WDNR built a workflow that accomplished all the necessary pieces of monitoring and modeling to estimate pollutant loads for low cost and high efficiency. A monitoring network of 20 new sites was established using pressure transducers paired with multiple methods for collecting instantaneous discharge to estimate a stage-discharge relationship. WDNR and partner agencies collected grab sample chemistry to estimate pollutant loading using modifications to the USGS LOADEST model that are more robust for sites with small sample sizes. The result is a truly unique TMDL monitoring design for the State of Wisconsin.

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Big Acute P Losses Test an Ag Runoff Treatment System in 2019

Kevin Fermanich, UW - Green Bay & Wisconsin Extension, fermanik@uwgb.edu
Paul Reneau, USGS - Middleton
Paul Baumgart, UW - Green Bay

Record breaking rainfall in 2019 showed the vulnerability of manure application practices to acute edge-of-field phosphorus losses. In a study of the effectiveness of an ag runoff treatment system, we observed high dissolved P (DP) losses following 2 summertime manure applications to a hayfield and large acute total P losses following an early fall incorporation of a third manure application. A September event resulted in about 1 lb/ac of P loss that was >90% DP. The high DP tile and surface runoff inputs were not significantly attenuated by the sediment basin + wetland treatment system. A one-day runoff event in November that followed the incorporated manure application, was dominated by particulate P (75%) and represented nearly 0.75 lbs/ac of TP loss. Winter cores from the sediment basin confirmed a large amount of P was

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captured in the treatment system. The legacy impact of these acute P runoff inputs into the treatment system are being evaluated. Our observations confirm that significant acute P losses can occur from typical dairy cropping practices especially in years constrained by persistent wet periods.

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Protecting Water Quality with Prairie Filter Strips

Craig Ficenec, Sand County Foundation, cficenec@sandcountyfoundation.org

Greater protections against farm runoff are needed in Wisconsin, especially under extreme weather events. Research from Iowa State University shows that establishing strips of diverse perennial vegetation (i.e. “prairie strips”) on 10% of a farm field can reduce soil and nutrient losses by over 80%, while enhancing biodiversity. Sand County Foundation and partners are installing prairie strips with Wisconsin farmers and modeling their ability to reduce phosphorus losses into waterways. This presentation will introduce this new practice and highlight its potential in watershed adaptive management efforts.

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Program Summary

Session 4A:
Surface Water Dynamics & Climate Change
Wednesday, March 3, 2021
3:30 - 5:00
Moderators: Mike Rupiper and Tim Asplund

Occurrences of Meteorologically induced Water Level Oscillations in Chequamegon Bay, Lake Superior

Hao-Chen Yan,* University of Wisconsin - Madison, Civil and Environmental Engineering, hyan76@wisc.edu
Yuli Liu, UW - Madison, Civil and Environmental Engineering
Chin H. Wu, UW - Madison, Civil and Environmental Engineering

Meteorologically induced water level oscillations (MIWLOs) are one of natural causes to coastal hazards like flooding, vessel capsizing, runup, leading to drownings or injuries in the Great Lakes. In semi-enclosed basins, amplitudes of MIWLOs can be amplified due to bay resonance, but the occurrence frequencies have been scantly investigated. In this talk, we characterize occurrences of MIWLOs in Chequamegon Bay (CB), Lake Superior by statistical analysis. Specifically, historical MIWLO events in CB are identified based on water level, atmospheric pressure and wind data, and radar reflectivity images. Energy sources of identified events are classified as pressure dominated, wind dominated, and pressure & wind dominated. Size-frequency analysis is conducted to reveal the occurrence frequency patterns of MIWLOs induced by different energy sources. It is found that 280 events per year occur in CB, more frequent than 200 per year in Lake Superior on average. Great majority (95%) of large events (amplitude > 0.4 m) are pressure dominated, featured with small recurrence periods (~0.06 year) and large amplification factors (~15 times). The findings from the statistical analysis on historical events are further explored in numerical experiments to assess vulnerabilities and risks associated with water level oscillations in CB. Overall, the statistical characterization provides valuable understanding and fosters awareness of MIWLO hazards in semi-enclosed bays of the Great Lakes.

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Flood Resiliency Planning in Wisconsin Municipalities

Margaret Thelen, Wisconsin Department of Health Services, margaret.thelen@dhs.wisconsin.gov
Natalie Chin, University of Wisconsin Sea Grant Institute

Over the past decade, flooding in Wisconsin has become more frequent, severe, and costly, both in terms of finances and human health. Flooding in Wisconsin is responsible for hundreds of millions of dollars in infrastructural and residential damage and is associated with many adverse health outcomes. In order to prevent the negative impacts of flooding events, Wisconsin municipalities need to prioritize flood vulnerability assessments and flood mitigation efforts. In this presentation, two tools, developed by the Wisconsin Department of Health Services (DHS) to aid communities in determining their existing vulnerabilities and provide recommendations for their improvement, will be shared: the Flood Resilience Scorecard (FRS) and the Risk Assessment Flood Tool (RAFT). In addition, findings from a pilot of the FRS, conducted in partnership with Wisconsin Sea Grant, for Washburn, Wisconsin, will be discussed. Both tools are intended to be used by local public officials and municipal staff to identify community vulnerabilities that could hinder their ability to prepare for and to respond to

* Student presentation.

Program Summary

flood events. The FRS and RAFT are intended to merge the fields of public health, urban planning, and civil engineering to allow Wisconsin municipalities to adapt to and become more resilient to the anticipated frequency and intensity of future precipitation events using a holistic approach.

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How Will Flood Hazard Change in a Warmer Future in Turkey River, Iowa?

Guo Yu,[*] University of Wisconsin - Madison, Civil and Environmental Engineering, yuguo365@gmail.com
Daniel Wright, UW - Madison
Kathleen Holman, Bureau of Reclamation

Predicting changes in overall flood hazard due to climate change is more difficult than predicting the change in the individual factors that cause floods (e.g. rainfall, soil moisture, and vegetation). Regional Climate Model (RCM) simulations hold great promise in weather forecasting, land-atmosphere studies, and projection of climate change impacts including rainfall and flood extremes. The relatively short (~10-year) model runs that are currently feasible, however, inhibit the assessment of the upper tail of flood quantiles (e.g. the 100-year recurrence interval) using conventional statistical methods. Stochastic storm transposition (SST) and process-based Flood Frequency Analysis (FFA) are two approaches that together can help overcome this limitation. We apply our RainyDay SST software and process-based FFA approaches with outputs from National Center for Atmospheric Research (NCAR's) climate simulations to examine current and future extreme flood quantiles in Turkey River watershed in Iowa. We first use the stochastic multiplier approach to correct seasonal RCM biases. These bias-corrected precipitation fields are then be used to large numbers of extreme rainfall "scenarios" by RainyDay. Finally, we use RainyDay rainfall "scenarios" as inputs to the process-based FFA framework, showing the potential to understand changes in flood magnitude and seasonality at various ranges of watershed scales.

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Spatio-Temporal Patterns of Extreme Storms in the Mississippi Basin

Camila Abe,* University of Wisconsin - Madison, Civil and Environmental Engineering, cabe@wisc.edu
Daniel Wright, UW - Madison
Danielle Touma, University of California Santa Barbara

Large floods in the Mississippi River and its major tributaries result from combinations of storms spatially and temporally distributed throughout the basin. The occurrence, intensity, duration, and frequency of these storms can be influenced by both interannual oscillations in sea surface temperatures and climate change. In this study, we developed an object-based approach to analyze how often storms of 2, 10 and 100-year return levels occur in the Mississippi Basin since 1951, and how they are distributed in space and time. We perform a trend analysis to verify the pattern of storm structures through time, in terms of number of occurrences and maximum duration. Preliminary results for the Upper Mississippi show that the number of 2-year and 10-year storms have increased in the winter season, whereas no trend is found for the 100-year storms and remaining seasons. Both 2 and 100-year storms during the summer are correlated with El Niño, whereas 100-year storms during the winter, fall and summer are related to the North Atlantic Oscillation. The Pacific Decadal Oscillation is correlated to 100-year storms during the summer. The findings of this research can help to better understand the patterns and trends of extreme storms in the Midwest and elsewhere in the Mississippi basin, as well as their association

[*] Student presentation.

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with climate drivers and climate change. This information can be relevant for developing design floods for major river systems under current and future climate conditions.

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Updating Rainfall Statistics for Infrastructure Design in a Warming Climate

Daniel Wright, University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, danielb.wright@gmail.com
Zhe Li, UW - Madison
David Lorenz, UW - Madison

There is overwhelming evidence that rainfall extremes are growing more severe due to human-induced climate warming. This understanding, however, has not translated into actionable information needed by hydrologists and engineers. In this presentation, we show that existing rainfall intensity-duration-frequency (IDF) statistics such as the “100-year storm” are inadequate for current and future needs, leading to serious deficiencies in our hydrologic design standards and infrastructure. We then discuss two solutions to address this challenge in both current and future conditions. We close with a “call to arms,” and show how the Wisconsin Initiative on Climate Change Impacts and the University of Wisconsin-Madison is working to provide support to the water resources and engineering communities to solve this challenging problem.

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Session 4B:
Great Lakes Water Levels 1
Wednesday, March 3, 2021
3:30 - 5:00
Moderators: Mike Parsen and Maureen Muldoon

Coastal Morphological Changes in Southeastern Wisconsin

Boyuan Lu,* University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, blu38@wisc.edu
Chin Wu, UW - Madison, CEE Department

Coastal morphological change including shoreline erosion and bluff recession is critical to human safety and property along the Lake Michigan coastline. With increasing pressure on bluff stability caused by rising lake levels, information of spatial and temporal changes of coastal morphology is essential. In this talk, we will show the patterns of coastal morphology in the southeastern Wisconsin coastline. Specifically, shoreline and bluff erosion are characterized into three levels: the 100-meter local scale, the 5-km reach scale, and the 40-km county scale. Recession rates of the bluff toe, crest, and shoreline as the index of the coastal morphological changes will be calculated. Potential causes like water level, wave impact height, coastal structures, and beach width to the morphological changes are discussed. Outcomes of this study will help with identifying critical erosion areas, evaluating the performance of coastal structures, and anticipating possible coastal hazards.

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Flooding Vulnerability in the East River Watershed, Wisconsin

Yuan Liu,* University of Wisconsin - Madison, Civil and Environmental Engineering, dlut_liuyuan@163.com
Miles Tryon-Petith, UW - Madison, Civil and Environmental Engineering
Chin Wu, UW - Madison, Civil and Environmental Engineering

Flooding increasingly threatens communities in the East River watershed due to increasing extreme rainfalls and high water levels in Green Bay, Wisconsin. To better understand flood vulnerability of inundated areas, an integrated hydrological and hydraulic model is developed and implemented. Specifically, river discharges are computed by a calibrated HEC-HMS model using NOAA ATLAS-14 frequency rainfall data. Downstream water level fluctuations are characterized using long-term frequency analysis. Flood elevations of 16 various return periods with a combination of discharges and water levels under 10, 50, 100, 500-year events are computed by a geo-referenced HEC-RAS model of the East River. Flood inundation areas are generated and compared with historical FEMA flood maps. Furthermore, vulnerability of various land-use types is mapped and characterized. Results show that increasing river discharges increase the extent of flooding more than elevated downstream water levels. Urbanized and densely-populated downstream areas such as institutional and commercial lands are more vulnerable to extreme flooding events than natural and agricultural areas prevalent in upstream regions of the East River. Overall, flood vulnerability of inundation areas in this study provides the baseline to build flood resilience in the East River watershed.

* Student presentation.

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Rip Current Detection Using Deep Learning Approach

Wei Wang,[*] University of Wisconsin - Madison, Civil and Environmental Engineering, wwang487@wisc.edu
Yuli Liu, UW - Madison, Civil and Environmental Engineering
Chin Wu, UW - Madison, Civil and Environmental Engineering

Rip currents, commonly occurring in the Great Lakes, are dangerous to beachgoers who can be pulled away from shoreline to deep water. Since 2002, rip currents have caused more than 670 drowning incidents in the Great Lakes. Detection of rip currents, which are transient and nonstationary at featureless beaches, is challenging. In this talk, a Deep-learning for Automatic Rip-detection Toolkit (DART) to provide timely and accurate rip current detection is presented. The DART is comprised of two components: (i) a smart dehazing algorithm to augment color features of rip currents in web-cam images and (ii) a fast regional convolutional neural network (F-RCNN) to detecting locations of rip currents. Three-year images of rip currents at Port Washington, WI are used to construct a training model. Validation results show that the model is well-performed for detecting rip currents with high accuracy (92.2%) and in very short time (< 10 s). Real-time detection by incorporating the DART outputs and the associated nearshore wave conditions is developed to assess risks of rip currents for awareness of beach users. Overall, the DART can be easily implemented to promote water safety in Great Lakes.

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Multiscale Water Level Fluctuations in Lower Green Bay: A Compound Risk Perspective for Coastal Resilience

Yuli Liu, University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, yliu99@wisc.edu
Chin Wu, UW - Madison, Civil and Environmental Engineering

Multiscale water level fluctuations can be vulnerabilities to coastal communities in flooding, water quality, and recreational water safety in the Laurentian Great Lakes. The compound risk due to multiscale water level fluctuations is critical to building coastal resilience but has yet been investigated in the Laurentian Great Lakes. In this talk, we will examine the risks of multiscale water level fluctuations in Lower Green Bay of Lake Michigan, a Great Lakes Area of Concern, as an example. Specifically, water level fluctuations are characterized into six scales, which range from climate-driven rising lake levels (O ~ decades) to storm-induced high-frequency water level fluctuations such as meteotsunamis (O ~minutes to hours). Extreme water level fluctuations at each time scale are identified and associated with physical drivers including atmospheric pressures, winds, precipitations, and stream flows. The exceedance probabilities are also estimated using cumulative frequency analysis. We will discuss compound risks using examples of simultaneous occurrence of extreme water level fluctuations at different time scales. Overall, a compound risk perspective of multiscale water level fluctuations will provide new insights on future planning and decision-making in building coastal resilience in the Laurentian Great Lakes.

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[*] Student presentation.

Program Summary

Re-assessing the Importance of Groundwater to Lake Superior

Martha Nielsen, US Geological Survey, Upper Midwest Water Science Center, mnielsen@usgs.gov
Paul Juckem, US Geological Survey, Upper Midwest Water Science Center

Limited understanding of groundwater's role in the Great Lakes' hydrology and water quality diminishes current assessments and future projections of lake health. To this end, the USEPA Cooperative Science and Monitoring Initiative (CSMI) has funded a new USGS project to assemble data and current knowledge on groundwater within the US portion of the Lake Superior Basin. Previous studies in the Lake Superior Basin have either been part of a larger evaluation of the entire Great Lakes system, lacked focus on the unique qualities of the Lake Superior Basin, or have focused on a single specific watershed or study area and not undertaken a broader contextual analysis within the Lake Superior Basin. The USGS CSMI effort will focus on assembling aquifer and geology data to understand the distinct hydrogeologic regions within the Basin, and evaluate water level, streamflow, water use, and chemical data within these hydrogeologic regions. Insights from published groundwater flow models in the Basin will also be used to help evaluate flow-system patterns and trends and enhance transferability spatially around the lake.

Program Summary

Session 5A:
Urban Hydrology
Thursday, March 4, 2021
10:00 - 11:30
Moderators: Mike Rupiper and Bill Selbig

Monitoring Tree Sway as an Indicator of Interception Processes Before, During, and After a Storm

Dominick Ciruzzi, University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, ciruzzi@wisc.edu
William Avery, UW - Madison
Harold Barker, UW - Madison
William Selbig, USGS Upper Midwest Water Science Center
Steven Loheide, UW - Madison

We developed a new approach to monitor tree sway period an indicator of changes in canopy water storage (i.e., interception) over a storm. The sway period of a tree is related to the tree's mass, stiffness, height, and diameter, among other factors. During the short time frame of a storm, only the mass of a tree changes as water is intercepted. The overall objectives of this research were to determine whether tree sway period changes across a storm; determine whether changes in canopy water storage were uniquely related to changes in tree sway period; and to evaluate the feasibility of using accelerometers to monitor changes in tree sway period related to changes in canopy water storage throughout a storm. We evaluated changes in canopy water storage as the partitioning of precipitation into throughfall, evaporation, and stemflow. We observed increases in tree sway period correlated with increases in canopy water storage during rainstorms, which suggests the timing and magnitude of changes in canopy water storage can be quantified from continuously monitoring tree sway. This research demonstrates the feasibility of a new, independent tool and approach to monitor, quantify, and evaluate interception dynamics in trees. In particular, we suggest this monitoring approach may be helpful in efforts that evaluate the role of trees in attenuating the timing and magnitude of stormwater runoff.

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Scaling Investment in Distributed Green Infrastructure Solutions

Cynthia Koehler, WaterNow Alliance, cak@waternow.org
Caroline Koch, WaterNow Alliance

WaterNow Alliance is a national network of local water leaders supporting sustainable, affordable, and climate resilient water strategies. Distributed green stormwater infrastructure (GSI) is a cost-effective and innovative approach to local water management and a key strategy for building climate resiliency. Bioswales, green roofs, permeable pavement, and rain barrels and more, limit flooding from severe storms, capture runoff and treat pollutants often more affordably and faster than built infrastructure. Municipal water agencies typically fund consumer-facing GSI rebates with operating cash which substantially limits scale and impact. WaterNow launched our Tap into Resilience (TiR) initiative to support cities and water agencies in scaling-up their GSI by financing these programs in the same way that they finance conventional infrastructure – by capitalizing them. WaterNow's presentation will focus on two key parts of TiR: (1) how water managers can use WaterNow's TiR Toolkit an online resource with answers to common tax, accounting, legal, and other implementing

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questions to explore whether and how to scale up consumer GSI programs; and (2) exploring a diverse set of utility case studies across the country that demonstrate the effectiveness of green infrastructure (and other distributed solutions) to address local water challenges as outlined in WaterNow's new report, "Innovation in Action: 21st Century Water Infrastructure Solutions" published on November 13, 2019.

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Relationships Between Land Use and Stream Temperature in the Yahara River Watershed

Yu Li,* University of Wisconsin - Madison, li728@wisc.edu
Anita Thompson, UW - Madison, Dept. of Biological Systems Engineering

Understanding the relationships between land use and stream temperature in the Yahara River Watershed (YRW) is important for urban planning and protecting water quality. We utilized stream temperature data collected monthly by the Rock River Coalition at the outlet of 17 independent sub-watersheds. At each site, we compared stream temperature from 2015 to 2017 with watershed characteristics including urban area, water area, woodland area, watershed size and Base Flow Index (BFI). Land use data for 2015 were obtained from the Capital Area Regional Planning Commission. We evaluated the urban and water area using three metrics: (1) area percentage in the entire watershed and in riparian zones with widths from 20-ft to 700-ft, (2) area factor, the ratio of woodland area in the riparian zone over urban area in the rest of watershed, and (3) inverse-distance-weighted (IDW) area percentage with proximity to watershed outlet and to stream. Water and urban area were better indicators of stream temperature compared to woodland, watershed size and BFI in the YRW. Water area percentage in the entire watershed was positively correlated with stream temperature from June to September, and IDW urban area percentage with proximity to watershed outlet was positively correlated with stream temperature from May to October. Results from this study can guide future urban planning in temperature-sensitive watersheds.

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Incorporating the Hydrologic Impacts of Low Impact Development in a Large-Scale Land Surface Model

G. Aaron Alexander,* University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, gaalexander3@wisc.edu
Carolyn B. Voter, UW - Madison, Dept. of Civil and Environmental Engineering
Steven P. Loheide, UW - Madison, Dept. of Civil and Environmental Engineering
Daniel B. Wright, UW - Madison, Dept. of Civil and Environmental Engineering

Urbanization substantially modifies both the water cycle and energy balance. Urban surfaces are less permeable, resulting in both increased runoff and flooding. At the same time, urbanization results in warmer temperatures, creating the so-called urban heat island (UHI) effect. The UHI causes moist air to heat and rise, triggering atmospheric feedbacks that lead to intensification of rainfall over cities. These feedbacks are particularly important in coastal communities like Milwaukee, where lakes provide ample moisture to initiate these mechanisms. We hypothesize widespread adoption of low impact developments (LIDs) like street trees, green roofs, and pervious pavements can reduce urban temperatures while addressing rainfall intensification. In the first step of this project, we modified the NOAH-MP land surface model to

* Student presentation.

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integrate the aggregate effects of LIDs. We find that LID practices alter both the surface water and energy balances in ways that cannot be captured by current state-of-the-art land surface models. We highlight simulated changes in surface energy partitioning and urban hydrology across multiple scales. Our results show widespread adoption of LIDs vastly increase the amount of evaporative cooling when compared with standard simulations without LIDs.

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Precipitation Throughfall Beneath Urban Tree Canopies: An Investigation of Precipitation Re-Direction

William Avery,[*] University of Wisconsin - Madison, Nelson Institute for Environmental Studies, waavery@wisc.edu
Steven Loheide, UW - Madison
William Selbig, USGS
Harold Barker, UW - Madison
Aaron Alexander, UW - Madison
Carolyn Voter, UW - Madison

Vegetation in urban environments can often slow the formation of surface runoff. Trees are significant contributors to the hydrologic cycle in many neighborhoods and represent a dominant form of vegetation. While the role of trees in the water budget is likely significant, the role of the canopy in interception loss is less understood. The characteristics of the urban tree canopy may result in a re-distribution of precipitation onto impervious surfaces. The spatial variability of throughfall in relation to the understory must be understood to help understand the role of urban trees in precipitation/runoff patterns. A study located in central Wisconsin was performed during the summer of 2019 to explore spatial patterns of throughfall beneath urban trees. Experimental design was structured around two street trees located in Fond du Lac, WI. Throughfall was measured via a system of plastic buckets (64) located in a grid pattern beneath each study tree placed prior to each storm. Results have shown high variability of throughfall as well as increased average throughfall on impervious surfaces suggesting an effect of regular placement of street trees relative to surface infrastructure. Additionally, "hot spots" of intense throughfall relative to precipitation depth were found to exist during larger storm events signaling a re-distribution effect exerted on throughfall via the canopies themselves.

[*] Student presentation.

Program Summary

Session 5B:
Central Sands
Thursday, March 4, 2021
10:00 - 11:30
Moderators: Jeff Helmuth and Adam Freihoefer

Experimental Discharge Reduction Impacts Fish, but Not Invertebrates, in a Central Sands Trout Stream

Robert Stelzer, University of Wisconsin - Oshkosh, stelzer@uwosh.edu
Michael Shupryt, Wisconsin DNR

Groundwater withdrawal has increased on multiple continents during the last several decades which poses risks for groundwater-dependent ecosystems. Few studies have simultaneously evaluated how multiple communities are impacted by experimental discharge reduction in streams. Our main objective was to assess how discharge reduction impacted benthic invertebrates, fish, and benthic algae in a groundwater-dependent stream and to assess proximate causes for measured impacts. We experimentally reduced discharge by 40-60% in a third-order stream during an 11-month period based on a BACI design. Discharge reduction decreased sediment grain size, mean water depth, and mean water velocity but not wetted width, wetted area or water quality metrics. Benthic invertebrate abundance, taxa richness and diversity were not impacted by discharge reduction. However, discharge reduction decreased the abundance and biomass of brown trout and total fish. The abundance of large brown trout was disproportionately impacted by discharge reduction. Discharge reduction also caused decreases in the cell density of benthic algae. Our results suggest that community responses to discharge reduction in streams may be uncoupled and that the proximate causes of community impacts associated with discharge decline may differ. Moderate discharge reduction in streams can negatively impact the habitat and abundance of salmonids.

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The Groundwater Connection: Implementing the Central Sands Lakes Study

Jeff Helmuth, Wisconsin Department of Natural Resources, jeffrey.helmuth@wisconsin.gov

This talk gives an overview of the Central Sands Lakes Study and supplies background for other talks on that topic. The study came about because the influence of water budget components, particularly groundwater withdrawals, on Wisconsin’s lakes has been difficult to measure or predict. To that end, the Wisconsin Legislature mandated that the WDNR evaluate and model the impacts of existing and future groundwater withdrawals on three lakes in Waushara County.

The three-year study began with a large data collection effort to support groundwater flow modeling and lake characterization. Study partners are currently engaged in modeling and lake impact risk assessment to determine if pumping-induced reductions below each lake's average seasonal water levels result in significant resource impacts on the three lakes. If significant lake impacts are predicted, the WDNR has until June 2021 to identify special measures to prevent or mitigate those impacts and evaluate economic impacts from those measures.

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Development of a Regional Groundwater Flow Model of the Central Sands

Megan Haserodt, US Geological Survey, Upper Midwest Water Science Center, mhaserodt@usgs.gov
Michael Fienen, USGS
Andrew Leaf, USGS
Stephen Westenbroek, USGS

Detailed simulation of groundwater flow in areas with few streams, such as the intermorainal area of the Wisconsin Central Sands, requires consideration of regional groundwater flow at the model boundaries. A transient, MODFLOW-NWT model was constructed for the Central Sands region to provide reasonable boundary conditions as a parent model to lake inset models. The regional model was built upon an existing groundwater flow model developed at University of Wisconsin – Steven Point. Model layering was improved with updated information about glacial and bedrock units from the Wisconsin State Geological and Natural History Survey. Updated recharge was estimated with a Soil Water Balance model developed for this study. Model calibration used a series of multipliers on the hydraulic conductivity fields from the existing model to utilize the patterns in previously published parameters fields while still responding to new information in an updated calibration dataset.

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Lake-Groundwater Interactions of Plainfield, Long, and Pleasant Lakes in the Central Sands of Wisconsin

Michael Parsen, Wisconsin Geological and Natural History Survey, UW–Madison Division of Extension, mike.parsen@wisc.edu
Carolyn Voter, Wisconsin Department of Natural Resources
Catherine Hein, Wisconsin Department of Natural Resources
Aaron Pruitt, Wisconsin Department of Natural Resources

The Wisconsin Department of Natural Resources (WDNR) is conducting a groundwater and lake level evaluation for Pleasant, Long, and Plainfield Lakes in Waushara County, referred to as the Central Sands Lakes Study (CSLS). An important component includes fieldwork designed to track water levels of the three study lakes and an accompanying network of lake-proximate monitoring wells. This hydrologic dataset provides a means to test hypotheses about lake-groundwater flow regimes and improve our understanding of localized groundwater-surface water interactions. Additional lines of evidence for the importance of groundwater to dynamics of these study lakes include seepage meter measurements, lake water budgets derived from stable isotope measurements, and lake water budgets derived from a groundwater flow model (MODFLOW). Results indicate that lake-groundwater fluctuations and gradients are largely consistent with physical (seepage meter), chemical (stable isotope), and modeled (MODFLOW) lake water budget investigations. These findings confirm the hypothesis that groundwater is a key component of the water balance at each of these dynamic lake systems and will ultimately inform the DNR's decision-making process in regards to lake-level impacts.

Program Summary

Session 6A:
Nitrate in Groundwater
Thursday, March 4, 2021
12:15 - 1:30
Moderators: Laurel Braatz and Gretchen Bohnhoff

Quantifying the Nitrate in Irrigation Water across the Wisconsin Central Sands

Tracy Campbell,* University of Wisconsin - Madison, Department of Agronomy, tacampbell@wisc.edu

Across Wisconsin it has become increasingly clear that nitrogen management strategies must be improved in order to prevent further contamination of groundwater. Using both on-farm fieldwork, as well as ecosystem modeling, we are: 1) assessing the amount of nitrate (N) found in irrigation water and 2) determining the impact of timing and quantity of nitrogen application on nitrate leaching and crop yield. Based on samples of irrigation water collected during the 2018, 2019, and 2020 growing season, results indicate a large spatial variability in N concentrations, while temporal variability is limited. Specifically, some wells only varied between 1 to 2 ppm of N from year to year. Through our combined approach of field and modeling research, we hope to provide farmers, researchers, and policy makers with the tools to make management decisions that will improve groundwater quality - which will be of heightened importance as increasing weather variability makes management of water resources and N applications to crops more challenging.

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Development of a Dashboard for Nitrate Trends in Public Water Systems

Jennifer Dierauer, University of Wisconsin - Stevens Point & University of Wisconsin - Madison, Division of Extension, jbrand@uwsp.edu
Grant Moser, UW - Stevens Point
Kevin Masarik, UW - Stevens Point & UW - Madison, Division of Extension

Nitrate is a concern for Wisconsin communities and rural residents that rely on groundwater as their primary water supply. Understanding whether nitrate is increasing or decreasing is of interest to water utility managers, private well owners, conservation professionals, and government officials. Unlike private wells, public water systems are required to regularly test for nitrate. While focusing only on public water systems (ex. municipal systems, bars, restaurants, churches, and mobile home parks) may underrepresent more rural parts of the state; this existing long-term dataset provides an opportunity to evaluate temporal changes groundwater nitrate.

Well data was downloaded from the DNR Groundwater Retrieval Network. Linear regression was performed on the nitrate data for each well. Results from the analysis were integrated into an interactive dashboard using R Shiny (https://shiny.theopenwaterlog.com/nitrate_trends/). The dashboard provides spatial and temporal visualization of the data. Additional functionality is built in to view data for an individual well, county summaries, and an overall statewide summary. Trends in the 9,739 public water supply systems suggest no significant trend in 89.4% of wells, an increasing trend in 6.8% of wells, and a decreasing trend in 3.9% of wells.

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* Student presentation.

Program Summary

Investigating Crop Rotational Effects on Water Quality below a Central Wisconsin Agroecosystem

Kevin Masarik, University of Wisconsin - Stevens Point & University of Wisconsin - Madison, Division of Extension, kmasarik@uwsp.edu
Christopher Kucharik, UW - Madison, Dept. of Agronomy

From 2016-2020, we used lysimeters and wells to quantify year-round water drainage and solute leaching below an irrigated agricultural field. Crops within the rotation included sweet corn, potato, field corn, and peas. Lysimeters were sampled approximately every two weeks and allowed for detailed temporal measurements of water drainage and nitrate and chloride leaching losses. Prior to planting, detailed water quality sampling of the water table below the field was performed to compare nitrate loading measurements from lysimeters to groundwater impacts from the previous year's crop. Results confirmed that crop type influenced annual nitrate leaching losses and subsequently groundwater quality; significant nitrate losses occurred outside the growing season in some of the years.
Lastly, a soil nitrogen balance was used to estimate leaching losses by comparing inputs (i.e. fertilizer and nutrients in irrigation water) to outputs (nitrogen removed via harvest and other miscellaneous losses). Annual nitrate losses and groundwater quality measurements compared well with leaching estimates calculated using the soil nitrogen balance. This information shows the importance of looking outside the growing season for opportunities to reduce nitrate leaching losses and highlights the role that simple soil nitrogen balances can play in informing nitrate reduction strategies.

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Developing a Nitrate Decision Support Tool for Wisconsin -- Phase 1: Scenarios for Drinking Water Wells

Paul Juckem, US Geological Survey-Upper Midwest Water Science Center, pfjuckem@usgs.gov
Chris Green, USGS-Water Mission Area
Laura Schachter, USGS-Upper Midwest Water Science Center
Nick Corson-Dosch, USGS-Upper Midwest Water Science Center
Anna Baker, USGS-Upper Midwest Water Science Center
Mike Fienen, USGS-Upper Midwest Water Science Center

Nitrate is the most widespread groundwater contaminant in Wisconsin (over 42,000 private wells exceed health standards; 10 mg/L), with most nitrogen loading traced to agriculture. However, few tools exist to assess the response time between changes in nutrient management and groundwater quality. The WiDNR, UW-Madison, and USGS are collaborating to develop a Nitrate Decision Support Tool to assist resource managers with such assessments. Development of the tool will be completed in phases. This presentation focuses on a Phase-1 effort for the groundwater transport component of the tool.

The groundwater reactive-transport method used by the tool involves coupling (via mathematical convolution) historical nitrate loads from an Agro-IBIS model and population-based septic estimates with groundwater age distributions. Age distributions are generated from a machine learning model trained on tracer-derived ages. Oxygen and nitrate reduction rates are estimated from historical age tracer and water quality studies. A set of scenarios allows users to evaluate how historical and future loading rates influence nitrate concentrations in wells over time, including options for computing reductions in loading required to reach specified target concentrations by specified dates. Enhancements envisioned for future phases include assimilating age distributions from existing numerical models to simulate transport to water bodies and delineate contributing areas for more targeted land management.

Program Summary

Session 6B:
Great Lakes Water Levels 2
Thursday, March 4, 2021
12:15 - 1:30
Moderators: Mike Rupiper and Anna Fehling

New Characterization of Shoreline Changes Under Water Levels Fluctuations in Lake Michigan

Sarah Peterson,* University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, speterson26@wisc.edu
Chin Wu, UW - Madison, Dept. of Civil and Environmental Engineering

Impacts of shoreline changes under extreme water level fluctuations in Lake Michigan pose considerable threats to property owners and municipalities. Numerous techniques for analyzing shoreline changes have been executed, but there is a lack of methodologies that consider beachfront slope with changing water levels. In this talk, we will present a new methodology to assess shoreline changes at three study sites: Alford Park, Kenosha Dunes, and Lakeshore Drive in Kenosha County, Wisconsin, with each presenting a different and unique shore condition. First, the method measures perpendicular distances to the shoreline edge from set coordinate placemarks along the beach on historical imagery from 2000-2018. Second, characterization of shoreline changes is achieved by plotting distances against water level fluctuations. Results show that steeper regression lines yield minor beach slopes. Distances are found to fluctuate more at lower water levels with changing beach slope than higher water levels, suggesting that the effect of erosion is greater on the measured distance at lower water levels. Distances below and above the regression line can be indicators for erosion and accretion, respectively. The new method characterizing shoreline changes can be applied to other beaches for identifying dynamic shoreline changes in the Great Lakes.

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Vanishing Groundwater Seepage along an Eroding Coastal Shoreline in Southern Lake Michigan

Benjamin Sieren,* University of Wisconsin - Madison, Geological Engineering, bsieren@wisc.edu
Chin Wu, UW - Madison, Dept. of Civil & Environmental Engineering
David Hart, Wisconsin Geological and Natural History Survey

Coastal groundwater seepage can provide ecosystem benefits such as supplying groundwater to coastal wetlands but can also elevate bluff and dune erosion. In this study, we examine seepage at an eroding shoreline located in the Kenosha Dunes State Natural Area, along the coast of Lake Michigan in Kenosha, Wisconsin. Specifically, we seek to uncover a vanishing groundwater seepage zone, i.e., visible at the toe of the eroding dunes at the northernmost end of the beach and disappearing at southward along the shoreline. A comprehensive groundwater monitoring network with water level sensors is installed to map the water table distribution and groundwater flow. Ground penetrating radar is employed to map the underlying glacial-till aquitard. In addition, direct measurements and calculated seepage rates are used to estimate the amount of groundwater supply. These findings will provide crucial information to the restoration infrastructure design, habitat improvement, and ecological enhancement in the ongoing Restoring Ecological Health and Aquatic Biodiversity (REHAB) at the Kenosha Dunes, WI.

* Student presentation.

Program Summary

Cumulative Impacts of Coastal Structures on Bluff Erosion in Lake Michigan

Miles Tryon-Petith,* University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, tryonpetith@wisc.edu
Chin Wu, UW - Madison, Dept. of Civil and Environmental Engineering

Cumulative impacts of coastal erosion threaten people, livelihoods, and environmental health. While coastal structures are commonly used to protect bluff stability around Lake Michigan, cumulative spatial-temporal impacts of adjacent areas near the structures are seen. In this talk, we will present a combined qualitative and quantitative approach to characterize the cumulative impacts of coastal structures on bluff erosion along the shoreline in southeastern Wisconsin. Historical and contemporary oblique imagery of the study site in Ozaukee county, Wisconsin are compiled, stitched, and analyzed to reveal spatial and temporal changes. Geographic Information Systems (GIS) in conjunction with aerial photos are used to identify structure-induced areas of intense erosion. Spatial analysis using Digital Shoreline Analysis System is used to quantify coastal erosion over time. Results show that rising trends in erosion appear under higher water levels and more intense storm events. Coastal structures can intensify adjacent bluff erosion in time and space in comparison to bluffs without structures.

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Effects of High-Water Levels on Wave Climate, Sediment Resuspension, and HAB in Lower Green Bay, WI

Josh Anderson, University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, janderson1@wisc.edu
Chin Wu, UW - Madison, Dept. of Civil and Environmental Engineering

Water levels on Lake Michigan have risen approximately 6 ft since 2013 to near historic highs. While the variation in water level is small compared to water depth, the variation in water level in shallow nearshore regions like Lower Green Bay (7-15 ft) has increased more than 40%. Furthermore, water levels can elevate wave climate due to the submergence of outer shoals and spits that typically shelter Lower Green Bay. In this talk we will present a coupled wave and current model that can assess wave climate variability in Lower Green Bay under the scenario of increasing water levels. Roles of wave climate on resulting storm surge and flood inundations are examined. Sediment resuspension and transport under the high water level and extreme wave climate will also be examined. Lastly, we will explore the possible linkage between extreme event-induced mixing and harmful algal blooms (HAB).

* Student presentation.

Program Summary

Session 7A:
Neonicotinoids
Thursday, March4, 2021
1:45 - 3:00
Moderators: Mike Parsen and Matt Diebel

Acute and Chronic Toxicity of the Neonicotinoid Insecticides Thiamethoxam and Imidacloprid to Select Aquatic Invertebrates

Elisabeth Harrahy, University of Wisconsin - Whitewater, harrahye@uww.edu
Austin Draper, UW - Whitewater
Jacob Lacki, UW - Whitewater
Anya Jeninga, UW - La Crosse
Tisha King-Heiden, UW - La Crosse

Neonicotinoid insecticides have been detected in streams and aquatic invertebrates may be at risk from exposure. The goal of this project is to determine the acute and chronic toxicity of thiamethoxam and imidacloprid to select aquatic invertebrates. In separate acute and chronic toxicity tests, water fleas (*Ceriodaphnia dubia*), amphipods (*Gammarus pseudolimnaeus*), and chironomids (*Chironomus dilutus*) were exposed to nine different concentrations (60% dilution) of thiamethoxam or imidacloprid. In the acute tests, there were four replicate beakers per treatment for the water fleas and chironomids, with five water fleas or ten chironomids in each beaker, and 20 replicate beakers per treatment for the amphipods, with one amphipod in each beaker (will eat each other). Acute tests ran for 48 hours (water fleas and chironomids) or 96 hours (amphipods). In the chronic tests, there were ten replicate beakers per treatment for the water fleas, with one water flea in each beaker, and 20 replicate beakers per treatment for the amphipods, with one amphipod in each beaker. Chronic tests ran for seven days (water fleas) or 10 days (amphipods). EC50 (effective concentration for 50% of the population; immobility) values were calculated for the water fleas and chironomids and LC50 (lethal concentration for 50% of the population) values were calculated for the amphipods at the end of the acute tests. We observed a significant decrease in number of neonates produced by water fleas, but no significant decrease in growth of amphipods in the chronic tests. Details for each chemical will be presented. Chronic tests with chironomids are ongoing. Impacts on populations of any of these species could have cascading effects on the structure and function of aquatic ecosystems.

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Program Summary

Temporal and Spatial Dynamics and Predictors of Neonicotinoid Contamination in Groundwater Fed Streams in Central Wisconsin

Megan Lipke,[*] University of Wisconsin - Madison, mnlipke@wisc.edu
Mike Parsen, Wisconsin Geological and Natural History Survey
Billy Fitzpatrick, Wisconsin Geological and Natural History Survey
Benjamin Bradford, UW - Madison
David Hart, Wisconsin Geological and Natural History Survey
Russell Groves, UW - Madison

Neonicotinoid pesticide use has dramatically increased over the last 20 years since their initial in the late 1990s. While estimates of ecological risk associated with non-target organisms has always been part of the pesticide registration process, additional research is now warranted under the recently proposed, interim re-registration decision of this important class. In the Central Sands region of Wisconsin, neonicotinoid insecticides have previously been detected in ground water resources through high-capacity well sampling. However, the patterns of detection in stream water resources remains poorly understood and merits investigation. Our research seeks to better define the temporal and spatial dynamics of neonicotinoids in stream water and analyze potential linkages to common land-uses Over the past two years, 82 stream sampling sites have been routinely monitored using ELISA-based kits to estimate concentrations of two neonicotinoids: imidacloprid and thiamethoxam. Monitoring results in streams will be evaluated using a calibrated groundwater flow model for the region to delineate groundwater contributing areas. Agricultural land use patterns within the groundwater contributing areas will then be analyzed to develop statistical relationships neonicotinoid concentration in streams. Results will provide stakeholders an additional tool to assess risk to aquatic invertebrates, better protect sensitive taxa, and inform regulatory and land-use management decisions.

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Use of Polar Organic Chemical Integrative Samplers (POCIS) to Monitor Neonicotinoid Insecticides in Streams and Ditches on the Central Wisconsin Sand Plain

Bill Devita, University of Wisconsin - Stevens Point, Center for Watershed Science and Education, wdevita@uwsp.edu

Polar organic chemical integrative samplers (POCIS) are passive sampling devices that are used to provide a time-weighted average of water quality over the period of deployment. They consist of two porous membranes that encase a polymer acting as the sorbent. In order to derive average water concentrations, POCIS rely on empirically determined effective sampling rates which define rates of accumulation of a specific compound into the sorbent.

In August 2019, these devices were deployed for 30-day periods in baseflow dominated streams and ditches on the Central Wisconsin Sand Plain. Bulk water samples were collected at the time of POCIS deployment and retrieval. Twenty sites were selected on the basis of proximity to headwaters, surrounding land use, baseflow from recent records, and position on the groundwater divide (east or west). Grab samples and POCIS were analyzed for five neonicotinoid insecticides: acetamiprid, clothianidin, dinotefuran, imidacloprid and thiamethoxam. Nine of the 20 sites exceeded chronic US EPA Aquatic Life Benchmarks for invertebrates for imidacloprid and five of the 20 sites exceeded these benchmarks for clothianidin. Neonicotinoid concentrations in the POCIS were consistently lower possibly reflecting dilution effects from heavy rains which occurred during the deployment period.

[*] Student presentation.

Program
Summary

Widespread Detections of Neonicotinoid Contaminants in Central Wisconsin groundwater

Russell Groves, University of Wisconsin - Madison, Dept. of Entomology, rgroves@wisc.edu
Benjamin Bradford, UW - Madison

Neonicotinoids are a popular and widely used class of insecticides whose heavy usage rates and purported negative impacts have led to questions about their mobility and accumulation in the environment. In 2008, the WI DATCP began testing for neonicotinoids in groundwater test wells in the state, reporting detections of one or more neonicotinoids in dozens of shallow groundwater test wells. In 2011, similar detection levels were confirmed in several high-capacity irrigation systems in central Wisconsin. The current study was initiated to investigate the spatial extent and magnitude of neonicotinoid contamination in groundwater in areas of irrigated commercial agriculture in central Wisconsin. From 2013±2015 a total of 317 samples were collected from 91 unique high-capacity irrigation wells and tested for the presence of thiamethoxam (TMX), a neonicotinoid, using enzyme-linked immunosorbent assays. 67% of all samples were positive for TMX at a concentration above the analytical limit of quantification (0.05 µg/ L) and 78% of all wells tested positive at least once. Mean detection was 0.28 µg/L, with a maximum detection of 1.67 µg/L. Five wells had at least one detection exceeding 1.00 µg/L. Furthermore, an analysis of the spatial structure of these well detects suggests that contamination profiles vary across the landscape and at different spatial scales, with differences in mean detection levels observed from landscape (25 km), to farm (5 km), to individual well (500 m).

Program Summary

Session 7B:
Groundwater Modeling
Thursday, March 4, 2021
1:45 - 3:00
Moderators: Andy Leaf and Mike Fienen

Recharge or runoff? Impacts of changing snow cover and frozen ground regimes on groundwater recharge in the Midwest

Katrina Hyman-Rabeler,* University of Wisconsin - Madison, Geological Engineering, rabeler@wisc.edu
Steven Loheide, UW - Madison, Civil and Environmental Engineering

The spring snowmelt accounts for a large percentage of annual groundwater recharge in the Midwest. However, in a warming climate, mid-winter snowmelts are becoming more common. While these mid-winter melt events can cause discrete recharge events, they can also leave the soil exposed to subsequent cold snaps, decreasing soil temperature and creating a nearly impermeable layer of frozen soil, reducing infiltration in subsequent melt events.

Using statistical and numerical modeling, we investigate relationships between winter precipitation, the soil thermal regime, and groundwater recharge to determine the factors that contribute to variations in winter and spring groundwater recharge. We analyze historical groundwater level, soil temperature, and meteorological data paired with numerical modeling of surface, vadose zone, and groundwater processes to explore relationships between snow, soil temperature, mid-winter melts, and groundwater recharge.

Results suggest that frozen ground plays a significant role in determining the partitioning between groundwater recharge and runoff, but the effect is sensitive to many factors, including soil texture and the magnitude and temporal sequence of events. Understanding the complex relationships between snow, frozen ground, and groundwater recharge is critical for predicting how climate change will affect water resources in the future.

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Models Supporting Groundwater Availability Decisions: Approaches and Methods from the USGS Mississippi Alluvial Plain project

Randall Hunt, US Geological Survey, Upper Midwest Water Science Center, rjhunt@usgs.gov
Andrew Leaf, USGS Upper Midwest Water Science Center
Burke Minsley, USGS Geology Geophysics and Geochemistry Science Center
Emily Emily Pindilli, USGS Science and Decisions Center
Jr Rigby, USGS Lower Mississippi Gulf Water Science Center
Wade Kress, USGS Lower Mississippi Gulf Water Science Center

Modern water availability questions require high-level and stakeholder-accepted science support, including numerical models. Moreover, as stakeholders have grown accustomed to near instant access to information such as real-time weather

* Student presentation.

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forecasts, methods for construction and refinements of water-resource support systems have not kept pace. Local stakeholders initiated the US Geological Survey's Mississippi Alluvial Plain (MAP) project in 2016, and identified the need to formulate a new approach for applying models to decision support. In the MAP, a variety of physically based and machine learning models are used, in a number of configurations, depending on the societal question being asked. The overarching goal is to provide responsive, consistent, and insightful high-quality science even as the decision-making concerns and associated forecasts change. Challenges to this vision include well-recognized problems of system scale and shortcomings in our ability to characterize an unseen subsurface. Upon completion, the MAP project will have developed a range of capabilities (e.g., incorporation of airborne geophysical data, automated inset model construction, socioeconomic linkages to groundwater models) and interdisciplinary workflows. Given the widespread occurrence of similar water availability issues, the MAP work also includes efforts to enhance transferability beyond the MAP area, such as documentation of tools, scripts, and online code repositories.

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Monte Carlo Simulations to Evaluate Potential Outcomes of a Lake Drawdown Test

Andrew Leaf, US Geological Survey, Upper Midwest Water Science Center, aleaf@usgs.gov
Ian Anderson, Wisconsin Dept. of Natural Resources
Megan Haserodt, US Geological Survey, Upper Midwest Water Science Center
Michael Fienen, US Geological Survey, Upper Midwest Water Science Center

While the physics of groundwater flow are well understood, the physical properties of aquifers and their boundary condition stresses are complex and defy accurate description at any scale, leading some to argue that groundwater models are at best data processing tools that can assimilate what is known, express what is unknown, and provide a distribution of possible outcomes. 2017 Wisconsin Act 10 mandated the Central Sands Lakes Study, requiring the causal connection between groundwater pumping and lake levels be verified in the field. A pumping test was proposed to achieve measurable drawdown in Plainfield Lake. The WDNR asked the USGS to use a groundwater model to determine an optimal pumping rate, duration, well configuration, and a discharge location that would not influence the test. Ensemble simulations were performed with an uncalibrated 63 km2 inset model around the Plainfield Lakes. Parameter ensembles were conditioned using the Schur complement as implemented in the pyEMU software. A step-wise approach was taken, starting with a simple scheme of global multipliers, progressing to distributed parameterization using pilot points. The pilot point parameterization—which better reflects the true unknowns—produced estimates of lake stage drawdown that were more diffuse and heavily skewed towards lower values. Simple parameterization schemes that neglect important unknowns can lead to unrealistic confidence in model results.

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Re-purposing Groundwater Flow Models for Age Assessments: Important Characteristics

Paul Juckem, US Geological Survey, Upper Midwest Water Science Center, pfjuckem@usgs.gov
Jeff Starn, US Geological Survey

Groundwater flow model construction often is time-consuming and costly, with development ideally focused on a specific question or purpose. As environmental challenges evolve, incentives to re-purpose existing models may grow. Few studies, however, have evaluated which characteristics of groundwater flow models deserve greatest consideration when re-purposing models for groundwater age and advective transport simulations. We compared simulated age metrics produced

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by three MODFLOW-MODPATH models of the same area but with differing levels of complexity (layering and zoned vs heterogeneous conductivity & porosity). Comparisons were made at three watershed scales (HUC 8 to HUC 12). Groundwater age metrics (young fraction and median age of the young and old fractions) were used for evaluation because they relate to intrinsic susceptibility and are simpler to interpret than full age distributions. Results indicate that: 1. the young fraction can be less sensitive to model layering than the median age of young and old fractions, suggesting that simple models may be adequate for basic intrinsic susceptibility assessments; 2. simulation of water table mounding and associated discharge into partially-penetrating boundaries, such as head-water streams, is important for simulating both the young fraction and the median age of the young fraction of groundwater; and 3. the influence of partially-penetrating head-water streams is maintained regardless of porosity distribution complexity.

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Session 8A:
Aquatic Habitat
Thursday, March 4, 2021
3:15 - 4:30
Moderators: Mike Rupiper and Amanda Bell

Linking Fluvial and Sedimentation Characteristics to Larval Dragonfly Habitat

Amy Johnston,* University of Wisconsin - Parkside, johns262@rangers.uwp.edu
Rachel Headley, UW - Parkside, Geosciences & Center for Environmental Studies
Jessica Orlofske, UW - Parkside, Biological Sciences
Christopher D. Tyrell, Milwaukee Public Museum

Located in Michigan's Upper Peninsula, the Huron Mountain region's rivers express dynamic fluvial processes creating habitat for diverse aquatic life, including sediment burrowing dragonflies (Odonata: Gomphidae). Research was conducted within two watersheds to determine dragonfly distribution. A Surber sampler was deployed in a single transect perpendicular to the flow to collect five replicate benthic invertebrate samples. All invertebrate material was processed in the field and dragonfly larvae were documented per replicate. Gomphid larvae were recorded at four of nine sites with the highest abundance at Rush Creek. Additionally, Wolman pebble counts were conducted, and bed load samples collected were sieved for grain-size characterization. Riverbed sample sizes varied at each site from extra-fine sand to large boulders. Rivers that contained larger rocks and coarse bed load have the potential to provide more habitat for larval gomphids. For example, Rush Creek had a bimodal clast distribution with peaks in coarse sand and medium-to-coarse gravel. Finally, water samples from each site were analyzed. Suspended sediment in the river could alter the chemical composition negatively impacting localized ecosystems. The observed sites had nitrate levels below 0.5mg/L apart from Salmon Trout Road at 1.2mg/L, while Phosphate averaged 1.61mg/L. Total suspended solids (TSS) were negligible at all sites. Bed characteristics will be used to model potential larval dragonfly habitat.

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Chronic Exposure to Thiamethoxam Causes Neurotoxicity in Larval Fish

Tisha King-Heiden, University of Wisconsin - La Crosse, tking-heiden@uwlax.edu
Shayla Michel, UW - La Crosse
Elisabeth Harrahy, UW - Whitewater

Neonicotinoid pesticides are the fastest-growing class of pesticides world-wide. These pesticides are designed to activate the nicotinic receptor of invertebrates, leading to neurotoxicity and death of invertebrate pests. In the Central Sands region of WI, the neonicotinoid thiamethoxam (TM) has been detected in waterways at concentrations that exceed ecological thresholds for chronic exposure, raising concern for aquatic organisms. While TM should pose minimal threat to fish, overstimulation of the nAChR by other neonicotinoids can lead to neurotoxicity in fish. The goal of this work was to determine whether chronic exposure to TM is capable of causing neurotoxicity in larval fish using behavior as a bioindicator. Fathead minnow and zebrafish were exposed to 0.02 – 200 g TM/L for 7 days beginning either just after

* Student presentation.

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fertilization (embryonic exposure) or post-hatch (larval exposure). Embryonic exposure decreased hatching success and survival. Increases in embryonic motor activity indicates that TM is capable of activating fish nAChR. Chronic exposure to TM results in non-monotonic dose-response with respect to predator-avoidance behaviors, specifically with respect to latency of response. Following 14 days of depuration, foraging efficiency was reduced, in a non-monotonic manner. While species-specific differences occurred, overall our data suggests that TM is capable of causing neurotoxicity in fish.

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Feasibility of Wetland Rehabilitation in the Upper Yahara River Estuary

Peter Torma, University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, torma.peter@epito.bme.hu
John R. Reimer, UW - Madison, Dept. of Civil and Environmental Engineering
Chin H. Wu, UW - Madison, Dept. of Civil and Environmental Engineering

Cherokee Marsh is a natural wetland that is located at the Upper Yahara River. The marsh is the largest wetland in Dane County, with a size of 3200 acres. Since 1937 Cherokee has lost more than 640 acres of highly diverse wetlands due to natural and anthropogenic causes, e.g. water level changes, wind waves, land use. As a result, wetland-related ecosystem functions and services have been significantly degraded. In this talk, we will show the shoreline and geomorphological changes through historical aerial photos. Causes of these changes are associated with hydrodynamic circulation patterns and wind wave climates for the past and present states. Feasibilities of restoration in the Cherokee Marsh are proposed, examined, and assessed through various factors like river flows, wave actions, and water temperatures. Potential benefits of the proposed restoration considering sedimentation, water quality, and habitat will be discussed.

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Boat Decontamination as AIS Prevention: Challenges and Successes in Vilas County

Becca Klemme, University of Wisconsin - Oshkosh, klemmer@uwosh.edu
Carmen Thiel, UW Oshkosh

The Clean Boats, Clean Waters program has a goal of sharing the message about aquatic invasive species (AIS) to slow the spread to transient water users. Although sharing the message about AIS is an effective way to prevent the spread of visible AIS, it is not always effective for smaller AIS that are not visible to the naked eye. In 2018, UW Oshkosh Environmental Research and Innovation Center was able to add a decontamination element to partner with the Clean Boats, Clean Waters Internship program in Vilas County in order to help prevent the spread of these tiny AIS. For the past 3 years the goal has been to slow the spread of Spiny Water Flea, a small translucent AIS, by using a trailer-mounted hot water and high-pressure washer unit. The heated pressure washer unit, also known as the boat decontamination unit, has been used at boat landings and fishing tournaments in order to allow lake users to have their boats and other equipment washed and decontaminated upon leaving the lake. Throughout the years, surveys have been administered to participants who have used the decontamination unit. This talk will discuss the UW Oshkosh Environmental Research and Innovation Center Boat Decontamination Program and successes and challenges of the program.

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Program Summary

Problems at the Intersection of Fluid Mechanics and Water Resources

Nimish Pujara, University of Wisconsin - Madison, Dept. of Civil and Environmental Engineering, npujara@wisc.edu

Water motion in the natural environment is part of the puzzle of complex water resources problems. This talk will give a few examples of research at the intersection of fluid mechanics and water resources, including how the settling of particulate matter is altered in wavy flow and how phytoplankton respond to ambient turbulent flow.

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Session 8B:
Hydrogeology
Wednesday, March 3, 2021
3:15 - 4:30
Moderators: Jeff Helmuth and Aaron Pruitt

Correlating Bedrock Folds to Higher Rates of Arsenic Detection in Groundwater, SE Wisconsin, USA

Eric Stewart, Wisconsin Geological and Natural History Survey, UW - Extension, eric.stewart@wisc.edu
Esther Stewart, WI Geological and Natural History Survey, UW - Extension
Kenneth Bradbury, WI Geological and Natural History Survey, UW - Extension
William Fitzpatrick, WI Geological and Natural History Survey, UW - Extension

Arsenic (As) in drinking water wells remains a problem in eastern Wisconsin. While most prior work on bedrock As sources has focused on discrete stratigraphic intervals, less work has been done on the potential role of geologic structures. As part of ongoing bedrock mapping in SE Wisconsin, we are exploring relationships between bedrock structures and As detection in groundwater. Mapping in Dodge and Fond du Lac counties identified a series of 100-200 foot amplitude folds. To assess whether these folds and other variables influence As detection, we ran a step-wise multivariate logistic regression using As concentrations from well water tests available in the WDNR online database. The regression showed that wells near mapped folds have a higher probability of As detection (≥2 µg/L). Additionally, wells drawing water from shallow bedrock were more likely to detect As compared to wells cased deeper. Both results could be related to the probability of the wells drawing water from oxidized bedrock. We hypothesize that increased fracturing associated with folds drives a deeper oxidation front, which may change the dominant host for As from sulfide to Fe-(hydr)oxide. Hydraulic conductivity estimates based on specific capacity tests from the St. Peter sandstone seem to support this model, showing that elevated values are generally restricted to areas near folds. Systematic changes in the As host may drive systematic changes in the probability of As release within the well borehole.

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An Updated Potentiometric Surface for the Confined Sandstone Aquifer in the Northeast Groundwater Management Area of Wisconsin (2019-2020)

John Luczaj, University of Wisconsin - Green Bay, Dept. of Natural and Applied Sciences, luczajj@uwgb.edu

The Northeast Groundwater Management Area (GMA) is located in parts of Brown, Calumet, and Outagamie counties in the confined Cambrian-Ordovician sandstone aquifer. Historically, two cones of depression were located in central Brown County (northern cone) and near the Fox Cities (southern cone). Since 2006, ten communities switched to surface water sources, resulting in water level recovery in the northern cone. The southern cone expanded and deepened over the past two decades. Monitoring water levels in the confined aquifer is a crucial practice because of the importance of this resource. Lack of a monitoring well network in most of the Northeast GMA has resulted in the need to use alternate methods to construct maps.

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[*] Student presentation.

Program Summary

We compiled static water level data for 2019-2020 from well construction reports, well filling & sealing reports, municipal well data, limited USGS data, and known flowing artesian wells. We constructed long-term hydrographs and an updated potentiometric surface map for the confined aquifer. Water levels in the northern cone continue to rise, and flowing artesian wells occur in northwestern Green Bay and areas to the north. A remnant of the northern cone remains southeast of Green Bay, and a shallow cone has developed in far northeastern Brown County. The southern cone appears mostly stable, with water levels stable or rising in some cities, and falling in others. Kimberly and Little Chute continue to see record low water levels over the past few years.

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Wisconsin Karst: Northeast Versus Southwest. What's the Same and What's Different?

Maureen Muldoon, Wisconsin Geological and Natural History Survey, muldoon@wisc.edu
Kenneth Bradbury, WI Geological and Natural History Survey

Karst is defined as a landscape created when water dissolves carbonate rocks, such as dolomite and limestone. Karst potential in Wisconsin occurs in a U-shaped pattern that extends southeast from St. Croix County along the Mississippi River, across the southern two tiers of counties, and northeast along Lake Michigan up to Marinette County. In eastern Wisconsin, karst develops within the Silurian dolomite aquifer. In western Wisconsin, karst forms within both the Sinnipee Group and Prairie du Chien dolomites. Long-term research in northeastern Wisconsin and the ongoing Southwest Wisconsin Geology and Groundwater (SWIGG) project provide opportunities to compare and contrast these karst aquifers. Both aquifers have a high percentage of wells not meeting drinking water quality standards for nitrate and/or total coliform bacteria. Flow along bedding-plane fractures appears significant in both aquifers, and both can contain perched flow systems over some portions of the aquifer.

While there are some similarities between these karst aquifers, there are significant differences in the topography, lithostratigraphy, structural geology, and geologic history between the two areas of the state. All of these factors contribute to differences in hydrogeology. Our understanding of Silurian aquifer characteristics and recharge dynamics may not be transferable to the southwestern part of the state. It is likely that these aquifers will require different protection strategies.

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Hydrologic and Geochemical Dynamics of the Karstic Aquifer Supplying Laguna Bacalar, Yucatan, Mexico

Tim Grundl, University of Wisconsin - Milwaukee, Dept. of Geosciences, grundl@uwm.edu
Ryan Matzuk, UW - Milwaukee

Laguna Bacalar is the second largest lake in Mexico. The lake occupies a topographic low that breaches the water table and as such provides insight into the dynamics of groundwater flow through this karstic system. Recently, the lake and the city of Bacalar have gained international attention because of the unique presence of large freshwater stromatolites. While fueling a growing tourism industry, this is threatening the health of this pristine freshwater ecosystem.

The lake averages 10m in depth and inflow is entirely supplied by groundwater upwelling out of deep cenotes found along the shoreline. Outflow is dominated by a surface water outlet in the southern portion of the lake. Lake water is strongly Ca-SO_4 in nature and is at saturation with gypsum and amorphous silica. The primary chemical processes controlling lake chemistry include influx of high alkalinity/high CO_2 groundwater in the southern portion, CO_2 evolution and a resultant pH

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rise and calcite precipitation. A minimum of 2.3E8 +1.9E7 m3/yr (7.3 + 0.6 m3/sec) of groundwater exits from a series of 5 cenotes. The largest cenote precipitates 4.0E7 kg/yr of calcite and exsolves 4.5E7 kg/yr of CO2. 13C isotopes indicate that 49% of this CO2 is modern and 51% is fossil CO2. The northern portion of the lake is dominated by evaporation with lesser groundwater influx. Residence times are ~120 days in the southern, well-flushed portion whereas the more stagnant northern portion has residence times of several years.

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Program Summary

Session 9A:
Groundwater Quality
Thursday, March 4, 2021
4:30 - 5:30
Moderators: Eric Booth and John Luczaj

Microbially-Mediated Oxidation of Trace Element-Bearing Sulfide Minerals in Sandstones of Trempealeau County, WI

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Iron disulfide (pyrite) mineral oxidation in circumneutral pH (subsurface) environments is a relevant groundwater quality subject for Wisconsin's sandstone and carbonate Cambrian-Ordovician aquifer system. This aquifer system has been observed to host varying abundances of metal-sulfide minerals, such as pyrite, across Wisconsin. Pyrite can oxidize, or degrade, when exposed to oxygenated groundwater or earth-surface conditions. Acid is generated during this reaction and could exceed the buffering capacity of the groundwater. Divalent metal(loid)s go into solution in acidic environments. We carried out ex situ microcosm experiments, monitoring chemical and biological parameters indicative of active, microbial pyrite oxidation (sulfate production, pH, cell viability). The microcosms contained ceramic-pulverized ex situ sandstone with either natural, negligible, or spiked abundances of pyrite with unadulterated groundwater containing live bacteria. Groundwater was collected from a private well pumping from same geologic unit(s) as the geologic material in the experiment.

One microcosm treatment showed a 5x greater rate of sulfate production (0.2 to 3 mM) in circumneutral pH after 86 days in live microcosms with natural abundance of pyrite compared to their abiotic controls. 16S rRNA genes was extracted from that treatment identified eletroautotrophic- and chemolithotrophic-like bacteria. Results imply accelerated microbially-mediated pyrite oxidation in circumneutral pH.

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Water Quality Indicators of Human Impacts to the Wetlands of Door Co., WI

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Sarah Gatzke, The Nature Conservancy
Michael Grimm, The Nature Conservancy
Van Helden Nicole, The Nature Conservancy

Poor quality groundwater discharging to a wetland can alter its ecology and negatively affect native plant and animal communities. In Door County there is a concern that groundwater nutrient and contaminant loading to interior and coastal wetlands may support the invasion and spread of aggressive non-native plants and impair habitat conditions that support rare species such as federally endangered the Hine's Emerald Dragonfly.

* Student presentation.

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We selected six representative wetlands in Door County that receive significant groundwater discharge. We sampled springs discharging directly to the wetlands for major ions, nitrate, phosphorus, metals, caffeine, artificial sweeteners, enterococci, and pesticides. The contributing zones to the springs were determined and the residential density and percentage of cropland and corn in the contributing zones were identified. We calculated the correlations between water quality, human and agriculturally sourced contaminants, residential density, percent cropland, and percent corn

We found that 1) percent cropland and corn in the contributing areas are correlated to higher nitrate concentrations and higher probability of pesticide detects, and 2) housing density in the contributing areas is correlated to a greater number of detects of caffeine and sweeteners and higher groundwater phosphorus concentrations. These correlations indicate a need for careful land use planning near these groundwater fed wetlands.

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Using Acesulfame to Determine Septic System Impact to Wisconsin Lakes

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Artificial sweeteners such as acesulfame in groundwater are helpful indicators of human waste source contamination in water. Acesulfame enters the groundwater through septic system effluent and is later carried to surface waters. Acesulfame's slow rate of decay allows for it to persist in groundwater and to be found in measurable concentrations in lakes across Wisconsin. The purpose of this study is to determine the relative contribution of septic system effluent to the water budget of a lake by measuring the concentrations of acesulfame in lake water. Since septic system usage and impact on surface water quality is difficult to estimate, we sought to develop a chemical method that accurately quantifies the concentration of acesulfame in the water and reveals the impact of septic system drainage to the lakes' water budgets. Laboratory methods were refined to improve the recovery of acesulfame through solid phase extraction by pH adjustment and addition of ethylenediaminetetraacetic acid (EDTA) with liquid chromatography–mass spectrometry (LC/MS) analysis. In this study, surface water samples were collected from lakes in central Wisconsin. The concentrations of acesulfame from the lakes will be compared to septic system density and groundwater inflow. Lakes near areas with high septic system density relative to the amount of the lake's inflow are expected to contain higher concentrations of acesulfame.

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[*] Student presentation.

Session 9B:
Contaminants
Thursday, March 4, 2021
4:30 - 5:30
Moderators: Mitch Olds and Pete Lenaker

Importance of Childhood Pb Exposure from Food Crops Grown in Contaminated Residential Soils Versus Exposure from Soil/Dust or from Drinking Water

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Lindsay Mchenry, UW - Milwaukee

Pb exposure causes poor health outcomes particularly in young children. In food-insecure areas, growing fresh produce in residential gardens is one option for parents; however, commonly grown crops accumulate Pb when grown in metals-rich soils. Produce crops were grown in soils from two metals-contaminated urban vegetable gardens, a former metal foundry, and commercial topsoil. Wavelength dispersive X-ray fluorescence and portable energy dispersive X-ray fluorescence quantification routines were developed that allowed detection of Pb at levels relevant to health standards (0.3 ppm). Accumulation of Pb in consumable tissues was the greatest in vegetables with a modified taproot (turnip, beetroot, radish, carrot), with lesser concentrations in fruits (tomato, pepper), and produce grown on modified stems (potato).
The primary sources of childhood Pb exposure in impoverished urban settings are ingestion of a) contaminated soil/dust; b) food grown in contaminated soil and c) contaminated drinking water. The relative importance of these three sources was evaluated under a variety of scenarios likely to be encountered in urban settings. Ingestion of contaminated soil/dust was the most important, followed by ingestion of food grown in contaminated soil. No scenario was found in which exposure via Pb contaminated water was a dominant factor. This result calls into question the relative economic benefit of Pb pipe removal as a means of reducing the incidence of Pb poisoning.

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Laboratory Contaminants in Microplastic Analysis

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Kim Fredericks, UW - Oshkosh
Caroline Greenberg, UW - Oshkosh

Microplastics are a growing pollutant of concern worldwide. This plastic debris has accumulated in our water bodies and sediments causing a negative impact on our aquatic environments. Because microplastics are becoming so widespread, contamination in the laboratory is becoming more prevalent. Examples of areas of concern are: laboratory equipment, clothing, indoor air, deionized water, etc. Because of this, taking the extra precaution in laboratory analysis is required to avoid lab contamination. Main points to be covered: the laboratory analysis; potential contaminant sources; and contamination prevention.

[Program Summary]

From Rivers to Lakes - The Movement and Distribution of Microplastics from Tributaries to the Great Lakes

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Steve Corsi, US Geological Survey, Upper Midwest Water Science Center
Sherri Mason, Penn State Behrend
Austin Baldwin, US Geological Survey, Idaho Water Science Center

The presence of microplastics has been documented in the Great Lakes and their tributaries. The distribution of particle types (fibers, fragments, beads/pellets, films, foams) have been found to vary in the water surface with a low proportion of fibers (< 14%) in Great Lake water and high proportion (> 70%) in the tributaries. Despite knowledge of microplastic presence, little is understood about the distribution and fate of microplastics in the Great Lakes. Two follow-up studies were conducted to understand the distribution and fate of microplastics in the Great Lakes: (1) evaluate the vertical distribution of microplastics in the water column in rivers, estuaries and nearshore Lake Michigan; (2) quantify microplastics in sediment samples from Lake Michigan and Lake Erie. Microplastics of all types, were observed in every sediment and water sample collected. Microplastic particles were distributed throughout the water column and sediment with increasing particle density from the water surface through the water column to the sediment. Results indicate that the discrepancy between high proportions of fibers in the water surface of the tributaries compared to the Great Lakes is explained by fibers settling through the water column and into the sediments. These studies provide progress towards understanding the distribution and movement of microplastics in the aquatic environment, key information for future assessments of potential effects on aquatic life.

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Initial State-wide Survey Results from the Wisconsin Department of Natural Resources (WDNR) Per- and Poly-Fluorinated Alkyl Substances (PFAS) Monitoring of Surface Water and Fish Tissue

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Michael Shupryt, WI Dept. of Natural Resources
Mehgan Williams, WI Dept. of Natural Resources
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In 2019, the Wisconsin Department of Natural Resources initiated pairwise sampling for PFAS in water and fish at major rivers throughout the state (e.g., Mississippi River, Wisconsin River, Menominee River, and others). The results of this statewide sampling effort would contribute to three important PFAS-related initiatives: 1) assessing the distribution of PFAS in the environment, 2) rulemaking efforts to develop surface water standards for perfluoro-octane sulfonic acid (PFOS), and perfluorooctanoic acid (PFOA), and 3) determining the need for PFOS-related fish consumption advisories. Both water and fish were sampled at multiple sites within rivers, and water was sampled at three different dates. Samples were analyzed for up to 36 PFAS compounds, to not only measure compounds for consumption advisories (i.e., PFOS), but also survey for the presence or absence for potential precursor compounds or compounds associated with potential anthropogenic uses. Concentrations of quantifiable PFOS ranged from 0.6 to 43.0 ng/L in water and 2.0 to 180 ng/g in fish. Differences were observed between and within river sites, as well as compound diversity. Differences between sites for PFOS concentration in water and fish, and their respective calculation bioaccumulation factors, suggest differences in bioaccumulation at these sites, which will require further sampling and study.

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