35TH ANNUAL MEETING

PROGRAM AND ABSTRACTS

Wisconsin's Role in Great Lakes Restoration

MARCH 3 & 4, 2011

RADISSON PAPER VALLEY HOTEL | APPLETON, WI

American Water Resources Association – Wisconsin Section

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.

AMERICAN WATER RESOURCES ASSOCIATION – WISCONSIN SECTION

35th ANNUAL MEETING

Wisconsin's Role in Great Lakes Restoration

March 3 - 4, 2011

Radisson Paper Valley Hotel
Appleton, Wisconsin

Hosts:
American Water Resources Association-Wisconsin Section
University of Wisconsin Water Resources Institute
Wisconsin Department of Natural Resources
Center for Watershed Science & Education, UW-Stevens Point
Wisconsin Geological and Natural History Survey
U.S. Geological Survey Wisconsin Water Science Center

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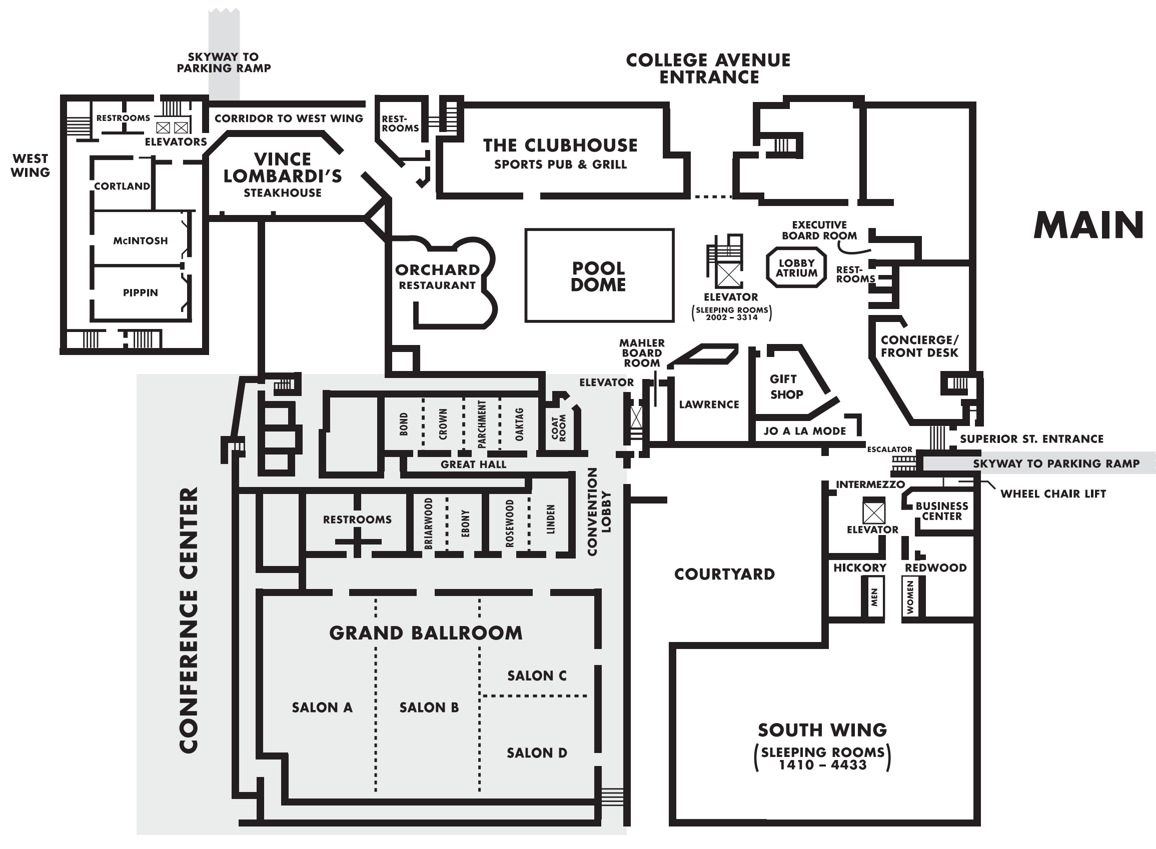

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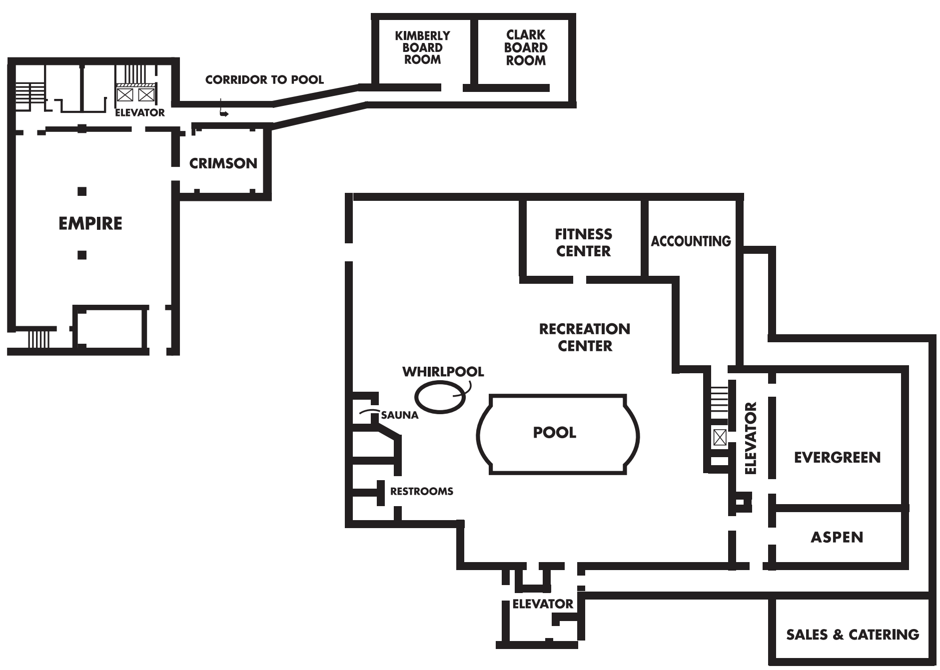

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The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management. The success of the Section is due in part to the dedication of past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

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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 other responsibilities related to the annual conference.

Vice-President (1-year term)

Shall perform the duties of 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 and assisting with the technical program review. Other miscellaneous duties as assigned.

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

Shall keep the minute of the Section's meetings, shall issue notices of meeting, 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 if financial affairs.

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PROGRAM SUMMARY

Wisconsin's Role in Great Lakes Restoration

35th Annual Meeting of the American Water Resources Association – Wisconsin Section

Appleton, Wisconsin

Thursday, March 3, 2011

9:00 a.m. - 2:15 p.m.	Registration
11:30 a.m. - 12:15 p.m.	Welcome and Lunch – Salon B
12:15 – 12:30 p.m.	Business Meeting – Salon B
12:30 – 2:00 p.m.	**Plenary Session**: Wisconsin's Role in Great Lakes Restoration

Cameron Davis
Senior Advisor to the U.S. Environmental Protection Agency Administrator on the Great Lakes
U.S. Environmental Protection Agency
Taking the Initiative: Where We Have Been, Where We Still Need to Go

Steve Galarneau
Director, Office of the Great Lakes
Wisconsin Department of Natural Resources
A Watershed Time for the Great Lakes

Greg Kleinheinz
Director, Environmental & Public Health Microbiology Laboratory
University of Wisconsin - Oshkosh
Great Lakes Beaches: From Data Collection to Redesign

2:00 – 2:15 p.m.	**Break**
2:15 – 3:35 p.m.	**Concurrent Sessions 1A and 1B**

Plenary Speakers' Biographies

Cameron Davis is the Senior Advisor to the U.S. Environmental Protection Agency Administrator on the Great Lakes In that capacity he provides counsel to Administrator Lisa Jackson on the Obama Administration's Great Lakes Restoration Initiative. His job includes coordinating Great Lakes policy and funding initiatives with more than one dozen federal agencies and with state, municipal, tribal, business and civic stakeholders. The focus of this work involves restoring habitat, reducing pollution, preventing the introduction of invasive species, reducing runoff and enhancing coastal health for people, fish and wildlife.

For more than two decades, Mr. Davis has worked to develop and implement water quality and quantity policy. Starting as a volunteer, he served as a litigating attorney and law teacher at the University of Michigan Law School before serving as president and CEO of the Alliance for the Great Lakes. Under his leadership, the organization won the American Bar Association's Distinguished Award in Environmental Law & Policy, the first time for a public interest organization in the honor's history. He earned his law degree, including certification in environmental and energy law, from the Chicago-Kent College of Law and a B.A. from Boston University in International Relations. He is the author of Confluence (BookSurge 2009), the first of a new genre, the "genoir."

While working in Washington, D.C., Chicago and throughout the eight Great Lakes states, Cam lives across the street from Lake Michigan with his wife, Dr. Katelyn Varhely, and son, where they try to swim in the lake several times a week, but only when it's warm enough.

Steve Galarneau is Director of the Office of the Great Lakes in the Department of Natural Resources. As Director, Mr. Galarneau serves as the State representative in multi-state and international management issues for the Great Lakes. Mr. Galarneau holds a MS in biology from the University of Wisconsin Milwaukee, Center for Great Lakes Studies.

Greg T. Kleinheinz, Ph.D. is a Professor and Director of the Environmental and Public Health Microbiology Laboratory and Associate Dean of the College of Letters and Science at University of Wisconsin Oshkosh. Dr. Kleinheinz received a B.S. in Biology from Northern Michigan University and a Ph.D. in Environmental Microbiology from Michigan Technological University. He was elected president of the Great Lakes Beach Association in 2009 and since 2008 has served as chair of the UW Solid Waste Research Council. Dr. Kleinheinz received a Presidential Citation Award from the Wisconsin Environmental Health Association in 2008. He is currently an Editorial Board Member for the Open Civil Engineering Journal. His research interests include identification and mitigation of microbial pollution sources at Great Lakes beaches. Dr. Kleinheinz and his colleagues are leaders in the area of pollution source identification at Great Lakes beaches. He has published over 35 papers in the field of environmental microbiology. His research has been funded by US DOE, US EPA, UW Solid Waste Research Program, WI DNR, WI Department of Health, and numerous corporate sponsors.

Session 1A – Biological and Chemical Contaminants

Salon C
Moderator: John Panuska, University of Wisconsin-Extension

2:15	Modern Statistical Methods for Predicting Bacterial Exceedances in Beach Water. Wesley Brooks**
2:35	Effects of Starvation on the Transport of *Escherichia Coli* K12 in Saturated Porous Media are Dependent on pH and Ionic Strength. Lucia Feriancikova**
2:55	Geochemical Indicators of Sanitary Sewer Effluent Transport into Deep Water Supply Wells in Madison, Wisconsin. Christopher A. Gellasch**
3:15	The Importance of Quantifying Gas Generation and Migration in Contaminated Sediments. Nathaniel R. Keller

Session 1B – Advances in Hydrologic Technology and Resources

Salon D
Moderator: Joe Dorava, Vierbicher Associates

2:15	Using Online Video To Tell People about Wisconsin's Water Resources. John Karl
2:35	Finding the Source: Fingerprinting of Suspended Sediment in Lower Fox River Wisconsin Tributaries. Paul D. Baumgart
2:55	Using Heated Distributed Temperature Sensing to Monitor Soil Water. Arlen M. Striegl**
3:15	Evaluation of Turf- Grass and Prairie- Vegetated Rain Gardens in a Clay Soil. William R. Selbig

3:35 – 3:55 p.m. **Break**

3:55 – 5:35 p.m. **Concurrent Sessions 2A and 2B**

Session 2A – Hydrogeologic Modeling

Salon C
Moderator: George Kraft, University of Wisconsin-Stevens Point

3:55	Groundwater Availability in the Lake Michigan Basin. Daniel T. Feinstein
4:15	Simulation of Groundwater / Lake-Water Interaction at Shell Lake, Washburn County, WI. Paul F. Juckem
4:35	Development of a Revised Groundwater Flow Model for Dane County, WI. Michael Parsen
4:55	Integrated Interpretation of Borehole Flow, Aquifer-Test Results, and Spring Discharge—Culver Springs, Wisconsin. Michael N. Fienen
5:15	Well Log and Geophysical Analysis for Creation of Hydrostratigraphic Models, Outagamie County, WI. Kallina M. Dunkle**

Session 2B – Agricultural Management

Salon D
Moderator: Birl Lowery, University of Wisconsin-Madison

3:55	Discovery Watersheds: Broadening the Scope of On-farm Research in Wisconsin. Amber Radatz
4:15	Soil Moisture and Rainfall Intensity Thresholds for Runoff Generation in Southwestern Wisconsin Agricultural Basins. Timothy F. Radatz
4:35	Characterizing Phosphorus Dynamics in Eastern Wisconsin Tile-Drained Agroecosystems. Allison M. Madison**
4:55	Evaluation of the Effects of Agricultural Best Management Practices on the Quality of Joos Valley and Eagle Creeks in Buffalo County, WI. Roger T. Bannerman
5:15	Mapping Carbonate Bedrock Surfaces in Glaciated Landscapes to Enhance Management Decisions. Eric Cooley

5:35 p.m. **Refreshments – Salon A**

6:00 p.m. **Dinner – Salon B**

Speaker: Greg Summers, Associate Professor of History, University of Wisconsin – Stevens Point

Greg Summers is an Associate Professor of History at the University of Wisconsin-Stevens Point, where he teaches American environmental history. He received his Ph.D. from the University of Wisconsin-Madison in 2001. He has published a book entitled *Consuming Nature: Environmentalism in the Fox River Valley, 1850-1950.* He is currently at work on a second book called The Comforts of Nature: A Natural History of the American Home.

His presentation is entitled: *Consuming Nature: Environmentalism in the Fox River Valley, 1850-1950*

7:45 p.m. **Poster Session and Dessert Social – Salon A**

1. Combination of Hydrous Iron Oxide Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water. Zhaohui Li
2. Removal of Arsenic and Chromium from Water Using Fe-Exchanged Zeolite, Caren J. Ackley*
3. Removal of Methylene Blue from Water by Swelling Clays. Sam Leick*
4. Optical Fiber-Based Tools for the Measurement of Zinc Concentrations in Aqueous Environments. Steve Kopitzke**
5. Accumulation of Heavy Metals in Stormwater Retention Facilities. Rachel E. Carver*
6. Analysis of the Chloride Concentration of the Pike River in Southeastern Wisconsin. Kyle S. Boron*
7. Influence of Regional Mercury Sources on Lake Michigan Tributaries: 15-Year Comparison. Christopher Babiarz
8. Evaluating Water Level and General Water Quality Data of Three Wetland Areas in the Albion Basin and Little Cottonwood Creek, Alta, Utah. Roberta A. MacDonald*
9. Over 20 Years of Well Water Testing: Increasing Capacity for Groundwater Education and the Building of a Well Water Quality Summary Tool. Kevin Masarik
10. Desorption of Phosphorus from Stream Sediments and the Impact on Stream Concentrations. Amy A. Timm**
11. Snowmelt Export of Phosphorus from Cropland: Edge-of-Field Runoff Monitoring Results from Pioneer Farm in Southwest Wisconsin. Randy S. Mentz
12. Proposed Methods for Quantifying Groundwater Contribution to Surface Water Resources, Park Falls District-Chequamegon National Forest, WI. Aaron H. Pruitt**

13. Using Geophysics to Compare the Subsurface Soils and Water Content of Turf Grass and Prairie Vegetated Rain Gardens. Alex R. Summitt

14. A Hydrogeophysical Study of the Fox River South of Waukesha, WI. Michael S. Baierlipp**

15. Preliminary Hydrogeologic Characterization Mink River Estuary – Water Chemistry and Flow. Maureen A. Muldoon

16. Preliminary Hydrogeologic Investigation Mink River Estuary -- Bedrock and Surficial Geology. Jack B. Borski*

17. Evaluating Hydrostratigraphic Boundaries in a Heterogenous Aquifer: an example from Vilas County, WI. Catherine I. MacLaurin**

18. Evaluating Soil Stability within Wetland Treatment Swales for Urban Runoff. Stephanie G. Prellwitz**

19. How High Will The Water Rise? Flooding of the Duck Creek Quarry as an Unintended Consequence of Deep Aquifer Recovery (Brown County, Wisconsin). John A. Luczaj

20. Hydrodynamic Drag of Native Wisconsin Wetland Plant Species. Zachariah P. Zopp

21. Climate Change Impacts on Wisconsin's Water Resources. Carolyn Rumery Betz

22. Long-term- Hydrologic Impacts of Land Use and Climate Change Across Wisconsin. Theresa M. Possley

23. *Nowcasting* Water-Quality at Great Lakes Beaches. Kyle R. Minks

<u>Friday, March 4, 2011</u>

7:00 – 8:00 a.m. AWRA- Wisconsin Section Board of Directors' Breakfast Meeting – Briarwood Room

8:20 – 10:00 a.m. **Concurrent Sessions 3A and 3B**

Session 3A – Groundwater Studies

Salon C
Moderator: Robert S. Stelzer, University of Wisconsin-Oshkosh

8:20 Assessing the Effect of Pleistocene Glaciation on the Water Supply of Eastern Wisconsin. Nathan C. Magnusson**

8:40 Spatio-temporal Relationship between Groundwater Recharge and Urbanization: Waukesha County, Wisconsin. Ulrike Galasinski

9:00 Surface Water/Groundwater Interactions in SE Wisconsin. Travis A. King**

9:20 Slow-Release Fertilizer Effect on Groundwater Nitrogen Concentration in Sandy Soils under Potato Production. Nicholas J. Bero**

9:40 Denitrification of Groundwater Nitrate in a Central Wisconsin River Network. Robert S. Stelzer

Session 3B – Climate Change and Wisconsin's Water Resources

Salon D
Moderator: Steve Loheide, University of Wisconsin-Madison

8:20 Climate Change and Wisconsin's Water Resources: Results of WICCI's First Adaptation Strategy Report. Tim Asplund

8:40 Using Risk Calculations to Support Climate Change Adaptation in Wisconsin. Zachary Schuster**

9:00 Climate Variability and Groundwater Recharge in Southwest Wisconsin. Madeline B. Gotkowitz

9:20 Evaluating Changes to Wisconsin Evapotranspiration under a Future Climate. Douglas R. Joachim**

9:40 Predicting Wetland Plant Composition Based on Soil Moisture Regime Using a Quasi-3D Variably-Saturated Groundwater Flow Model. Eric G. Booth**

10:00 – 10:20 a.m. **Break**

10:20 – 11:40 a.m. **Concurrent Sessions 4A and 4B**

Session 4A – Great Lakes Restoration and Research

Salon C
Moderator: Kevin Fermanich, University of Wisconsin-Green Bay

10:20 USGS Great Lakes Restoration Initiative Projects in Wisconsin. Charles A. Peters.

10:40 The Wisconsin Coastal Atlas: Building the Coastal Spatial Data Infrastructure to Promote Restoration and Stewardship of the Great Lakes. David A. Hart

11:00 Using Microsatellite Markers to Characterize the Genetic Diversity of Wild Rice in Great Lakes Coastal Habitats: Implications for Restoration. Anthony J. Kern

11:20 Spatial Narratives of the St. Louis River Estuary: Deep Mapping in Estuarine Research. Janet Silbernagel

Session 4B – Watershed and Wetland Management

Salon D
Moderator: David J. Hart, Wisconsin Geological and Natural History Survey

10:20 Kinnickinnic River Flood Management and Watercourse Rehabilitation. Ryan P. Van Camp

10:40 Prioritizing Barrier Removal and Restoring Stream Connectivity in the Pensaukee-Duck Watershed. Jeffrey T. Maxted

11:00 BioHaven Floating Islands: Restoring Near Shore Health and The Future of Habitat Management. David A. Wentland.

11:20 Geophysical Survey of an Arsenic Contaminated Site in the Kewaunee Marsh, Kewaunee, WI. David J. Hart

11:40 – Close **Closing Remarks and Announcement of Student Award Winners – Salon C and D.**

* Undergraduate student presentation

** Graduate student presentation

SESSION 1A:

Biological and Chemical Contaminants

Thursday, March 3, 2011

2:15 – 3:55 p.m.

Modern Statistical Methods for Predicting Bacterial Exceedances in Beach Water

**Wesley Brooks, USGS Wisconsin Water Science Center, Middleton, WI, *wrbrooks@usgs.gov*

Michael N Fienen, USGS Wisconsin Water Science Center, Middleton, WI, *mnfienen@usgs.gov*

Steven R Corsi, USGS Wisconsin Water Science Center, Middleton, WI, *srcorsi@usgs.gov*

Beaches on the Great Lakes are posted with warnings against bathing based on the concentration of *E. coli*, which indicates the possible presence of human pathogens. Because direct measurement of *E. coli* concentration takes 24 hours, it is common to "nowcast" the *E. coli* concentration using a regression model that relates the concentration to a suite of readily available surrogate variables, like rainfall and hydrodynamic conditions.

Most such models use ordinary least squares (OLS) regression; since the surrogate variables are generally correlated, the model produced by OLS is not unique, which makes model selection difficult and negatively impacts the utility of the model in prediction of novel observations. This study applies modern regression and model selection methods to the problem of nowcasting *E. coli* concentration, with the goal of producing an automated software tool that makes model building easy and objective, and that outperforms existing options.

Among the methods considered in this study are partial least squares regression, logistic regression, spline regression, least-angle regression, and support vector machines. Data sets for three beaches are used to validate our methods. Predictive models are generated from past beach seasons and then used to predict exceedances during the test season. Focus is placed on methods that predict whether or not the *E. coli* concentration exceeds a specified action threshold; performance is measured by the rates of false positives and false negatives.

** Graduate student presentation

Effects of Starvation on the Transport of *Escherichia Coli* K12 in Saturated Porous Media are Dependent on pH and Ionic Strength

**Lucia Feriancikova, Department of Geosciences, UW-Milwaukee, Milwaukee, WI, *lucia@uwm.edu*

Shangping Xu, Department of Geosciences, UW-Milwaukee, Milwaukee, WI

Jacob J Walczak, Department of Geosciences, UW-Milwaukee, Milwaukee, WI

Lixia Wang, Department of Civil Engineering and Mechanics, UW-Milwaukee, Milwaukee, WI

Sonia L. Bardy, Department of Biological Science, UW-Milwaukee, Milwaukee, WI

Jin Li, Department of Civil Engineering and Mechanics, UW-Milwaukee, Milwaukee, WI

In this research, we investigate the effects of starvation on the transport of E. coli K12 in saturated porous media. Particularly, we examine the relationship between such effects and the pH and ionic strength of the electrolyte solutions that were used to suspend bacterial cells. E. coli K12 (ATCC 10798) cells were cultured using either Luria-Bertani Miller (LB-Miller) broth (10 g trypton, 5 g yeast extract and 10 g NaCl in 1 L of deionized water) or LB-Luria broth (10 g tryptone, 5 g yeast extract and 0.5 g NaCl in 1 L of deionized water). Both broths had similar pH (~7.1) but differed in ionic strength (LB-Miller: ~170 mM, LB-Luria: ~ 8 mM). The bacterial cells were then harvested and suspended using one of the following electrolyte solutions: phosphate buffered saline (PBS) (pH ~7.2; ionic strength ~170 mM), 168 mM NaCl (pH ~5.7), 5% of PBS (pH ~ 7.2; ionic strength ~ 8 mM) and 8 mM NaCl (pH ~ 5.7). Column transport experiments were performed at 0, 21 and 48 hours following cell harvesting to evaluate the change in cell mobility over time under “starvation” conditions. Our results showed that 1) starvation increased the mobility of E. coli K12 cells; 2) the most significant change in mobility occurred when bacterial cells were suspended in an electrolyte solution that had different pH and ionic strength (i.e., LB-Miller culture suspended in 8 mM NaCl and LB-Luria culture suspended in 168 mM Nacl); and 3) the change in cell mobility primarily occurred within the first 21 hours. The size of the bacterial cells was measured and the surface properties (e.g., zeta potential, hydrophobicity, cell-bound protein, LPS sugar content, outer membrane protein profiles) of the bacterial cells were characterized. We found that the measured cell surface properties could not fully explain the observed changes in cell mobility caused by starvation.

** Graduate student presentation

Geochemical Indicators of Sanitary Sewer Effluent Transport into Deep Water Supply Wells in Madison, Wisconsin

**Christopher A. Gellasch, Department of Geoscience, University of Wisconsin-Madison, Madison, WI,*gellasch@wisc.edu*

Kenneth R. Bradbury, Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, Madison, WI, *krbradbu@wisc.edu*

Jean M. Bahr, Department of Geoscience, University of Wisconsin-Madison, Madison, WI, *jmbahr@geology.wisc.edu*

Ongoing research by the Wisconsin Geological and Natural History Survey has demonstrated the presence of human enteric viruses in several Madison, WI municipal wells. The upper aquifer (Tunnel City Group and Wonewoc Formation) and lower aquifer (Mount Simon Sandstone) are separated by the Eau Claire aquitard. These wells are the drinking water source for the City of Madison, are typically 700 to 900 feet deep, are cased through the aquitard, and draw water from the lower aquifer. We suspect these viruses are in the lower aquifer, but do not yet understand the transport pathways from the surface to the lower aquifer. The most likely source of these viruses is effluent from leaking sewer lines.

The goal of the current project is to identify transport pathways that facilitate movement of sewer effluent into the deep, confined aquifer. One aspect of the research involves sampling groundwater above and below the Eau Claire aquitard for major ions, metals and electrical conductivity. Samples were collected from the deep municipal well, upper aquifer monitoring wells, and sanitary sewer. Resulting data were analyzed using Piper and Stiff diagrams to identify trends that suggest relationships between sewer effluent and groundwater samples. Conductivity and major ion data, including chloride, bromide, and chloride/bromide ratios, were analyzed for trends. When coupled with other methods, geochemical analysis of sewer and groundwater samples is a useful tool to achieve the goal of identifying preferential groundwater transport pathways of sewer effluent.

** Graduate student presentation

The Importance of Quantifying Gas Generation and Migration in Contaminated Sediments

Nathaniel R. Keller, RMT Inc., Madison, WI, *nate.keller@rmtinc.com*

Ted M. O'Connell, RMT Inc., Madison, WI, *ted.oconnell@rmtinc.com*

Eugene L. McLinn, RMT Inc., Madison, WI, *gene.mclinn@rmtinc.com*

Thomas R. Stolzenburg, RMT Inc., Madison, WI, *tom.stolzenburg@rmtinc.com*

Recent work by RMT at a number of contaminated sediment sites has shown that ebullition (biogenic gas generation) within sediment can cause migration of chemical contamination (specifically in NAPL form) into the overlying water column. This mechanism, which has previously not been recognized, is a critical parameter in remedy selection and design. Biogenic gas from sediments can cause functional failure of sediment caps. Examples of ebullition driven NAPL transport, cap failure, and gas quantification will be discussed. This talk will specifically focus on the means and methods currently being researched and used to measure gas generation from sediments. Gas generation measurement is much more challenging than other typically-measured sediment parameters, such as contaminant concentration, bulk sediment properties, or even dissolved transport. Gas generation poses unique scaling issues, spatial and temporal variations, and sampling device design challenges. This presentation will showcase a number of approaches that are being tested.

SESSION 1B:

Advances in Hydrologic Technology and Resources

Thursday, March 3, 2011

2:15 – 3:55 p.m.

Using Online Video to Tell People about Wisconsin's Water Resources

John Karl, UW-Madison Water Resources Institute, Madison, WI, *jkarl@aqua.wisc.edu*

Many Wisconsin citizens and businesses have little understanding of our state's water resources: Where does our water come from? How much do we have? How clean is it? To help people better understand these issues and the challenges we face in managing them, the UW Water Resources Institute has begun a project to make accessible, educational videos of each of the projects it funds.

The videos are hosted by You Tube and are embedded in the online version of the *Aquatic Sciences Chronicle*, the newsletter of the UW Aquatic Sciences Center, which houses the UW Water Resources Institute and the UW Sea Grant Institute. Topics to be addressed in the video series include fecal source tracking in well water, using temperature sensing to characterize flow through wells, removing arsenic from water with Zeolite filtration, forecasting impacts on groundwater of extreme precipitation events, and many others.

This session will present two four-minute videos. The producer will briefly describe the production of the videos and distribution plans for them. Discussion will be encouraged about the clarity, accessibility, and usefulness of the videos and additional distribution ideas. Here are two samples:

Testing Well Water for Microorganisms

www.youtube.com/uwasc#p/u/6/ey-xqU0i9PI

A New Measure of Groundwater Flow

www.youtube.com/uwasc#p/u/7/gOBCnZGpSiU

Finding the Source: Fingerprinting of Suspended Sediment in Lower Fox River Wisconsin Tributaries

Paul D. Baumgart, University of Wisconsin – Green Bay, Green Bay, WI, *baumgarp@uwgb.edu*

J. Val Klump, Great Lakes WATER Institute, University of Wisconsin-Milwaukee, Milwaukee, WI, *vklump@uwm.edu*

Kevin J. Fermanich, University of Wisconsin – Green Bay, Green Bay, WI, *fermanik@uwgb.edu*

Identifying the primary sources of suspended sediment is vital to understanding how management strategies can be developed to target reductions necessary to achieve desired water quality objectives in Lower Fox River tributaries, and ultimately Green Bay. This study utilized fingerprinting techniques and the radionuclides Be-7, Pb-210 and Cs-137 as tracers to investigate the sources and fate of suspended sediments in agricultural and urbanizing watersheds within the Lower Fox River sub-basin.

Time-integrated suspended sediment tube samplers were deployed in eight streams to collect sufficient sample mass for radionuclide analysis during runoff events from 2006 to 2010. Where possible, samplers were placed near an existing USGS monitoring station so that continuous flow and daily calculated TSS and TP loads could be compared to the sediment tube samples. Stream bank samples and both upland soil cores and sub-soil cores from agricultural fields served to characterize potential source materials. Sediment core samples were collected from urban detention ponds to assess both the potential fate and source of sediment. Cores from detention ponds and surface soils were sectioned and analyzed accordingly. The results of our fingerprinting analysis will be presented in terms of the relative contributions from upland and stream bank erosion to tributary suspended sediment loads, on an annual and seasonal basis.

Using Heated Distributed Temperature Sensing to Monitor Soil Water

**Arlen M. Striegl, Department of Civil and Environmental Engineering, University of Wisconsin – Madison, Madison, WI *striegl@wisc.edu*

Steven P. Loheide II, Department of Civil and Environmental Engineering, University of Wisconsin – Madison, Madison, WI *loheide@cae.wisc.edu*

Department of Civil and Environmental Engineering, University of Wisconsin – Madison, Madison, WI

Vadose zone hydrology varies both spatially and temporally and is a primary factor governing vegetation composition and patterning. Understanding site soil water dynamics is critical for hydrologic model development, parameterization, and calibration. Soil water heterogeneity and transience is difficult to capture using traditional measurement techniques.

When embedded in soil, commercially available single needle heat dissipation sensors have been used to measure soil water by introducing a heat pulse into the soil and monitoring the induced temperature response. Wet soils exhibit a more muted temperature response because of their superior ability to conduct heat away from the needle as compared to dry soils. Distributed temperature sensing (DTS) systems, which are also commercially available, are capable of measuring temperatures at two meter intervals along fiber optic cables up to 30km long. By combining DTS with heat dissipation sensor methodology, we propose that soil water can be monitored over large distributed scales previously unattainable. Numerical simulations guided the design and fabrication of a custom bundle of fiber optics, resistance heating conductors, and protective coatings. This custom cable was buried at a depth of 20cm to monitor the soil water dynamics of a floodplain transect near the Upper East Branch Pecatonica River south of Barneveld, Wisconsin. The temperature response of the cable was empirically related to co-located standard soil water measurements. Accurate and reliable spatially distributed, temporally continuous measurements of soil water are now being obtained using this technology.

** Graduate student presentation

Evaluation of Turf- Grass and Prairie-Vegetated Rain Gardens in a Clay Soil

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The U.S. Geological Survey compared the capability of rain gardens with different vegetative species and soil types to infiltrate stormwater runoff from the roof of an adjacent structure. Two rain gardens, one planted with turf grass and the other with native prairie species, were constructed side-by-side in 2003 at a location with clay as the dominant soil type.

Both rain gardens were capable of storing and infiltrating most of the runoff over the 5-year study period. The prairie rain garden retained and infiltrated 100% of all precipitation and snowmelt events during water years 2004–07. The turf rain garden occasionally had runoff exceed its confining boundaries, but was still able to retain 96% of all influent. Precipitation intensity and number of antecedent dry days were important variables that influenced when the storage capacity of underlying soils would become saturated, which resulted in pooled water in the rain gardens.

Of the six observed exceedences of storage capacity in the turf rain garden, five were predicted by use of a combination of the normalized surface storage volume, the median infiltration rate, and an estimate of specific yield for soils under the rain garden to a depth equal to the uppermost limiting layer. By use of the same criteria, in water year 2008, when the contributing drainage area to the prairie rain garden was doubled, all four observed exceedences of total storage capacity were predicted. The accuracy of these predictions suggests that by applying measurements of the appropriate soil properties to rain garden design, environmental managers and engineers may improve the tailoring of design specifications of rain gardens for new or retrofitted areas.

An examination of soil structure and the root systems in the rain gardens revealed striking differences between turf and prairie vegetation. Soils under the prairie rain garden, although they possessed the remnants of a limiting clay layer, appeared well-drained, whereas those under the turf rain garden showed marked evidence of a perched water table. Although roots were present in all horizons sampled within the prairie rain garden, roots were limited to the upper horizons within the turf rain garden. Collectively, these differences point to greater pedoturbation and soil development in the prairie rain garden relative to the rain garden planted with turf grass.

SESSION 2A:

Hydrogeologic Modeling

Thursday, March 3, 2011

3:55 – 5:35 p.m.

Groundwater Availability in the Lake Michigan Basin

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Groundwater availability in the Lake Michigan Basin was studied as part of the Great Lakes Basin Pilot for a USGS assessment of water availability and use. A groundwater-flow model was constructed to quantify groundwater availability by simulating the system response to climatic and anthropogenic stresses. The study area extends over 83,000 $miles^2$ and vertically from land surface to Precambrian bedrock in twenty layers representing heterogeneous glacial deposits overlying bedrock units dipping from the Wisconsin Arch into the Michigan Basin. Because of salinity in the Michigan Basin, the model was solved using the USGS density-dependent flow code SEAWAT. The finite-difference model has over two million cells and simulates the transient (1864-2005) response of the system to multiple pumping centers across several aquifer systems. Regional recharge was estimated using a soil-water balance approach applied to the model's 13 stress periods. Calibration involved advanced techniques adapted to hundreds of parameters and thousands of observations. The model was used to show the source of water to wells through time. Direct discharge of groundwater to Lake Michigan was found to be approximately 2% of the available basin groundwater. Sustainability indicators were developed from the transient water budgets to evaluate the availability of groundwater to streams and wells at different scales. Because the regional model is too coarse to accurately examine groundwater/surface-water interactions, an inset model was extracted from the regional model to demonstrate techniques for evaluating the effect of pumping and climate change on a small watershed.

Simulation of Groundwater / Lake-Water Interaction at Shell Lake, Washburn County, WI

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Shell Lake, the largest seepage lake (no stream outlet) in Wisconsin, experienced large-scale flooding during the late 1990s and early 2000s. In 2002, the City of Shell Lake obtained a permit to construct a pipeline to divert water from the lake to lower the lake level, and from November, 2003 to July, 2005 the City diverted three billion gallons of water. As part of the permit, the City was required to evaluate the effects of this diversion on the water levels of Shell Lake and adjacent lakes; this was addressed through a cooperative study with the U.S. Geological Survey.

As part of this study, nested monitoring wells were installed around the lake and the lake-aquifer system was simulated with a MODFLOW model that incorporated several packages to simulate the lakes (LAK7), streams (SFR7), and overland runoff to the lakes (UZF1). Geologic core samples and measured hydraulic heads indicated a complex geology and groundwater flow system near the lake, with limited groundwater / lake-water interaction. The lake is approximately 40 feet above nearby down-gradient streams, and hydraulic heads along the up-gradient shoreline illustrate both groundwater discharge to the lake and underflow beneath the lake. Simulation of the flow system was performed using hydraulic conductivity fields that were estimated by use of pilot points and associated regularization using the parameter estimation code PEST. Simulated flow patterns matched field data, and transient results indicate that the diversion caused the water level of Shell Lake to decline by approximately 3 feet by the end of 2005. Results of this study will be used by the City and Wisconsin Dept. of Natural Resources to evaluate potential future diversions and are now being used to help understand changes in lake water quality.

Development of a Revised Groundwater Flow Model for Dane County, WI

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Dane County relies almost entirely on deep aquifers to meet their growing water supply needs. Surface water features are also an important asset to the region and are intricately connected to groundwater processes. A groundwater flow model is critical for supporting decisions to ensure the sustainable use and management of these precious resources. Currently we are preparing a new model, drawing on developments in groundwater modeling technology over the past 15-20 years as well as improvements in our understanding of the regional hydrogeologic systems present within the county. This project is a collaborative effort between the Wisconsin Geological and Natural History Survey, the US Geological Survey, the Capitol Area Regional Planning Commission, the Dane County Department of Land and Water Resources and numerous municipalities within the county.

Key components of this model include the use of transient flow conditions, refined grid spacing, the inclusion of more surface water features, improved calibration methods and more detailed hydrostratigraphic layering. New Modflow modeling packages including Streamflow Routing (SFR), Lake Stage (LAK), Unsaturated Zone Flow (UZF) and the Newton Solver (NWT) will help to account for complex hydrologic interactions while providing more robust model solutions.

To date the project has focused on model design, delineation of hydrostatic units and understanding groundwater/surface-water interactions. We anticipate that this model will advance the science of groundwater management models in Wisconsin.

Integrated Interpretation of Borehole Flow, Aquifer-Test Results, and Spring Discharge—Culver Springs, Wisconsin

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Borehole flow logs can be used to estimate hydraulic conductivities and heads of the larger flow system. Flow logs typically are interpreted with variants of the Theim solution, which assume flow to the wellbore is horizontal. Vertical flow can be simulated with radially symmetric MODFLOW models which are created easily with a new tool, AnalyzeHOLE. This tool also facilitates estimation of hydraulic conductivity distributions in the surrounding aquifer system with regularized inversion to flow and drawdown observations. Differences between measured and simulated observations are minimized, and attainment of a unique solution is attained through regularization, within PEST.

We measured flows under ambient and pumping conditions in well CS2 located near Culver Springs in northeastern Dane County, WI. Measured flows through well CS2 and spring discharge were simulated with a three-dimensional flow model to constrain vertical-to-horizontal anisotropy and transmissivity upgradient of Culver Springs. Ambient wellbore flow defined vertical-to-horizontal anisotropy. Spring discharge informed transmissivity of the Tunnel City formation on a regional scale. Significant ambient flow, nearly 150 gpm, has been measured in the borehole emanating from and discharging to bedding planes in the Tunnel City formation. The vertical hydraulic-conductivity distribution, transmissivities, and vertical-to-horizontal anisotropy were estimable because simple models were fit simultaneously to borehole flow changes from pumping, drawdown, ambient borehole flow, and spring discharge. Hydraulic property estimates from this investigation are comparable in scale to regional flow-model parameters. These estimates appropriately will define simulated hydrostratigraphic discharge in the Dane County regional model which currently is being revised.

Well Log and Geophysical Analysis for Creation of Hydrostratigraphic Models, Outagamie County, WI

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In Outagamie County, WI, an east-west trending bedrock valley is filled with a thick (over 300 ft.) sequence of sediment, dominated by lake sediment with some glacial till and sand lenses of uncertain origin. Outside the valley, fine-grained sediment is significantly thinner but appears to drape over the bedrock. This sediment appears to form an extensive aquitard of very low conductivity overall, but includes sand lenses of unknown extent and continuity. These lenses are likely preferential flow paths within the aquitard and the source of groundwater for many rural residents in the county.

Approximately 2,500 well logs with driller described lithologies of unconsolidated sediment were categorized in order to identify distinct hydrofacies ranging from dominantly clay or silty clay to coarse sand or gravel. These data were imported into Rockworks v. 2006 and formatted for three-dimensional display. Electrical resistivity imaging was used at 8 sites to determine the average and range of sizes of the sand bodies. The well log analysis and geophysical images were then used in the construction of a hydrostratigraphic model, created with multiple-point geostatistics, which uses training images instead of the traditional variogram approach. In on-going work, several hydrostratigraphic models will be imported into groundwater flow and transport models as part of a study investigating the nature of sand lenses as preferential flow paths within aquitards.

** Graduate student presentation

SESSION 2B:

Agricultural Management

Thursday, March 3, 2011

3:55 – 5:35 p.m.

Discovery Watersheds: Broadening the Scope of On-farm Research in Wisconsin

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The UW-Discovery Farms program, in cooperation with the USGS, has helped agricultural producers identify the water-quality impacts (both positive and negative) of a number of farming systems in different landscapes throughout Wisconsin. For the past decade, water-quality samples and data have been collected continuously at more than 25 edge-of-field, in-stream, and subsurface-tile stations. Typically, data were collected from several locations on each of several privately owned farms, as efforts were focused on understanding losses from individual farms and fields. Through this robust data set, we discovered critical runoff periods and field conditions in which runoff, sediment, and nutrient losses were most likely to occur, and the importance of the timing of field-management activities – most notably livestock manure applications – in relation to the timing of runoff.

With this in mind, the Discovery Farms program is taking what we have learned from the field edge approach to “Discovery Watersheds”. In both the Jersey Valley Watershed (Monroe and Vernon Counties) and the Willow River Watershed (St. Croix County), we will be collecting water-quality data from both field edges and in streams, and will work with local producers and community members to help identify and mitigate critical nonpoint-source contribution areas. The overall goal of Discovery Watersheds will be to demonstrate, with tangible data, the relationship between changes in land management and improvements in water quality. This project creates a challenging and exciting opportunity to look at conservation education in an innovative way; utilizing involvement of producers and other community members, critical source area identification, and an intensive monitoring system.

Soil Moisture and Rainfall Intensity Thresholds for Runoff Generation in Southwestern Wisconsin Agricultural Basins

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Identifying time periods when land application of manure is likely to contribute to surface runoff contamination is important for making proper management decisions and reducing the risk of surface water contamination. The goal of this study was to improve our understanding of the factors that influence runoff generation in agricultural watersheds during non-frozen ground periods. Six small basins (ranging from 6 to 17 ha) within two southwestern Wisconsin farm sites were instrumented and surface runoff continuously monitored from 2004 to 2007 by the University of Wisconsin Discovery Farms Program (DFP) and the University of Wisconsin – Platteville Pioneer Farm (PF). The soils in all basins were silt loam. A direct-plant management strategy and corn-soybean crop rotation were utilized within basins at the first farm site (DFP). The second farm site (PF) utilized a conventional tillage system (chisel plow in the fall followed by soil finisher in the spring) and a corn-oat-alfalfa crop rotation within the basins. Tillage differences between the farm sites influenced the amount of surface runoff generated during the non-frozen ground period. At PF, the amount of precipitation leaving the landscape as surface runoff (2%) was approximately two times greater compared to DFP (0.9%), indicating that the direct-plant management system was better at retaining precipitation than the chisel plow/soil finisher system. An antecedent soil moisture (ASM) threshold of 0.39 cm^3cm^{-3} for runoff generation was determined for all six basins. Below this threshold, runoff coefficients (runoff depth divided by precipitation depth) were near zero. Above this threshold, runoff coefficients increased with ASM. Maximum 30 minute rainfall intensity (I30) thresholds for runoff generation increased as ASM decreased and as crop cover increased. Avoiding manure application during time periods when soil moisture is near or above a critical soil moisture threshold would decrease the risk of surface water contamination.

Characterizing Phosphorus Dynamics in Eastern Wisconsin Tile-Drained Agroecosystems

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Artificial subsurface drainage provides an avenue for the rapid transfer of phosphorus (P) from agroecosystems to surface water. Through the University of Wisconsin Discovery Farms program, long-term surface and subsurface water monitoring stations were established on four fields in eastern Wisconsin to measure surface and tile drainage P losses. These sites, which received frequent manure applications, represent a range of crop management practices [two chisel plowed corn fields (CP1, CP2), a no-till corn-soybean field (NT) and a grazed pasture (GP)]. Subsurface drainage was the dominant pathway of water loss at each site accounting for 66 to 96% of total discharge.

Long-term subsurface flow-weighted total P (FW-TP) concentrations were 0.75, 0.55, 0.22, and 1.31 mg L-1 for sites CP1, CP2, NT, and GP, respectively. High TP concentrations measured at the grazed site were likely caused by the field's use as an overwintering paddock with high animal densities throughout the winter months. Low TP concentrations at the NT site were due to tile drain interception of groundwater flow where large volumes of tile drainage water diluted the FW-TP concentrations. Long-term surface TP-FW concentrations were 3.59, 2.69, 4.08, and 6.36 mg L-1 for sites CP1, CP2, NT, and GP, respectively. Subsurface pathways contributed between 17 and 41% of the TP loss across sites. Only at the NT site did P export clearly appear to be driven by incidental P-loss following manure applications. Based on these field measures, P losses from artificial subsurface pathways must be integrated into field level P budgets and P loss calculations on heavily manured soils.

** Graduate student presentation

Evaluation of the Effects of Agricultural Best Management Practices on the Quality of Joos Valley and Eagle Creeks in Buffalo County, WI

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The purpose of the study was to assess the effectiveness of watershed-management practices for controlling nonpoint-source contamination to Eagle and Joos Valley Creeks in the Waumandee Priority Watershed Project. Streamflow-gaging stations, equipped for automated sample collection and continuous recording of stream stage, were installed in July 1990 at Eagle and Joos Valley Creeks and were operated through September 2007. Best-Management Practices (BMPs) recommended in the priority watershed plan were implemented from 1993 to 2000 in Eagle and Joos Valley Creeks sub-watersheds.

Base-flow and storm water samples were collected and analyzed for total suspended solids, total phosphorus, and ammonia nitrogen for the pre-BMP period (1993 to 2000) and the post-BMP period (2001 to 2007). For both Eagle and Joos Valley Creeks the median concentrations of suspended solids and total phosphorus in base flow were significantly lower during the post-BMP period compared to the pre-BMP period. The decreases in storm-load regression residuals from the pre- to the post-BMP periods for both Eagle and Joos Valley Creeks were statistically significant for all three constituents at the 0.05 significance level and indicated an apparent improvement in water-quality in the post-BMP period.

Because the pre- and post-BMP periods may represent different hydrologic conditions, separate pre- and post-BMP regressions were used to estimate the theoretical pre- and post-BMP storm loads. The resulting percent reductions for suspended solids, total phosphorus, and ammonia nitrogen were 89, 77, and 66 respectively for Eagle Creek and 84, 67, and 60 respectively for Joos Valley Creek. These differences in the pre- and post-BMP residuals, and estimated storm loads were attributed to the BMPs that were installed during the study period, as well as, to a decrease number of farms with livestock, which mimicked the water-quality benefits of BMPs, such as fencing and streambank protection. These data support that the suspended solids and phosphorus reduction goals selected for the Waumandee Priority Watershed have been achieved.

Mapping Carbonate Bedrock Surfaces in Glaciated Landscapes to Enhance Management Decisions

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Land application of fertilizers, pesticides, and agricultural, municipal, or industrial wastes can pose a threat to groundwater quality, especially in areas with carbonate bedrock and thin overlying glacial deposits. Contaminant attenuation is limited in carbonate bedrock systems, and the thickness and texture of the overlying unlithified materials are critical for attenuating contaminants in infiltrating waters. The development of karst features have been observed in landscapes where carbonate bedrock is the uppermost bedrock unit and overlying unlithified materials are less than 50 feet. Depth to bedrock can be highly variable, even within the same field, and most existing maps do not provide this information in sufficient detail to be used at the field level.

Careful examination of well construction reports (WCRs) combined with geostatistical modeling provided a means to improve depth to bedrock mapping, as demonstrated in Calumet County in northeastern Wisconsin. From over 4,000 WCRs, 1,900 were precisely located and utilized as surrogate geologic logs to construct a best-fit statistical model of depth to bedrock using the ArcGIS Geostatistical Analyst tool. This model was used to produce three-dimensional representations of the thickness of unlithified material between bedrock and the land surface. Field verification was conducted at multiple locations to confirm the accuracy of the model through the use of a Geoprobe® impact drill and seismic refraction. Verification results indicated that the techniques employed produced maps of sufficient accuracy and scale for use at the field level. Mapping carbonate bedrock features across the state in vulnerable landscapes could help counties prioritize areas for allocation of future resources and conservation measures.

POSTER SESSION

Thursday, March 3, 2011

7:45 p.m.

1. Combination of Hydrous Iron Oxide Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water

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Groundwater arsenic contamination imposes a great threat to people worldwide. Thus, developing new and cost-effective methods to remove arsenic from groundwater and drinking water becomes imminent. With several patents granted, using hydrous iron/aluminum hydroxides (HFO/HAO) to remove arsenic from water is a proven technology. The method involved addition of ferric iron or alumina to induce precipitation for arsenic sorption. Filtration is needed to separate the precipitates from water. Currently used filtration media were limited to sand, granular activated carbon, granular activated alumina. In this research, a natural clinoptilolite zeolite was used as the filtration media to remove arsenic-containing HFO/HAO co-precipitates. The larger surface areas, higher cation exchange and sorption capacity of zeolite enable it as a better filtration media in lieu of sand to filtrate the arsenic-containing HFO/HAO. The method could achieve better results when the water was under oxic condition, particularly in the presence of extensive dissolved Fe.

2. Removal of Arsenic and Chromium from Water Using Fe-Exchanged Zeolite

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Arsenic and chromium are two of the most harmful environmental contaminants. In this research, a natural clinoptilolite zeolite was exchanged with iron (III) to enhance its arsenic and chromium removal. Batch test results showed that the zeolite could sorb as much as 100 mmol/kg of Fe(III). The arsenic (As) sorption on the Fe-exchanged zeolite (Fe-eZ) could reach up to 100 mg/kg while that of chromate could be as high as 200 mg/kg of Cr, or 3.5 mmol/kg. Columns packed with Fe-eZ were tested for As removal from water collected from acid mine drainage (AMD) and groundwater containing high natural organic matter and high As(III). With an initial As concentration of 147 μg/L in the AMD water, a complete As removal was achieved up to 40 pore volumes. However, the Fe-eZ was not effective to remove As from Chia-Nan Plain groundwater due to its high initial As concentration (511 μg/L) and high natural organic matter, as well as its low oxidation-reduction potential, under which the As was in reduced As(III) form.

*Undergraduate student presentation

3. Removal of Methylene Blue from Water by Swelling Clays

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Extensive but separate studies have been conducted to focus on utilization of swelling clays to removal cationic dyes from aqueous solution and to investigate the feasibility and applicability of methylene blue (MB) adsorption for cation exchange capacity (CEC) and specific surface area (SSA) determination. This research aimed at elucidating the mechanism of MB adsorption on low charge montmorillonite in order to better understand the principles behind MB removal using swelling clays and to validate the practices of using MB for CEC and SSA determination. Stoichiometric desorption of exchangeable cations from the clays accompanying MB adsorption as well as the close match between the MB adsorption capacity and the CEC of the clays confirmed cation exchange as the most important mechanism for MB removal. XRD and TG-DTG analyses revealed interlayer adsorption, thus, intercalation of MB molecules. FTIR analyses suggested that hydrogen bonding may not play a major role in MB adsorption. The results confirmed that the charge density, rather than the SSA was the limiting factor for MB adsorption. For the treatment of wastewater containing cationic dyes, swelling clays with a high CEC value would result in a greater removal of MB.

*Undergraduate student presentation

4. Optical Fiber-Based Tools for the Measurement of Zinc Concentrations in Aqueous Environments

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Our current work focuses on the development of field-deployable fiber-optic sensors for real-time remote monitoring of metal ions in aqueous environments. A prototype system has been developed using zinc ions as a target analyte.

Zinc, while an essential nutrient, is toxic at high levels. It is commonly used in industry and therefore requires monitoring. Current methods require time consuming sampling and instrumental analysis making it difficult to sample large numbers of sites.

Our sensor is a zinc-specific fluorescent dye that is embedded in a polymer matrix, which in turn is attached to the core of an optical fiber. Using a microtemplating procedure, the polymer matrix is made highly porous, which consequently, reduces the sensor response time. The sensor is interrogate by laser pulses traveling down the core of the optical fiber to the sensor regions; in the presence of zinc, the fluorescence intensity of the sensor dye changes proportional to the zinc concentration. The sensor is capable of detecting zinc levels of 90 ng/L with a 30-second response time.

** Graduate student presentation.

5. Accumulation of Heavy Metals in Stormwater Retention Facilities

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Jeffrey J. Clark, Lawrence University, Appleton, WI, *jeffrey.j.clark@lawrence.edu*

Heavy metals associated with parking lot and road runoff have long been recognized as critical pollutants in urban stormwater. Most urban areas have adopted Best Management Practices (BMPs) like biorentention and biofiltration systems to treat storm flows and minimize the release of heavy metals into receiving waters. A portable X-Ray Fluorimeter was used to determine concentrations of heavy metals, in particular Zn, Cu, Co, Mn, and Pb on the surface of three separate biofiltration systems in three parking lots in an industrial park in Neenah, WI and three retention ponds along the College Avenue Bridge in Appleton, WI. These concentrations were compared to background levels at each site to see if any were elevated. Zinc was the only metal found to be consistently elevated in relation to background levels, which suggests that Zinc is an important pollutant associated with vehicle use and wear. No significant differences in Zn concentration was observed between the ponds which collect effluent from the roadway vs. the parking lots.

* Undergraduate student presentation

6. Analysis of the Chloride Concentration of the Pike River in Southeastern Wisconsin

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Research shows that high levels of chloride in surface waters can be detrimental to the surrounding ecosystem and its inhabitants. Water samples from the Pike River, that flows through southeastern Wisconsin and empties into Lake Michigan, were obtained in order to determine the effect of road salt on the chloride concentration of the river. During Spring 2010, the chloride concentration in the river spiked to 221.2 ± 25.3 ppm. Fall 2010 river data yielded a mean chloride concentration of 87.0 ± 1.4 ppm for the lower half of the Pike River. Initially, this longitudinal study began in Fall 2007 and focused upon the lower part of the Pike River. However, in order to obtain a more representative sample of the river, five new sites were added along the entire Pike River, including the headwaters of the river where it is narrow and shallow. Data was easily collected at these sites in Spring 2010; however, due to lack of rainfall and low water levels, samples from the upper half of the Pike River were unable to be collected during Fall 2010. In addition, two sites on Lake Michigan were also added and baseline chloride data for the lakeshore was 19.4 ± 0.7 ppm. In collaboration with the Geography Department, research involving flow rates and hydrological aspects of the river is being performed concurrently in an attempt to further understand the movement of chloride in the Pike River.

*Undergraduate student poster presentation

7. Influence of Regional Mercury Sources on Lake Michigan Tributaries: 15-Year Comparison

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Fifteen years have passed since the inception of the Lake Michigan Mass Balance Study (LMMB), and during that period both industrial use and atmospheric emissions of mercury (Hg) have been reduced. Given these reductions, and new information on the residence time of Hg in aquatic ecosystems, we have begun an abridged version of the tributary monitoring project to provide an interim benchmark before new caps on mercury emissions are completely met.

Our past work has shown that flow rate strongly influences the concentration of total mercury (HgT), methylmercury (MeHg), and suspended particulate matter (SPM), in rivers. Because the relative speciation of mercury also varies with flow rate the project focuses on three distinct flow regimes: base flow, storm events, and the spring melt. Measurements of HgT and MeHg concentration in the unfiltered and filtered phases, and important ancillary chemistry (DOC, pH, specific conductivity, and temperature) are being quantified.

By establishing the current condition of these tributaries, the project provides two important outcomes: (a) the data will be an important longitudinal benchmark to assess the impact of recent and future emissions reductions, and (b) the premise that tributaries can be used as sentinels will be tested by comparing the current data to those collected during the LMMB. By laying this groundwork, we hope to quantify the regional impact of current Hg emission rules and provide a scientific basis for future decisions about implementing additional control programs in the region.

8. Evaluating Water Level and General Water Quality Data of Three Wetland Areas in the Albion Basin and Little Cottonwood Creek, Alta, Utah

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Albion Basin in Alta, Utah serves as the headwaters to Little Cottonwood Creek which is a major source of drinking water for the residents of Salt Lake City. Groundwater chemistry and water level data from three wetlands areas in the basin have been collected for the past five summers (2006-2010) and are being analyzed.

Water levels were collected from nine piezometers installed in the three wetlands areas (Albion Basin, Catherine's Pass, and Collins/Sugarloaf) using pressure transducer dataloggers. The water level response characteristics at Catherine's Pass suggest that it is a groundwater dominated wetland. The Collins/Sugarloaf wetland exhibits greater variability in water levels suggesting that precipitation has a greater influence on water levels in this area than in Catherine's Pass. Water level data from Albion Basin in 2007 and 2008 suggests a precipitation dominated wetland. The pressure transducer measurements collected from 2009 did not produce useable data but initial 2010 data looks to be similar to the 2007/2008 data.

Samples for laboratory analysis of general water quality were collected from the piezometers and springs at the three wetland areas and from Little Cottonwood Creek.

Standard piper diagrams show that the water samples represent calcium, magnesium carbonate fresh water that is likely derived from limestone and dolomite rocks in the area.

The water quality results at Albion Basin Fen suggest precipitation dominated wetland while the Catherine's Pass results suggest a groundwater dominated wetland. The water quality results at Collins/Sugarloaf indicate the source of water is a mixture of precipitation and groundwater.

*Undergraduate Student Presentation

9. Over 20 Years of Well Water Testing: Increasing Capacity for Groundwater Education and the Building of a Well Water Quality Summary Tool

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Groundwater is utilized by 95% of Wisconsin communities and virtually all rural residents for their everyday water needs. Surprisingly, many people lack a basic understanding of where their drinking water comes from and know little about the safety of their water supply. Meanwhile, communities looking to address groundwater quality concerns often lack information because of the difficulty and expense of gathering data.

To address these needs, we organize community drinking water programs as a convenient way for private well owners to have water tested. Following the water testing an educational program is arranged where participants receive their test results, learn about water concerns and the basics of groundwater movement and occurrence. The added benefit of these programs is the insight collected on groundwater quality and water quality trends in local communities.

One well test does little to provide insight into groundwater quality; however, these programs have utilized a citizen-based groundwater monitoring approach to gain knowledge of a community's groundwater resource. Over the past 20 years many communities have performed extensive testing; the information collected has helped communities identify and inform groundwater management decisions. Groundwater summaries have been generated for Iowa, St. Croix, Dodge and Fond du Lac counties. These summaries help highlight local groundwater concerns and can serve as a baseline for the future.

We have recently begun work on an on-line mapping tool that will allow individuals to view well water data and generate summaries that will actively engage local communities to learn about groundwater quality. We will allow participants to demo the interactive mapping tool to search for well water quality information in their county.

10. Desorption of Phosphorus from Stream Sediments and the Impact on Stream Concentrations

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The interaction between sediment phosphorus and stream phosphorus concentrations can be important to meeting nutrient standards in streams. Stream sediments may be a reservoir of phosphorus that slows the reduction of stream concentrations after reductions in nonpoint and point sources. This study examined the potential for phosphorus release throughout Mill Creek in central Wisconsin. This stream has decreasing phosphorus concentrations ranging from 0.5 to 0.1 mg/L across 70 km. Both point and nonpoint sources contribute to the phosphorus load. Public treatment plants in the watershed serve a population of 20,000. The watershed also contains approximately 11,000 cows with about 50% of the land in dairy crop rotation. The stream is currently on the 303(d) list of impaired waters due to low dissolved oxygen from high biological productivity.

We measured phosphorus stream concentrations, sorption/desorption to sediments, and pore-water profiles to evaluate phosphorus-sediment interactions. The results were used to develop a stream model that incorporated external loads and flow with internal sediment phosphorus cycling. The model projects the sensitivity of stream phosphorus concentration on the sediment phosphorus reservoir as a result of sorption/desorption in the sediment. These results will be useful to assist restoration efforts in Mill Creek and elsewhere when stream phosphorus concentrations must be reduced to meet water quality standards.

**Graduate student presentation

11. Snowmelt Export of Phosphorus from Cropland: Edge-of-Field Runoff Monitoring Results from Pioneer Farm in Southwest Wisconsin

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Nonpoint phosphorus runoff is an increasingly important public and regulatory concern. While most research on phosphorus runoff has focused on storm runoff, winter precipitation and snowmelt runoff both can be sources of agricultural overland runoff and have the potential to be significant contributors of nutrient export.

Winter runoff has been monitored since 2002 by researchers at Pioneer Farm. Pioneer Farm is a 430-acre mixed-livestock farm associated with the University of Wisconsin-Platteville. The headwaters of the Fever (Galena) River flow through the center of the farm. More than 90% of the watershed is in row crop agriculture and during snowmelt and winter rains, the watershed is conspicuously dissected by intermittent streams that clearly convey water from fields to the Fever River. Instrumentation at the edge of fields was installed to measure runoff flow rates and sample water quality to estimate pollutant export.

Results from edge-of-field runoff monitoring indicate an average of 30 mm/year (1.2 inches/year) of winter runoff on these fields. During these events, the mean annual phosphorus loss was 1.5 lbs/acre with more than 85% of the phosphorus in the dissolved reactive form. The median suspended solids concentration is less than 50 mg/l. Although significant phosphorus losses were measured over the study period, mean losses over time were well under the 6 lb/acre benchmark in the Wisconsin Phosphorus Index.

12. Proposed Methods for Quantifying Groundwater Contribution to Surface Water Resources, Park Falls District-Chequamegon National Forest, WI

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Groundwater and surface water are intimately related in forest ecosystems. In recognition of this relation, the US Forest Service has begun classifying streams in the Chequamegon-Nicolet National Forest in Northern Wisconsin based on mean bankfull width, mean annual maximum stream temperature and mean alkalinity. These three parameters were chosen because of their relationship to both groundwater and ecology. While groundwater discharge is known to affect stream temperature and alkalinity, this relationship has not been quantified within the context of this current classification system. Typically, as groundwater discharge increases, the water temperature decreases and alkalinity increases. Lakes are similarly affected by groundwater discharge. We are determining how groundwater discharge affects surface water classification and vulnerability to drought.

To determine the volume and importance of groundwater discharge into different surface water bodies, we will apply multiple techniques such as stable isotope and geochemical mass balance, baseflow recession analysis, and geochemical characterization. The Wisconsin Geological and Natural History Survey and the US Geological Survey are creating a groundwater flow model of the Chequamegon-Nicolet National Forest; we will use this model to determine groundwater discharge into streams and lakes, and compare these values with those calculated using other methods.

We are also addressing additional parameters that might control surface water characteristics, such as groundwater chemistry within contributing aquifers and relative size of surface water and groundwater catchment areas, as well as surface water vulnerability to climate change.

** Graduate student presentation

13. Using Geophysics to Compare the Subsurface Soils and Water Content of Turf Grass and Prairie Vegetated Rain Gardens

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Rain gardens are an important part of storm water management. They can be placed in areas with limited space and are easily installed. However, because rain gardens are often installed without knowledge of the subsurface conditions their performance can be difficult to predict.

We used geophysics to better understand how rain gardens function and to explain differences in performance between rain gardens with different vegetation. In July and September 2008, ground penetrating radar (GPR) and electrical resistivity tomography (ERT) surveys were used to characterize subsurface soil layers and water content of two rain gardens; one planted with turf grass and the other with native prairie species. Continuous clay layers were identified in both rain gardens but in the prairie rain garden this layer seemed more disturbed and did not provide a distinct hydrologic boundary as in the turf rain garden. Geophysics also suggested that the soil moisture of prairie vegetation was higher than that in the turf grass. These differences were explained by the presence of a greater and deeper root mass in prairie vegetation.

Geophysics provided another source of information to understand the differences between the two rain gardens. It was non-invasive, required little time to implement, and complemented other studies of these rain gardens.

14. A Hydrogeophysical Study of the Fox River South of Waukesha, WI

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A geophysical study along the Fox River south of the city of Waukesha, Wisconsin is in progress to help determine hydrologic properties of the glacially derived near surface sediments. It is part of a larger study to determine the interaction between the groundwater and surface water. Electromagnetic induction (EM) lines using a Geonics EM-31MK2 have covered approximately 1.1 km of the river, and parts of the surrounding shoreline. Forty electrical resistivity tomography (ERT) lines have been measured in the immediate area west of the river, with two additional lines across the river. The ERT was completed using a GF instruments Ares profiling system. The EM studies in the river have located two areas of low electrical conductivity that suggest these areas are underlain by material of high hydraulic conductivity such as gravel and sand. The ERT surveys are correlated with nearby lithologic well logs and electrical well logs. The ERT surveys west of the river show dominantly east - west regions of higher electrical resistivity that may be preferential groundwater pathways providing a hydrologic connection between the river and the groundwater system.

** Graduate student presentation

15. Preliminary Hydrogeologic Characterization Mink River Estuary – Water Chemistry and Flow

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The Mink River Estuary, located in northeastern Door County, is one of the most pristine freshwater estuaries in the country. Groundwater quantity and quality are critical to the health of the estuary, but to date there has been little investigation of groundwater inputs to the system. The objectives of this project are to 1) establish a groundwater monitoring network around the estuary, 2) gather preliminary information on the groundwater system, and 3) evaluate mixing between the Mink River and Lake Michigan.

During the summer of 2010 a survey of surface-water chemistry revealed a distinct mixing pattern between groundwater discharging in discrete spring complexes and Lake Michigan waters. Stream discharge measurements and in-stream mini-piezometers yielded mixed results concerning groundwater/surface-water interactions. In the northwest arm of the Mink River, both stream discharge and mini-piezometer data collected in May suggest that groundwater discharges from discrete springs near the edges of the marsh but that the Mink River does not gain flow along significant reaches. In contrast, mini-piezometers installed in the northeast arm in August 2010 showed consistently upward hydraulic gradients. Heat-pulse flow logs from three bedrock monitoring wells indicate upward flow from fractures near the base of the wells (~90 ft. depth) to fractures near the bedrock surface (~depth 20 - 40 ft.). We are collecting continuous water-level measurements from both bedrock wells and stilling wells in the estuary. Quarterly samples of both surface and groundwater were collected in November and February.

16. Preliminary Hydrogeologic Investigation Mink River Estuary -- Bedrock and Surficial Geology

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Located in northern Door County, the Mink River Estuary is perhaps the most pristine natural estuary along the Great Lake's coastline. The Mink is home to a diverse variety of wetland species, including the endangered Hine's emerald dragonfly. However, very little is known about the hydrogeologic characteristics of the estuary. This study aims to provide a preliminary characterization of the MRE, and to establish a long-term groundwater monitoring network. Information gathered will be used for future groundwater modeling studies of the area.

Work on this project included the installation of four bedrock monitoring wells at various points around the MRE, to be sampled quarterly for major cations, major anions, and nutrients. Geophysical logs were collected from each well. These wells build on a previously constructed database of private wells used to predict depth to bedrock in the area.

While upland monitoring wells provide depth to bedrock around the estuary, logistical limitations prohibit the installation of such wells in wetlands. An EM31 earth conductivity survey was conducted to infer depth to bedrock throughout the marsh. Numerous measurements showed systematic changes in the EM31data, however, their significance was not clear. Core samples of the marsh sediments indicate that peat overlies marl deposits within the marsh. It is likely that the depth to bedrock exceeds the penetration depth of both the EM31 and hand-coring efforts. We hope to employ shallow seismic techniques to better define the bedrock surface beneath the wetland.

* Undergraduate student presentation

17. Evaluating Hydrostratigraphic Boundaries in a Heterogenous Aquifer: an example from Vilas County, WI

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This investigation is part of an on-going hydrogeologic study on the Nature Conservancy's Catherine Wolter Wilderness Area in Vilas County, Wisconsin, located within the Pleistocene drift region. The stratigraphy at this 2,189 acre site is characterized by interweaving of discontinuous strata, lens-shaped sedimentary layers, and paleo-channels deposited during glaciations. The long term goal is to understand the groundwater flow in the region. Locating hydrostratigraphic boundaries in heterogeneous aquifers is often difficult; however, a comprehensive understanding of the hydrostratigraphy can be improved by utilizing well construction reports and electrical resistivity profiles and soundings.

Water-level elevations at 44 wells and surface water elevations were used to construct a water table map. Using over 20 electrical soundings conducted in 2003 and six electrical profiles using a GF Instruments profiling system (ARES) conducted in October 2010, four stratigraphic sections were constructed. Electrical resistivity data is charted along with subsurface stratigraphy to produce a multi-layer stratigraphic model within a single aquifer to aid in understanding the water movement throughout the region. Historically, two wells have significantly lower water levels which are explained by our model.

* Undergraduate student presentation

** Graduate student presentation

18. Soil Stability within Wetland Treatment Swales for Urban Runoff

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Wetlands can be utilized to treat and filter stormwater runoff through microbial uptake processes and by storing and filtering pollutants. In urban areas, these wetlands are often composed of invasive monocultures that offer limited ecological benefits. The ability of diverse native wetland vegetation to stabilize soil and to prevent erosion and resuspension of deposited sediment remains understudied and is an important component of the overall function of a wetland to improve the quality of stormwater runoff.

Sediment detachment occurs when the shear stress from flowing water exceeds a critical value that is a function of soil and plant conditions. This study investigated soil stability and critical shear stress in wetland treatment swales and is one component of a larger study of the impact of wetland plant diversity on water quality (nitrogen, phosphorus, and sediment removal), infiltration, and plant establishment over multiple growing seasons. The project's wetland treatment facility is located at the University of Wisconsin-Madison Arboretum. Treatment plots within three swales were planted with polycultures (three or nine) of native plant species. A cohesive strength meter (CSM) was used to measure critical shear stress within the swale treatments. The CSM utilizes infrared optical sensors within a testing chamber to measure water transparency after the soil is subjected to water pulses at increasing pressures and correlates these values to critical shear stress.

During the first growing season, four primary soil and surface conditions developed within the swales and resulted in different critical shear stress values. Compared to bare soil conditions, *Mnium* moss, algal, and root mats within the wetland treatment swales functioned as principal soil stabilizers. Presence of the *Mnium* moss mat corresponded to the highest critical shear stress values (greatest soil stability), followed by algal mat, root mat, and bare soil conditions (lowest soil stability). First-year differences in the dominant plant species within treatment plots had little impact on critical shear stress. The relationship between established vegetation and resultant soil conditions, as well as the potential for increased significance of vegetative effects corresponding to enhanced root establishment, will be studied throughout future growing seasons.

**Graduate Student Presentation

19. How High Will The Water Rise? Flooding of the Duck Creek Quarry as an Unintended Consequence of Deep Aquifer Recovery (Brown County, Wisconsin)

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The Cambro-Ordovician sandstone aquifer in the Northeast Groundwater Management Area (GMA) experienced a dramatic water level recovery in central Brown County after 2007. Between 2006 and 2007, eight communities stopped pumping groundwater for their municipal supplies and began using surface water instead, reducing daily withdrawals from the deep aquifer by ~12.25 million gallons. The potentiometric surface has increased as much as 150 feet in many parts of the GMA. The villages of Howard and Suamico have seen a large part of the deep aquifer recovery. In places, the potentiometric surface has exceeded ground level resulting in multiple flowing artesian wells, including the Village of Howard municipal Well #3, about 7,000 feet north of the Duck Creek Quarry.

The Duck Creek Quarry produced dolostone from the Sinnipee Group between 1827 and 2001. It is the largest and deepest (170 feet) in the area and is known to have intercepted or nearly intercepted the St. Peter Sandstone at its deepest point. Before the water supply switch, the potentiometric surface in the aquifer was below the quarry floor. Presently it is near, or possibly above ground level near the quarry.

We tracked quarry water levels directly during 2009-2010 and reconstructed water levels for 2002-2008 using historical photographs. Data suggest that the rate of increase in the quarry's water level has accelerated as the deep aquifer recovery has progressed. Climatic variability in precipitation and temperature over the past decade does not appear to be a significant factor in the water level recovery rate, although significant contribution from the shallow dolostone aquifer is apparent from seeps observed on the quarry walls. If the water level rise continues at its present rate of 4 inches/week, the quarry will flood out some time during the fall of 2011. This could have significant implications for low-lying properties adjacent to the quarry and for water quality in the Duck Creek.

20. Hydrodynamic Drag of Native Wisconsin Wetland Plant Species

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Aquatic macrophytes and terrestrial plants generate drag in the presence of flowing water, thereby reducing water velocity and enhancing particle deposition. The use of native Wisconsin wetland plants to treat urban stormwater is dependent, in part, on their ability to generate drag and reduce flow velocities. To date, this topic has remained largely unexamined. For this study, drag forces on ten native Wisconsin wetland plants, categorized by three groups (forb, graminoid, and grass) were measured in a laboratory flume. The flume simulated expected flow velocities and depths through wetland swales established at the University of Wisconsin-Madison Arboretum to treat urban runoff.

Experimental treatments consisted of three plant growth periods (two, four, and six months), four flow velocities (0.08, 0.15, 0.23, 0.30 m/sec) and three flow depths (0.06, 0.18, 0.30 m). The plants were grown in a greenhouse with similar lighting and temperature conditions to that of a Wisconsin summer. A representative shoot from each species was attached at its base to a 0.32 cm diameter vertical steel rod. The steel rod connected to a horizontal aluminum air sled above the flume. The sled hovered on a 360° stream of compressed air, which allowed the sled to move without friction. The sled was connected to a 1.5 Newton load cell that measured the drag force generated by the plant.

A plant's hydrodynamic drag depends on several factors such as foliage, flexibility, and shoot diameter and density. In addition to drag force, plant wetted frontal area and shoot bending angle were measured for each plant and flow condition. Relationships between drag forces as well as dimensionless drag coefficients and Reynolds numbers will be examined and presented. Results will be used to identify native Wisconsin wetland species and/or classes that are best suited to reduce stormwater runoff velocity in treatment systems. This study is one component of a collaborative project conducted by the University of Wisconsin-Madison, the Wisconsin Chapter of the Nature Conservancy, and the Environmental Law Institute to investigate innovative approaches to stormwater treatment. Information gained from this study will guide watershed based planning for wetland restoration and mitigation in the Pensaukee Basin of Wisconsin.

21. Climate Change Impacts on Wisconsin's Water Resources

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The first adaptation strategy report on climate change has been released by the Wisconsin Initiative on Climate Change Impacts (WICCI). Wisconsin's climate is changing and our water resources are changing, too. Climate scientists analyzed seasonal and annual precipitation and temperature data from 1950 to 2006 to document historical climate change. Water resource experts also looked at long term ice cover, lake level, groundwater and stream baseflow data. Changes to our water resources are intimately linked to local and regional hydrologic conditions.

Members of WICCI's Water Resources Working Group used projected temperature and precipitation data to identify six major impacts of climate change on water resources. With input from other experts, we identified adaptation strategies to address these impacts. The team is now striving to implement these adaptation strategies by defining and implementing new research priorities and projects, developing educational materials, and working with professional and lay audiences who are invested in our state's water resources.

22. Long-term- Hydrologic Impacts of Land Use and Climate Change Across Wisconsin

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Increases in stormwater runoff and non-point source (NPS) pollution associated with a changing regional climate could pose significant economic, environmental, and public health challenges to communities across Wisconsin. At present, state and local decision-makers, planners, and the public lack place-based information on the relative magnitude of hydrologic and water quality impacts that have occurred in the recent past, as well as those that are likely to occur in the future under alternative scenarios. A high-resolution, statewide dataset of historic and projected future changes in runoff and NPS pollutant loadings – under alternative climate and land use scenarios – has been developed using the Long-Term Hydrologic Impact Assessment (L-THIA) model. Regionally-calibrated/spatially-distributed L-THIA models have been built and run for the period between 1957 and 2006 at a 100 meter resolution. Ten-year average annual runoff and NPS pollutant loadings were modeled for the approximately 1,700 sub-watersheds and 50,000 stream catchments comprising the state's land area. Average annual runoff and NPS pollutant loadings were also calculated under multiple future climate and land use scenarios using projected land use from a regional land transformation model and downscaled global climate model precipitation for the period between 2046 and 2055.

24. ***Nowcasting* Water-Quality at Great Lakes Beaches**

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While the use of multivariate statistical models to predict beach water quality has been found to be more timely and accurate than standard monitoring, beach managers have been slow to adopt this method. A capacity-building study conducted by the Wisconsin Department of Natural Resources (WDNR) in 2008-2009 identified several barriers to widespread adoption, including the need for more user-friendly modeling tools, limited training opportunities, lack of technical assistance, difficulty accessing data, and the disconnect between modeling and routine monitoring and data-reporting procedures.

Building on recommendations resulting from this study, WDNR is working with its local and federal partners to expand nowcast modeling across Wisconsin's Lake Michigan and Lake Superior coasts, with a goal of 20 operational nowcasts by 2013. Models are being developed for approximately 60 candidate beaches using EPA's *Virtual Beach* software, as well as complimentary modeling tools developed by USGS. To help facilitate local operation and maintenance of the nowcasts over time, the state's Beach Health website and data archive is being modified to integrate nowcast processes with routine data-reporting procedures already required under the federal BEACH Act.

SESSION 3A:

Groundwater Studies

Friday, March 4, 2011

8:20 – 10:00 a.m.

Assessing the Effect of Pleistocene Glaciation on the Water Supply of Eastern Wisconsin

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Water resource replenishment is of concern all over the world, including Wisconsin. The primary municipal water source in eastern Wisconsin is the Paleozoic sandstone aquifer that is confined beneath the Maquoketa Shale and Sinnippee Group. It is therefore important to understand how and when the water in this aquifer was recharged. This research is looking to determine the age and origin of water contained in the deep sandstone aquifer of eastern Wisconsin in its entirety as an expansion of work done by Klump et al. 2008.

The primary means of obtaining the information for this work has been through sampling municipal water wells in west-to-east transects through Brown County and Fond du Lac to Ozaukee Counties. A total of 18 wells were sampled along the flow path starting just west of the confining units and extending eastward toward Lake Michigan.

The water samples have been tested for standard ionic composition, stable isotopes including $\delta^{18}O$, δD and $\delta^{34}S$, noble gas concentrations, and 14C isotopic signature. This data is being used for general geochemical modeling, dating of groundwater along the flow path, and determining the recharge history and temperature record through the late Pleistocene.

** Graduate student presentation

Spatio-temporal Relationship between Groundwater Recharge and Urbanization: Waukesha County, Wisconsin

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The decline in groundwater level within Waukesha County, located in southeastern Wisconsin, was analyzed in regards to the degree of urbanization in the county. Utilizing a geographic information system, US Geological Survey's potentiometric surface level data were compared to the permeability of the subsurface ranging from low to high in Waukesha County and detailed land use data through multiple overlay operations. The produced maps indicate that low potentiometric surface levels usually intercept with either areas of low permeability or areas of increasing urbanization. A statistical analysis confirmed that the degree of urbanization which corresponds to the extent of impervious urban surfaces is significant in explaining the decline of potentiometric surface in Waukesha County between 1900 and 2000. A trend analysis of total annual precipitation data from two weather stations in Waukesha County confirmed that an increase in precipitation during the last several decades did not outweigh the groundwater decline due to human activity in the high permeability zone. Additionally, USGS data regarding groundwater withdrawal showed that groundwater extraction was high in areas where natural recharge is diminished through low subsurface permeability. A correlation analysis showed that in areas of low subsurface permeability potentiometric surface level and total groundwater withdrawals have a strong significant correlation while in areas of high subsurface permeability potentiometric surface and the degree of urbanization show a strong significant correlation.

Surface Water/Groundwater Interactions in SE Wisconsin

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The City of Waukesha faces key long term water management issues due to a projected rise in its water use set against the backdrop of declining water levels and naturally occurring radium contamination in the deep sandstone aquifer. Waukesha currently reduces radium levels by treatment of radium affected water and by blending water from existing deep wells with radium-free water from three shallow wells. These shallow wells are in close proximity with the Fox River. Waukesha currently discharges its treated wastewater into the Fox River and the potential for interaction between shallow wells and the Fox River is being studied. Natural and anthropogenic tracers have the potential for understanding interactions between groundwater and surface water and can provide insight into groundwater flow paths and residence times.

A monitoring network of wells, streams, and wastewater effluent were sampled and analyzed for major ion chemistry, pH, dissolved oxygen, and concentrations of lithium, boron, bromine, and iodine. Results will show an increase in anthropogenic chloride from two sources (road salting and treated effluent) as well as limits on groundwater travel time and the possible presence of treated effluent.

**Graduate student presentation

Slow-Release Fertilizer Effect on Groundwater Nitrogen Concentration in Sandy Soils under Potato Production

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Current nitrogen (N) fertilizer management practices for potato farming have led to elevated levels of N in the local groundwater. Slow-release fertilizer, specifically Environmentally Smart Nitrogen® (ESN) may reduce the amount of N leaching to groundwater; however no field scale studies have been performed in Wisconsin to validate these assertions. Field experiments were conducted at the Hancock Agricultural Research Station using Russet Burbank potato, planted in Plainfield Loamy sand. Four fertilizer rates, 0 N control, 224 kg ha^{-1} ESN, 280 kg ha^{-1} ESN, and current University of Wisconsin-Extension recommended 280 kg ha^{-1} ammonium sulfate-ammonium nitrate (AS-AN) were used. Day of planting was April 29, with fertilizer applied twice, once at plant emergence on May 17, and the second application on June 2, 2010. This study included three replicates to create twelve 15.24 m by 15.24 m field plots. Three monitoring wells spaced diagonally across plot, were installed in each plot to sample groundwater for N assessment. Potato plant growth parameters and yields were measured. Groundwater sampling regime was weekly throughout the growing season and monthly afterward assessed for nitrate, ammonium and total N. In general, results indicate that ESN reduced the amount of nitrate leaching to groundwater. Potato growth parameters and yields were maintained, and demonstrates that use of slow-release ESN fertilizer is a reasonable alternative to current management practices of AS-AN applications. Fall application of Br^- and Cl^- tracers indicated that no cross contamination of N occurred and plot sizes were large enough to be representative of full scale fields.

** Graduate student presentation

Denitrification of Groundwater Nitrate in a Central Wisconsin River Network

Robert S. Stelzer, Department of Biology and Microbiology, University of Wisconsin Oshkosh, Oshkosh, WI, *stelzer@uwosh.edu*

Lynn A. Bartsch, Upper Midwest Environmental Sciences Center, United States Geological Survey, La Crosse, WI, *lbartsch@usgs.gov*

Groundwater in much of Central Wisconsin has elevated nitrate concentration that can compromise drinking water quality and harm ecosystems. Our previous research has shown that groundwater nitrate processing is substantial in deep sediments of a single stream (Emmons Creek) in the Central Sand Ridges Ecoregion (CSRE). The main objective of the current study was to determine if denitrification and nitrate retention occur in deep sediments throughout a river network in the CSRE. Eight study sites were chosen in the Waupaca River Watershed that varied by three orders of magnitude in groundwater nitrate concentration. Sediment cores to 35 cm were collected and denitrification of core sections was measured by acetylene block in the laboratory. *In situ* nitrate retention in sediments was assessed with peeper samplers. Denitrification rates tended to be higher in shallow sediments but deeper sediments accounted for a large proportion of areal denitrification rates at some locations. Mean areal denitrification rate, which ranged from 0.1 to 200 mg 1N_2O-N m-2 h- among sites, was positively related to groundwater nitrate concentration. In turn, groundwater nitrate concentration and dissolved oxygen concentration were positively related. Preliminary results from the peepers suggest that there was considerable *in situ* nitrate loss in deep sediments along groundwater flow paths. Our results suggest that denitrification and nitrate retention may be widespread in deep stream sediments, particularly in watersheds with high groundwater nitrate concentration.

SESSION 3B:

Climate Change and Wisconsin's Water Resources

Friday, March 4, 2011

8:20 – 10:00 a.m.

Climate Change and Wisconsin's Water Resources: Results of WICCI's First Adaptation Strategy Report

Tim Asplund, Wisconsin Department of Natural Resources, Madison, WI, t*im.asplund@wisconsin.gov*

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The Wisconsin Initiative Climate Change Impacts (WICCI) released its first climate change adaptation strategy report in February 2011, *Wisconsin's Changing Climate: Impacts and Adaptation*. The report is a product of a statewide collaborative effort between the University of Wisconsin, the Department of Natural Resources, and other agencies and institutions.

Climate scientists analyzed historic temperature and precipitation data to document how the state's climate has changed. Water resource experts also looked at long term ice cover, lake level, groundwater and stream baseflow data. The conclusions are that changes in Wisconsin's climate are reflected in changes to our water resources, but the direction and magnitude of those changes are intimately linked to local and regional hydrologic conditions. Future projections of temperature and precipitation allowed the Water Resources Working Group to identify six probable impacts of climate change on our water resources that should be addressed in an adaptation framework: increased flooding; increased harmful blue-green algal blooms; increased demand for groundwater extraction and demand for water; changes in seepage lake levels; increased sediment and nutrient loading; and increased spread of aquatic invasive species.

At last year's AWRA meeting, the WICCI Water Resources Working Group sponsored a special workshop to begin developing adaptation strategies to address these impacts. We also identified who could implement the strategies, discussed the scale and timing of the strategies, and articulated potential obstacles. This year we will share these adaptation strategies and discuss next steps for implementation. We have already funded new research projects, developed educational materials for schools, and shared information with professional organizations. We plan on working with lake and watershed groups, local public health groups and regional and municipal government officials as part of our outreach efforts.

Using Risk Calculations to Support Climate Change Adaptation in Wisconsin

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Many studies of the impacts of climate change on precipitation have found that it is very likely that the magnitude and frequency of intense precipitation events will increase for the Midwestern United States over the next century. With a consensus coalescing around these projected changes, the task for water resource decision-makers now becomes to use that knowledge to help states and communities prepare adaptation strategies for flooding caused by a changing climate.

The goal of this study is to use both climate model precipitation projections and historical precipitation data to develop a framework for assessing how the precipitation regimes for Wisconsin's communities are projected to change over the next half-century and how these projected changes can be used in the climate change adaptation process.

The damages caused by intense precipitation events frequently behave non-linearly, with the most intense events causing a majority of the total damage calculated for a given precipitation distribution. One method of accounting for this non-linearity is by multiplying a damage function and a precipitation threshold exceedance probability distribution to obtain a value of total risk for a given precipitation record.

This study applies damage functions to statistically-downscaled and de-biased General Circulation Model (GCM) precipitation data for the state of Wisconsin to determine the magnitude of projected changes in total risk over the next half-century due to climate change. We then seek to put the model changes into perspective by comparing the total risk calculated based on Wisconsin historical records from 1950-2007 with those calculated for the other Midwestern states of Illinois, Iowa, Minnesota, and Missouri.

The future temperature regimes for Wisconsin are projected to resemble those that currently occur in locations to the south and west of the state. This total risk method allows us to determine if similar shifts in Wisconsin's precipitation patterns are expected to occur. It also provides a framework for using known historical precipitation records from other locations as the basis for preparing climate change adaptation strategies for Wisconsin's communities.

** Graduate student presentation

Climate Variability and Groundwater Recharge in Southwest Wisconsin

Madeline B. Gotkowitz, Wisconsin Geological and Natural History Survey, Madison, WI

Doug R. Joachim, Dept. of Civil and Environmental Engineering, UW – Madison, Madison, WI

Steven J. Vavrus, Gaylord Nelson Institute of Environmental Study, UW- Madison, Madison, WI

Steven P. Loheide II, Dept. of Civil and Environmental Engineering, UW – Madison, Madison, WI

Kenneth R. Bradbury, Wisconsin Geological and Natural History Survey, Madison, WI

Record precipitation in 2007 and 2008 contributed to widespread groundwater flooding near Spring Green, WI, and caused over $17 million in economic losses. About $8.5 million will be invested in the area to mitigate such flooding and high water table conditions. We assessed the utility of flood mitigation efforts by simulating future changes to recharge and water table elevation. In this evaluation, eight statistically-downscaled global circulation models (GCMs) predict daily values of precipitation, temperature, and relative humidity. These provide the basis for the soil water balance model, which produces daily estimates of runoff and infiltration. Infiltration is applied as recharge to the water table in a transient groundwater model of the region. Model simulations from 1981-2000 provide a base case for comparison to predictions from future periods of 2046-2065 and 2081-2100.

Results show that while recharge may decrease on average, the variability in annual recharge may lead to occasional years of high groundwater levels. Under the base case, annual recharge averages 14.1 inches across the model domain. Despite a general increase in precipitation during both future climate periods of 2.3 inches, simulated average annual groundwater recharge decreases 0.6 inches by 2065 and decreases an additional 1.5 inches by 2100. The simulated decrease in average recharge is driven by increasing annual temperatures and a resulting increase in simulated evapotranspiration. However, this set of eight GCMs leads to a broad range in annual recharge, with the range in recharge varying from no change from the base case to a decrease of over 7.5 inches per year. High groundwater levels may indeed become more common despite drier conditions overall, as suggested by a positively skewed frequency distribution of annual recharge. These results suggest that preserving current land use in Spring Green may require implementation of the proposed mitigation efforts.

Evaluating Changes to Wisconsin Evapotranspiration under a Future Climate

**Douglas R. Joachim, UW-Madison Department of Civil and Environmental Engineering, Madison, WI, *djoachim@wisc.edu*

Steven P. Loheide II, UW-Madison Department of Civil and Environmental Engineering, Madison, WI, *loheide@wisc.edu*

Evapotranspiration (ET) is the second largest component of Wisconsin's water budget after precipitation, but relatively little work has been done evaluating how ET will change in the state under a future climate. Changing precipitation and cloud cover patterns may have a significant impact on soil water content and the availability of incoming solar radiation. Additionally, increasing temperatures will cause a lengthening of the annual growing season, which may increase the importance of transpiration in total ET. Vegetation will also experience a change in stomatal conductance due to changing climate factors such as temperature, vapor pressure deficit, and CO_2 concentration which will affect the ability of plants to transpire in the future

To evaluate ET changes in several different regions under a variety of vegetation types, we have developed hydrologic model using Matlab that calculates ET via the FAO Penman-Monteith method. The model was parameterized for specific vegetation types using data obtained from Ameriflux eddy covariance sites in Wisconsin and nearby states. Records of latent heat flux (observed ET) were compared with estimated ET from available climate data (predicted ET). Downscaled global climate model (GCM) data was then integrated with the Matlab model to estimate ET at sites across Wisconsin under a future climate. A user-friendly graphical user interface (GUI) was then created to allow the public to easily estimate how ET will change for a specific location and vegetation type over time to aid in water resource and agricultural planning.

** Graduate student presentation

Predicting Wetland Plant Composition Based on Soil Moisture Regime Using a Quasi-3D Variably-Saturated Groundwater Flow Model

**Eric G. Booth, University of Wisconsin – Madison, Limnology and Marine Science, Madison, WI, *egbooth@wisc.edu*

Steven P. Loheide II, University of Wisconsin – Madison, Department of Civil and Environmental Engineering, Madison, WI, *loheide@wisc.edu*

The ability to predict vegetation composition based on environmental variables can be powerful for assessing the impacts of land-use change, climate change, or land management activities on an ecosystem. In wetland ecosystems, the soil water regime is the primary environmental variable controlling the distribution of vegetation. Previous studies have used observed and simulated depth-to-water-table as a proxy of the soil water regime to predict vegetation composition. However, depth-to-water-table may not be an effective indicator of the soil water regime at some sites due to several factors including strong vertical hydraulic gradients and deep water table. In these cases, soil moisture may be more effective for developing regime metrics as predictors of plant composition.

We have developed a methodology that links a quasi-3D, variably-saturated, groundwater flow model with a statistical vegetation model to predict the probability of presence of several dominant plant species across a recently-restored floodplain wetland near Barneveld, WI. The hydrologic model was created using a general-purpose, finite-element software (COMSOL) and consists of a 2-D confined saturated groundwater flow model linked with a 1-D variably-saturated groundwater flow model. The statistical vegetation model then uses several simulated soil moisture regime metrics (e.g., mean growing season soil moisture at 25 cm depth) as predictors in a non-parametric regression model using the software HyperNiche 2. This modeling framework produces predictive maps of vegetation distribution and provides the ability to assess potential climate and land-use change scenarios.

** Graduate student presentation

SESSION 4A:

Great Lakes Restoration and Research

Friday, March 4, 2011

10:20 – 11:40 a.m.

USGS Great Lakes Restoration Initiative Projects in Wisconsin

Charles A. Peters, U.S. Geological Survey, Middleton, WI, *capeters@usgs.gov*

In 2009, the Obama Administration announced the Great Lakes Restoration Initiative (GLRI) to protect, restore, and maintain the Great Lakes ecosystem. The USEPA is responsible for administering GLRI funding and is coordinating the interagency initiative in collaboration with 15 other Federal Agencies.

The U.S. Geological Survey (USGS) received funding for 25 projects in 2010 to provide tools and information to make effective restoration decisions throughout the Great Lakes basin. A portion of that funding was allocated for work in the Lakes Michigan and Superior drainages within Wisconsin. In 2011, USGS's total GLRI funding was reduced by more than half and the projects being conducted and their scope were adjusted to address that reduction.

USGS GLRI projects include work in tributaries, embayments, beaches, and the nearshore. These projects include monitoring, modeling, remote sensing, and development of databases decision support tools. A brief overview of the USGS projects in Wisconsin will be presented.

The Wisconsin Coastal Atlas: Building the Coastal Spatial Data Infrastructure to Promote Restoration and Stewardship of the Great Lakes

David A. Hart, University of Wisconsin Sea Grant Institute, Madison, WI,
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A coastal web atlas is defined as "a collection of digital maps and datasets with supplementary tables, illustrations, and information that systematically illustrate the coast, oftentimes with cartographic and decision-support tools, and all of which are accessible via the Internet." While Wisconsin has long been applying geospatial technologies to coastal issues, the process of building a Wisconsin Coastal Atlas has just begun. This presentation will share the strategy used to build the atlas and examine different ways the atlas can be used.

Since 1994, the University of Wisconsin Sea Grant Institute and the Land Information and Computer Graphics Facility at UW-Madison have actively supported the application of geospatial technologies to better understand coastal issues facing the Great Lakes. The Wisconsin Coastal GIS Applications Project (http://coastal.lic.wisc.edu/) leveraged the sizeable investment in local government land information systems and supported decision-making about Great Lakes coastal management. Many lessons about coastal data integration were learned as Wisconsin moved from discovery, acquisition, integration, and analysis of spatial data from multiple sources to the development of interoperable web mapping services and spatial data catalogs.

The Wisconsin Coastal Atlas is a new initiative to provide access to maps, data, and tools to support decision-making about the Great Lakes. Initial funding for a two-year period was provided by UW Sea Grant starting in February 2010. The atlas serves as a gateway to spatial decision support tools relevant to Great Lakes management and provides a means to learn more about coastal issues and places. The initial focus of the atlas is on coastal hazards, but it is built with an open architecture that allows addition of new tools and components over time. Besides building the framework for the atlas, the project also tackles important research topics that address the science needed to effectively build and link coastal web atlases. Design of the Wisconsin Coastal Atlas is based on concepts from the successful Oregon Coastal Atlas (http://coastalatlas.net/), refined through interaction with Wisconsin coastal science and management communities. The atlas is organized into four useful sections – *maps, search, tools,* and *learn*. A gallery of web mapping interfaces provides customized perspectives related to specific coastal issues in Wisconsin. Users can search for geospatial data through an interface that connects to distributed catalogs maintained by other coastal data custodians.

Using Microsatellite Markers to Characterize the Genetic Diversity of Wild Rice in Great Lakes Coastal Habitats: Implications for Restoration

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Alexander L. Kahler, University of Minnesota, St. Paul, MN, *kahl0041@umn.edu*

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American wild rice (*Zizania palustris*) is an emergent aquatic grass with significant ecological, economic, and cultural importance. Due to human activities and exotic species invasions, the plant has declined precipitously across much of its range, including Great Lakes coastal habitats. Because wildrice is a major target for restoration, and because little is known about the genetic diversity of wild rice in these habitats, our labs have developed a suite of 38 polymorphic microsatellite markers for use in investigating wild rice genetic diversity and patterns of reproduction. As part of this project, these markers have been optimized for use in high-throughput, automated fluorescent analysis using an ABI 3100 genetic analyzer. Here, we report the results from an initial set of six microsatellite markers tested on an isolated population of wild rice from Pokegama Bay in the St. Louis River estuary near Superior, WI. The markers had a mean polymorphism information content of 0.92 (range: 0.54 to 0.93), indicating high power to discriminate between individuals and populations. A mean of 18 alleles was observed per locus (range: 14 to 20), suggesting high levels of allelic diversity in the Pokegama Bay population. Mean expected heterozygosity across all loci was 0.94, whereas observed mean heterozygosity was significantly lower at 0.77. Despite its allelic diversity, the genetic data indicate that the Pokegama Bay wild rice population is significantly inbred (F=0.19), possibly due to its isolation as a result of historic, severe population fragmentation and associated reductions in population size. We will present the diversity and relatedness data for nine wild rice populations from Lake Superior coastal habitats and for one population from Lake Michigan, and discuss possible implications of the genetic data for wild rice restoration and population augmentation activities.

Spatial Narratives of the St. Louis River Estuary: Deep Mapping in Estuarine Research

Janet Silbernagel, University of Wisconsin-Madison, Department of Landscape Architecture & Conservation Biology & Sustainable Development, Madison, WI, *jmsilber@wisc.edu*

The St. Louis River Estuary, a recently designated National Estuarine Research Reserve, is a complex mosaic of high quality aquatic habitat intermingled with areas of heavy industrial use, contaminated sediments, and effluents from the surrounding urban landscape. The estuary is Lake Superior's largest tributary and home to the Duluth-Superior international seaport. The NOAA Sea Grant Program plays a significant role in promoting education, outreach and stewardship in Great Lakes coastal communities and environments. Geospatial thinking can enhance Sea Grant's objectives, yet few tools exist to foster such an approach on a regional scale. We illustrate the use of spatial narratives and deep maps as socially and spatially rich tools for meeting these objectives through a joint Wisconsin/Minnesota Sea Grant project. Our research connects aquatic science research on human-based stressor gradients in the watershed with spatially explicit vignettes of local resource issues and place-based games around those local issues to enhance spatial awareness and stewardship of the estuary. We will discuss our work in integrating two seasons of local informant interviews with stressor gradient data to develop "deep maps" for the estuary, and demonstrate how spatial narratives and deep maps feed into design of innovative place-based learning, including "geo-quests" and ship-based tours. We will conclude by arguing that spatial narratives are valid tools to capture social and spatial complexity of place for research, literacy and stewardship.

SESSION 4B:

Watershed and Wetland Management

Friday, March 4, 2011

10:20 – 11:40 a.m.

Kinnickinnic River Flood Management and Watercourse Rehabilitation

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Patrick C. Elliott, Milwaukee Metropolitan Sewerage District (MMSD), Milwaukee, WI, *pelliott@mmsd.com*

The Kinnickinnic River watershed is an approximately 25 square mile, highly urbanized drainage area, located in south central Milwaukee County and tributary to the Milwaukee River Estuary. The Kinnickinnic River has undergone considerable alteration in the past, including channel widening and realignment, and the installation of concrete lining along a significant portion of its length. These channel modifications were completed to provide flood management, and for a period of time reduced water surface elevations during periods of intense rainfall. Continued urban development in the watershed, plus a recent pattern of more frequent high intensity rainfall events, resulted in an unacceptable level of flood management for the one-percent probability (100-year) design event along significant portions of the watercourse. As a result, the Milwaukee Metropolitan Sewerage District (MMSD) initiated a series of projects to provide enhanced flood management and watercourse rehabilitation within the watershed.

Two final design and construction projects are currently being completed along a downstream segment of the Kinnickinnic River as part of the initial efforts in the long term program. These “early out” projects include replacing of the South 6th Street Bridge to expand the hydraulic opening and rehabilitating approximately 1,000 feet of watercourse, located immediately downstream. The upstream portion of the watercourse segment (500 feet) contains a concrete lined channel confined by steep embankments and existing infrastructure. The downstream portion of the watercourse segment (also 500 feet) contains an earthen/rock lined channel, with a steep/failing south embankment. Watercourse rehabilitation improvements include removing the concrete lined channel; developing a stone-lined main channel, with riffle and pool sequences; salvaging and reusing on-site limestone blocks; establishing stable embankment side slopes through the development of tiered retaining walls, where necessary; developing a vegetated wetland floodplain and upslope vegetated communities, using native plant species; and grading to allow the future development of an important link within an urban bike trail.

Prioritizing Barrier Removal and Restoring Stream Connectivity in the Pensaukee-Duck Watershed

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Restoring access to spawning habitat is an important aspect of protecting and restoring populations of migratory and stream-resident species in the Lake Michigan basin. Human alteration of the natural hydrologic network, including the installation of dams and culverts, can disrupt the stream network and cut off access to suitable habitat. Recently, efforts to reverse the effects of these alterations have increased, resulting in a growing need for connectivity restoration guidance. The overall objective of this project is to guide the restoration of surface water connectivity by identifying the most significant migratory and resident fish barriers in the Pensaukee-Duck watershed.

This project is using established GIS-based analytical approaches to value barrier removal on both the amount and quality of reconnected habitat. The results of this project will include a map of habitat suitability and accessibility for northern pike and stream-resident species (brook trout, or a different species to be determined), and round goby (an invasive species) and a list of barriers ranked on connectivity effect. The benefit of removing a barrier will be determined by balancing potential benefits to pike and other native species with potential spread of the invasive goby. These products will provide a quantitative basis for prioritizing barrier removal and tracking the progress of connectivity restoration.

BioHaven Floating Islands: Restoring Near Shore Health and the Future of Habitat Management

David A. Wentland, Midwest Floating Island, LLC, St. Paul, MN, *davewentland@docks-marinas.com*

The BioHaven floating island (BFI) was developed by Floating Island International. Midwest Floating Island is a licensee. Mimicking natural floating treatment wetlands, they have rooted, emergent plants growing through a floating matrix of recycled, non-woven polymer strands. They provide nutrient uptake, wave absorption, wildlife and fisheries enhancement and natural aesthetics in nearshore areas.

BFIs support plants similar to those in surface and subsurface flow natural wetlands. They behave mechanically like a stormwater detention pond, and biologically like a wetland. Un-intense and low-impact, and proven by independent, peer-reviewed research, they are considered a practical and sustainable way to clean up water.

BFIs are cost-effective when it comes to maintenance and operations. Since the root mass of vegetation remains fully exposed to the water, they have the advantage of being unaffected by fluctuating water levels that can submerge and adversely stress sediment-rooted vegetation. The advantage allows BFIs to be built at a fraction of the size and cost of constructed wetlands while allowing treatment efficacy to occur.

Selected by the USACE for tern nesting, and 3,200 installations world-wide, BFIs are a preferred solution for water and habitat restoration challenges. Innovative and cost-effective, BFIs offer a tremendous man-made ecological best management practice to help accomplish the Great Lakes Restoration Initiative.

Geophysical Survey of an Arsenic Contaminated Site in the Kewaunee Marsh, Kewaunee, WI

David J. Hart, Wisconsin Geological and Natural History Survey, Madison, WI, *djhart@wisc.edu*

Peter M. Chase, Wisconsin Geological and Natural History Survey, Madison, WI, *pmchase@wisc.edu*

We used an EM-31 ground conductivity meter to map the extent of arsenic pesticide contamination in the Kewaunee Marsh. The source of the arsenic is thought to be from a spill that occurred 60 years ago at a nearby railroad. The survey illustrates a successful use of geophysics where the method was properly matched to the project needs and setting.

The geophysical investigation was designed around the site and contaminant. Although the site has undergone remediation by capping the contaminated area, contaminant levels remain extremely high, greater than 1000 mg/Kg in the peat and silt sediment and greater than 1,000,000 ug/L in groundwater samples. These very high levels caused the electrical conductivity of the contaminated sediment and water to be much higher than the uncontaminated areas. The investigation was further constrained by the marsh setting where well installation and sediment sampling is difficult. Much of the site was either covered in a thin layer of melting ice with several inches of water above the ice or in very soft sediment. We chose the EM-31 ground conductivity meter because it could resolve conductivity differences between contaminated and background locations at the depths of interest. The survey was conducted in less than two hours and delineated the extent of the arsenic.

The survey results will be used to focus selection of locations for additional groundwater and sediment sampling. This geophysical survey succeeded because the needs, site, and methods matched.

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