

14th Annual Maine Water Conference

March 19, 2008
Augusta Civic Center
Augusta, Maine



Senator George J. Mitchell Center for Environmental and Watershed Research
University of Maine, Orono, Maine

United States Geological Survey
Maine Water Science Center, Augusta, Maine

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MAINE WATER CONFERENCE

The Maine Water Conference was founded in 1994 by the Senator George J. Mitchell Center for Environmental and Watershed Research at the University of Maine as an annual forum for water resource professionals, researchers, consultants, citizens, students, regulators, and planners to exchange information and present new findings on water resource issues in Maine.

The conference format includes two concurrent sessions and a morning plenary session. During breaks and lunch, posters and displays by students, organizations, agencies, departments, consultants and businesses are available for viewing and discussion. Because the Maine Water Conference is the main meeting for many Maine water resource professionals, adequate breaks are intended to allow for one-on-one networking and discussion.

Program At-A-Glance

CONFERENCE AGENDA

- 7:30am Registration, Continental Breakfast, Poster & Exhibit Viewing**
- 8:30am Morning Concurrent Sessions**
Session A: The Legislature: Agendas Now and in the Future
Session B: Anthropogenic Trace Contaminants: Impact on Environmental & Human Health
Session C: Information Systems: If You Build It...Will They Come?
Session D: Watershed Management - The Local Perspective
Session E: Drinking Water Topic - Public Law 2007 Chpt 353
Session F: Groundwater Threats and Private Wells
- 10:00am Morning Break — Auditorium**
- 11:00am Plenary Session — Welcome & Introduction**
Karen Wilson, Assistant Research Professor, University of Southern Maine
- 11:05am Laurie Fowler, Director of Policy, UGA River Basin Center**
The Etowah Aquatic Habitat Conservation Plan: Marrying Science with Policy in a Conservative State
- 11:40am Introduction**
Robert Marvinney, Director, Maine Geological Survey
- 11:45am Mark Myers, Director, U.S. Geological Survey**
USGS Integrated Science – In and Beyond Maine Waters
- 12:20pm Poster award presentations**
Robert Lent, Director, USGS Maine Water Science Center
David Hart, Director, Senator George J. Mitchell Center
- 12:30pm Lunch**
- 1:30pm Afternoon Concurrent Sessions**
Session F: Groundwater Threats and Private Wells (cont.)
Session G: Impacts of Climate Change on Water Resource-Related Sectors
Session H: Low Impact Development Case Studies
Session I: Tools for Watershed Managers
Session J: Maine's Administrative Procedure Act: A Roadmap for Agency Rulemaking
Session K: What Works? Selecting Simple & Effective Outreach Evaluation Tools
- 2:30pm Afternoon Break – Auditorium**
- 3:00pm Afternoon Concurrent Sessions (continued)**
- 4:00pm Conference close**

Program At-A-Glance

MORNING CONCURRENT SESSIONS

	8:30am - 8:55am	9:00am - 9:25am	9:30am - 9:55am
Session A: The Legislature: Agendas Now and in the Future Facilitator: Peter Sly	8:30am-9:10am: Updates, Alewives and Dams. Panelists: Representative Ted Koffman, Senator Dennis S. Damon, Dave Wilby. 9:15am-9:55am: The Media's Role in Defining the Water Agenda. Panelists: Naomi Schalit, John Richardson, Susan Sharon.		
Session B: Anthropogenic Trace Contaminants & their Impacts Chair: Greg Mayer	Pharmaceutically-derived estrogens inhibit DNA repair processes in zebrafish. Greg Mayer	Evaluating spatial patterns in mercury and methylmercury in northeastern lakes. Sarah Nelson	Preliminary study on multiple stressor effects in early life stage Atlantic salmon. Crista Straub
Session C: Information Systems: If you build it...will they come? Chair: Gordon Longworth	Environmental Geographic Analysis Database (EGAD). Christian Halsted	Regionalized stormwater data management and inspection program. Phil Ruck & Brenda Zollitsch	The Maine Water Atlas. Apoorv Gehlot
Session D: Watershed Management: Local Perspective Facilitator: Tamara Lee Pinard	This roundtable discussion will focus on ways municipalities can approach watershed planning that lead to on-the-ground fixes. A variety of watershed approaches including those utilized in urban impaired streams will provide the basis for discussion. Panelists: Jan Patterson, Wendy Warren, Jim Hughes, Chris Feurt.		
Session E: Drinking Water Topic: Public Law 2007 Chapter 353 Facilitator: Kirsten Ness	This session brings together state agencies & municipalities to discuss benefits of protecting water supplies. A presentation by Andy Tolman will be followed by a roundtable discussion about the law and its implementation. Panelists: Andy Tolman, Tim Glidden, Dwight Doughty, Andy Fisk, George Powell, Steve Timpano.		
Session F: Groundwater Threats & Private Wells Facilitator: John Peckenham	Investigation of road-salt constituents in bedrock aquifers. Charles Schalk & Joshua Katz	Salt contamination of private wells: It's not as simple as it may seem. Keith Taylor	Spatial patterns of rural water quality derived from wells in three communities. Teresa Thornton

AFTERNOON CONCURRENT SESSIONS

	1:30pm - 1:55pm	2:00pm - 2:25pm	3:00pm - 3:25pm	3:30pm-3:55pm
Session F: Groundwater Threats & Private Wells Facilitator: John Peckenham	Impacts to water supply wells from closed municipal landfills in Maine. Richard Heath	MtBE after the Ban. James M. Tarr	Microorganisms associated with private wells with high arsenic levels in Northport. Jennifer Weldon	Bedrock geology control of domestic well water radon & uranium concentrations. Tom Hess
Session G: Impacts of Climate Change on Water Resource-Related Sectors Chair: Tom Huntington	Internal phosphorus cycling in Maine lakes: Implications due to global warming. Bjorn Lake	The geologic variables that affect saltwater intrusion in coastal wells in fractured bedrock. Robert Gerber	Evidence for changing flood risk in New England since the late 20th Century. Mathias J. Collins	Conserving freshwater and coastal resources in a changing climate. Abigail Hardy & Regina Lyons
Session H: Low Impact Development (LID) Case Studies Chair: Sam Merrill	Performance evaluations for stormwater LID & other devices in a cold climate. James J. Houle	LID strategies illustrated through New England case studies. Richard A. Claytor	Jordan Cove Urban Watershed Project. Bruce Morton	Overcoming local obstacles to implementing LID. Wendy Coffin
Session I: Tools for Watershed Managers Chair: Rob Dudley	Comparison of peak-flow estimation methods for small watersheds in Maine. G. Hodgkins & C. Hebson	Stormwater retrofit inventories for Maine impaired streams. Zach Henderson	Water level and flow regulation implementation: Public water system implications. Andy Tolman	Application of a distributed-parameter watershed model to the Dennys River basin. Robert W. Dudley
Session J: Maine's APA: A Roadmap for Rulemaking Facilitator: Nancy Beardsley	Part I: Discussion of steps an agency must follow in the adoption of a new regulation. Topics include differences between rules, public hearings, public input, response to comments and final rule adoption. Don Wismer		Part II: Discussion with representatives from various groups involved in the rulemaking process including state agencies and the private sector. Panelists: Ernie Hilton, Andy Fisk, Scott Anderson	
Session K: Selecting Effective Evaluation Tools Facilitators: Barb Welch & Kathy Hoppe	With the need to document outcomes for environmental outreach projects, assessment tools are becoming increasingly important to justify continued support for programs. These tools are also important in improving		program effectiveness, inspiring local participants, and enhancing transfer to other areas. Panelists: Christine Reinhart, Tamara Lee Pinard, Barb Welch, Kathy Hoppe	

Plenary Session

11:00AM

WELCOME & INTRODUCTION

Karen Wilson

University of Southern Maine

Karen Wilson is an assistant research professor with the Department of Environmental Science and the Aquatic Systems Research Group at the University of Southern Maine. Karen has a Ph.D. in Limnology/Zoology from the University of Wisconsin-Madison, where she studied the long-term effects of an invasive crayfish on lake communities. Karen studied the impacts of invasive zebra and quagga mussels on Lake Ontario benthos for her post-doctoral fellowship at the Department of Zoology, University of Toronto, and the Ontario Ministry of the Environment, Toronto, Ontario. Karen's current research focuses on freshwater-marine linkages, anadromous alewife, salt marsh restoration, and freshwater crayfish in Maine. This summer she will also take on the role of research coordinator for the Diadromous Fish Restoration Research Network associated with the Penobscot River restoration.

11:05AM

LAURIE FOWLER

Director for Policy, University of Georgia River Basin Center

The Etowah Aquatic Habitat Conservation Plan: Marrying Science with Policy in a Conservative State

Twenty-one local governments in Georgia have developed the Southeast's first regional aquatic habitat conservation plan pursuant to the federal endangered species act, rewriting the rules of development in order to protect imperiled darter species. The UGA River Basin Center provided key staffing for this effort. Fowler will discuss what brought the players to the table, the process for developing the cutting-edge research projects and mitigation policies at low-cost, elements of the plan, and the public response.

Laurie Fowler is an environmental attorney with a joint appointment at the University of Georgia School of Law and Odum School of Ecology. She is the director for policy of the River Basin Center, where ecologists, lawyers, planners, and economists research the effects of land use on water quality and biodiversity and assist governments in the development of management strategies to protect water resources.

11:40AM

INTRODUCTION

Robert Marvinney

Maine Geological Survey

Robert Marvinney, director of the Maine Geological Survey since 1995, is a bedrock geologist by training. His undergraduate work was at Rutgers University and his graduate work at Syracuse University focused on bedrock mapping in northwestern Maine. After a few years working for Exxon in Houston, he came to Maine in 1987 to enhance the Maine Geological Survey's (and the State's) GIS capabilities. He has conducted geologic mapping in several areas of the state and since becoming Director, has taken on broader responsibilities. These include involvement in a number of coastal issues such as erosion at Camp Ellis and dredging of Wells Harbor. Bob currently chairs the legislatively mandated Water Resources Planning Committee, the focus of which is to address water issues on a watershed basis.

Plenary Session

11:45AM

MARK MYERS

Director, U.S. Geological Survey

USGS Integrated Science – In and Beyond Maine Waters

Maine is a water-rich state with abundant natural resources, including the Maine Woods, critical Atlantic salmon habitat, and important public lands such as Acadia National Park and ten National Wildlife Refuges. Over the next decade, with potential changes in climate, changing land-use patterns, and increased competitive demand for water, difficult decisions of how to manage these resources must be supported by sound, unbiased science. This science, in turn, must be underpinned by robust data that are integrated across science disciplines to provide new insights and new knowledge for improved decision making.

The U.S. Geological Survey has developed a new 10-year science plan designed to address complex, large-scale environmental and societal challenges by promoting integrated science investigations across traditional academic disciplines. In Maine, and throughout New England, the U.S. Geological Survey has begun the task of aligning its science activities with the priorities defined in this plan.

***Mark Myers** is responsible for leading the U.S. Geological Survey, the nation's largest water, earth, biological science, and civilian mapping agency in its mission to provide the scientific data that enable decisionmakers to create sound policies for a changing world. He is an internationally recognized geologist and former State Geologist and head of Alaska's Geological Survey.*

Myers, an expert on North Slope sedimentary and petroleum geology, served as survey chief for field programs in the MacKenzie Delta (for the ARCO corporation, 1985), Cook Inlet (for the State of Alaska/USGS, 1997), and North Slope (ARCO, 1999). He also served as sedimentologist for 13 other North Slope field programs.

He is a past president and board member of the Alaska Geological Society; a certified professional geologist with the American Institute of Professional Geologists; a certified petroleum geologist with the American Association of Petroleum Geologists; and a licensed geologist with the State of Alaska.

Myers has a doctorate in geology from the University of Alaska-Fairbanks and bachelor's and master's degrees in geology from the University of Wisconsin-Madison.

12:20PM

POSTER AWARD PRESENTATIONS

Presentation of poster awards by Robert Lent, Director, USGS Maine Water Science Center and David Hart, Director, Senator George J. Mitchell Center for Environmental and Watershed Research.

12:30PM

LUNCH

Session A

The Legislature: Agendas Now and in the Future

The first part of this session will include a brief update on current issues in the legislature, including the alewives dispute. It will also peer into the future, looking at long term hydroelectric/energy and dam removal issues. In the second part of this session a panel of prominent journalists will consider the practical and ethical issues involved in covering water in the media.



SESSION FACILITATOR

Peter W. Sly, Colby College

Peter W. Sly is the Mellon Fellow in Environment and Justice at Colby College and a specialist in water, Indian, energy and ethics law. His practice has included Indian water settlements, federal water rights, the Colorado River, FERC relicensing, the Endangered Species Act, and water matters related to the PG&E bankruptcy. He has represented major urban water purveyors in Nevada and California; the states of Arizona, Hawaii, Montana, Nevada and Wyoming; and several local governments and community coalitions. His book, *The Reserved Water Rights Settlement Manual*, is a neutral reference for parties and their attorneys seeking settlement of complex multi-party water adjudications. At Colby College, he has taught courses on water policy, federal Indian law, environmental justice, and conservation easements. He organized a March 13-14 Colby conference, "Preserving Landscapes and Livelihoods in Northern Maine." One of his current courses at Colby is "Dammed Maine," in which each student prepares a biography of a dam in Maine. He earned his J.D. in 1974 from Yale and his A.B. in 1968 from Stanford. He is a certified Maine Assessor and admitted to practice law in California and Maine.

Session A - The Legislature: Agendas Now and in the Future

8:30AM - 9:10AM

UPDATES, ALEWIVES AND DAMS

Panelists:

Ted Koffman, *Chair, Natural Resources Committee*

Dennis S. Damon, *Chair, Marine Resources Committee*

Dave Wilby, *Independent Energy Producers of Maine*

9:15AM - 9:55AM

THE MEDIA'S ROLE IN DEFINING THE WATER AGENDA

Panelists:

Naomi Schalit, *Kennebec Journal and Morning Sentinel*

John Richardson, *Portland Press Herald*

Susan Sharon, *Maine Public Broadcasting*

Session B

Anthropogenic Trace Contaminants: Impacts on Environmental and Human Health

The term “trace contaminants” encompasses a myriad of chemicals that exist in very low levels in the environment. These chemicals range in composition from detergents, to pharmaceuticals, to elemental matter. Realization of the impacts of trace contaminants is beginning to emerge, as better detection methods and more sensitive biological assays allow investigators to gain a better understanding of the pervasiveness of low-concentration, environmental pollutants. This session will discuss the occurrence and/or the biological effects of a diverse array of trace-level aquatic contaminants.



SESSION CHAIR

Greg Mayer, Dept. of Biochemistry, Microbiology, Molecular Biology, University of Maine

Greg Mayer is an assistant professor of molecular and environmental toxicology at the University of Maine. One of Mayer's foci is estrogen-induced carcinogenesis. Estrogens such as those used in oral contraceptive and hormone replacement therapies are a class of environmental pollutants that have been scrutinized for their infiltration into the environment and their ability to influence sexually dimorphic phenotypes in aquatic fauna. The Mayer laboratory investigates the co-carcinogenic potential of such environmental estrogens and their ability to exacerbate the effects of environmental carcinogens that are preferentially repaired by the nucleotide excision repair pathway.

8:30AM – 8:55AM

Greg Mayer

Biochemistry and Molecular Biology, University of Maine, Orono, ME; gmayer@maine.edu

PHARMACEUTICALLY DERIVED, WATERBORNE ESTROGENS INHIBIT DNA REPAIR PROCESSES IN ZEBRAFISH

Natural phenolic steroid estrogens and the semi-synthetic pharmaceutical estrogen, 17 α -ethinylestradiol, have been detected in the aquatic environment in quantities sufficient to elicit altered physiologi-

Session B: Anthropogenic Trace Contaminants

cal processes in fish. Pharmaceutical estrogens enter the aquatic environment primarily via wastewater treatment facilities as excretory products or after improper disposal of unused prescriptions. Numerous investigations throughout the past several years have implicated pharmaceutical estrogens in altered reproductive status of aquatic fauna including unwarranted vitellogenesis and many other reproductive abnormalities. In addition to altering reproductive endpoints, aquatic estrogens are known mutagens and tumor promoters. Currently, little to no data exist that explain the role of estrogens in neoplastic transformation. We exposed zebrafish (*Danio rerio*) to effluents from three wastewater treatment plants in Maine that use differing treatment types. Estrogenicity was analyzed by *in vitro* reporter assays (luciferase production), examined via analysis of known biomarkers of estrogen exposure *in vivo* (vitellogenin and CYP1A1 mRNA abundance), and these endpoints were correlated with zebrafish hepatic DNA repair parameters (nucleotide excision repair gene expression and activity) after exposure to wastewater effluent. Results of this and corollary studies suggest waterborne estrogens in wastewater effluent can hinder DNA repair capacity in exposed fish and implicate aquatic estrogens as co-factors in environmental carcinogenesis.

9:00AM – 9:25AM

Sarah J. Nelson

Senator George J. Mitchell Center, University of Maine, Orono, ME; sarah.nelson@umit.maine.edu

EVALUATING SPATIAL PATTERNS IN MERCURY AND METHYL MERCURY IN NORTHEASTERN LAKES: LANDSCAPE SETTING, CHEMICAL CLIMATE, AND HUMAN INFLUENCES

Mercury (Hg) contamination of surface waters and biota is widespread in the Northeast. Although watershed processing of Hg is complex, several research projects have identified landscape factors such as wetland extent and forest type, and chemical covariates such as dissolved organic carbon, as controls on Hg in surface waters. We hypothesize that watershed characteristics control Hg concentrations in the Northeast. Specifically, we suggest that low-conductivity, wetland-dominated systems with high lake DOC concentrations will have higher Hg concentrations than high-conductivity high-trophic-level lakes affected by human development. This project is using a Geographic Information Systems (GIS) framework to link landscape statistics to a coordinated chemical data set that contains total Hg (HgT), methyl Hg (MeHg), and full ion chemistry for a statistical population of lakes in the northeastern U.S., all sampled within a single summer index period. The overarching goal is to identify landscape types conducive to high surface water Hg levels. We will present early results of the analysis, with a focus on comparing Hg and landscape factors in Maine lakes to those in other states throughout the study region.

9:30AM – 9:55AM

Crista Straub

School of Biology and Ecology, University of Maine, Orono, ME; crista.straub@umit.maine.edu

PRELIMINARY STUDY ON MULTIPLE STRESSOR EFFECTS IN EARLY LIFE STAGE ATLANTIC SALMON (*SALMO SALAR*)

Atlantic salmon (*Salmo salar*) decline has become an increasing concern with total runs depleted from half a million adults returning to all United States rivers each year in the early 1800s to approximately

Session B: Anthropogenic Trace Contaminants

one thousand returning today and only to Maine rivers. The current study investigated the possible role of environmental conditions in Maine rivers contributing to salmon decline. Blueberry pesticides, including Velpar™ (active ingredient hexazinone), are found at detectable levels in Down East Maine Rivers, but there has not been extensive research on the sublethal effects of these formulations. In addition, Velpar™ is proposed to be replaced by Callisto™ (active ingredient mesotrione). Pesticides are not the only stressors found in Maine rivers. Some potential stressors (acidity, aluminum (Al), endocrine-disrupting chemicals, organochlorines, etc.) are present in the rivers at the same time. Effects on organisms exposed to multiple stressors may differ significantly from exposure to single stressors. Our goal was to determine how blueberry pesticides, acidic water, and high Al combinations might affect resident Atlantic salmon. The experimental setup included exposing swim up fry (sensitive early life stage) to current- and proposed-use pesticides in the presence and absence of high acidity (pH = 3.9 - 5.2) and elevated inorganic aluminum (254 - 573 ppb). Pesticide exposure included environmentally realistic concentrations (0.75 ppb a.i.) and concentrations ten fold higher (7.5 ppb a.i.). Fish were exposed for 5 days in a flow-through system at 14°C. Survival, prey capture, and immune function were evaluated. Pesticide treatment alone had no effect on survival when compared to controls. However, acid/aluminum treatments significantly reduced survival. Prey capture results were confounded by high variability, and immune function assays were inconclusive. In general, the results indicate that pesticide effects on prey capture and survival may increase in the presence of acid/aluminum. However, additional endpoints and replicates are needed to determine conclusive treatment effects.

Session C

Information Systems: If you build it...Will they come?

There has been a proliferation of geospatial-based information systems available on the Web in recent years. However, many of these systems remain difficult to use and may not well serve the audience they were designed for. This session will discuss geospatial information system design and implementation. How can those designing information systems about water resources provide citizens, municipalities, policy-makers and others with tools they need and can use? What makes some systems more successful than others? What designs provide for ease-of-access without compromising the richness of information? How can those building these information systems know what will work best for the intended audience?



SESSION CHAIR:

Gordon Longworth, College of the Atlantic GIS Lab

Gordon Longworth received a B.A. in human ecology from College of the Atlantic in 1990 and earned a Master of Regional Planning from the University of Pennsylvania in 1992, where he studied under Ian McHarg and Dr. C. Dana Tomlin. His advanced undergraduate and graduate work focused on applying GIS as a tool of human ecology as applied to town and regional planning. Longworth was introduced to GIS as an undergraduate at COA and was a lead student in the establishment of the GIS Laboratory. Appointed as GIS Lab Director in 1993, he has taught courses around land use planning, introductory and advanced GIS courses and workshops, has supervised projects spanning many disciplines and has provided vision and direction to the GIS program. He has coordinated and supervised numerous projects with outside organizations linking students and faculty to outside communities in real ways. His primary interests include land use and conservation planning and assisting students with projects spanning the full range of academic disciplines.

Session C: Information Systems

8:30AM - 8:55AM

Christian Halsted and **Richard Heath**

Maine Department of Environmental Protection, Augusta, ME

Christian.H.Halsted@maine.gov, Richard.H.Heath@maine.gov

ENVIRONMENTAL GEOGRAPHIC ANALYSIS DATABASE (EGAD) – INTEGRATION OF AN ENTERPRISE PRODUCTION ENVIRONMENTAL SAMPLING DATABASE WITH ARCMAP AND GOOGLE EARTH

EGAD is used by the Maine Department of Environmental Protection (DEP) as a repository for environmental data generated through a variety of state and federal programs. EGAD services programs including Solid Waste, Uncontrolled Sites, Petroleum Spill Remediation, Biological Monitoring and Ambient Toxic Monitoring. Currently, approximately six million individual records of environmental data are stored in an Oracle production database. Associated spatial information is maintained in ESRI's Spatial Database Engine (SDE). Spatial and production data are linked through common site and sample location identifiers allowing information from both systems to be passed to GIS applications.

A very flexible database design allows storage of data associated with groundwater, soil, surface water, porewater, landfill gas, air quality, macroinvertebrate and algae sampling. Department staff have developed numerous applications for importing, retrieving, analyzing, and displaying EGAD data. The use of Department-owned application platforms (e.g., Microsoft Access, ArcMap and Citrix), freely available software (Google Earth and KML), focused commercial software packages (Grapher, Chemstat, Rockworks) and high level programming languages (e.g., Visual Basic) controls costs and allows Department database and GIS staff to respond efficiently to user needs.

The successful implementation of the EGAD tools has relied on the principles of simple modularity, direct user input, in-house programming, appropriate level of customization and project oversight by front-line users. We will discuss how these principles have delivered a robust spatial information system to DEP users and how we are currently working to provide these data and the analysis results to the public, consulting and regulated communities.

9:00AM - 9:25AM

*Eric Johns*¹, **Phil Ruck**², *Wendy Warren*³ and **Brenda Zollitsch**⁴

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² CES; Brewer, ME; pruck@ces-maine.com

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⁴ Bangor Area Storm Water Group, Portland, ME; bmzconsulting@aol.com

DEVELOPMENT AND IMPLEMENTATION OF A REGIONALIZED STORMWATER DATA MANAGEMENT AND INSPECTION PROGRAM TO MEET NPDES PHASE II PERMIT REQUIREMENTS: A CASE STUDY OF COLLABORATIVE WORK CONDUCTED BY THE BANGOR AREA STORM WATER GROUP

This presentation will showcase a new model for regionalizing stormwater management data, inspections and inspection trainings, based on a successful collaborative program developed by the seven

Session C: Information Systems

municipalities and three state-owned Municipal Storm Sewer Systems (MS4s) in the Bangor Urbanized Area.

Data management for stormwater management programs can be both costly and time-consuming for MS4s. In response to this ever-increasing burden, the members of the BASWG have undertaken grant-funded efforts to:

- Perform regionalized municipal infrastructure mapping to identify storm sewer system components as part of a GIS development process for the regulated MS4 entities in the BUA;
- Coordinate municipal staff trainings for all monitoring and inspection activities associated with the MS4 Program, including storm sewer system, illicit discharge detection, and construction activities;
- Develop a customized database management system for maintaining all of the monitoring and inspection data collected in the BUA to demonstrate MS4 General Permit compliance; and
- Develop a training program for all users of the system in the BUA.

These efforts are allowing regional MS4s to evaluate the effectiveness of their individual stormwater management plans while also addressing decision-making from local, watershed, regional and statewide perspectives.

This case study will discuss the results of these efforts and provide guidance for transferring this model to other regions. Discussion will include both the positive and negative aspects of the database system and training development process, potential areas for improvement, as well as future initiatives to expand the BASWG regionalization efforts.

9:30AM - 9:55AM

Apoorv Gehlot¹, *Gordon Longworth*¹, *Peter Vaux*², *Ivan Willig*¹

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² Senator George Mitchell Center, University of Maine, Orono, ME; peter.vaux@maine.edu

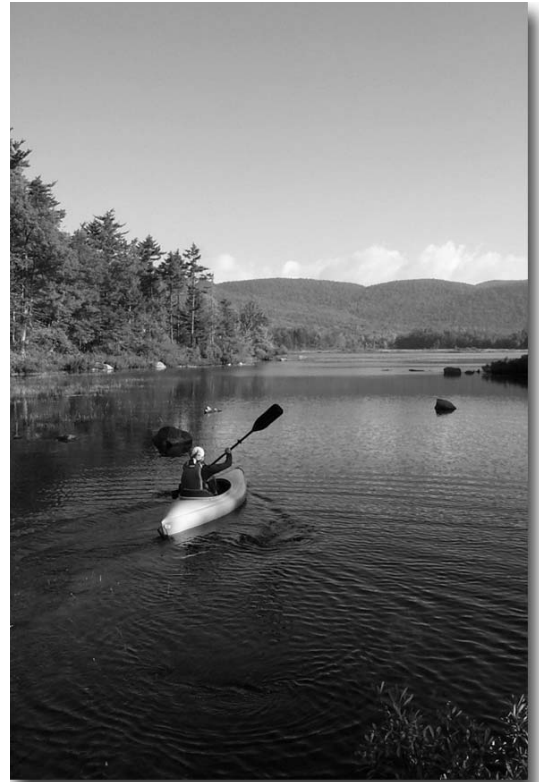
MAINE WATER ATLAS

Maine Water Atlas is an online resource to access multiple types and sources of lake- and watershed-specific data. The Atlas contains three primary components. Google Earth and ArcIMS interfaces provide access to spatially referenced data from the PEARL data bank (www.pearl.maine.edu). From these interfaces, the user can navigate to a lake or watershed and then click on links that lead to the associated Lake and Watershed Overview pages in PEARL. The overview pages provide background information about the spatial unit, dynamic data visualization and data extraction tools, and access to source data tables as well as bibliographic data specific to the spatial unit. A third component of the Atlas is a Forum for sharing 'non-traditional' or 'experience-based' information – also spatially referenced within the Atlas to lake and watershed codes. This information is of a type that typically does not reside in formal databases and thus tends to be relatively 'invisible'. It nevertheless represents a potentially rich source of knowledge about Maine's environment. With password-controlled access, site users can contribute information to the Forum via a simple user interface. The Forum is searchable by spatial unit, topic and date of post, and includes dynamically-generated mapping. The Forum will be launched pre-loaded with a rich set of information from a series of expert interviews conducted statewide by The Nature Conservancy, focusing on biodiversity and other facets of environmental quality in the state's lakes and watersheds.

Session D

Watershed Management: The local perspective

This roundtable discussion is for municipalities, and anyone working with municipalities, that are interested in improving water quality. Discussion will focus on ways municipalities can approach watershed planning that leads to on-the-ground fixes. A variety of watershed approaches including those utilized in the urban impaired streams of Long Creek, Hart Brook and Penjajawoc Stream will provide the basis for discussion. Topics will include where to begin, working with stakeholders, and lessons learned.



SESSION CHAIRS:

Tamara Lee Pinard, Cumberland County Soil & Water Conservation District

Tamara Lee Pinard is a senior project manager with the Cumberland County Soil and Water Conservation District. Her work is currently focused on coordinating the Long Creek Watershed Management Planning Project in cooperation with the City of South Portland and implementing behavior change stormwater education for 14 municipalities in Cumberland and York Counties. Pinard served as the lakes program manager with the Soil and Water Conservation Districts (SWCD) of Southern and Western Maine from January 2001 through June 2005. Prior to that, she worked for three years as a project manager with the Cumberland County SWCD. Pinard has a biology degree from Bates College and over ten years of professional experience with watershed management, water quality monitoring, and watershed education.

PANELISTS

Jan Patterson, Project Engineer, City of Lewiston

Wendy Warren, Environmental Coordinator, City of Bangor

Jim Hughes, Councilor, City of South Portland

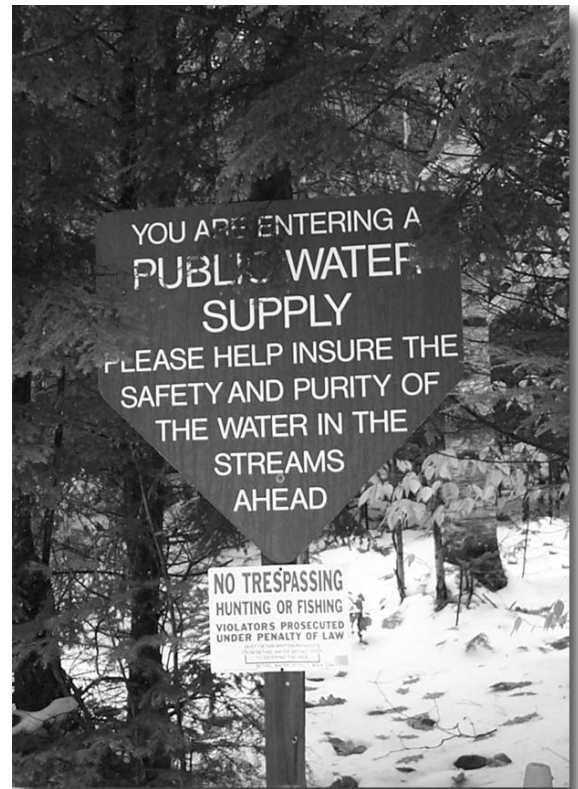
Chris Feurt, Director, Center for Sustainable Communities, University of New England

Session E

Drinking Water Topic - Public Law 2007 Chapter 353:

An act to implement recommendations of the Drinking Water Program regarding public water supply protection.

In 2007, the Maine State Legislature passed Public Law 2007 Chapter 353, “An Act to Implement recommendations of the Drinking Water Program Regarding Public Water Supply Protection.” One of the requirements of the new law is that “when undertaking actions that have a negative impact on a public water supply, a state agency shall consider the impact and evaluate alternatives to avoid and minimize the impact.” This provision of the law went into effect in September 2007, and the Drinking Water Program has opened discussions with a number of state agencies about how to effectively implement it.



SESSION FACILITATOR

Kirsten Ness, Portland Water District

Kirsten Ness is a Water Resources Specialist with the Portland Water District where she focuses on watershed protection, water quality monitoring, and environmental outreach around Sebago Lake. Ness received her B.A. in biology with a concentration in environmental science from Colby College and her M.S. in ecology and environmental science from the University of Maine. Her graduate research focused on the effects of shoreline development on selected lakes in downeast Maine.

INTRODUCTION

The goal of this session is to bring together state agencies and municipalities to discuss how we all can benefit from protecting water supplies. The session will begin with a presentation by Andy Tolman of the Maine Drinking Water Program. This will be followed by a roundtable discussion about the law and its implementation.

Questions for Consideration:

- How will this new provision of law affect state agencies' activities?
- What resources can state agencies commit to integrate this legislation into each agency?
- What barriers do you see to integrating drinking water protection into Maine state agencies' actions?

Session E: Drinking Water Topic

PANELISTS

Andy Tolman

Water Resources Team Leader, Maine Drinking Water Program, Department of Health and Human Services, Maine Center for Disease Control & Prevention, Division of Environmental Health

Tim Glidden

Director, Land for Maine's Future Program

Dwight Doughty

Manager, Groundwater & Hazardous Waste Division, Environmental Office, Maine Dept. of Transportation

Andy Fisk

Bureau Director, Land & Water Quality, Maine Dept. of Environmental Protection

George Powell

Director, Boating Facilities Division, Maine Bureau of Parks & Lands

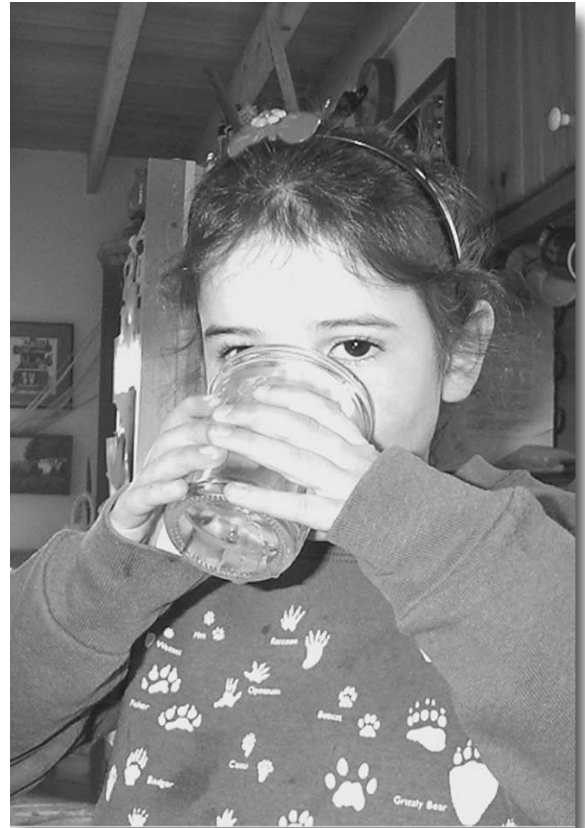
Steve Timpano

Environmental Coordinator, Maine Dept. of Inland Fisheries & Wildlife

Session F

Groundwater Threats and Private Wells

Landfill leachate, road salt, MtBE, and radon are some of the biggest threats to groundwater quality in Maine. We have been hearing about these trouble-makers for many years, yet we still have numerous wells ruined by their unwelcome appearance. In this session we will explore where the problems are now being found and what can be done to minimize the risks they pose in the future. This session will be of interest to anyone who drills wells, drinks well water, treats water to make it safe to consume, or formulates policy to protect public health.



SESSION CHAIR

John Peckenham, Mitchell Center, University of Maine

John Peckenham is director of the Maine Water Research Institute and assistant director of the Senator George J. Mitchell Center for Environmental and Watershed Research at the University of Maine. John's research interests are: drinking water quality, source water protection, and remediation of contamination. He is a member of the American Water Works Association, American Water Resources Association, National Ground Water Association, and American Geophysical Union, and serves on the Board of Directors of the National Institutes for Water Research and the Penobscot River and Bay Institute.

8:30AM - 8:55AM

Charles Schalk and Joshua Katz

USGS, Augusta, ME; cwschalk@usgs.gov

INVESTIGATION OF ROAD-SALT CONSTITUENTS IN BEDROCK AQUIFERS IN MAINE

Data collected in the past by Maine Department of Transportation (MDOT) indicate that road-salt constituents in bedrock aquifers do not behave the same as those in unconsolidated aquifers. Studies have shown that road-salt constituents tend to flush through unconsolidated aquifers relatively quickly

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and predictably, whereas the MDOT data seem to show that road-salt constituents move much more slowly through bedrock aquifers (at best) or accumulate in these aquifers (at worst).

Hypothesizing that transmissive fractures are playing a significant role in the persistence of road-salt constituents in bedrock aquifers, the U.S. Geological Survey (USGS) and MDOT began investigation of the timing and mechanisms of flow and road-salt transport in bedrock aquifers adjacent to State highways in Maine. Data being collected include continuous water levels, specific conductance, and water temperature in as many as eight wells; some of the data are being reported in real time. Borehole geophysical investigations, begun in the autumn of 2007 and scheduled to be completed in the spring of 2008, will be used to identify transmissive fractures and, consequently, appropriate sampling depths for road-salt constituents in the wells. The data-collection effort will span two winters and one summer. USGS and MDOT anticipate that data collected throughout the winter of 2007-08 will provide a good basis for conceptual models of the interactions among fractured bedrock, concentrations of road-salt constituents, and recharge events.

9:00AM - 9:25AM

Keith Taylor

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SALT CONTAMINATION OF PRIVATE WELLS: IT'S NOT AS SIMPLE AS IT MAY SEEM

Salt contamination of private wells is familiar to many, but the simple scenario of a salt pile leaching to a nearby private well may be the exception rather than the rule. Case studies from Raymond, Windham, and Brunswick show salt contamination from road spreading rather than storage piles, and neither the geology nor topography were obvious clues as to the source. In two cases, bedrock topography and structure combined to make the private wells highly susceptible to contamination. The solutions to road salt contamination are similarly not always as simple as drilling a new well. An understanding of subsurface geology was critical to solving the contamination problem at these sites. Other case studies from Windham and Scarborough show salt contamination of private wells whose origin may have little or no connection to road salt. Mineralized discharges from a water softener and trapped glacial-era seawater were identified as a contributor to or the primary source of the salt contamination rather than storage piles or road applications. Identifying the source of road salt contamination requires a comprehensive assessment of geology, topography, land use, and geochemistry.

9:30AM - 9:55AM

Teresa Thornton¹ and **John Peckenham²**

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² Senator George Mitchell Center, University of Maine, Orono, ME; jpeck@maine.edu

SPATIAL PATTERNS OF RURAL WATER QUALITY DERIVED FROM WELLS IN THREE MAINE COMMUNITIES

About 40 percent of the people in Maine drink water from private wells. There is a growing concern that communities will not have the water resources needed to support future populations. Private drinking water supplies are of a particular interest because they are neither regulated nor tested fre-

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quently. Development and commercial land-uses may affect both the quantity and quality of groundwater. Although the regulatory environment is set up to protect groundwater resources, varied approaches to management and enforcement may not be sufficient to ensure future potability. Current research is quantifying how land use affects groundwater quality on a town scale (kilometers). The test case has studied how gravel mining has affected water quality in towns in Hancock and Waldo counties. Three years of data collected from private wells in collaboration with students in grades 5 to 12 will be presented that show changes in spatial patterns of water quality. Preliminary conclusions include evidence of elevated risks from road salt and nitrates. However, the road salt risk is most strongly associated with roads relative to other types of land uses.

1:30PM - 1:55PM

Richard Heath¹, *Richard Behr*² and *Robert Birk*³

¹ Maine Dept. of Environmental Protection, Augusta, ME; richard.h.heath@maine.gov

² Maine Dept. of Environmental Protection, Augusta, ME; richard.s.behr@maine.gov

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IMPACTS TO WATER SUPPLY WELLS FROM CLOSED MUNICIPAL LANDFILLS IN MAINE

Maine has approximately 414 municipal landfills including 15 currently licensed operating sites, 388 closed sites, and 11 inactive sites which have not undergone an approved closure. Many municipal landfills began operation in the 1950's and 60's. Hundreds of these unlined attenuation landfills continued operation until the early 90's. Today many of these inactive or closed landfills threaten ground and surface water quality because of inappropriate siting, inadequate design or improper operation. In 1988 the Maine Legislature created the Landfill Closure and Remediation Program to oversee the closure and maintenance of landfills that pose threats to public health and the environment. Investigations performed under this program have revealed numerous instances where water supply wells have been impacted by landfill related contamination. Recent residential development of properties near closed landfills pose a threat to newly installed private water supplies.

Several case studies are presented where contaminants including volatile organic compounds, arsenic, and other landfill-related constituents were present at private water supply wells.

Remediation of these impacts included point of entry filtration, extension of public water supply lines, and purchase of properties.

2:00PM - 2:25PM

James M. Tarr and *Adam Galonski*

Corporate Environmental Advisors, Inc., Concord, NH; jtarr@cea-inc.com

MTBE AFTER THE BAN

Recent groundwater contaminant concentration data from 25 active retail gasoline stations in New Hampshire were compared with historic data from the same sites to evaluate the overall impact of the State of New Hampshire banning the use of methyl tertiary butyl ether (MtBE) on January 1, 2007 as a part of its Oxygen Flexible Reformulated Gasoline (OFRFG) program. The data were statistically

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evaluated to determine the efficacy of eliminating MtBE from supply tanks. Preliminary findings will be discussed as well as outlining the long term study plans.

2:30PM - 3:00PM

BREAK

3:00PM - 3:25PM

Jennifer Weldon and Jean D. MacRae

University of Maine, Orono, ME; Jennifer.Stowe@umit.maine.edu, Jean.MacRae@umit.maine.edu

A CASE STUDY OF MICROORGANISMS ASSOCIATED WITH PRIVATE WELLS WITH HIGH LEVELS OF ARSENIC LOCATED IN NORTHPORT, MAINE

Consumption of arsenic laden drinking water can cause a variety of health effects. In Maine, approximately 40% of residents obtain their drinking water from private wells. Many of these wells contain arsenic in excess of the EPA limit of 10 ppb. Since there is no requirement to test private well water, thousands of Mainers may unknowingly be exposed to high arsenic concentrations.

For arsenic to occur in groundwater it must be present in aquifer materials and conditions must be favorable for arsenic release. Many microorganisms are capable of accelerating natural weathering processes in groundwater as well as altering arsenic speciation in groundwater. Microorganisms can reduce arsenate, As (V), to the more toxic and mobile form arsenite, As (III), via respiratory and detoxification mechanisms. Other microorganisms can alter the iron oxyhydroxides that coat aquifer materials and bind arsenic to the surfaces, causing the arsenic to be released. As the redox potential of the groundwater is lowered, these microbial activities that can result in an increase in total arsenic as well as an increase in arsenite are favored.

The microbial populations in groundwater taken from four wells with different arsenic concentrations from a single aquifer in Northport, ME were identified using molecular biological techniques. A comparison of microbial sub-groups and water chemistry parameters is providing new insight into the relationships between microorganisms and chemicals in the subsurface. The wells were also sampled five months apart and temporal variations in the microbial communities are being examined.

3:30PM - 3:55PM

Paul Smitherman¹, C. Tom Hess¹, Y. Zheng², M. C. Loiselle³, C. W. Culbertson⁴

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³ Maine Geological Survey, Augusta, ME; Marc.C.Loiselle@maine.gov

⁴ USGS, Maine Water Science Center, Augusta, ME; cculbert@usgs.gov

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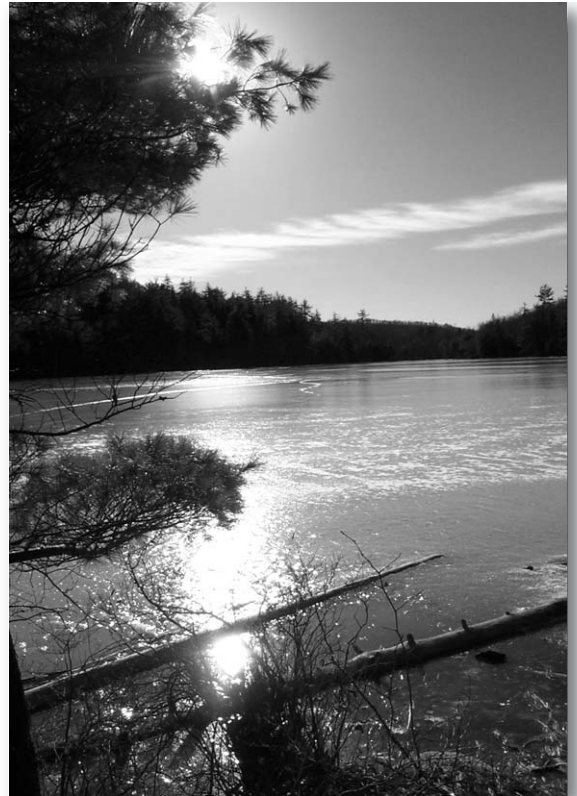
BEDROCK GEOLOGY CONTROL OF DOMESTIC WELL WATER RADON AND URANIUM CONCENTRATIONS IN GREATER AUGUSTA, MAINE, USA

A collaborative study with Columbia University and the University of Maine Department of Physics collected well water samples from 1,130 private residences in the Augusta, Maine area in 2006 and 2007. Radon concentrations for both years were analyzed at the University of Maine. Uranium concentrations for the 2006 sample set were analyzed by ICP-MS by the Columbia team at CUNY. The radon and uranium data are both lognormally distributed with geometric means of 2,780 pCi/L for radon and 1.02 µg/L for uranium. Maximum concentrations of 208,600 pCi/L for radon and 484 µg/L for uranium were measured. Radon and uranium concentrations in well water are mapped together with township, granite pluton and metamorphic grade information, showing a confirmation of the correlation of radon concentration with granite plutons, with a geometric mean of 5460 pCi/L on the plutons. Uranium is similarly correlated with a geometric mean of 4.68 µg/L on the plutons. Both radon and uranium concentrations are shown to be higher on the higher metamorphic grades of bedrock. Radon is also correlated with uranium with a Pearson correlation of 0.39 and a slope for the regression fit of 0.25. A secular equilibrium calculation shows theoretical radon concentrations using the measured concentrations of uranium. This calculation gives supported radon concentrations much lower than the observed concentrations. Current work is focused on correlations between high chloride and high radium in the water samples. Radium is being measured by delayed recounting of the high radon and high uranium samples.

Session G

Impacts of Climate Change on Water Resource-Related Sectors

Climate changes evident in the 20th century have already affected hydrologic conditions in Maine, including the timing of high spring flows, precipitation and snowfall amounts, and lake and river ice dynamics. Climate projections and hydrologic modeling indicate that additional changes are likely in the 21st century including more frequent droughts, a lengthening of the summer low flow period, and higher rainfall intensities. These changes are likely to affect many water resource-related sectors including sensitive aquatic biota, availability of water for domestic, industrial and agricultural needs, and lands susceptible to flooding. In this session we will address the potential impacts of climate change on these and other water-related resources.



SESSION CHAIR

Thomas G. Huntington, U.S. Geological Survey, Maine Water Science Center

Tom is a research hydrologist with the U.S. Geological Survey in Augusta, Maine. He earned his bachelor's degree at Cornell University in 1974 in biology/ecology and his Ph.D. in soil science from the University of Kentucky in 1984. His professional career began with a postdoctoral research fellowship in the Environmental Studies Program at Dartmouth College. He then worked as a Research Assistant Professor at the University of Pennsylvania. In these positions he studied small watershed biogeochemical processes related to the effects of forest harvesting and acidic deposition on forest soils. In 1990 he took a position as a research hydrologist with the U. S. Geological Survey where he has worked through the present. He continued working on small water biogeochemical processes relating to the effects of acidic deposition on forest soils and stream water chemistry and began working on carbon cycling in forest soils. His research dealt with the factors regulating carbon storage and net ecosystem exchange in forest, grassland and agricultural soils. In more recent years his research has focused on carbon cycling at larger river basin scales and on hydrologic responses to climate change. His experience in this area includes both time series analysis of historical data and projections for changes in hydrologic variables during the 21st century. He is particularly interested in studying the processes by which climate change influences carbon cycling in terrestrial systems. He has authored or coauthored more than 36 research papers in peer-reviewed scientific journals, eight book chapters, seven conference proceedings, and various USGS series.

Session G: Impacts of Climate Change

1:30PM - 1:55PM

Bjorn Lake¹, *Aria Amirbahman*² and *Steve Norton*³

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² Civil and Environmental Engineering, University of Maine, Orono, ME; aria.amirbahman@umit.maine.edu

³ Earth Sciences, University of Maine, Orono, ME; Norton@maine.edu

INTERNAL PHOSPHORUS CYCLING IN MAINE LAKES: IMPLICATIONS DUE TO GLOBAL WARMING

Global warming will affect the water quality of Maine lakes. Processes within lakes that supply the water column with nutrients during the summer months will be altered by enhanced thermal stratification, solar irradiation, and microbial activity. Our current research has focused on understanding the mechanisms which lead to internal loading of phosphorus (P) in Maine lakes. We have utilized a combination of water column data and chemical characterization of sediments to delineate the parameters that lead to internal P loading in a diverse set of lakes. These characteristics are the degree of anoxia during the summer months, the iron and aluminum content of the sediment, and the microbial mineralization of organic P compounds. With this knowledge, we can surmise the effect warmer temperatures will have on P availability in Maine lakes.

2:00PM - 2:25PM

Robert G. Gerber

Sebago Technics, Inc., Westbrook, ME; rgerber@sebagotechnics.com

THE GEOLOGIC VARIABLES THAT AFFECT SALTWATER INTRUSION IN COASTAL WELLS IN FRACTURED BEDROCK.

Localized saltwater intrusion into coastal fractured bedrock aquifers has already been documented through a number of coastal town-wide studies the author has conducted over the past 30 years. With the expected rise in sea level due to global warming more wells will be at risk. Given the difficulty, energy, and expense required to remove salt from water, it is important for land use planners to know which geologic factors increase the chances of saltwater intrusion. Using the USGS density-dependent groundwater model SEAWAT2000 in several environments, the author will describe geologic conditions that enhance the chances of saltwater intrusion. The extent of inland saltwater intrusion is inversely proportional to the distance to the groundwater divide and to the precipitation recharge rate between the ocean and the divide. It is also inversely related to the thickness of sediments covering the intertidal and subtidal area but directly related to the vertical permeability of these sediments. The greater the ratio of the distance to the groundwater divide divided by the width of an estuarine channel, the less the chance of saltwater intrusion. Fracture anisotropy and single high-transmissivity fracture orientations also affect the likelihood of saltwater capture. Other evaluations are in progress and will be reported at the conference. One could use these factors to develop guidelines for allowable coastal residential development densities where the water supply relies on drilled wells.

Session G: Impacts of Climate Change

2:30PM - 3:00PM

BREAK

3:00PM - 3:25PM

Mathias J. Collins

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EVIDENCE FOR CHANGING FLOOD RISK IN NEW ENGLAND SINCE THE LATE 20TH CENTURY

Long-term flow records for watersheds with minimal human influence have shown trends in recent decades toward increasing streamflow at regional and national scales, especially for the lower flow quantiles like the annual minimum and annual median flows. Trends for higher flow quantiles are less clear, despite recent research showing increased precipitation in the coterminous United States over the last century that has been brought about primarily by an increased frequency and intensity of events in the upper 10th percentile of the daily precipitation distribution—particularly in the Northeast. This study investigates trends in 28 long-term annual flood series for New England watersheds with dominantly natural streamflow. The flood series are an average of 75 years in length and are continuous through 2006. Twenty-five series show upward trends via the non-parametric Mann-Kendall test, forty percent (10) of which are statistically significant ($p < 0.1$). Moreover, an average standardized departures series for 23 of the study gages indicates that increasing flood magnitudes in New England occurred as a step change around 1970. The timing of this is broadly synchronous with a phase change in the low frequency variability of the North Atlantic Oscillation (NAO), a prominent upper atmospheric circulation pattern that is known to effect climate variability along the United States east coast. Identifiable hydroclimatic shifts should be considered when the affected flow records are used for flood frequency analyses. Special treatment of the flood series can improve the analyses and provide better estimates of flood magnitudes and frequencies under the prevailing hydroclimatic condition.

3:30PM - 3:55PM

***Abigail Hardy*¹, *Regina Lyons*², *Elizabeth Grubin*³, *Amelia Schmale*³, *Takeo Sugii*³**

¹ Urban and Environmental Policy and Planning, Tufts University; Somerville, MA,

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CONSERVING FRESHWATER AND COASTAL RESOURCES IN A CHANGING CLIMATE

The effects of climate change have already been seen, including changes in global average air and ocean temperatures, a rise in sea levels, an increase in precipitation in some areas and droughts in others, and an increase in the occurrence of intense weather events. These impacts are projected to continue into the future, and will dramatically impact aquatic ecosystems. This project was produced for The Nature Conservancy (TNC) and examines the vulnerability to climate change of three types of aquatic ecosystems: freshwater, wetland, and coastal regions, which occur in the eastern region of the

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United States. This report identifies technological tools, such as mapping and modeling techniques, and adaptation measures, such as land use regulation and ecosystem restoration methods, that are available for analyzing and adapting to impacts of climate change. We make a series of recommendations to TNC that will promote understanding and conservation of aquatic ecosystems including: specific areas where more research is needed, investment in modeling and mapping technologies to promote more accurate analysis of ecosystems to inform conservation decisions, the use of conservation oriented land-use policies, and collaboration with regional agencies to promote regional planning that integrates climate change concerns.

Session H

Low Impact Development Case Studies: Developers keeping the water clean

Although developers are often maligned for causing negative impacts on water quality and wildlife habitat, times are changing. Recent years have seen examples around New England of 'Low Impact Development' that can protect water quality and still provide a reasonable financial return. Speakers in this session will discuss examples of low impact development projects, from porous pavement to green roofs.



SESSION CHAIR

Sam Merrill, New England Environmental Finance Center

Sam is an assistant research professor at the Muskie School of Public Service, University of Southern Maine, and director of EPA's New England Environmental Finance Center, housed at the Muskie School. He received a Master's and Ph.D. in conservation biology from the University of Minnesota, where he studied forest songbirds and wolves. For six years he worked as a research biologist in Minnesota, during which time he received a military medal for distinguished public service and many other awards. Before coming to the Muskie School in 2001 he was executive director of a land trust on the coast of Maine. Merrill's research interests include the fiscal and policy connections between land conservation and development in New England, including some work on Low Impact Development finance case studies. In the last several years he has also developed an applied policy focus on local adaptation to global challenges of climate change, specifically in: 1) land use permitting issues around installation of new renewable energy generation capacity and 2) fiscal preparations municipalities must undertake.

Session H: Low Impact Development

1:30PM - 1:55PM

*Robert M. Roseen*¹, *Thomas P. Ballester*² and *James J. Houle*³

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² Department of Civil Engineering; The UNH Stormwater Center, University of New Hampshire, Durham, NH; tom.ballester@unh.edu

³ Outreach Coordinator/Program Manager, The UNH Stormwater Center, University of New Hampshire, Durham, NH; James.Houle@unh.edu

PERFORMANCE EVALUATIONS FOR A RANGE OF STORMWATER LID, CONVENTIONAL STRUCTURAL, AND MANUFACTURED TREATMENT DEVICES IN A COLD CLIMATE

A suite of 16 separate stormwater treatment best management practices (BMPs) were evaluated for a range of water quality performance and storm volume reduction. The study includes evaluation of 26 rainfall-runoff events between September 2004 and September 2006 representing a diverse array of hydrological and seasonal characteristics. Evaluated BMPs include conventional structural systems (swales, retention ponds), Low Impact Development (LID) designs (gravel wetland, bioretention, sand filter, tree filter, porous asphalt), and manufactured BMPs (filtration, sub-surface infiltration, and hydrodynamic separators). Contaminant event mean concentration (EMC), and water quality and water quantity performance efficiencies were evaluated for the range of storms. Prior research demonstrated that treatment performance of stormwater control measures varies widely in response to site-specific contaminant loading functions. For this reason, the devices were tested in parallel, with a single influent source providing uniform loading to all devices. Stormwater treatment BMPs were uniformly sized to target a rainfall-runoff depth equivalent to 90% of the annual volume of rainfall. Under the parallel and uniformly sized configuration, a normalized performance evaluation is possible because treatment devices of the same scale receive runoff from events of the same duration, intensity, peak flow, volume, antecedent dry period, and watershed loading. Runoff constituent analyses included total suspended solids (TSS), diesel range organics (DRO), dissolved inorganic nitrogen (DIN), zinc (Zn), and total phosphorus (TP). In addition, several water quality parameters (temperature, dissolved oxygen, pH, conductivity) were monitored as real-time data. Two years of performance data and real-time water quality parameters were used to evaluate seasonal variations between systems. Performance evaluations indicate that several LID designs have very high removal efficiencies of 80-100%. In contrast, conventional structural BMPs perform poorly or modestly for most measures. The manufactured systems tended to vary widely and were dependent upon the design and contaminant of interest.

2:00PM - 2:25PM

Richard A. Claytor, Jr.

Horsley Witten Group, Inc. Sandwich, MA; rclaytor@horselywitten.com

LOW IMPACT DEVELOPMENT STRATEGIES ILLUSTRATED THROUGH NEW ENGLAND CASE STUDIES

This session will review several basic strategies and tools to design better site development projects and will cover such topics as conservation design, reduced impervious cover, redevelopment strate-

Session H: Low Impact Development

gies, natural-system stormwater management and establishment of riparian buffer areas. The applicability of these practices will be illustrated using several New England case studies.

2:30PM - 3:00PM

BREAK

3:00PM - 3:25PM

Bruce Morton,

Aqua Solutions, Marlborough, CT; bruce@aquasolutionsltd.com

JORDAN COVE URBAN WATERSHED PROJECT

The Jordan Cove Urban Watershed Section 319 National Monitoring Program Project is located in Waterford, Connecticut along the coast of Long Island Sound. The study began in 1995, and was designed to determine water quantity and quality benefits of using pollution prevention Best Management Practices (BMPs), now known as low impact development (LID) techniques, for managing stormwater runoff within a residential subdivision. Runoff monitoring took place over a 10 year time-frame, inclusive of pre-, during, and postconstruction. What made this project unique was not the use of specific LIDs for stormwater management, but rather the use of a multitude of LIDs in one location.

From the monitoring program, two major conclusions were drawn: 1) low impact development can maintain pre-development peak runoff and volume of runoff levels while generally not increasing pollutant export except for phosphorus and sediment; and, 2) traditional development increases runoff by two orders of magnitude while pollutant export also increases.

This presentation will summarize the findings of a real world study which dispels many apprehensions about the use of LIDs to control snowmelt and rainfall runoff events in an urban residential subdivision.

3:30PM - 3:55PM

Wendy Coffin

Woodard & Curran, Portland, ME; wcoffin@woodardcurran.com

OVERCOMING LOCAL OBSTACLES TO IMPLEMENTING LOW IMPACT DEVELOPMENT

Low Impact Development (LID) strategies are being promoted at the state and federal level for new and redevelopment projects in order to maintain watershed hydrologic integrity and to reduce stormwater impacts. The basic tenets of the LID approach, maintaining pre-development hydrology, employing decentralized redundant stormwater management structures, maximizing time of concentration, and maximizing infiltration are very important to effective stormwater management. Unfortunately, some of these principles are counter to many long-standing engineering principles and standards.

To encourage and facilitate use of LID principles by developers and engineers, municipal ordinances, regulations, site design guidelines, and standards need to clearly allow their use. Traditional engineering design standards for curbing, parking lots, roads, sidewalks, and drainage utilities are often not conducive to LID implementation. In many municipalities, existing regulations, guidelines and design and construction standards conflict with, or greatly restrict the use of LID practices, thereby requiring use of

Session H: Low Impact Development

the variance application process. The variance application process is time consuming and cumbersome to the developer and can be confusing and difficult for local planning boards and their staff to administer. In the end this can lead to continued reluctance to employ LID stormwater management practices.

This presentation will point out some of the typical contradictions between municipal design requirements and Low Impact Development designs and will provide an approach municipalities can take to overcome these obstacles with an overview of project case-studies. Important steps in this process will be highlighted. Additionally, the presentation will discuss typical concerns of municipal managers and the need for education and demonstration projects that reduce uncertainty related to LID implementation.

Session I:

Tools for Watershed Managers

When managing local water resources, it is often important to do so in the context of the entire watershed. Diverse technical knowledge, methods, and data collection are often required to effectively manage water resources including the regulation of flows, setting of withdrawal limits, management of floodplains, and the construction or removal of hydraulic structures. Without adequate tools to plan, monitor, and adapt water-resource management plans, there may be unintended effects on the quality and quantity of surface and ground-waters that are difficult to foresee. Speakers in this session will address the need, development, and application of various tools available to watershed managers for decision-making at points within a watershed or for the watershed as a whole.



SESSION CHAIR

Rob Dudley, USGS, Maine Water Science Center

Rob Dudley is a hydrologist with the USGS Maine Water Science Center in Augusta, Maine. He has been employed by the USGS since 1992, where he has led a variety of geophysical, hydrologic, hydraulic, and statistical modeling studies encompassing stormwater runoff quality and quantity, riverine sediment mapping, geomorphology, public-water-supply water budgets, statistical hydrology, and hydraulic modeling. Ongoing and recent work involves investigations of hydrologic and climatic changes in New England, watershed modeling in cooperation with NOAA and the Maine Bureau of SeaRun Fisheries and Habitat to support management of Atlantic salmon habitat and water resources, and flood documentation and inundation mapping in cooperation with FEMA and the Maine State Planning Office. Dudley is a licensed professional engineer in the State of Maine and received a B.S. in mechanical engineering (1994) and M.S. in civil and environmental engineering (1998) from the University of Maine.

Session I: Tools for Watershed Managers

1:30PM - 1:55PM

Glenn Hodgkins¹, Charles Hebson², Pamela Lombard³, Alexander Mann⁴

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² Maine Department of Transportation, Augusta, ME; charles.hebson@maine.gov

³ U.S. Geological Survey, Augusta, ME; plombard@usgs.gov

⁴ Maine Department of Transportation, Bangor, ME; alexander.mann@maine.gov

COMPARISON OF PEAK-FLOW ESTIMATION METHODS FOR SMALL WATERSHEDS IN MAINE

Understanding the accuracy of commonly used methods for estimating peak streamflows is important because the design of bridges, culverts, and other river structures are based on these flows. Methods for estimating peak streamflows were analyzed for small watersheds in Maine by the U.S. Geological Survey (USGS) and Maine Department of Transportation (MaineDOT). Modeled peak flows were compared to observed statistical peak flows with return periods of two, 50, and 100 years for 17 streams in Maine and adjoining parts of New Hampshire with drainage areas of one to 10 square miles. Peak flows were modeled by the Rational Method, the Natural Resources Conservation Service TR-20 method, USGS regression equations, and the Probabilistic Rational Method. The regression equations were the most accurate method of computing peak flows and the Probabilistic Rational Method was the next most accurate. The Rational Method and particularly the TR-20 method had much larger errors.

USGS and MaineDOT are cooperating on data collection for watersheds with areas less than one square mile so that regression equations can be extended to these very small watersheds, but it will be five to 10 years before enough data is collected. MaineDOT has used the TR-20 method, the Rational Method, and engineering judgment for estimating peak flows at these very small watersheds in recent years. The research presented here implies that MaineDOT can apply the current regression equations at very small watersheds with some confidence, until the new regression equations are available.

2:00PM - 2:25PM

Zach Henderson

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STORMWATER RETROFIT INVENTORIES FOR MAINE IMPAIRED STREAMS

The Cities of Lewiston and South Portland are developing specific stormwater management plans for the improvement of urban impaired streams. In both cases, the small stream watersheds drain important industrial and commercial growth areas for the cities. The streams are not meeting their intended classification due to urban non-point source pollution and habitat degradation. The probable cause of non-point source pollution and habitat degradation are in part due to directly-connected impervious areas (DCIA).

The Maine DEP, the City of Lewiston, and project consultants assembled new and existing GIS and other watershed data in order to develop a comprehensive, specific list of structural and non-structural stormwater solutions for the watershed. In order to develop specific recommendations on the disconnection or treatment of DCIA, the consultant team developed a retrofit inventory strategy that would identify decentralized structural stormwater management options within the watersheds. Strategy goals were to identify critical subwatersheds that show the most potential for restoration as deter-

Session I: Tools for Watershed Managers

mined through evaluation of existing in-stream water quality monitoring data, community input and geomorphic conditions. Individual structural retrofit locations were selected in order to minimize impact/modification to existing infrastructure and maximize opportunities for landowners to integrate these relatively low-cost changes during redevelopment or maintenance. Additionally, important community resource areas were identified as a part of the strategy development in order to integrate stormwater management retrofits with future community improvement options, such as community trail development, improved pedestrian access, and open space enhancement.

This presentation will discuss the data needs for development of a stormwater retrofit inventory strategy, strategies used in Maine, retrofit inventory results from Lewiston, Maine and how these decentralized management systems may be integrated with capital improvement projects, existing programs, and community activities.

2:30PM - 3:00PM

BREAK

3:00PM - 3:25PM

Andrews L. Tolman

Maine CDC Drinking Water Program, Augusta, ME; Andrews.l.tolman@maine.gov

WATER LEVEL AND FLOW REGULATION IMPLEMENTATION PUBLIC WATER SYSTEM IMPLICATIONS

After more than seven years of discussion, hearings, and stakeholder groups, regulations for water level and flow were adopted by the Legislature and the Board of Environmental Protection in 2007. This process began in the late 1990's when agricultural withdrawals for irrigation and the conservation of Atlantic salmon came into conflict in Washington County. In reaction to that issue and some instances of Aroostook County irrigation interfering with aquatic habitat, the Legislature directed state agencies to collect water use data.

The collected data indicated that public water systems (PWS) were the largest single user of water that did not return it to the same water body (paper mills and hydropower use much more water, and generally return it to the same river). As more data accumulated, we identified a number of coastal PWS's who utilize relatively small lakes and streams to supply seasonally large populations. Their withdrawals result in relatively large fluctuations in water levels and stream flows. These fluctuations exceed the 'normal' changes in water level and flow that are envisioned in Chapter 587, the new flow rule. We have been working with DEP for the last several years to balance the needs of PWS's and their customers with various versions of the proposed rules.

We're now working with DEP and these water systems to develop a clear picture of their investment in the source, the population served by the system, and the hydrologic and habitat effects of their operation. We will be developing 'withdrawal certificates' that allow the water system to continue to serve their customers and identify opportunities to improve habitat as the system changes over time.

Session I: Tools for Watershed Managers

3:30PM - 3:55PM

Robert W. Dudley

USGS, Augusta, ME; rwdudley@usgs.gov

APPLICATION OF A DISTRIBUTED-PARAMETER WATERSHED MODEL TO THE DENNYS RIVER BASIN TO SUPPORT CHARACTERIZATION OF SUB-BASIN HYDROLOGY

The timing and quantity of water moving through the sub-watersheds of the Dennys River Basin and the relative amounts of that water apportioned to surface runoff and groundwater discharge are not well known due to a lack of data. The USGS, in cooperation with the Maine Atlantic Salmon Commission, began a study in 2004 to characterize the quantity, variability, and timing of streamflow in the Dennys River by doing a synoptic summary of historical streamflow data in conjunction with short-term streamflow gages in the Dennys River basin and an application of a distributed-parameter watershed model. The watershed model is a tool that provides the means to characterize sub-watershed hydrology in the Basin and estimate the relative amounts of surface and groundwater contributions to streamflow throughout the watershed. This information will lead to a better understanding of water quantity and quality in the basin that will subsequently support the planning and execution of ongoing and future Atlantic salmon protection efforts.

Session J:

Maine's Administrative Procedure Act: A Roadmap for Agency Rulemaking

In response to concern about regulatory activity, Maine, along with many other states, has adopted an administrative procedure act. The intent is to improve public access to agency decision-making and to increase awareness of agency rules.

The Maine Administrative Procedure Act was adopted at the First Session of the 108th Legislature, with some amendments since. It applies uniform requirements to state agencies with rule-making power, and sets minimum standards for agencies to follow in adopting and implementing rules.

This session will provide a forum for participants to gather more information on how rulemaking in Maine works, how LD 2213 will improve this process, and the various ways the public can contribute in the process.



SESSION FACILITATOR

Nancy Beardsley, Division of Environmental Health, Department of Health & Human Services

Nancy serves as the director of the Division of Environmental Health in the Dept. of Health and Human Services. Previously, she served as director of the Maine Drinking Water Program. Nancy started her Maine government career at the Maine Geological Survey, then spent the next 10 years working in various capacities at the Department of Environmental Protection. Nancy graduated from Boston University with a bachelor's degree in geology and later received a master's degree in public administration from the University of Maine. In 2006, Nancy served as president of the Association of State Drinking Water Administrators which represents the interests of all 50 states and territories. Nancy also served on the Environmental Protection Agency's National Drinking Water Advisory Council.

1:30PM - 2:30PM

Don Wismer

Bureau of Corporations, Elections and Commissions, Department of Secretary of State, Augusta, ME; don.wismer@maine.gov

Don Wismer will discuss the various steps a state agency follows in the adoption of a new or amended regulation. Topics to be covered include the difference between routine technical rules and major

Session J: Maine's Administrative Procedure Act

substantive rules, advertising the proposed rule, public hearings, public input, response to comments and final rule adoption.

2:30PM - 3:00PM

BREAK

3:00PM - 4:00PM

Ernie Hilton

Board of Environmental Protection

Ernie Hilton will speak about the BEP's role in the rulemaking process, in that the Board is the body that conducts the rulemaking process for the agency.

Andy Fisk

Bureau of Land and Water Quality, Maine Department of Environmental Protection

Andy Fisk will review the department's experience with substantive rulemaking and perhaps briefly discuss the petitioned rulemaking process.

Scott D. Anderson

Verrill Dana LLP

Scott Anderson will speak about his firm's experiences with agency interpretation and application of regulations. This will include a discussion of how the courts handle challenged agency decisions.

Session K:

What works? Selecting simple and effective evaluation tools for environmental outreach projects

As foundations and funding agencies place demands on recipients to document outcomes for environmental outreach projects, assessment tools are becoming increasingly important to justify continued support for programs. These tools are also important in improving program effectiveness, inspiring local participants, and enhancing transfer to other areas.



SESSION FACILITATORS

Barb Welch & Kathy Hoppe, Maine Department of Environmental Protection

Kathy Hoppe has worked for the Maine DEP in the Northern Maine Regional Office for over 18 years in the non-point source and recently stormwater programs. Being in a regional office Kathy has been a jack of many trades, but has taken her interest in outreach statewide through a variety of water quality projects.

Barbara Welch has worked as an aquatic biologist for the Maine DEP for 32 years. The first 14 years were spent doing lake diagnostic/feasibility studies and running the lake volunteer monitoring program. For the past 18 years Barb has focused on education and outreach on water quality issues. Kathy & Barb often work together and with other partners to design outreach using social marketing principles to provide more effective programs for stormwater, stream, and lake protection.

PANELISTS

Christine Reinhart, Wright-Pierce Engineers

Tamara Lee Pinard, Cumberland County Soil & Water District

Barb Welch, Maine Dept. of Environmental Protection

Kathy Hoppe, Maine Dept. of Environmental Protection

Session K: Evaluation Tools for Environmental Outreach

INTRODUCTION

Assessment data are important from the start to ensure programs are aimed at the right problem, the right audience, as well as choosing the right outreach tool. Learn about the AIDA model as a quick, easy project planning tool to ensure greater success.

Part 1

In Part I, we will discuss three projects each utilizing a different tool for assessment: two on-the-ground surveys for assessing non-point source problems in commercial and neighborhood areas; using mini-focus groups to test brochures, signs, logos, etc. before going into production, and surveys to check on what is and isn't working in a pilot program. Discussion will focus on the pros and cons of the different tools used, how the evaluation would be done differently if used again, and how feedback from the assessment was used to initiate project improvements.

Part 2

Part II of the session will include phone and intercept surveys and a discussion period for those projects. The phone survey (using Survey Monkey to handle the data) covered attitudes, awareness and behavior regarding common stormwater issues prior to a major outreach effort. The intercept survey was designed by the Maine DEP to assist groups in evaluating awareness and adoption of best management practices for addressing stormwater or non-point source pollution issues. The survey tool and accompanying excel sheet for compiling and reporting data will be available.

Poster Exhibition

High School, Undergraduate and Graduate Juried Poster Exhibitions

The Senator George J. Mitchell Center for Environmental and Watershed Research and the U.S. Geological Survey have sponsored a juried student poster exhibition at the Maine Water Conference since 2000. Winners receive a cash award and their names are engraved on a plaque housed at the Mitchell Center. There are separate competitions for high school, undergraduate and graduate students.

Posters are on display throughout the day and can be viewed at any time. The scheduled poster viewing session, when presenters are requested to be available to answer questions, is during the morning break from 10:00am-11:00am.

Student presenters are indicated in bold type.

POSTER CHAIR

Laura Wilson, UMaine Cooperative Extension

Laura is an assistant water quality scientist with the University of Maine Cooperative Extension. Laura organizes and runs the successful Watershed Stewards Program, in addition to participating in New England Regional Extension sustainable landscaping and drinking water outreach efforts. Currently, she is focusing work in the areas of assisting lake groups to design and implement education programs that can be evaluated for success, and social marketing to elicit behavior change. Laura received her B.S. in water resources management from the University of New Hampshire, and her M.S. in ecology and environmental sciences (water resources) from the University of Maine.

HIGH SCHOOL POSTER ABSTRACTS

Kayla Easler and Nathan Baird

Nokomis High School, Newport, Maine

THE LIFE AQUATIC: EXPLORING THE PHYSICAL AND BIOLOGICAL ENVIRONMENT IN NOKOMIS POND, NEWPORT, MAINE

Nokomis Pond is the source of local drinking water in Newport, Maine. The health of this water body may change over time with changes in climate and/or land use around the pond. As students in Ms. Kelly's statistics class, we designed an experiment to investigate aspects of the water quality of Nokomis Pond. Specifically, we investigated how temperature varies in the pond throughout the year. Additionally, we surveyed the different types of algae that were in the pond. The project started in November 2007 and is still currently going on. To measure water temperature, we placed temperature sensors at different depths and locations around the pond. Two sensors were placed at shallow depths and three were placed at the deepest part of the pond ranging from just below the water's surface to



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the pond's floor. Zooplankton and phytoplankton samples were collected by a plankton tow. Our class project is ongoing. We are anticipating to analyze our data in a number of ways. For example, we are interested to see how temperature varies over time. In addition, we plan to test whether there is a relationship between algal density and temperature, and whether temperature affects the growth rate of algae. We would also like to see how these variables relate to the quality of the drinking water.

Erik Jacobson

Greely High School, Cumberland, Maine

THE EFFECT OF NICKEL ON GROWTH AND DEVELOPMENT IN *ORCONECTES IMMUNIS* (CRAYFISH)

Concentrations of nickel (Ni), classified as a heavy metal, are increasing globally in both fresh and salt water. Although it is a naturally occurring element, aberrant sources are causing nickel concentrations to reach unprecedented heights. Mining, refining, and stainless steel production are the largest sources of nickel pollution. While metals like mercury have been investigated for chronic effects, nickel has not. Nickel, unlike other heavy metals, does not pose as large of a threat because it is not stored, but instead passed through the body. Marine organisms, such as crayfish, bioaccumulate nickel in their outer shell. This leads to the possibility of chronic side effects such as inhibited growth and development, as seen when plants are exposed to nickel contaminated soil. This possibility was then tested, by designing an experiment which would consist of two samples of crayfish, one as a control and one exposed to a concentration of nickel higher than the recommended criteria for surface water. Twelve crayfish, in one tank, were exposed in water with 300 ppb Ni, while the other tank of 12 crayfish was exposed to nickel free water. Every week the crayfish were analyzed by mass, volume, length, width, and height to test for overall growth. After two months, it was determined that the nickel did inhibit the growth of the crayfish. The crayfish that were chronically exposed to the toxic levels of nickel did grow significantly less ($P= 1.66E-07, 2.64E-05, 0.012043$) than those in the control.

Carin P. King

Waterville Senior High School, Waterville, Maine

DETERMINATION OF ARSENIC IN NATURAL WATERS USING SURFACE PLASMON RESONANCE: A LOW COST ANALYTICAL TOOL FOR ARSENIC SCREENING

Arsenic is a known toxin that is found in water throughout the world. Arsenic contamination is a particular problem in developing countries where drinking water is often drawn from shallow, unmonitored wells. Long-term exposure to unsafe levels of arsenic causes cancer and precancerous diseases. An inexpensive and robust screening method for arsenic is needed for routine analysis of drinking water. Forzani et al. (2007) reported success in the detection of arsenic using differential surface plasmon resonance, SPR. We have modified the Forzani SPR method for single beam instrumentation, using dithiothreitol as an arsenic-specific surface receptor and will report arsenic detection limits for this simplified technique. Single beam SPR offers the potential for a low-cost, field-portable sensor for arsenic.

Poster Exhibition

Emily Pike, Dimitriy Skoog and Kaitlin Stenberg

Maine School of Science & Mathematics, Limestone, Maine

MERCURY IN WINTER SOILS: THE EFFECTS OF SOIL TEMPERATURE AND WATER TYPE

The goal of this project was to investigate how temperature and water type affect soil mercury (Hg) concentrations in the winter. This study is a follow-up to a 2007 student project which showed that Hg content was higher in soils that had been exposed to de-ionized (DI) water than in control soils (exposed to no water). The conclusion from that project was that perhaps the DI water had impeded volatilization of Hg from the soil (volatilization rate increases with temperature). In the current study DI water, stream water, and melted snow were poured through soil samples kept at room temperature, and soil samples kept at a cooler temperature. Cold soils exposed to melted snow had significantly more Hg than other cold soil treatments (including dry controls), as well as warm soils exposed to melted snow. Warm soils exposed to DI had significantly more Hg than cold soils exposed to DI. We concluded that differences in pH and dissolved organic carbon (DOC) content of the waters used likely played a role in our results, as did the increased volatilization of Hg at higher temperatures. Our results indicate that what happens to soil samples between collection and analysis can influence the measured soil Hg content. In addition, the type of the water draining through soils in nature may have a significant impact on actual exposure of living things to Hg.

UNDERGRADUATE POSTER ABSTRACTS

William Ball¹, Laura Wilson¹, Christopher Brewer², Kate Gaudet¹ and Theodore Smythe¹

¹ University of Maine Cooperative Extension, Orono, ME; William.ball@umit.maine.edu

² Penobscot County Soil and Water Conservation District, Bangor, ME

ENHANCING LAKEFRONT BUFFER ADOPTION THROUGH SOCIAL MARKETING

The leading causes of water pollution in the state of Maine include sediment and nutrient loading. This project was designed to reduce the input of these pollutants by encouraging the use of vegetative buffers on lakefront property on Pushaw Lake, Maine. The goals were to identify barriers to installing lakefront buffers and to develop marketing tools to effect behavior change concerning installation and maintenance of lakefront buffers. By using two focus groups and a survey, we determined that the lakefront landowners who participated or responded have concerns about the water quality of Pushaw, have some knowledge of nutrient and water quality issues, and realize that their lakefront property may be contributing to the rising levels of phosphorus in Pushaw. A large percentage of respondents indicated a willingness to make changes on their property in order to protect the lake. We used a targeted outcome process developed by the New Hampshire Department of Environmental Services and New Hampshire Sea Grant to develop three social marketing-based outreach tools: pre-designed landscaped custom landscape packages, garden parties, and incentives for signing a buffer "pledge." We learned that no matter the offer of incentive, personal contact with the target audience (as opposed to direct mail or door-hanger advertising) yields better results.

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John Hall, Zach Helm, Bernadette Bibber, D. Whitney King

Colby College, Department of Chemistry, Waterville, ME, jahall@colby.edu

DYNAMIC MODELING OF THERMOCLINE FORMATION IN EAST POND RELATED TO INTERNAL LOADING OF PHOSPHORUS.

East Pond is a shallow mesotrophic lake that has been experiencing increasing algal bloom frequency. Although East Pond is only seven meters deep, significant stratification was observed in 2005 and 2006, but not in 2007. These stratification events led to anoxia and a significant benthic phosphorous flux to the hypolimnion. Also observed in 2005 and 2006 were strong blue-green algae blooms coincident with thermocline erosion. In 2007 East Pond was well mixed, had deeper Secchi depths, and a significantly weaker bloom than in previous years. A Dynamic Reservoir Simulation Model (DYRESM) was run for 2006 and 2007 and calibrated against actual temperature data. The model reproduces thermocline structure and dynamics while allowing sensitivity analysis of weather and biological influences on thermocline formation. The model has been used for both analysis of historical bloom events and prediction of future climate forcing.

Katie Harris, Ali Brandeis, Brian DeMento, D. Whitney King

Colby College, Department of Chemistry, Waterville, Maine; Keharris@colby.edu

HYDROGEN PEROXIDE PRODUCTION IN DEEP, SUBOXIC LAKE WATERS

Hydrogen peroxide (H_2O_2) has long been known to be an important species in the redox cycling of metals and the oxidation of organic compounds in natural waters. In lake systems, the vast majority of H_2O_2 is produced via photochemical (euphotic zone) processes involving dissolved organic carbon. However, laboratory and field studies have indicated a steady state concentration of H_2O_2 can be produced from reactions involving Fe(II) and oxygen in the deep water of temperate lakes. Past and recent studies of Great Pond and Snow Pond in the Belgrade Lakes chain have shown a significant plume of H_2O_2 at the thermocline and sediment-water interface that can be directly connected to the oxidation of Fe(II). The production of kinetically reactive H_2O_2 in the deep water of lakes has the potential to drive metal speciation to new dynamic, steady state concentrations that are no longer in equilibrium with dissolved oxygen.

Erik B. Larson, Christopher Bitner, Clayton Kern, Michael Lewis, Raymond Stuart and Lois K. Ongley

Environmental Analysis Program, Unity College, Unity ME

el Larson06@unity.edu, cbitner05@unity.edu, ckern04@unity.edu, mlewis05@unity.edu, rstuart04@unity.edu, longley@unity.edu

ASSESSMENT OF EUTROPHICATION POTENTIAL ON PATTEE'S POND, WINSLOW, MAINE

The average annual Secchi disk transparency in Pattee's Pond, Winslow, ME has decreased about 0.5 m over the past 4 years after many years of improving average Secchi transparency. In addition, the 2007 variability of Secchi transparency measured by the volunteer lake monitor ranged from about 2.7 m to 4.9 m with decreased transparency apparently correlating with rain during the prior week. Although analysis of topographic maps and aerial photos showed no significant change in lake surface

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area (about 208 hectares) for more than 70 years, residents think that algal blooms have been increasing and are concerned about the possible increase in eutrophication. On July 5, 2007 after a few days of stormy wet weather, the total dissolved phosphorus concentration (P_{tot}) of a water sample taken from 1m depth at the center of the pond was 170 µg L⁻¹. The Secchi transparency was 2.3 m. On July 17, 2007 the P_{tot} and Secchi transparencies were 40 µg L⁻¹ and 4.3 m respectively. In early August 2007 water from Bellows Stream overflowed Pickerel Point Rd. after a sudden heavy down-pour. The following Sunday the Secchi transparency was very low. In November 2007 we measured P_{tot} (with concentrations up to 1,800 µg L⁻¹) at several points along Bellows Stream. We verified previously unpublished Maine Department of Environmental Protection data showing elevated P concentrations during storm events in the watershed. Storm water erosion adds a great deal of P to Pattee Pond which probably increases the potential for significant eutrophication of that water body.

Jamie O'Connell, Claire Thompson, Kristyn Loving, David Firmage, Russell Cole, Tracey Greenwood

Department of Biology, Colby College, Waterville, ME;

jkoconne@colby.edu, cythomps@colby.edu, keloving@colby.edu, dhfirmag@colby.edu, frcole@colby.edu, trgreenw@colby.edu

PHOSPHORUS LOADING IN THE SOUTH BASIN OF LONG POND, KENNEBEC COUNTY, MAINE

During the summer and fall of 2007, Colby College collected data on physical, chemical and biological parameters in Long Pond, South Basin. This water body has been placed on a list of impaired lakes established by the Maine Department of Environmental Protection (DEP) due to a declining trend in water quality. DEP used decreasing levels of dissolved oxygen and transparency as criteria for their decision, a trend also consistent with data collected during the summer months of 2007. Based on a GIS analysis of land use in the watershed and the summer and fall data, a phosphorus model was constructed for the watershed. Sources of phosphorus loading were studied and projections for the future were made. Buffer strips between residences and the shoreline were evaluated as well as the condition of roads in the watershed. The largest watershed contributors of phosphorus to the lake are agricultural land (22%), mixed forest (13%), and successional land (12%). However, 79% of the water and 63% of the phosphorus comes directly from the North Basin of Long Pond and lakes upstream. Thus Long Pond's water chemistry status is largely dependent on factors outside of the direct watershed. Despite negative trends, Long Pond South is still a relatively healthy lake but actions must be taken to preserve its current state.

Leanne Powers, Zachary Helm, D. Whitney King

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REACTIVITY OF SUPEROXIDE IN NATURAL WATERS

Superoxide (O₂⁻) is a radical anion that is produced in surface waters by the photooxidation of dissolved organic matter. Because of its intermediate redox potential, superoxide participates in the oxidation of dissolved organic materials and the redox cycling of dissolved metal ions like iron and copper. Due to the reactivity of O₂⁻, steady state concentrations are in the range of 10⁻¹² to 10⁻¹⁰ M in natural waters and require a sensitive chemiluminescence system for detection. Superoxide standards are pro-

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duced by the photolysis of acetone in a saturated ethanol solution or enzymatically by the xanthine/xanthine oxidase system. The chemiluminescence system has been calibrated with these standards for both the reaction of superoxide and the 2-Methyl-6-(4-methoxyphenyl)imidazo[1,2-a]pyrazin-3(7H)-one (MCLA) and the reaction of superoxide and 1,10-phenanthroline in a cetyltrimethylammonium bromide micelle. Using these systems we have studied the photochemistry of superoxide in natural waters. A surprising outcome of these studies is the reaction of superoxide with dissolved CO₂ (O₂⁻ + CO₂(aq) → CO₄⁻) to form the peroxy carbonate radical and/or other radical dimers. Using the chemiluminescence system, we have investigated the reactivity of the peroxy carbonate radical and will report on the significance of this reaction for the fate and reactivity of O₂⁻ in Maine lakes.

Daniel Stephens and Robert Sanford

University of Southern Maine

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THE EXISTENCE AND DOCUMENTATION OF VEGETATIVE BUFFERS IN CUMBERLAND COUNTY, MAINE

This poster illustrates the goals, methodology and initial results of an ongoing study to document the existence of vegetative buffers along streams and rivers in Cumberland County, Maine. The intention of the research is not to determine the efficacy of such buffers as a means to improve water quality, but to build a detailed inventory of their existence and status. The research documents the buffer's relationship to existing federal and state natural resource laws, such as Maine's Shoreland Zoning Act. It also examines the correlation between each buffer's physical status and its "paper" status as documented by municipal government. The primary result of the research is a GIS database consisting of numerous layers that graphically depict research results, such as buffer location, size and quality, available documentation relating to permit status, and inspection status. These data will provide an important link between known measurements of water quality and correlations between local policy, planning, resource management and habitat/water quality.

Robert Treat

University of Southern Maine, Gorham, Maine; robert.treat@maine.edu

A TOPOGRAPHICALLY-BASED SOIL SATURATION MODEL

A soil saturation model based on topographic controls was implemented using GIS and a 10-m resolution digital elevation model of the Gorham, Maine quadrangle. A topographic index (or wetness index) was calculated using data on surface slope and overland flow patterns (such as directionality and areas of accumulation) found using hydrological functions native to ArcGIS. The result was a map that acts to predict which areas are likely to become saturated during a precipitation event, hence generating overland flow, and which are likely to remain unsaturated.

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Kerry Whittaker, Eva Gougian, Jessica Harold, David Firmage, Russell Cole, and Tracey Greenwood

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THE IMPACT OF DEVELOPMENT AND CHANGING LAND-USE PATTERNS ON THE WATER QUALITY OF LONG POND SOUTH BASIN

In the fall of 2007, Colby College analyzed land-use and development patterns in the Long Pond South watershed to determine their impact on lake water quality. Recently, the Maine Department of Environmental Protection has observed a decreasing trend in the water quality of Long Pond. We imported 2003 Digital Orthophoto Quadrangles from the Maine Office of GIS into ArcGIS 9.2 to quantify the various land-use types found in the Long Pond South watershed. Land use patterns in 1966 were also digitized from aerial photographs. Although there has been a decrease in agricultural land (4.3%) and forested land (6.0%), there has been an increase in residential area in the watershed (2.0%). Current residential development is less than in the north basin with only 126 versus 239 shoreline homes. However, with a projected population increase in the surrounding towns of 65% by 2030, the potential for shoreline and watershed development in Long Pond South Basin is high. There are roughly 50 undeveloped lots along the shoreline, as well as large blocks of land in the watershed that could be developed in the future. Although current water quality is good (Total phosphorus concentration = 9.1 ppb), future development in the watershed poses a threat to the water quality of Long Pond South Basin.

GRADUATE POSTER ABSTRACTS

Adam J. Baumann, Jane Towse and Steve Kahl

Center for the Environment, Plymouth State University, Plymouth, NH; ajbaumann@plymouth.edu

FULLY AUTOMATED TOTAL PHOSPHORUS ANALYSIS AND ITS POTENTIAL TO IMPROVE NUTRIENT DATA IN AQUATIC SYSTEMS

Phosphorus is a limiting nutrient in many aquatic ecosystems and has historically been used to index aquatic health. As the use of phosphorus data in this context increases, our analytical methods for total phosphorus (TP) determination need to be revisited. The lack of automation in TP analyses is a major limitation of the existing methodology for several reasons. Current wet chemical, bench-top methods for TP analysis call for long and tedious digestion procedures leading to high potential for both analytical and human error as well as decreasing data reproducibility. Automation of the entire procedure, although convenient, commonly increases the measurement range to a level no longer useful in environmental analyses. Here we describe a fully automated flow injection analysis method for TP that performs with precision, accuracy and detection limits comparable to current off-line digestion procedures. Potential pitfalls of this analytical technique are also discussed. We examine the dependence of TP measurements on particulates in surface waters of currently impacted lakes using this automated procedure. Further study of the temporal and spatial variability of the relationship between particulates and the automated TP analysis will increase the quality of environmental data produced, as well as the ease of its analysis.

Melinda Diehl and **Aria Amirbahman**

Dept. of Civil and Environmental Engineering, University of Maine, Orono, ME
melinda.diehl@umit.maine.edu, aria.amirbahman@umit.maine.edu

DESIGN AND OPTIMIZATION OF REACTIVE THIN-FILM MEMBRANES FOR STUDYING MERCURY MOBILITY AND TRANSFORMATION IN SEDIMENT POREWATER

The inland and coastal waters in Maine have been subject to decades of anthropogenic mercury (Hg) loading. The mobility and toxicity of Hg are primarily controlled by the biogeochemical conditions present at a given site. Of particular concern is the Hg sediment flux in estuaries that can rapidly shift under changing redox conditions driven by tides. Measuring sediment Hg fluxes in estuaries is difficult due to redox sensitivity, high spatial heterogeneity, and the low porewater Hg concentrations. The purpose of this work is to develop a technique to study Hg flux in estuarine sediments at spatially and temporally relevant scales. Current methods of Hg sediment analysis typically lack the spatial resolution necessary to elucidate surface-water interface dynamics, disrupt Hg speciation by changing the redox condition of the sample, or do not provide temporally-relevant Hg flux data. In trying to bypass these shortfalls, we have developed a reactive thin-film membrane that can increase the spatial and temporal resolution of Hg concentration measurement in sediment porewater. The membranes have exhibited high Hg uptake capacity and fast uptake kinetics. These reactive thin-film membranes will provide quantitative information regarding the flux, mobility and bioavailability of sediment Hg, characteristics that affect Hg bioaccumulation.

Mitchell Wark¹, **Berc Kalanyan**¹, **Lucas Ellis**¹, **Joerg Fick**², **Laurie Connell**³, **David Neivandt**² and **John F. Vetelino**¹

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³ School of Marine Sciences, University of Maine, Orono, ME; laurie.connell@umit.maine.edu

A LATERAL FIELD EXCITED ACOUSTIC WAVE SENSOR FOR THE DETECTION OF SAXITOXIN IN WATER*

In the United States, approximately 20% of all food-borne disease outbreaks result from the consumption of seafood products. Specifically, the disease paralytic shellfish poisoning (PSP) is caused by consuming molluscan shellfish contaminated with a suite of algae (such as red tide) produced neurotoxins the most potent of which is saxitoxin (STX). The current accepted method for STX detection is an expensive laboratory-based test called the mouse bioassay in which samples of coastal shellfish meat are injected into mice, and the toxicity of the samples is estimated based on their time of death. A novel acoustic wave sensor is being developed which utilizes a lateral field excited (LFE) acoustic wave sensing platform coated with a STX-sensitive crown ether chemical film for the detection of STX. The LFE sensor measures electrical and mechanical property changes in its sensing film due to the binding of STX, resulting in the sensitive in situ detection of STX in water. The feasibility of the sensor has been demonstrated in pure de-ionized (DI) water environments and can detect STX in concentra-

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tions as small as 1 μM . The LFE sensor has shown to be significantly more sensitive, quicker, and cheaper in the detection of STX compared to the mouse bioassay. Research continues into developing the LFE sensor for reliable operation in non-ideal environments and for the detection of other toxins associated with PSP. The successful development of the LFE sensor will result in a viable sensor for the detection of STX in shellfish and in seawater.

* This work was funded in part by National Science Foundation grants GK-12 0538457 and REU 0452021.

Elizabeth A. Whitmore and Katherine E. Webster

School of Biology and Ecology, University of Maine, Orono, ME; elizabeth.whitmore@umit.maine.edu

FACTORS INFLUENCING CLADOCERAN COMMUNITY COMPOSITION AND SIZE IN ACADIA NATIONAL PARK LAKES

In aquatic ecosystems cladocerans play an important role in pelagic food webs, so their community and size structure can provide useful information on the effects of stressors on lake ecosystems. The objectives of this research were to (1) determine abundance and body size of the zooplankton taxa present in eight lakes in Acadia National Park (ANP) along a total phosphorus (TP) gradient of 1.7-11.7 $\mu\text{g P/L}$ and (2) determine whether *Daphnia* were responding to UV radiation in two clear water lakes in ANP. Monthly zooplankton and water chemistry samples were taken from June through August in 2007. Cladoceran abundance and body size were quantified and compared to the trophic drivers TP and dissolved organic carbon (DOC). We saw a clear connection between *Daphnia* abundance and TP in the month of July. Except for the lakes with the smallest and the highest TP values, there was an overall increase in *Daphnia* body size over the study period. Also, when there was an increase in *Daphnia* abundance there was an increase in invertebrate predators. The percent of *Daphnia* with visible bands of the photoprotective pigment melanin was higher in Jordan Pond (41%) than in Eagle Lake (5%); Jordan Pond had consistently higher UV-B absorbance values. Our results suggest that for these lakes the cladoceran community is being influenced by more than just TP and DOC, and top-down factors may have more influence than the bottom-up factors. We also found that in Jordan Pond UV-B radiation is influencing the cladoceran community.

PROFESSIONAL POSTER ABSTRACTS

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METHYLMERCURY DYNAMICS IN THE PENOBSCOT RIVER ESTUARY (MAINE, USA) SEDIMENT

Due to the presence of high concentrations of organic matter and sulfate, estuarine sediments may produce a great deal of methylmercury (MeHg). Using equilibrium dialysis samplers and molecular analysis of the resident microbial population in contaminated sediments of Penobscot estuary, we observed a correspondence between the density of the sediment sulfate reducing bacteria and methy-

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lation in porewaters. We also observed rapid MeHg demethylation close to the sediment-water interface (SWI) that may be due to the presence of iron reducing bacteria that are dominant close to the SWI, or to the presence of mer-A genes that may be expressed in contaminated sediments, such as the ones studied here. We studied Hg methylation in intact sediment cores by manipulating the location of the redoxcline in laboratory. Induced shoaling of the redoxcline was correlated with a shoaling of the net MeHg production zone and an increase in net MeHg production rate. Based on this, environments such as salt pannes, where the shallow redoxcline leads to the shoaling of the MeHg front, are likely to be Hg methylation and release hotspots in coastal environments.

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MERI BLUE HILL BAY WATERSHED MONITORING PROJECT, 2004-2007

The Marine Environmental Research Institute (MERI) initiated the Blue Hill Bay Watershed Monitoring Project in 2004. The first comprehensive monitoring effort of Maine's large watersheds, the project has expanded to include 40 freshwater and marine sites that are monitored between April and October for physical water quality parameters, nutrients and bacteria. Physical parameters (temperature, pH, salinity, dissolved oxygen, specific conductance, and turbidity) were found to be within acceptable limits. However, critical indicators of ecosystem health suggest some sites are clearly impacted by sources of point and nonpoint pollution. The discovery of elevated bacterial counts (*Enterococcus* spp) at local swimming beaches, decreased dissolved oxygen levels in area streams, and presence of invasive species in ponds support the need for continued monitoring. The value of the project was demonstrated in spring 2007 when MERI's monitoring team located the source of bacterial contamination for the town beach, enabling officials to remediate the problem and safely reopen the beach to the public.

The MERI Blue Hill Bay Watershed Monitoring Project offers a six-month watershed internship each year to a qualified college student or recent graduate. The internship offers mentoring in environmental health sciences, intensive training in field and laboratory methods, and hands-on experience in a unique coastal environment.

Plans for 2008 include expanded monitoring of bacterial contamination at local beaches, assessing water quality at off-shore mussel aquaculture farms, and an increased effort to document invasive species in the watershed.

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MAINE WATER ATLAS

Maine Water Atlas is an online resource to access multiple types and sources of lake- and watershed-specific data. The Atlas contains three primary components. Google Earth and ArcIMS interfaces provide access to spatially referenced data from the PEARL data bank (www.pearl.maine.edu). From these interfaces, the user can navigate to a lake or watershed and then click on links that lead to the associated Lake and Watershed Overview pages in PEARL. The overview pages provide background information about the spatial unit, dynamic data visualization and data extraction tools, and access to

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source data tables as well as bibliographic data specific to the spatial unit. A third component of the Atlas is a Forum for sharing 'non-traditional' or 'experience-based' information, also spatially referenced within the Atlas to lake and watershed codes. This information is of a type that typically does not reside in formal databases and thus tends to be relatively 'invisible'. It nevertheless represents a potentially rich source of knowledge about Maine's environment. With password-controlled access, site users can contribute information to the Forum via a simple user interface. The Forum is searchable by spatial unit, topic and date of post, and includes dynamically-generated mapping. The Forum will be launched pre-loaded with a rich set of information from a series of expert interviews conducted statewide by The Nature Conservancy, focusing on biodiversity and other facets of environmental quality in the state's lakes and watersheds.

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EAST POND BIOREMEDIATION STUDY: PHASE II - FISH REMOVAL AND DISPOSAL

Following several years of study of the water quality and fish-zooplankton and phytoplankton relationships in East and North (downstream comparison) ponds, fish removal and disposal activities commenced following ice-out in late spring 2007. A total of 40,570 fish were captured during the period April 19 through May 15 using five trap nets fished over 134 trap nights. Of this total, 98% by number were targeted fish species, comprised of 86% white perch, 6.6% yellow perch, and 5.4% black crappie. The remaining 2% of the non-target fish species released were comprised of golden shiner, chain pickerel, white sucker, and sunfish – with small numbers of black bass (largemouth and smallmouth), brown bullhead, and only a few brook and brown trout. A total of 39,812 adult fish were removed, including 34,959 white perch, 2,678 yellow perch and 2,175 black crappie. In terms of weight and disposal, a total of 10 tons of fish were composted at an area farm, with white perch comprising 89%, black crappie 5.7%, and yellow perch 5.3%. Two to three-year old age classes of white perch were not generally observed during this sampling period. Only 18-23% of the adult white perch population (173,500 +/- 23,700) was effectively removed. During the summer, the assemblage of surviving resident fishes was assessed using a standard catch per unit effort deploying a combination of active fishing gears (sinking gill nets, nighttime beach seining, and expert baitfish angling). Fish removal, disposal and resident fish assemblage assessment will continue with an expanded effort in 2008.

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THE PENOBSCOT RIVER WATERSHED EDUCATION PROGRAM: CELEBRATING AND STRENGTHENING COMMUNITY CONNECTIONS TO THE RIVER THAT SUSTAINS US

Faculty and fifth grade students at Old Town Elementary School are piloting a new, multidisciplinary education program. The program engages students in watershed and river restoration science, sea-

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run fish ecology, and cultural studies through five classroom and field-based curriculum units, and two community projects. The curriculum units began in September 2007, focusing on: watershed hydrology/ecology; sea-run fish ecology; industrial uses of the river; cultural history/human ecology in the watershed; and current river restoration efforts. Community projects include conducting oral history interviews, and creating a series of educational posters for two permanent public information kiosks along the river. Through the program, the students met with watershed managers and fisheries biologists, local industry professionals, and river restoration and cultural history professionals working throughout the Penobscot River watershed. They also interviewed family and community members, explored historical documents and photographs in local museums, and conducted research on the cultural, social, economic, and ecological importance of the river. The students are currently compiling information from their oral history interviews, field trips, guest lectures and classroom lessons to create three educational posters. In the spring of 2008, they will help build two information kiosks for their posters at waterfront sites in Old Town.

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A NEW EPA METHOD FOR DETERMINING TRACE BROMATE CONCENTRATIONS IN NATURAL WATERS USING 2-D ION CHROMATOGRAPHY WITH SUPPRESSED CONDUCTIVITY DETECTION

The International Agency for Research on Cancer has determined that bromate is carcinogenic in animals and is a potential human carcinogen. Bromate is commonly formed from the ozonation of drinking water containing naturally occurring bromide. Currently, bromate is regulated in drinking water at 10 ug/L. Environmental Protection Agency Methods 300.1 B, 317.0, and 326.0 are approved by the US EPA for compliance monitoring. Ion chromatography with suppressed conductivity detection, as described in Method 300.1 B, is the most common approach used to determine trace concentrations of bromate in drinking waters. It also has the highest method detection limit (Part B, 1.44 ug/L). However, high concentrations of common anions, such as chloride, sulfate, and carbonate, can produce poor bromate peak shapes and lower recoveries. This often requires the analyst to either dilute the sample which raises the minimum reporting limit (MRL) or pre-treat the sample offline prior to analysis. Pretreatment of samples requires increased time and cost for each analysis. Therefore, the objective of this project was to develop a method that eliminates high concentrations of matrix ions and minimizes their interferences for the determination of trace concentrations of bromate. This paper describes a two-dimensional (2D) ion chromatographic (IC) method with suppressed conductivity detection for the determination of trace bromate. In the first dimension, 1000 μ L is injected on a 4-mm high capacity ion exchange column to separate bromate from the matrix anions. Bromate is heart-cut using automated valve switching onto a concentrator column. In the second dimension, bromate is separated using a 2-mm anion exchange column followed by quantitation after suppressed conductivity detection. In this paper, we describe the 2D IC instrumentation and demonstrate the method robustness and performance for determining trace concentrations of bromate in environmental waters. This new method, which is being considered by EPA for publication, has sensitivity that equals that of the postcolumn-based methods.

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DOES MELTING SNOW CONTRIBUTE MERCURY TO VERNAL POOLS? STUDENT-LED RESEARCH IN THE SCHOODIC WATERSHED

This research evaluated the potential for litterfall (leaves and needles that have fallen to the ground) and soils to contribute mercury (Hg) as snow melts in spring. We hypothesized that melting snow would leach mercury from soils and litter, based on observations in the literature that suggest a large pulse of Hg occurs during snowmelt. Soils and litter collected in the newly-developed Schoodic Watershed in Acadia National Park were subjected to three leaching treatments to test this hypothesis: wicking ultrapure (mercury-free) water through the substrates, pouring ultrapure water through the substrates, and soaking substrates in ultrapure water for three hours. In all three cases, there was less mercury in substrates that had not been subject to leaching (controls) than in our experimental treatments. We propose two potential mechanisms to explain the discrepancy between the hypothesis and our observations: 1) warming the soils and litter in the laboratory affected the control samples, causing mercury to volatilize, and 2) mercury in the experimental samples was effectively preserved by using acidic (pH ~5.5) ultrapure water, leading to higher concentrations. Future work to evaluate these mechanisms would provide new information regarding winter fluxes and emission of mercury.

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MEMAP (MAINE ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM) DIRECTORY: AN ONLINE DIRECTORY TO MONITORING PROGRAMS AND MONITORING DATA IN MAINE.

The Maine Environmental Monitoring and Assessment Program (MEMAP) Directory is a searchable online directory designed to make it easy for teachers, students, researchers, land-use stewards and other citizens to locate monitoring programs and scientific monitoring data that are relevant to Maine. Our purpose is to make it easier for citizens to draw from scientifically gathered information as they seek to understand environmental change in Maine. Examples are provided for how teachers and students have used MEMAP and environmental data in the classroom to answer interesting questions with environmental data.

Monitoring programs may be searched by keyword (e.g. Acadia, temperature, stream flow), resource category (e.g. freshwater, biological, atmosphere), sponsoring organization (e.g. Maine DEP, Presumpscot River Watch), or by HUC-8 watershed. Updates to the database and its development are ongoing, and we rely on input from program sponsors and MEMAP users for new additions, corrections and suggestions.

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MEMAP was originally developed in 2002 with partial funding from the National Science Foundation, as a resource for teachers and students to participate in local water quality monitoring programs and to easily access monitoring data. The database was recently updated and moved to the University of Maine Fogler Library server and now lists many kinds of environmental monitoring programs, with links to program and data web sites. MEMAP is a free public service provided by the University of Maine with support from Fogler Library, the Forest Bioproducts Research Institute, the Climate Change Institute, Maine InfoNet, and the Center for Science and Mathematics Education Research.

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AQUATIC COARSE WOODY DEBRIS: IMPLICATIONS OF PAST AND PRESENT MANAGEMENT PRACTICES

Coarse woody debris (CWD) is an important structural component of streams. CWD forms pools, dams, and other channel features creating hydrological and habitat diversity. Because in-stream CWD originates from the riparian zone, the history of timber harvests influences the volume of CWD within the stream channel. In 2007, we sampled 130 stream sites to determine how timber management near streams influences key components of aquatic and riparian biodiversity, including in-stream CWD. We sampled streams within old-growth, late-successional, and historically managed stands with and without recent (<20 years) management within 25m of the stream. Streams within the historically managed groups had significantly less in-stream CWD volume than streams within old-growth and late-successional stands. The majority of forests in Maine have been managed and therefore most streams have reduced volumes of in-stream CWD. Trees within the riparian zone are the source for future in-stream CWD. Larger trees provide a more stable and longer lasting structure than smaller trees and therefore density of large trees can be a good predictor of future CWD recruitment. The number of large (≥ 40 cm dbh) trees near the stream channel is significantly lower in both managed groups. However, managed sites without recent timber removal near the stream had significantly more large trees and a greater potential for high quality CWD recruitment. Retaining trees near the stream channel can provide future supplies of CWD to stream channels, a structural feature that is significantly reduced in the majority of Maine's streams.

❧ *thank you* ❧

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