

**Senator George J. Mitchell Center for
Environmental & Watershed Research
Annual Technical Report
FY 2011**

Introduction

The Maine Water Resources Research Institute is the primary locus that sustains water science in the state through its support of research, graduate studies, and outreach. These fundamental and essential functions, which would not exist without Congressional authorization and appropriations, are not duplicated in the state in any other form. The federal money that supports the Water Resources Research Institute is highly leveraged with other funds provided by stakeholders, universities, and researchers. Research project proposals are evaluated by peer-review and approved by our Research Advisory Board composed of members from the U.S.G.S. Water Science Center, State Environmental Agencies, U.S. EPA, academia, and industry. During the FY11 period, the Maine Institute supported four (4) research projects, including two student-directed projects: (1) Release for heavy metals from ultramafic rocks; (2) Biogeochemistry and microbial community ecology in uranium contaminated groundwater; (3) Determinants of fish tissue mercury concentrations in temperate lakes; and (4) Sim-stream learning environment for middle school students (IT). The MWRRRI supported additional Information Transfer activities such as the Maine Water Conference and GET WET! activities. These projects directly provided support to four graduate students and three undergraduate students.

The Maine Institute Director, John Peckenham, also serves as the Assistant Director of the Senator George J. Mitchell Center for Environmental and Watershed Research. The Mitchell Center provides the administrative home for the Institute. This structural association greatly enhances our efforts to have the Maine Institute increase the breadth and accessibility of water research in Maine. The Mitchell Center is the recipient of a five-year EPSCoR grant from the National Science Foundation to develop the Sustainability Solutions Initiative. This grant is fostering even greater multi-institutional interdisciplinary research, including several projects related to water resources.

The 18th annual Maine Water Conference was held in March and continues to be the most important regional event for the water community. The number of people and organizations who support and contribute to this conference reflects the importance of water to the people of the State of Maine. Through the hard work of Institute staff, the Conference Steering Committee, and major supporters, we have been able to address the important water issues in Maine and to bring together diverse interest groups.

The Water Resources Research Institute's affiliation with the Mitchell Center gives us the ability to support both large and small projects that address important local needs. It also provides us leverage to develop and attract funding from other agencies. This program is strongly supported by our Vice-President for Research who has contributed \$50,000 to the 104b research projects. In FY11, the Maine Institute had projects that brought in other funds from state agencies (e.g. Department of Inland Fish and Wildlife, Department of Environmental Protection), federal agencies (e.g. Fish and Wildlife, Environmental Protection Agency, National Oceanic and Atmospheric Agency), and foundations. None of these projects would be possible without the support of the federal Water Resources Research Institutes program and the U.S. Geological Survey.

Research Program Introduction

The Maine Water Resources Research Institute supports research and information transfer projects using 104b funds. Projects are awarded on a competitive basis using a two-stage selection process. The Research Advisory Committee, comprised of the Institute Director, Regional U.S.G.S. Chief Scientist, State and Federal Agencies representatives, and Water Resources Professionals, set the research priorities based on current state needs and issues. The Institute issues a call for pre-proposals in the spring. The pre-proposals are reviewed by the Executive Committee (5 individuals) and full proposals are solicited for 150% of available funds. Full proposals are sent out for external review (out-of-state reviewers are required). The full Research Advisory Committee (12 members) reads the proposals and reviews to provide the Institute Director with a selection of proposals to fund. Much effort is made to solicit suggestions for themes, to diversify the types of projects funded, and to include researchers from the small colleges and universities in the state. Preference is given to support new faculty and projects developed by students. Investigators are encouraged to collaborate with state and federal agencies and to seek additional contributions for their projects.

A special student competition was initiated in FY09 to fund summer research. In consultation with our Research Advisory Committee Executive we have simplified the process to include students in our general call for proposals. Response to this student-centered program has been strong and it will be continued. Students are leading the development of over half the submitted proposals.

Release of Metals to Groundwater from Ultramafic Rocks on Deer Isle, Maine

Basic Information

Title:	Release of Metals to Groundwater from Ultramafic Rocks on Deer Isle, Maine
Project Number:	2011ME235B
Start Date:	5/1/2011
End Date:	2/28/2012
Funding Source:	104B
Congressional District:	2
Research Category:	Water Quality
Focus Category:	Geochemical Processes, Hydrogeochemistry, Toxic Substances
Descriptors:	None
Principal Investigators:	Amanda Albright Olsen

Publications

There are no publications.

Release of Metals to Groundwater from Ultramafic Rocks on Deer Isle, Maine
Amanda Albright Olsen, Department of Earth Sciences, University of Maine, Orono, ME
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This project addresses heavy metal release via serpentinite weathering. Serpentinites are ultramafic rocks enriched in Cr, Ni, Cd, Co, and Mn and depleted in nutrients K, P, and Ca. Serpentine soils host unique biota that differ significantly from biota on different lithologies in the same regions. Very little is known about the fate and transport of these metals once they are released from rocks via chemical weathering. Because these rocks are often geographically isolated, they have not been extensively studied. However, the release of heavy metals could pose a significant health risk to the families who drink groundwater in these areas.

The goal of this study is to understand at what rate serpentinites release heavy metals, and in particular Cr, to ground and surface waters. Specifically, we will answer:

- How quickly are heavy metals released from serpentinites via chemical weathering?
- Are heavy metals disproportionately partitioned into soils, groundwater, or surface waters during chemical weathering?
- Are these heavy metals transported via groundwater, and do levels of heavy metals exceed WHO recommended maximum contaminant levels?

Preliminary results suggest that Cr is depleted relative to the bedrock in soils. Chromium is found below the WHO recommended maximum contaminant level of 100 $\mu\text{g/L}$ in both soil water (2-15 $\mu\text{g/L}$) and nearby Torrey Pond (<2 $\mu\text{g/L}$). Future work will install a well on-site to determine Cr concentrations in groundwater.

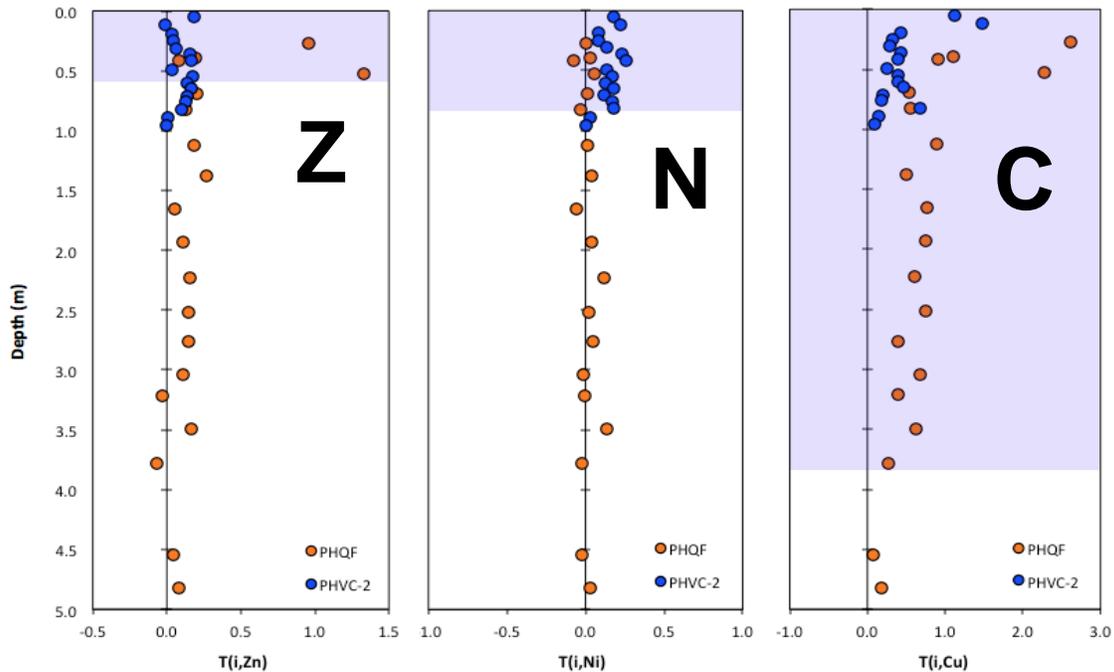


Figure 1. Enrichment in trace metals due to chemical weathering in the bedrock. Ca, K, and T show depletion relative to the parent rock, while Mg, Si, Fe, and Cr show no statistically significant change.

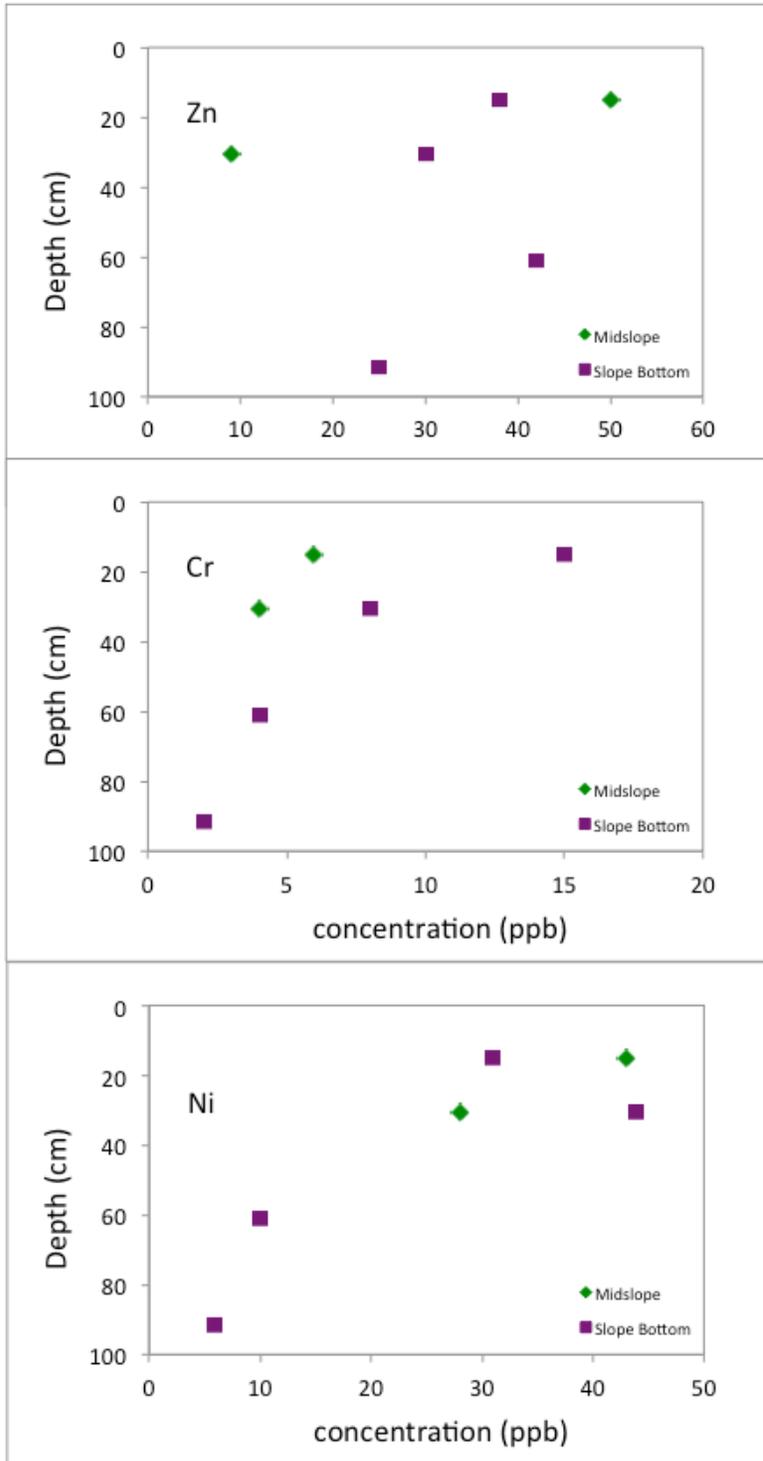


Figure 2. Heavy metal concentrations in soil waters from lysimeters placed at the mid-slope and slope bottom. Lysimeters placed at the hilltop were destroyed by vandals and will be replaced this summer.

Complex systems assessment of biogeochemical factors and microbial community members associated with naturally occurring uranium contamination in groundwater resources

Basic Information

Title:	Complex systems assessment of biogeochemical factors and microbial community members associated with naturally occurring uranium contamination in groundwater resources
Project Number:	2011ME236B
Start Date:	3/1/2011
End Date:	2/28/2012
Funding Source:	104B
Congressional District:	ME-02
Research Category:	Water Quality
Focus Category:	Hydrogeochemistry, Radioactive Substances, Ecology
Descriptors:	None
Principal Investigators:	Paula J Mouser, Charles Thomas Hess, Jean Macrae, Robert Marvinney, Donna Rizzo, Andy Tolman

Publications

There are no publications.

Progress Report 2011-2012

Contract Information

Title	Complex systems assessment of biogeochemical factors and microbial community members associated with naturally occurring uranium contamination in groundwater resources
Project Number	2011ME236B
Start Date	3/1/2011
End Date	2/28/2013
Focus Category	Hydrogeochemistry, Radioactive Substances, Ecology
Keywords	Bacteria, Biotechnology, Geochemistry, Groundwater Quality, Heavy Metals, Mathematical Models, Statistics
Lead Institute	University of Maine
Principal Investigators	Paula Mouser*, Jean MacRae, Tom Hess
Collaborators	Robert Marvinney, Andy Tolman, Donna Rizzo

*Currently located at The Ohio State University.

Abstract

Naturally occurring radionuclides, such as uranium, are present in low concentrations in many granitic geological formations in the northeast. Mineral dissolution processes, microbial activity, and changes in nutrient loading promotes the release of this metal in groundwater aquifers that serve as public and private water supplies. Human consumption of groundwater containing elevated uranium concentrations and its radionuclide daughter product, radon, increases the risk of kidney damage and lung cancer. Unfortunately, mechanisms controlling the *in situ* release and mobility of naturally-occurring uranium from bedrock materials is poorly understood, and must be addressed to limit human exposure and improve water quality in Maine. The overarching objective of this research is to assess whether microorganisms are drivers of subsurface conditions controlling elevated levels of uranium in the groundwater. The research involves analysis of groundwater biogeochemistry and microbial community profiles targeting the 16S rRNA gene from supply wells historically elevated in uranium, and application of statistical models with combined biogeochemical data to identify potential drivers of mobilized uranium in the groundwater. Our findings will assist the Maine Geological Survey and Drinking Water Program in classifying areas at risk to elevated U exposure, identifying possible pollutant sources that might be stimulating microbial activity related to uranium mobilization, and developing management strategies for lowering uranium in supply wells.

Problem

About 60% of Maine's residents rely on groundwater resources as their primary source of drinking water and other daily uses. On the order of 5% of these supply wells are estimated to have elevated levels of uranium, many at concentrations more than 10 times the Environmental Protection Agency's (EPA) maximum contaminant level (MCL) of 30 mg/l U. This is concerning because: 1) uranium and its daughter product radon pose serious health risks, 2) private supply wells in Maine are not required to test for uranium, so residents may be unaware that they are consuming groundwater with elevated U, and 3) the pretreatment of uranium-contaminated groundwater or the drilling of alternate supply wells can be a costly expense for residents.

Granitic bedrock materials are well known sources of uranium, and because many of the groundwater supply wells identified with elevated uranium are located in granites that are widely distributed across coastal and southern Maine, we can infer the source of uranium is from naturally-occurring aquifer materials. Under circumneutral, chemically oxidizing conditions, uranium forms dissolved complexes with carbonates and phosphates that are readily mobile in the groundwater. Under chemically-reducing conditions, which can occur in groundwater

aquifers when infiltration recharge or the diffusion of atmospheric oxygen is limited, the mobile uranium ionic forms (e.g. UO_2^{2+}) may be reduced to other more insoluble forms (e.g. UO_2) by the presence of organic materials and sulfides or through microbially-mediated enzymatic reduction processes. Re-oxidation and remobilization of reduced uranium ions can also occur in the presence of oxygen and nitrate species, or as a byproduct of microbial oxidation processes, suggesting that mobility of uranium in aquifers is dependent upon a complex balance of biogeochemical and hydrologic conditions, along with the abundance and activity of certain groups of microorganisms in the subsurface.

Unfortunately, mechanisms controlling the *in situ* release and mobility of naturally-occurring uranium from bedrock materials is poorly understood, and must be addressed before we can understand the sourcing and occurrence of uranium and its daughter product radon. The proposed study seeks to elucidate the possible microbially-mediated biogeochemical mechanisms associated with elevated levels of uranium in Maine groundwater using a complex systems approach. **The objectives of this research were to: 1) analyze groundwater biogeochemistry and microbial community profiles in supply wells historically elevated in uranium, and 2) apply statistical and neural network models with combined biogeochemical data to identify potential drivers of mobilized uranium in the groundwater.** Progress to date on these objectives includes the following methods and preliminary findings.

Methodology

During June 2011 Monica Plante, Jean MacRae and I met with stakeholders from the Maine Geological Survey (Robert Marvinney, Robert Johnston) and the Drinking Water Program (Andy Tolman) to identify supply wells that met sampling criteria outlined on our proposal and existing information collected by Columbia University during 2006-2007. We determined approximately 10 possible wells based on pre-existing concentration data, geologic formation information, and geographic location. Based on this short list, we contacted homeowners to determine interest and feasibility of sampling. Three wells were chosen for sampling, with the characteristics shown in Table 1.

Table 1: Characteristics of private supply wells chosen for sampling in this study.

Well ID	Address	Sample Date	Ground Surface Elevation	Depth to Water Level	Geologic Formation
W118	126 Maple St. Farmingdale	6/13/2011	265'	10'	Vasselboro Formation, Metamorphic
W93	163 Granite Hill Rd. Manchester	6/17/2011	305'	9.5'	Devonian Granite
W634	201 Granite Hill Rd. Manchester	6/20/2011	320'	Artesian 2.25' above G.S.	Devonian Granite - Background

Prior to sampling, Monica Plante (graduate student) and Rita Cooper (undergraduate student) were trained on proper handling of equipment and calibration of equipment for geochemical assessment. A peristaltic pump and dedicated tubing was used to collect water at multiple discrete depths in each borehole (Table 2). Boreholes were sampled under low flow conditions (200 ml/min) to minimize turbidity and drawdown of the groundwater and to ensure that we were collecting water from the targeted depth. Once field parameters stabilized (temperature, pH, conductivity, dissolved oxygen) samples were collected in triplicate for geochemical and microbiological parameters including total and dissolved metals, total organic carbon, radon, and microbial community. In-field analysis of groundwater geochemistry included: hydrogen sulfide

(H₂S), dissolved oxygen (DO), phosphate (PO₄⁻³), sulfate (SO₄⁻³), nitrate (NO₃⁻), ferrous iron (Fe(II)), ammonium (NH₄⁺), and nitrite (NO₂⁻).

Table 2. Elevation (ft amsl) of groundwater samples collected in this study.

W118	W93	W634
233	225	195
208	201	170
158	181	140
65	161	115
	146	

Within two weeks of obtaining all data, reports were provided to the homeowners showing the minimum, maximum, and average concentrations for total metals and selected geochemical constituents and field parameters collected in their well. Where concentrations exceeded maximum contaminant levels, levels were noted, and we included brochures developed by the State of Maine Drinking Water Program describing health risks and methods for reducing contaminant concentrations in private drinking supplies.

As part of this grant and additional funding support from the Maine Department of Environmental Protection, Monica Plante and Rita Cooper traveled to Ohio State University in August 2011 to take part in a one week crash course environmental biotechnology training workshop put on by PI-Mouser. During this training they learned basic molecular biology methods to conduct laboratory work at the University of Maine. Further geochemical analysis was conducted during the summer and fall of 2011 by Plante. Water samples were analyzed for total organic carbon, total phosphorous, and total nitrogen at the University of Maine. Samples were also analyzed for total and dissolved metals at the Sawyer Environmental Lab. Assessment of radon and radium was conducted by co-PI Hess. Extraction of DNA from microbial filters for microbial community fingerprinting is still in progress at the University of Maine. Once filters have been extracted, we will amplify the 16S rRNA gene using targeted primers and create fingerprints using the method of terminal restriction fragment length polymorphism (T-RFLP). Statistical analysis of geochemical data and microbial community profiles will be conducted during Summer and Fall 2012.

Preliminary Findings

Comparison of total and dissolved U concentrations suggests uranium is present primarily in its dissolved, oxidized form (U(VI)). In Figures 1-4, concentrations of select metals and geochemical parameters are plotted by depth below surface. Also shown are the locations of the water table (blue line) and bottom of well casing (black dotted line). Samples were only collected in the open borehole portion of the well. Concentrations of total uranium were highest in W118, located in the metamorphic Vasselboro formation (Figure 1). Total uranium concentrations also exceeded the MCL in W93 located in the Plutonic Devonian Granite (Figure 2) but not in W643, drilled to approximately the same depth approximately one mile from W93 (Figure 3). In the well with the highest levels of uranium (W118), total U, dissolved U, and total iron (Fe) increased by a factor of 15 at a depth of 165 feet above sea level (Figures 1 and 4). Dissolved iron, on the other hand, decreased by a factor of 25 across this same interval, indicating a switch from a dissolved, reduced form (Fe(II)) to particulate (probably Fe(III)) form (Figure 4).

Several geochemical and hydrologic observations are of note. Firstly, W118 had detectable levels of oxygen (3-6 mg/l) while W93 and W634 had oxygen levels below 1 mg/l. Secondly,

W634 acted as an artesian aquifer, with groundwater levels above the top of casing which set several feet above ground. Groundwater levels in the other two locations (W93 and W118) were below ground surface with no obvious upward gradient.

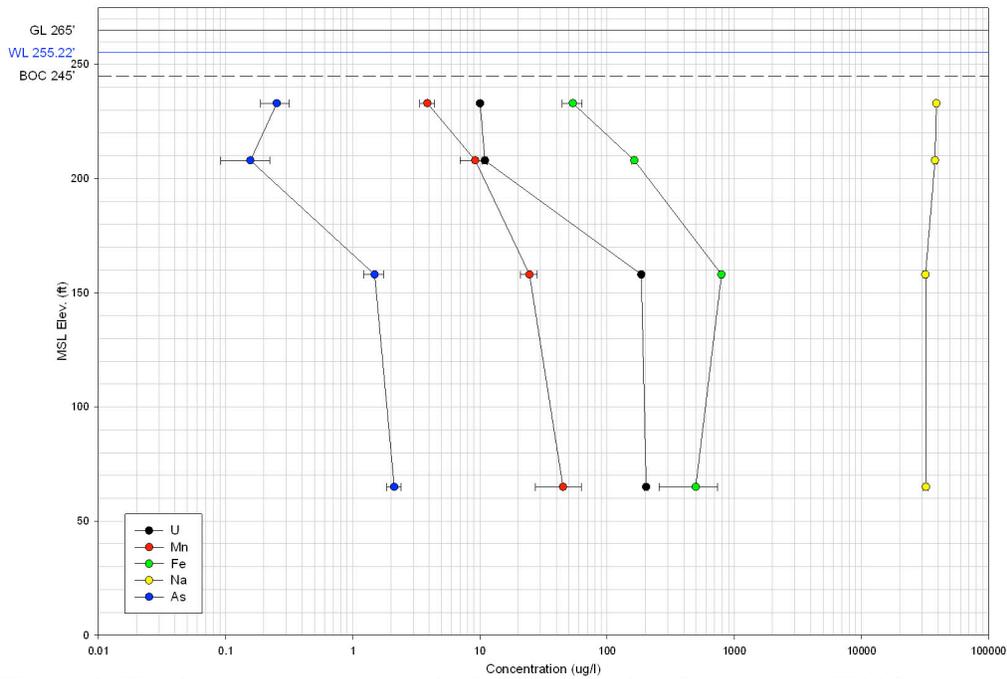


Figure 1. Total concentration trends for five metals of interest in W118.

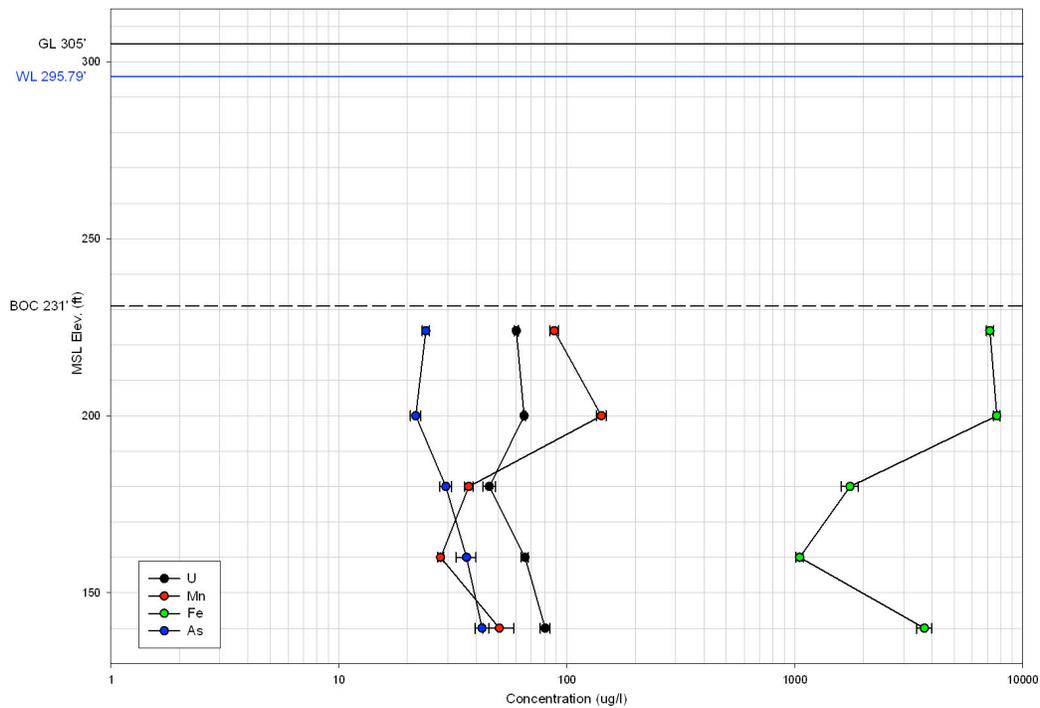


Figure 2. Total concentration trends for four metals of interest in W93.

provide more opportunities for radon stripping relative to other locations. 2) The oxic nature of W118 may promote a higher level of uranium dissolution and mobility relative to other locations. 3) The 15 fold increase of uranium with depth in W118 may indicate a change in stratigraphy where the shallower rock is comprised of an overall lower uranium source concentration and the deeper rock is more enriched in uranium. Further data reduction and statistical analysis is underway.

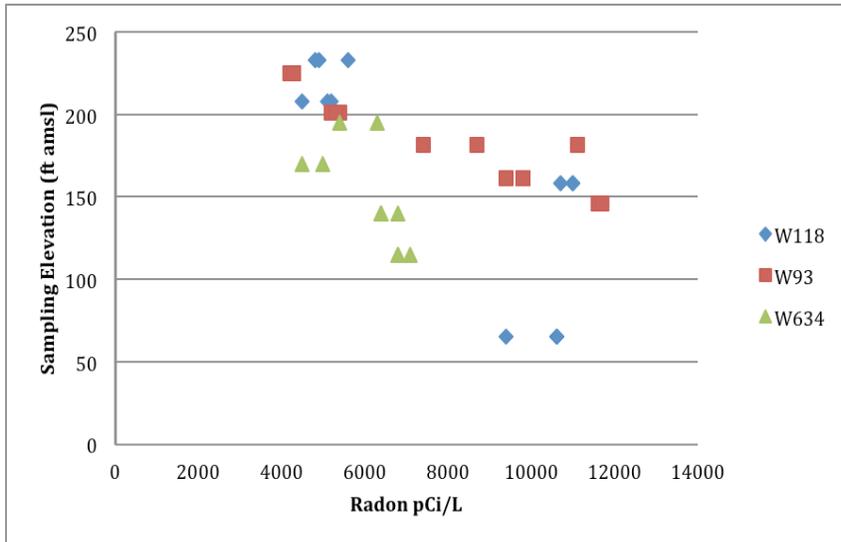


Figure 5. Concentration of radon for all three wells sampled in this survey.

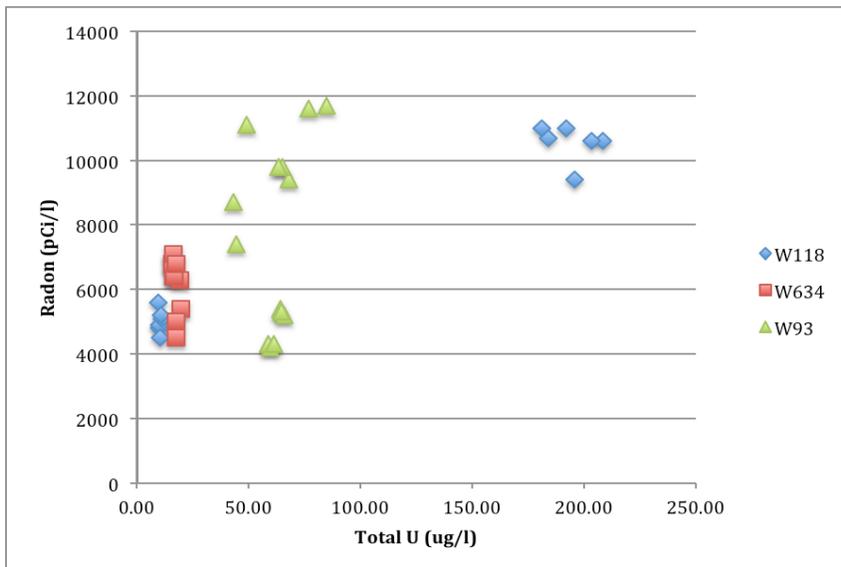


Figure 6. Relationship between total uranium and radon concentrations in wells sampled during this survey.

Significance

Our preliminary data suggest conditions within a borehole can have a dramatic effect on uranium concentrations and/or mobility. Our assessment of microbial community fingerprints (yet to be completed) may shed further light on microorganisms and associated biogeochemical conditions driving differences in uranium trends in these supply wells.

Publications/Proceedings/Conference Presentations

1. Kekacs, D, Plante, M, Mouser, PJ, and MacRae, J, (2012): Geochemical Analysis of Three Groundwater Supply Wells with Elevated Uranium Concentrations, Maine Water Conference, Augusta, ME, March 14.

Students Supported By Project

1. Monica Plante – M.S. student in the Department of Civil and Environmental Engineering (June 2011-Dec 2011). Note: Monica took a leave of absence from UMaine in December 2011 and decided not to return to graduate school.

2. Rita Cooper – Senior undergraduate student in the Department of Civil and Environmental Engineering (June 2011-Oct 2011)

3. Daniel Kekacs – M.S. student in the Department of Civil and Environmental Engineering (May 2012-current).

Awards or Achievements

None to date.

Identification of the determinants of fish tissue mercury concentrations in temperate lakes: Factors to be considered in the establishment or revision of fish consumption advisories

Basic Information

Title:	Identification of the determinants of fish tissue mercury concentrations in temperate lakes: Factors to be considered in the establishment or revision of fish consumption advisories
Project Number:	2011ME238B
Start Date:	3/1/2011
End Date:	2/28/2012
Funding Source:	104B
Congressional District:	2
Research Category:	Water Quality
Focus Category:	Hydrogeochemistry, Non Point Pollution, Surface Water
Descriptors:	None
Principal Investigators:	Aria Amirbahman, Stephen A. Norton

Publication

1. Bacon, L.C., A. Amirbahman, S. Norton, B. Mower. 2011. Elucidation Complex Relationships Among Factors Influencing Mercury Fish Tissue Contamination. Maine Water Conference, Augusta, ME, March 16, 2011.

Interim Report Project Number: 2010ME238B:

**Identification of the determinants of fish tissue mercury concentrations in temperate lakes:
Factors to be considered in the establishment or revision of fish consumption advisories**

Project Type: Research

Focus Category: Hydrogeochemistry, Non Point Pollution, Surface Water

Keywords: Geochemistry, Lakes, Pollutants, Water Quality Monitoring, Water Chemistry

Start Date: 3/1/2011

Original Date: 2/28/2012 – Extension Requested

Congressional District: 2

PI: Amirbahman, Aria; email:aria@umit.maine.edu

Co-PI(s): Norton, Stephen; email:Norton@Maine.Edu; phone: 207-581-2156

Basis. Increased loadings of mercury (Hg) documented in the U.S. have translated to Hg contamination in fish in freshwater and coastal environments. In response, all states and all of the eastern Canadian provinces have established consumption advisories for marine and/or freshwater fish. Maine's advisory applies to *all* inland waters which reduces recreational opportunity and eliminates a source of high quality protein for residents. High Hg concentrations also pose a threat to fish-eating birds and mammals. The source of the Hg is believed to be atmospheric deposition, yet Hg contamination of fish is highly variable between lakes in close proximity. The focus of the larger project of which this grant is a part, is to understand the environmental factors that control Hg bioavailability in Maine lakes which may allow targeted fish consumption advisories.

Status. Significant progress has been made on this project, which is being funded from multiple sources including this USGS WRRRI Grant. During 2010 and 2011, biopsy samples from 952 fish were analyzed for total mercury (Hg) concentrations; these fish were collected from 87 Maine lakes along with water and sediment samples. Funds received from this WRRRI Grant were used to support the following analyses of samples collected in 2011: total mercury in fish tissue, total mercury in water, and methyl mercury (MeHg) in water. To date, water analyses are complete; sediment analysis has just begun and results are anticipated in late 2012.

Preliminary statistical analysis reveals a weak correlation between total Hg and MeHg in water ($R^2 \sim 0.34$), which is not surprising given the various geochemical factors that control MeHg concentrations. We are currently assembling information on factors that can control MeHg concentrations in sediment, water and fish using GIS (wetland area and proximity attributes), in-lake variables that control lake's oxic status (volume, sediment contact area), and sediment mercury lability using sequential chemical extractions (weaker mineral bound vs. stronger organic bound). A dataset containing results from all completed analyses is currently being compiled for multivariate analyses which is expected to begin within the next four months.

Information Transfer Program Introduction

Information Transfer activities for the Maine Institute can be assigned to five categories: (1) Maine Water Conference; (2) Web-based information; (3) Participation on state-wide boards and committees; (4) Educational Outreach (GET WET!); and (5) Direct response to inquiries. The Maine Water Conference is the primary water event in the state and brings together a very broad array of interest groups. This conference is very popular and continues to be the most important information transfer event for the Maine Institute. The Maine Institute's web page is the location to find information for current issues, activities, and publications. The web page is updated on a regular basis to include project outputs such as publications and presentations. Also, it serves as a notice board for meetings, student opportunities, and calls-for-proposals.

The Water Institute Director serves on several state-wide and national boards and committees (e.g. Maine Water Utilities Association, Penobscot River and Bay Institute, American Water Works Association, National Institutes for Water Research). These activities provide opportunities to promote relevant institute-sponsored research and education. Also, it provides a process for the Maine Institute to collect information about the concerns and challenges of water resources in the state and region. This effort helps to keep the Maine Institute at the core of water resources in the state. Finally, the Water Institute receives public inquiries on a regular basis. Typically, someone is hoping that outcomes from funded projects can help solve their water-related problem. Responding to these inquiries is important and we make every effort to help citizens in finding answers and solutions to their problems. Although most inquiries come from Maine, we have received requests from around the globe.

Prototype Development of SimStream, a Computer-Based Immersive Learning-Environment for Introducing Environmental Systems Concepts to Middle-School Students

Basic Information

Title:	Prototype Development of SimStream, a Computer-Based Immersive Learning-Environment for Introducing Environmental Systems Concepts to Middle-School Students
Project Number:	2011ME247B
Start Date:	3/1/2011
End Date:	2/28/2012
Funding Source:	104B
Congressional District:	2
Research Category:	Not Applicable
Focus Category:	Management and Planning, Hydrology, Models
Descriptors:	None
Principal Investigators:	Shaleen Jain, Mike Scott

Publications

There are no publications.

Prototype Development of SimStream, a Computer-Based Immersive Learning-Environment for Introducing Environmental Systems Concepts to Middle-School Students

The Need

U.S. middle-school students have few opportunities to explore contemporary environmental issues in the classroom in ways that connect with their experience, motivations, and technology use. Furthermore, while issues relevant to environmental science motivate lesson plans in earth science and civics alike, discussions are compartmentalized by disciplinary boundaries, leaving students to explore relationships between topics on their own. The need for improved, interdisciplinary environmental science training in U.S. schools is recognized at the federal level. A 2009 National Science Foundation Advisory Committee for Environmental Research and Education report describes the challenge to instilling K-12 students with an "understanding of the world as coupled natural and human systems involving complicated, multi-scale interactions and having the potential for complex behaviors such as tipping points."



The State of Maine is in an ideal position to lead the nation's charge for integrating environmental science concepts via cyber-learning into STEM classrooms through its Maine Learning Technology Initiative (MLTI), specifically the Maine Laptop Program, which provides every middle-school student in the state with a personal laptop computer, offers students potential exposure to the computer programming, animation, and visualization technology that continue to revolutionize learning and creative thinking.

Program Overview & Objectives

Working with K-12 student- and teacher focus groups, the project develops a prototype computer-based immersive environment framework concept exploring relationships between a watershed and neighboring human settlement. *SimStream* is designed for integration into middle-school science curricula. The target audience is 6th-8th graders. The framework uses various population, ecological and hydrological models for students to explore and learn a variety of fundamental environment science concepts. By understanding and visualizing systems and quantitative problem solving, students learn to navigate in an uncertain future.

The objective of this project is to provide a substantial learning tool that, in principal could be further developed into a comprehensive decision tool to analyze hydrologic changes, quantify impacts on human and ecosystems, and test and assess the adequacy of policy in the face a changing climate and uncertain forecast. The project seeks to push the educational frontier of this critical area of environmental sustainability, one that is complex and uncertain, by ascertaining flexibility, probability of surprises, and determining courses of action (flexibility in policy). The project also seeks to cultivate, in all *SimStream* users—learners of all ages, appreciation and understanding of the researcher-agency-stakeholder collective.

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**Maine Water Institute
FY 2011 Project**

Maine Information Transfer

Basic Information

Title:	Maine Information Transfer
Project Number:	2011ME251B
Start Date:	3/1/2011
End Date:	2/28/2012
Funding Source:	104B
Congressional District:	2
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	None
Principal Investigators:	John M. Peckenham

Publications

There are no publications.

Publications

Peer Reviewed Publications

Cronan, C.S. 2011. Biogeochemistry of the Penobscot River watershed, Maine, USA: nutrient export patterns for carbon, nitrogen, and phosphorus. *Environmental Monitoring and Assessment*: DOI 10.1007/s10661-011-2263-8.

Lindenfeld, L.A., D.M. Hall, B. McGreavy, L. Silka, and D. Hart. 2012. Creating a place for Communication Research in Sustainability Science. *Environmental Communication. A Journal of Nature & Culture*. Volume 6 (March), pp. 23-43.

Neville, M. and Beard, K. 2011. Analysis of mercury contamination in a coastal ecosystem using geospatial tools. *Ecosystems* (in preparation).

Peckenham, J.M., H. Paterson, C. Roesler, J. Pinto, and C. Proctor. 2011. Real-Time Algae Monitoring For Drinking Water Security, Lakelines, Dec. 2011.

Peckenham, J.M., T. Thornton, and P. Peckenham. 2011. Validation of Student Generated Data for the Assessment of Groundwater Quality, *Journal of Science Education and Technology*, DOI 10.1007/s10956-011- 9317-0.

Waring, T.M. and P.J. Richerson. 2011. Towards Unification of the Socio-Ecological Sciences: The value of coupled models. *Geografiska Annaler: Series B, Human Geography*, 93(4).

Presentations

Bacon, L.C., A. Amirbahman, S. Norton, B. Mower. 2011. Elucidation Complex Relationships Among Factors Influencing Mercury Fish Tissue Contamination. Maine Water Conference, Augusta, ME, March 16, 2011.

Elskus, A. 2011. Monitoring Contaminant Exposure of Endangered Species: Lethal, Non-Lethal and Surrogate Approaches. Maine Water Conference, Augusta, ME, March 16, 2011.

Hall, D., L. Silka, L. Lindenfeld. 2011 Theoretical Frameworks for Integrating Communication Research and Stakeholder Engagement. Maine Water Conference, Augusta, ME, March 16, 2011.

Hutchins, K., K. Bell, J. Leahy, L. Silka, L. Lindenfeld. 2011. Problemscaping Maine: Reaching Out to Communities to Inform Research? Maine Water Conference, Augusta, ME, March 16, 2011.

Jain, S. 2011. Changing Climate and Regional Hydrology. Maine Water Conference, Augusta, ME, March 16, 2012.

Jansujwicz, J., A. Calhoun, R. Lilieholm. 2011. Integrating Social Science into Natural Resources Conservation to Enhance Management of Vernal Pools. Maine Water Conference, Augusta, ME, March 16, 2011.

Johnson, M., C. Cronan, D. Owen, S. Meyer, R. Lilieholm. 2011. Using Bayesian Belief Networks to Identify At-Risk Aquatic Resources Under Alternative Future Developments Scenarios. Maine Water Conference, Augusta, ME, March 16, 2011.

McGreavy, B., T. Webler, A. Calhoun. 2011. Science in Translation: A Mixed Methods Approach to Describe Local Decision Maker Attitudes to Vernal Pool Conservation in Maine. Maine Water Conference, Augusta, ME, March 16, 2011.

Meyer, S., M. Johnson, R. Lillieholm, C. Cronan. 2011. Temporal and Spatial Distributions of Conserved Lands in Maine. Maine Water Conference, Augusta, ME, March 16, 2011.

Mouser, P. 2011. Detecting and Delineating Groundwater Contamination at a Leaking Waste Disposal Site Using Microbial Community Profiles. Maine Water Conference, Augusta, ME, March 16, 2011.

Neville, Melinda. 2011. Spatiotemporal Database Integration of Mercury Research in Maine. Maine Water Conference, Augusta, ME, March 16, 2011.

Neville, M. and Beard, K. 2011. Geospatial analysis of mercury data in coastal catchments. Accepted Abstract for the 10th International Conference on Mercury as a Global Pollutant (ICMGP), Halifax, Nova Scotia, Canada, July 24, 2011.

Peckenham, J., L. Wilson, A. Tolman, J. Jemison, and P. Peckenham. 2011. Fluoride, arsenic, and chloride in private water wells in eastern Maine, Private Well Symposium, Southbury, CT, November 15, 2011.

Peckenham, J. and T. Thornton. 2011. Validation of Student Analyses of Drinking Water, Citizen Scientist Symposium, University of Maine, Orono, ME, May 12, 2011.

Peckenham, J. and S. Jain. 2011. Defining typology for Source Water Protection in Maine, New England Water Works Association Source Water Protection Symposium, Boxborough, MA, Oct. 27, 2011.

Peckenham, J. and S. Jain. 2011. Typology of Source Water Protection in Maine, American Water Works Association Annual Conference and Exposition, Washington, DC, June 13, 2011.

Ranco, D. 2011. Kolunkayowan Wikpiyik II: Protecting the Ash for Future Generations Symposium. George Mitchell Center, University of Maine.

Shearin, A., A. Calhoun, C. Loftin. 2011. Using Automated Audio Recording Devices to Improve Listener-Based Amphibian Surveys. Maine Water Conference, Augusta, ME, March 16, 2011.

Strock, K., J. Saros, B. Gawley, A. Ellsworth. 2011. Understanding the Interactive Effects of Climate Change and Air Pollution on Lake Ecosystems: Implications for Declining Water Clarity in Acadia National Park. Maine Water Conference, Augusta, ME, March 16, 2011.

Thornton, T., J. Leahy. 2011. Social Capital and Social Network Changes in a School-Centered Research Program that Promotes Community Management of Drinking Water Resources. Maine Water Conference, Augusta, ME, March 16, 2011.

Zoellick, B., B. Bisson, S. Nelson. 2011. Watershed Studies in Schools to Support Student Understanding of Systems Concepts. Maine Water Conference, Augusta, ME, March 16, 2011.

Reports

Hutchins, K., L.A. Lindenfeld, L. Silka, J. Leahy, and K.P. Bell. August, 2011. Maine Municipal Official Survey Technical Report.

Hutchins, K. and A. Foster. July, 2011. Non-Point Source Pollution Communication Intercept Survey Final Report: Bangor Area Stormwater Group.

Ranco, D., R.J. Lillieholm, J. Daigle, J. Neptune, E. Quigley, T. Secord and M. Lizotte. 2011. Kolunkayowan Wikpiyik II: Protecting the Ash for Future Generations Symposium Report. Sustainability Solutions Initiative, University of Maine. 21 pages.

Other Publications

Hallsworth, R., K. Raymond, and K. Ridley. 2011. SSI Fall Newsletter. University of Maine. Solutions Vol. 1 No. 1.

Waterlines...in brief

Mitchell Center newsletters are distributed via email on a regular basis to the Mitchell Center's mailing list of over 2,000 people. The newsletter is also posted on-line (<http://www.umaine.edu/WaterResearch/outreach/waterlines.htm>) and includes news and information on current activities at the Mitchell Center, Maine's Sustainability Solutions Initiative and Maine WRRI.

Waterlines in brief. Web-based news sheet, March 2011

Waterlines in brief. Web-based news sheet, April, 2011

Waterlines in brief. Web-based news sheet, June 2011

doSSler

doSSler is the team newsletter of Maine's Sustainability Solutions Initiative, a program of the Mitchell Center. The newsletter is published bi-weekly and provides news and updates for the SSI team. It is e-mailed to 150 participating faculty and students and posted to the SSI web site.

- [DoSSler Issue No. 41](#) (2/8/2012)
- [DoSSler Issue No. 40](#) (1/25/2012)
- [DoSSler Issue No. 39](#) (1/11/2012)
- [DoSSler Issue No. 38](#) (12/9/2011)
- [DoSSler Issue No. 37](#) (11/21/2011)
- [DoSSler Issue No. 36](#) (10/24/2011)
- [DoSSler Issue No. 35](#) (10/4/2011)
- [DoSSler Issue No. 34](#) (9/15/2011)
- [DoSSler Issue No. 33](#) (8/29/2011)
- [DoSSler Issue No. 32](#) (8/10/2011)
- [DoSSler Issue No. 31](#) (7/7/2011)
- [DoSSler Issue No. 30](#) (5/26/2011)
- [DoSSler Issue No. 29](#) (4/25/2011)
- [DoSSler Issue No. 28](#) (4/6/2011)
- [DoSSler Issue No. 27](#) (3/23/2011)
- [DoSSler Issue No. 26](#) (3/3/2011)

Poster Presentations

Arter, Barbara, Dietert, M. *Penobscot River Science Exchange: A Consortium for Dam Removal and Diadromous Fish Restoration Research*. Maine Water Conference Poster Presentation. March 16, 2011.

Ashe, Wesley, Coghlan, S. *Atlantic Salmon (salmo salar) Growth and Survival as an Indicator of Habitat Quality in Tributaries of the Machias River Watershed*. Maine Water Conference Poster Presentation. March 16, 2011.

Bell, Kathleen, Lewis, L. *Who Gives a Dam?: Taking Stock of Public Support for River Restoration Projects*. Maine Water Conference Poster Presentation. March 16, 2011.

Dietert, Matthew, Arter, B. *Diadromous Species Response to Water Chemistry: A Literature Review Summarizing Impacts of Endocrine Disrupting Chemicals on Diadromous and Freshwater Fish in the Gulf of Maine*. Maine Water Conference Poster Presentation. March 16, 2011.

Dreyer, Stacia, McCoy, S., Teisl, M., Noblet, C., Wellman, J., Wibberly, M., Cosely, B., Pickering, R., Newell, E. *Do Environmental Attitudes Predict Pro-environmental Behavior and Recreation Orientation?* Maine Water Conference Poster Presentation. March 16, 2011.

Giordino, William, Blais, J., Smith, O. *Permaculture Design Research Initiative*. Maine Water Conference Poster Presentation. March 16, 2011.

Kary, Daniel, Bell, K., Jain, S. *Residential Land Conversion and Peak Streamflow Response*. Maine Water Conference Poster Presentation. March 16, 2011.

Marrinan, Sarah, Price, K., Wibberly, M., Teisl, M., Noblet, C., McCoy, S.. *Who Cares About Water? Influences Affecting Concern for Water Quality and Quantity*. Maine Water Conference Poster Presentation. March 16, 2011.

McGreavy, Bridie, Hutchins, K., Richards, M., Lindenfeld, L., Silka, L., Hall, D., Smith, H., Quartuch, M., Budzinski, C., Utley, L., Becker, A., Kacer, N., Thornbrough, L. *Knowledge Action Systems in an Interdisciplinary Collaborative Sustainability Science Research Project*. Maine Water Conference Poster Presentation. March 16, 2011.

Nason, Rynne, Carle B., Peckenham, P., Kirby, K. and Wilson, L. *Exploring Barriers to Well Water Testing*. Maine Water Conference Poster Presentation. March 16, 2011.

Parr, Thomas, Cronan, C., Ohno, T., Simon, K. *Patterns of Dissolved Organic Matter Composition Along and Urbanization Gradient in Maine*. Maine Water Conference Poster Presentation. March 16, 2011.

Scall, David G., Elskus, A. *Fish Scales as Non-Lethal Bio-sensors of Surface Water Contaminants*. Maine Water Conference Poster Presentation. March 16, 2011.

Spinney, Eileen, Olsen, A. *Lizardite Dissolution: Implications for Serpentine Soils*. Maine Water Conference Poster Presentation. March 16, 2011.

Springsteen, Anna, MacRae, J., Kim, J., Jain, S. *A Look at Trends in Sebago Lake*. Maine Water Conference Poster Presentation. March 16, 2011.

Weldon, Jennifer, MacRae, J. *Microbial Populations Associated with Private Wells with High Levels of Arsenic Located in Northport, Maine*. Maine Water Conference Poster Presentation. March 16, 2011.

Conferences and Annual Meetings

Maine Water Conference 2011

The 2011 Maine Water Conference took place on March 16 at the Augusta Civic Center in Augusta, Maine. Sessions topics included river restoration, sustainability science, outreach and education, green remediation, groundwater geochemistry and wetland ecology. Plenary speakers were Jeff Opperman, Sr. Advisor for Sustainable Hydropower, The Nature Conservancy, and Dominic DiToro, Professor of Civil and Environmental Engineering, University of Delaware.

The Maine Water Conference is the largest environmentally-related conference in Maine attracting over 350 water resource professionals. It provides unprecedented opportunities to promote both the Mitchell Center's and UMaine's role in environmental research and problem-solving throughout Maine and to build stronger relationships with state and federal agencies, NGOs, and the private sector. The MWC Steering Committee is made up of key water resource stakeholders from across the state.

Sponsorship for the 2011 Maine Water Conference was provided by: U.S. Geological Survey, Senator George J. Mitchell Center and the Maine Water Institute, Maine Drinking Water Program/Dept. of Health & Human Services, Maine Dept. of Environmental Protection, Maine WasteWater Control, Maine Geological Survey, Maine Water Utilities Association, Maine Congress of Lake Associations, University of Maine Cooperative Extension, and Maine Volunteer Lake Monitoring Program.

Public Service

Media/Press

Bangor Daily News, September 16, 2011

<http://bangordailynews.com/2011/09/16/news/bangor/maine-scientists-to-attend-water-quality-conference/?ref=latest>

Committees and Service

David Hart

- Member, Science and Technical Advisory Committee, American Rivers
- Member, Sustainable Oceans, Coasts, and Waterways Advisory Committee, Heinz Center for Science, Economics, and the Environment, 2004 – present.
- Member, President's Advisory Committee on Water Information (representing the Ecological Society of America), 2003 – present.

John Peckenham

- Board Member (New England Regional Representative), National Institutes for Water Research.
- New England Private Well Initiative – Water Quality Extension and US EPA Region 1
- Source Water Collaborative and American Water Works Association Source Protection Committee
- New Business Development – Maine Water Security LLC (managing partner), Mainely Sensors LLC (consultant), Zeomatrix (consultant)
- Penobscot River Keepers (~500 students on the river)
- GET WET! (~125 students, water quality testing).
- River Flow Advisory Commission- Drought Task Force
- Maine Water Conference Organizing Committee
- Maine Water Utilities Association- Water Resources Committee
- Sustainable Water Withdrawal- Land and Water Resources Council
- Maine Waste Water Control Association- Residuals Management Committee
- Penobscot River and Bay Institute- Board of Directors
- Northern Maine Children's Water Festival
- DEP-Consulting Engineers of Maine Task Force
- New England Water Quality Extension Advisory Board

Sarah Nelson

- Convener, Mercury in Acadia and northeast protected areas. In collaboration with NPS-ARD, NPS-Acadia, SERC Institute
- Lead scientist, Acadia Learning project, 2007-present
- Steering committee member, Acadian Internship in Regional Conservation and Stewardship, 2010-present
- Steering committee member, Downeast and Acadian Initiative, 2010-present
- Maine Water Conference, Science Program Chair, 2010-2011
- Acadia Web Portals working group, coordinator, 2009-2010
- Scientist-teacher liaison, Acadia Learning project, 2007-present
- MDI Water Quality Coalition student mentor, 2006-present
- Appalachian Trail Environmental Monitoring Program, Water Quality Working Group
- Coordinator, University of Maine Mercury Research Group, 2006-present
- Board member, Maine Lakes Conservancy Institute 2007 - 2010
- Maine Water Conference Organizing Committee

Workshops and Other Activities

Maine's Sustainability Solutions Initiative (SSI) at the Mitchell Center

In July 2009, the Senator George J. Mitchell Center was awarded a \$20 million, five-year grant by NSF EPSCoR to support Maine's Sustainability Solutions Initiative. With SSI now heading into its 4th year, synergy between SSI and the Maine WRRRI program provides important leveraging opportunities for water resource projects across the state. A key component of the SSI project is its partnership with 12 other educational institutions across Maine. All of these institutions are funded to conduct research under the SSI program – many related to water resources in Maine. WRRRI Director John Peckenham acts as liaison between SSI and the partner institutions building relationships that also strengthen the WRRRI program. It is also important to note that many faculty who have been funded under the WRRRI research program are key collaborators on the SSI project.

SSI partner institutions include: Bates, Bowdoin, Colby, Unity, University of New England, College of the Atlantic, University of Southern Maine, University of Maine at Farmington, University of Maine at Augusta, University of Maine at Machias, University of Maine at Presque Isle, University of Maine at Fort Kent.

Introduction to Maine's Sustainability Solutions Initiative

Producing knowledge and linking it to actions that meet human needs while preserving the planet's life support systems is emerging as one of the most fundamental and difficult challenges for science in the 21st century. There is growing consensus that traditional methods of generating and using knowledge must be fundamentally reorganized to confront the breadth, magnitude, and urgency of many problems now facing society. Maine's Sustainability Solutions Initiative seeks to transform Maine's capacity for addressing these scientific challenges in ways that directly benefit Maine and other regions. The program of research will also help Maine increase economic activity and technological innovation in ways that sustain the State's remarkable "quality of place".

Maine's Sustainability Solutions Initiative Research Projects

The following funded projects provide direct linkages with the Maine WRRRI program. Opportunities for further collaborations that enhance both research programs will be actively pursued in the future.

- Linking Knowledge with Action: Refining Maine's Mercury Fish Consumption Advisory Team Leader: Aria Amirbahman, Civil & Env. Engineering, University of Maine
- Protecting Natural Resources at the Community Scale: Using population persistence of vernal

- pool fauna as a model system to study urbanization, climate change and forest management
Team Leader: Aram Calhoun, Wildlife Ecology, University of Maine
- Decision tools to support water resources sustainability of managed lake systems
Team Leader: Andy Reeve, Dept. of Earth Sciences, UMaine
- Adaptation Strategies in a Changing Climate: Maine's Coastal Communities and the Statewide Stakeholder Process
Team Leader: Shaleen Jain, Civil & Env. Engineering & Climate Change Institute, UMaine
- Analysis of Alternative Futures in the Maine Landscape using Spatial Models of Coupled Social and Ecological Systems
Team leader: Rob Lillieholm, Forest Resources
- Sustaining and Restoring Urban Stream Resources in Maine
Team leader: Dave Owen, School of Law, University of Southern Maine
- Researching Knowledge-to-Action Linkages to Promote Stakeholder and Community Engagement
Team leaders: Laura Lindenfeld, Communication and Linda Silka, Margaret Chase Smith Center for Public Policy
- Modeling Stakeholder Acceptance of Solutions to Environmental Problems
Team leaders: Mario Teisl, Shannon McCoy, University of Maine
- Spatial forest planning to meet multiple natural resource goals: Developing geospatial tools to forecast management outcomes across a diverse landscape of ownership types and stakeholder interests
Team leader: Jeremy Wilson, University of Maine
- The Maine Tidal Power Initiative: Linking knowledge to action for responsible tidal power development
Team leaders: Teresa Johnson, Gayle Zydlewski, University of Maine
- Ecological and economic recovery and sustainability of the Kennebec and Androscoggin Rivers, estuary and nearshore environment
Team leader: John Lichter, Bowdoin College, Bates College, University of Southern Maine
- Sustaining Quality of Place in the Saco River Estuary through Community Based Ecosystem Management
University of New England
- Modeling Resilience and Adaptation in the Belgrade Lakes Watershed
Team leader: Whitney King, Colby College
- Modeling evolving ecological, cultural, and economic systems of the Aroostook River watershed of northern Maine for sustainable development (Planning Grant)
Team leader: Jason Johnson, University of Maine at Presque Isle (UMPI)
- Planning for Watershed-based Sustainable Development: Bridging the Belgrade and Rangeley Lakes Regions
Team leader: Wendy Harper, University of Maine at Farmington (UMF)

Senator George J. Mitchell Lecture on Sustainability

The October 13, 2011 Senator George J. Mitchell Lecture on Sustainability featured Baruch Fischhoff, a cognitive psychologist and professor of social and decision sciences from Carnegie Mellon University.

Fischhoff presented his research using “non-persuasive communication” to explain science to the public in ways that help people make more informed decisions about complex issues to an audience of more than 450 attendees, including students, faculty and the general public.

Baruch Fischhoff, whose leadership roles include chairing the FDA's Risk Communication Advisory Committee and serving on the EPA's Scientific Advisory Board and chairing its Homeland Security Advisory Committee, focuses on helping the public understand and respond to health and environmental risks. His research interests include establishing a new interdisciplinary approach to communicating science to the public.

Mitchell Center and SSI Seminars

- **March 29, 2011** – Damon Hall, University of Maine, Sustainability Solutions Initiative Strategies and Tactics for Community-based Sustainability Science Research
- **September 21, 2011** – Phil Nyden, Director, Center for Urban Research, Loyola University, Chicago
Do We Know It All? Combining University and Community Knowledge in Research
- **October 17, 2011** – Stanley Temple, University of Wisconsin, Madison.
Aldo Leopold, Phenology and Climate Change
Followed by film screening – “Green Fire: Aldo Leopold and a Land Ethic for Our Time”
- **November 4, 2011** – Gil Pontius, School of Forest Resources, Clark University.
One day workshop on Land Use Modeling
- **November 9, 2011** – Mark Schildhauer, National Center for Ecological Analysis and Synthesis
Emerging Cyberinfrastructure for Environmental Sciences
- **February 23, 2012** – Robert Jacobson, Research Hydrologist, USGS
Conceptualizing and Communicating River Restoration and Re-engineering the Lower Missouri River for Ecosystem Recovery: A Long Strange Trip

Environmental Seminars at UMaine

As part of a larger initiative to have the Mitchell Center become the focus of environmental initiatives on campus, Center staff worked with other departments and institutes to put together a comprehensive list of all the environmentally-related seminars taking place at UMaine each semester. This initiative has been very well received by staff, faculty and students, and several faculty members noted that this was an important role for the Mitchell Center.

Web Sites

The Mitchell Center hosts two Web sites, the main Mitchell Center Web site (<http://www.umaine.edu/WaterResearch/>) and the new SSI Web site. WRRRI program information is available on the Mitchell Center web site and includes updates on funded projects, grant programs and related conferences and grant opportunities. The site is updated weekly.

The SSI Web site was launched in 2009 (www.umaine.edu/sustainabilitysolutions) and is designed to assist with SSI communication efforts. The site contains information covering many aspects of the initiative including current research projects, faculty and student involvement, student opportunities and recruitment materials, resources, and news and events.

GET WET!

Groundwater Education through Water Evaluation and Testing (GET WET!) is an experiential project to raise community awareness about groundwater quality and to provide data for a study of gravel mining and water quality. There are three key objective categories: science, community, and education.

Scientific goals include:

- Create long-term water quality databases in towns through annual well monitoring and sampling.
- Utilize students to sample. The wells sampled are located in, over, or next to the sand and gravel aquifer.
- Include in the database: 1) Water chemistry of nitrate, alkalinity, chloride, conductivity, and turbidity. 2) Locations of wells mapped into a GIS program. 3) Operational excel spreadsheets with all information gathered. 4) Statistics and charts to graphically represent information.

Community goals include:

- Increase awareness, understanding, and interest in water resources within towns.
- Involve local citizens in the sampling, monitoring, and maintenance of water quality within their town.
- Generate a water quality database that can be used by the community to formulate productive choices in planning, management, and development.

Education goals include:

- Create an interdisciplinary study focusing on natural resources water and development.
- Employ all grades and educators involved in chemistry, geology, geodesy, mapping, GIS, statistics, computer programs, and environmental studies.
- Encourage student development in: 1) Field sampling techniques. 2) Laboratory skills. 3) Computer competence. 4) Internet research capabilities. 5) Mapping abilities in both interpolation of hard copy topographic maps and interpretation of computer based topographic maps. 6) Recognition and identification of locations by latitude and longitude on topographic maps. 7) Comprehension in terminology and function of water chemistry testing for nitrates, alkalinity, chloride, conductivity, and turbidity. 8) Understanding of why conservation and commitment to a healthy environment takes an entire community. 9) Public presentation.

Professional Partnership and Praxis

Sarah Nelson is participating as a partner in the project “Professional Partnership and Praxis: Connecting Teachers, Working Scientists, and College Education Faculty to Attain New Learning Results” through Maine Title II, Mathematics and Science Partnerships program. Although Nelson is involved with all goals of the project through collaboration with Acadia Partners for Science and Learning and other partners, her primary activities relate to planning and design sessions, lesson and research program planning and design, direct engagement between students, teachers, and working scientists, and statewide outreach and invitation to participate.

Acadia Partners for Science and Learning

The Mitchell Center, represented by Sarah Nelson, has partnered with Acadia Partners and several other organizations to connect working scientists with high school teachers to provide the teachers with training in summer institutes and with ongoing support during the school year so that they can improve their ability to support inquiry-based, student-directed field research. Examples of some projects can be found on the Acadia Partners web site - <http://www.sercinstitute.org/>.

Acadia Learning

This program takes research issues and topics of interest to National Parks out to teachers and schools across Maine, engaging students in useful citizen science research while providing them with enriched science education. The initiative is made of a number of interconnected projects that focus on different scientific and educational research problems. For more information see <http://parkcitizenscience.org/>.

Research Coordination Network: Diadromous Species Restoration Research Network

The Diadromous Species Restoration Research Network (DSRRN) is an NSF-funded network whose goal is to advance the science of diadromous fish restoration and to facilitate interactions among scientists, managers, and stakeholders. A web site for the network has been established at <http://www.umaine.edu/searunfish> and a full-time Science Information Coordinator was hired in March 2009. In November 2008, a Stakeholders Workshop was convened to introduce the Network and to gather information to identify research questions and restoration goals. Over 30 stakeholders attended and discussed potential impacts and changes as a result of the anticipated dam removals on the Penobscot River.

In 2010, the Network hosted two gatherings of the Penobscot Science Exchange. The spring meeting was held in March while the fall meeting was held in October. The purpose of the Exchange is to meet biannually to share information regarding research and monitoring in the Penobscot Watershed. Each researcher was asked to provide a two-minute update describing his/her research on the Penobscot. There were also presentations on the NOAA Restoration Monitoring Plan, Penobscot Trust Project and DSRRN Activities. In addition, the Coordinator reviewed the recently updated Penobscot Science Exchange Research Summary, a database which describes recent research on the Penobscot. Information about both the Stakeholders Meeting and the Science Exchange Meeting can be found at <http://www.umaine.edu/searunfish/research/Penobscot-exchange.htm>.

The second DSRRN workshop, "Variability of North Atlantic Diadromous Fish Populations: Establishing Reference Points for Restoration Assessment" was held on May 26-27, 2011 at the Mitchell Center.

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	5	0	0	2	7
Masters	5	0	0	15	20
Ph.D.	1	0	0	11	12
Post-Doc.	0	0	0	6	6
Total	11	0	0	34	45

Notable Awards and Achievements

Maine's Sustainability Solutions Initiative (SSI) at the Mitchell Center

In July 2009, the Senator George J. Mitchell Center was awarded a \$20 million, five-year grant by NSF EPSCoR to support Maine's Sustainability Solutions Initiative. Synergy between SSI and the Maine WRI program provides important leveraging opportunities for water resource projects across the state. A key component of the SSI project is its partnership with 12 other educational institutions across Maine. All of these institutions are funded to conduct research under the SSI program many related to water resources in Maine. WRI Director John Peckenham is the liaison between the SSI Management Team and the partner institutions, building relationships that also strengthen the WRI program. Many faculty who have been funded under the WRI research program are also key collaborators on the SSI project.

SSI partner institutions include: Bates College, Bowdoin College, Colby College, Unity College, University of New England, College of the Atlantic, University of Southern Maine, University of Maine at Farmington, University of Maine at Augusta, University of Maine at Machias, University of Maine at Presque Isle and University of Maine at Fort Kent.

Water Resource-Related SSI Projects

The following funded projects provide direct linkages with the Maine WRI program. Opportunities for further collaborations that enhance both research programs will be actively pursued in the future.

- Protecting Natural Resources at the Community Scale: Using populations persistence of vernal pool fauna as a model system. Team leader: Aram Calhoun, UMaine.
- Decision Tools to Support Water Resources Sustainability of Managed Lake Systems Team leader: Jean MacRae, UMaine
- Researching Knowledge-to-Action Linkages to Promote Stakeholder and Community Engagement Team leaders: Laura Lindenfeld and Linda Silka, UMaine.
- Sustaining and Restoring Urban Stream Resources in Maine Team leader: Dave Owen, University of Maine School of Law
- Linking Knowledge with Action: Refining Maine's Mercury Fish Consumption Advisory Team leader: Aria Amirbahman, UMaine.
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- Modeling Resilience and Adaptation in the Belgrade Lakes Watershed Team leader: Whitney King, Colby College
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- Modeling Evolving Ecological, Cultural and Economic Systems of the Aroostook River Watershed of Northern Maine for Sustainable Development Team leader: Jason Johnson, University of Maine at Presque Isle
- Promoting Watershed-based Sustainable Development through Ecological and Socio-economic Research and Educational Initiatives Team leader: Wendy Harper, University of Maine at Farmington
- Application of an Integrative Decision Support Tool and Spatial Modeling to Assess the Implications of Future Growth Scenarios on Sensitive Aquatic Resources in Maine Team leader: Rob Lilieholm, UMaine

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Publications from Prior Years

1. 2010ME204B ("Permaculture Design Research Initiative") - Other Publications - Giordino, William, Blais, J., Smith, O. Permaculture Design Research Initiative. Maine Water Conference Poster Presentation. March 16, 2011.
2. 2010ME214B ("Fish Scales as Non-Lethal Biosensors of Surface Water Contaminants ") - Other Publications - Scall, David G., Elskus, A. Fish Scales as Non-Lethal Bio-sensors of Surface Water Contaminants. Maine Water Conference Poster Presentation. March 16, 2011.
3. 2010ME216B ("Database development to support spatiotemporal analysis of coastal Maine mercury data") - Articles in Refereed Scientific Journals - Neville, M. and Beard, K. 2011. Analysis of mercury contamination in a coastal ecosystem using geospatial tools. Ecosystems (in preparation).
4. 2010ME216B ("Database development to support spatiotemporal analysis of coastal Maine mercury data") - Conference Proceedings - Neville, Melinda. 2011. Spatiotemporal Database Integration of Mercury Research in Maine. Maine Water Conference, Augusta, ME, March 16, 2011.
5. 2010ME216B ("Database development to support spatiotemporal analysis of coastal Maine mercury data") - Conference Proceedings - Neville, M. and Beard, K. 2011. Geospatial analysis of mercury data in coastal catchments. Accepted Abstract for the 10th International Conference on Mercury as a Global Pollutant (ICMGP), Halifax, Nova Scotia, Canada, July 24, 2011.
6. 2010ME214B ("Fish Scales as Non-Lethal Biosensors of Surface Water Contaminants ") - Conference Proceedings - Elskus, A. 2011. Monitoring Contaminant Exposure of Endangered Species: Lethal, Non-Lethal and Surrogate Approaches. Maine Water Conference, Augusta, ME, March 16, 2011.
7. 2010ME227B ("Atlantic salmon (*Salmo salar*) as an indicator of habitat quality in tributaries") - Other Publications - Ashe, Wesley, Coghlan, S. Atlantic Salmon (*salmo salar*) Growth and Survival as an Indicator of Habitat Quality in Tributaries of the Machias River Watershed. Maine Water Conference Poster Presentation. March 16, 2011.
8. 2010ME228B ("Microorganisms that can alter groundwater chemistry in an arsenic enriched aquifer") - Other Publications - Weldon, Jennifer, MacRae, J. Microbial Populations Associated with Private Wells with High Levels of Arsenic Located in Northport, Maine. Maine Water Conference Poster Presentation. March 16, 2011.