19th Annual Maine Water Conference

March 19, 2013
Augusta Civic Center
Augusta, Maine

Senator George J. Mitchell Center
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: Groundwater Management and Sustainability
Session B: Development and Use of Environmental Indicators in Decision-making
Session C: Stayin' Alive: Education, Outreach, and Citizen Science
Session D: The State of Maine's Water Resources
Session E: What's a Town to do? Municipal Decision-making about Water Resources
Session F: Fisheries: Habitat and Passage

10:00AM **Morning Break and Poster Session — Auditorium**

11:00AM **Plenary Session — Welcome & Introduction**
Jasmine Saros, University of Maine

11:05AM **Craig Williamson, Miami University of Ohio**
Managing Water Resources in a Changing Climate: Deciphering the Sentinel Responses of Lakes in a Warmer and Wetter World

11:40AM **Introduction**
Kirsten Ness, Portland Water District

11:45AM **Timothy Ford, University of New England**
Global Studies in Water and Health: Implications for Maine

12:20PM **Poster Award Presentations**
Robert Lent, Director, USGS Maine Water Science Center
John Peckenham, Poster Chair, Senator George J. Mitchell Center

12:30PM **Lunch**

1:30PM **Afternoon Concurrent Sessions**
Session A: Groundwater Management and Sustainability (cont.)
Session B: Development and Use of Environmental Indicators in Decision-making (cont.)
Session G: Intensity, Frequency, and Variability:Maine's Changing Climate
Session H: Nonpoint Source and Emerging Contaminants
Session I: Restoration Potential and Barriers in Maine Rivers

2:30PM **Afternoon Break — Auditorium**

3:00PM **Afternoon Concurrent Sessions** (cont.)

4:00PM **Conference Close**

Plenary Session

11:00AM WELCOME & INTRODUCTION

Jasmine Saros
Climate Change Institute and School of Biology & Ecology, University of Maine

Dr. Jasmine Saros is an Associate Professor of Biology at the University of Maine, and Associate Director of the Climate Change Institute. Her research focuses on understanding the effects of climate change on lake habitat and water quality in Maine, as well as sensitive alpine and arctic regions of the world. She teaches limnology and paleoecology, and mentors several graduate students. She currently serves as the Program Director of the Adaptation to Abrupt Climate Change IGERT, focused on training more than 20 doctoral students in this new field.

11:05AM CRAIG WILLIAMSON

Global Change Limnology Laboratory, Miami University of Ohio

MANAGING WATER RESOURCES IN A CHANGING CLIMATE: DECIPHERING THE SENTINEL RESPONSES OF LAKES IN A WARMER AND WETTER WORLD

The world is getting warmer and wetter, and lakes and reservoirs are some of the most responsive ecosystems. As the lowest point in the landscape these inland waters provide signals of change that we have yet to fully decipher. Understanding these signals is critical to the effective management of surface water resources. Lakes respond in opposite ways to these two components of climate change. Warmer temperatures may increase water clarity but also aggravate harmful algal blooms. Wetter conditions may pose an even more severe challenge by decreasing water clarity due to an increase in dissolved organic matter. Consequences include reduction in UV transparency in particular, the potential for natural and artificial UV disinfection of surface water supplies, and increases in the production of carcinogenic disinfection byproducts. Decreasing UV transparency may also open up invasion windows for undesirable invasive species, while increasing UV transparency may reduce the spawning success of commercially important fish. Extreme events are becoming more common and are aggravating these changes. The question is, can we decipher the meaning of the sentinel responses of lakes and reservoirs in time to improve our ability to manage our water resources effectively in a changing climate?

Craig Williamson *leads the Global Change Limnology Laboratory in the Department of Zoology at Miami University in Oxford, Ohio. He received his PhD from Dartmouth College and was a faculty member in limnology and aquatic ecology at Lehigh University for over two decades. In 2005 he moved to his current position as the Ohio Eminent Scholar of Ecosystem Ecology at Miami. Williamson's expertise is in the ecology of ultraviolet radiation, and his current interests are centered on understanding the value of lakes as sentinels of climate change. As the lowest point in the landscape lakes provide signals of change in local, regional, and global climate conditions. His research focuses on a variety of questions ranging from the effects of UV and climate change on the ecology of infectious diseases to developing and deploying mobile as well as profiling buoy systems with advanced sensors. The lakes on which he works range from inland reservoirs in highly disturbed agricultural landscapes to heavily forested glacial lakes and high elevation alpine lakes. Williamson serves on the United Nations Environment Programme Environmental Effects Assessment Panel which*

reports to the United Nations annually on the status of UV effects related to ozone depletion, under the auspices of the Montreal Protocol. He also serves on the Freshwater Indicators Technical Team for the United States Global Change Research Program that prepares the National Climate Assessment for the president and congress. He and his students do comparative lakes research in collaboration with the Global Lake Ecological Observatory Network (GLEON), National Ecological Observatory Network (NEON), and marine scientists as well. For more details, see the text, photos, and videos at: http://www.users.muohio.edu/willia85/.

11:40AM INTRODUCTION

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. She 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.

11:45AM TIMOTHY FORD

Dean of Graduate Studies and Public Health and Interim Dean, Westbrook College of Health Professions, University of New England

GLOBAL STUDIES IN WATER AND HEALTH: IMPLICATIONS FOR MAINE

Waterborne disease is a major cause of morbidity and mortality worldwide, yet we continue to struggle to effectively make the epidemiological link between exposure and disease. This is critical if we are to influence policies for positive change. In this talk, examples will be used from studies in Russia and India, and the difficulties of sustaining interventions to reduce the burden of waterborne disease discussed. Key questions are: how are we so different in the US, and particularly in rural Maine?; and does climate change place water supplies at significant risk, and what opportunities are there to improve surveillance for waterborne disease?

***Tim Ford** obtained his PhD in aquatic microbiology from the University College of North Wales. After completing a postdoctoral fellowship at Harvard University, he joined the faculty of the Harvard School of Public Health where he both founded and directed the School's Program in Water and Health. After 17 years at Harvard, he joined the faculty of Montana State University (MSU) as Professor and Department Head of Microbiology. At MSU, he became program director of Montana's NIH-funded Idea Networks for Biomedical Research Excellence. The program was designed to support projects at four-year institutions and tribal colleges throughout the State, and was focused on both infectious disease and environmental health research.*

Ford's research interests have focused on source and drinking water microbiology, and the epidemiology of waterborne disease. He has both directed and participated in water quality related projects in the US, Canada, the UK, Mexico, India, Russia and the Philippines, and is currently building collabo-

rations with colleagues in Hong Kong and China. He is widely published in water and public health related fields and was the 2006 recipient of the Gen-Probe Joseph Award for "exemplary leadership and service in the field of public health." His current work in environmental health is focused on exposure assessment to both chemical and microbiological contaminants on American Indian Reservations in Montana, where he continues to advise doctoral students. In addition to a number of international initiatives, he anticipates developing new research areas on health disparities in Northern New England.

12:20PM POSTER AWARD PRESENTATIONS

Presentation of poster awards by Robert Lent, Director, USGS Maine Water Science Center and John Peckenham, Director, Maine Water Institute, Senator George J. Mitchell Center.

12:30PM LUNCH

Session A

Groundwater Management and Sustainability

Groundwater 101: How does groundwater work? This session focuses on the basics and current research on Maine's groundwater resources

SESSION CHAIR

Daniel B. Locke
Maine Geological Survey, Augusta, ME; daniel.b.locke@maine.gov

Daniel B. Locke is a Hydrogeologist with the Maine Geological Survey. His responsibilities have included sand and gravel aquifer mapping, various ground water quality investigations, and DEP/LURC application review primarily pertaining to ground water. More recent activities involve detailed ground water studies of select basins in cooperation with the USGS and a DOE funded investigation examining thermal gradient in deep bedrock borings in Maine. He is a Maine certified geologist, licensed site evaluator, and a Professional Hydrogeologist through the American Institute of Hydrology. Dan is a graduate of the University of Maine (Geological Sciences).

8:30AM – 8:55AM

Charles R. Fitts
University of Southern Maine, Portland, ME; cfitts@usm.maine.edu

RESPONSE OF GROUNDWATER/SURFACE WATER SYSTEMS TO PUMPING AND OTHER STRESSES

Groundwater and surface water systems are linked and dynamic. Heads, stages, velocities, and discharges all vary through time as natural and human-induced transients have their impacts. Using example mathematical models and case studies, we will explore how a variety of these systems

respond to common stresses such as pumping, leaching fields, drought, and storms, and why different settings respond in different ways and at different rates. We will examine confined, unconfined, and coastal aquifers, and impacts including drawdown, subsidence, and salt water intrusion.

9:00AM – 9:25AM

Martha G. Nielson, Daniel B. Locke
Maine Geological Survey, Augusta, ME; mnielsen@usgs.gov, daniel.b.locke@maine.gov

WATER AVAILABILITY ANALYSIS IN WATERSHEDS OF CONCERN IN MAINE

The Maine Geological Survey and U.S. Geological Survey have been collaborating since 2009 on a series of projects to better understand water availability in small Maine watersheds that have been identified by the State as being “of concern” because of large water demand (both natural and anthropogenic) in relation to their size. The study designs include conducting an in-depth analysis of water withdrawals in the studied watersheds, streamflow monitoring, and developing a watershed-wide groundwater flow model for each project. To date, one study has been completed–in two small watersheds in Freeport–and another is underway in the Branch Brook watershed in Kennebunk, Sanford, and Wells. The Freeport study found that site-specific geologic data and streamflow measurements were critical inputs for groundwater flow modeling to develop a realistic and quantifiable analysis of streamflow depletion. Recharge areas and discharge zones for the confined aquifer used for municipal supply also were identified. The model can evaluate interactions between the aquifer, streams, and pumping wells for current conditions and potential future drought and increased withdrawal scenarios. The second study, currently in progress, will assess the impact of all local groundwater withdrawals on streamflow in Branch Brook and the nearby Merriland River. Lessons learned during the Freeport study are being used to improve data collection and groundwater model development for the Branch Brook study.

9:30AM – 9:55AM

Robert G. Gerber, P.E. & C.G.
Ransom Consulting, Inc., Portland, ME; Robert.Gerber@RansomEnv.com

USING GROUNDWATER STORAGE TO PROVIDE A SUSTAINABLE IRRIGATION SUPPLY

This presentation explores the concept of using wells to capture groundwater at some distance from a stream and rely to a large extent on groundwater storage to produce irrigation water during the dry summer months. Many large-scale irrigation operations in Maine were historically supplied by direct withdrawal from great ponds and streams. The DEP’s In-Stream Flow Rule has forced growers to look for other ways of supplying needed summer water. For those operations on or near to extensive and thick sand and gravel aquifers, the aquifer itself provides a large amount of natural storage. This paper will show how one large irrigation requirement on the order of 3000 gallons per minute for a 6-week summer period has been modeled and managed. The groundwater withdrawal causes increasing streamflow reduction with time as the well begins to capture increasing portions of groundwater flow on its way to discharging to the stream. However a pumping history spanning over ten years shows that repeated seasonal withdrawals at large sustained rates have not affected the spring and

early summer groundwater levels in the aquifer nor the summer baseflow in the stream. The effects on the water levels in nearby wetlands have also been studied and show a small and brief impact during the time of pumping. The groundwater use at this site has been done in a sustainable manner and shows how proper planning, modeling, and monitoring can be used to provide an irrigation source that has very small impact on streamflows without the construction of large expensive holding ponds.

1:30PM – 1:55PM

Peter Garrett
Emery & Garrett Groundwater, Waterville, ME; Peter.Garrett@eggi.com

DISSOLVED FE/MN IN SAND AND GRAVEL AQUIFERS: OLD TOWN'S STORY AND THE BIG PICTURE

In 1960 Old Town Water District switched their source of supply from the Stillwater River to wells installed in a riverside aquifer. At first water quality was excellent. Within a few years, however, treatment was required to remove high concentrations of iron and manganese. Detailed hydrogeological investigation of the aquifer showed that the wells induced flow from the river to provide 90% of withdrawals. River water, however, had low concentrations of iron and manganese.

The Stillwater was used in the 1800s for the lumber trade. Logs floated downstream to mills located on the waterfalls. Waste wood was dumped into the river where it remains in a layer 4-12 feet thick overlying the aquifer through which river recharge flows to the wells. Geochemical investigations showed that river water passing through the wood waste becomes anoxic, which dissolves iron oxide coatings on aquifer sand grains.

Iron and manganese are common geochemical components of groundwater withdrawn from sand and gravel aquifers throughout New England. Many are likely to derive their high Fe/Mn concentrations via recharge through organic deposits, be they wood waste, wetland peat, leaf deposits on the bottom of lakes or abandoned meanders. Engineering remedies using hydrogeological principles may be available in particular situations.

2:00PM – 2:25PM

Dale F. Knapp
Stantec Consulting, Scarborough, ME; dale.knapp@stantec.com

IDENTIFYING AND ADDRESSING SUBSURFACE HYDROLOGIC CONNECTIONS IN ASSOCIATION WITH LARGE SCALE LINEAR PROJECTS

This presentation will review the methods developed to identify near-surface groundwater flows in sloping landscapes to determine their location and flow direction. Anthropogenic disturbances of these areas can alter water quality and natural groundwater hydrology. These resources are often not jurisdictional under State or Federal regulations through the Natural Resources Protection Act or the Clean Water Act; however, identifying and properly managing these resources can better protect down-gradient wetlands and waterbodies. As responsible scientists and environmental managers, we should identify these features so that appropriate site design can be completed by project engineers and reg-

ulatory agencies are able to make informed decisions. Many techniques can be incorporated into the project design to maintain groundwater flows below the soil surface. This presentation will include specific field examples, representative photos, and interactive discussion to demonstrate the management of these issues.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

John D. Echeverria
Vermont Law School, South Royalton, VT; JEcheverria@vermontlaw.edu

TIME FOR REFORM OF MAINE'S GROUNDWATER LAW?

The purpose of this talk is to examine whether Maine should consider reforming its traditional groundwater legal doctrine. The talk will conclude that, while there are significant outstanding questions about this issue that deserve better answers than are now available, there are substantial reasons to believe that Maine's groundwater law is ripe for reform. Maine, along with a very small handful of other states, including Texas, still subscribes to the so-called rule of capture, or absolute dominion, to define private rights to the use of water. Under this doctrine, a landowner may withdraw unlimited quantities of groundwater from beneath his or her property without regard to any potential adverse effects on the ability of other landowners (including individuals, private firms, and government entities) to access and make use of the groundwater beneath their lands. While the rule of capture was once the dominant legal doctrine governing rights in groundwater across the United States, almost every other state has abandoned this doctrine in favor of some form of reasonable use principles which limit each landowner's right to exploit groundwater to the extent its exercise harms other landowners' rights to use groundwater. In 1999, in the case of Maddocks v. Giles, the Maine Supreme Court declined to accept the argument that it should exercise its authority to modify Maine's rule of capture. One of the primary reasons the Court cited for its decision was that the parties in that case had not presented sufficient "evidence" that "the absolute dominion rule has not functioned well in Maine." An interesting question for the future is whether the state of knowledge about the operation of the rule of capture in Maine has evolved to the point that the issue of reforming Maine's groundwater law has now become ripe for consideration. If such evidence is not now presently available, is the reason that groundwater exploitation in Maine is currently imposing no material harm on other property owners or is further research required to identify and document harms that actually are occurring? In addition, in light of evolving economic conditions and the likelihood of climate change and potential consequent declines in water supplies in Maine, New England, the rest of the country, and/or indeed the world, do the prospects for increased competition over groundwater resources in Maine over the next century help make the legal case for groundwater law reform in Maine? All of these questions will be examined both in the context of Maine's groundwater legal regime and the current state and direction of groundwater law across the country.

3:30PM – 3:55PM

Robert G. Marvinney
Maine Geological Survey, Augusta, ME; Robert.G.Marvinney@maine.gov

WATER USE, WATER TRENDS, AND WATER POLICY IN MAINE

The characteristics of Maine's water resources and the impacts of water use have been widely debated in policy and scientific arenas for the past several decades. Early discussions of appropriate policies often ran up against a lack of information on available water resources and cumulative uses. To address this, the Legislature first directed the Maine Geological Survey to map significant sand and gravel aquifers systematically across the state, a task completed in the late 1990s. Mapped aquifers are protected from activities that may compromise their quality and are the water source for more than 70 community water systems, numerous agricultural irrigators and several water bottlers. Through discussions in the early 2000s, further protections were added to the State's water resources. First, users of large volumes of surface water or groundwater were required to report their use, allowing state agencies to compile reasonable estimates of water use on a watershed basis. Second, large-scale non-agricultural wells were subjected to rigorous permitting requirements aimed at limiting production to sustainable levels that minimize impacts on neighboring uses.

Through the Water Resources Planning Committee, established by the Legislature in 2007, the Maine Geological Survey first completed a statewide analysis of water supply and demand on a watershed basis, using information from the water use reporting program, and decades of stream flow and groundwater level monitoring by the U.S. Geological Survey. This analysis identified several watersheds with high cumulative water use that have been the subject of more detailed investigations. The intent of this effort is to identify potential conflicts before they become critical and work with stakeholders to resolve the issues.

As part of the effort, we have worked with stakeholders to support the USGS's groundwater level monitoring network and to augment it with long-term groundwater information from other sources. Review of these long-term records suggests that over the past several decades, groundwater levels have been increasing in almost all areas of the state.

Session B

Development and Use of Environmental Indicators in Environmental Decision-making

Many states and communities identify indicators of environmental health, but how do they use them? The talks in this session cover a broad range of indicators and their use in assessing environmental health and water quality. Topics include data acquisition, addressing emerging issues, use of structured decision making to address complex environmental decisions, website maps and tools, comparing European Union to U.S. approaches and policies for water quality, managing uncertainty, inter-lake variation in fish mercury, and novel optical techniques for assessing physical and biological processes in lakes.

SESSION CHAIR

Adria Elskus

U.S. Geological Survey and University of Maine, Orono, ME; aelskus@usgs.gov

Adria Elskus is a Research Fishery Toxicologist with the U.S. Geological Survey, Maine Field Office at the University of Maine. She is interested in the response of aquatic organisms to pollutants, including metals, fuel oil, organochlorines, and pesticides with a focus on physiological processes, reproduction, early life stage development, biochemical metabolism and the development of tolerance to chemicals. She is co-Chair of the Contaminants sub-committee of the Gulf of Maine Ecosystem Indicator Partnership, and current president of the North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry. Adria is a graduate of Mount Holyoke College (Biochemistry), the University of Rhode Island's Graduate School of Oceanography (Biological Oceanography), and the Boston University Marine Program (Biology).

Session B: Use of Environmental Indicators in Decision-making

8:30AM – 8:55AM

Curtis Bohlen
Casco Bay Estuary Partnership, Muskie School of Public Service, University of Southern Maine, Portland, ME; cbohlen@usm.maine.edu

CASCO BAY ESTUARY PARTNERSHIP ENVIRONMENTAL INDICATORS: BALANCING SCIENCE, TECHNOLOGY, POLICY AND FUNDING

Casco Bay Estuary Partnership (CBEP) produces a "State of the Bay" report every five years. The report is based on our monitoring plan, which highlights fourteen "environmental indicators", plus additional indicators that address emerging issues. While CBEP collects data on environmental condition and funds collection of more by our partners, most of our indicators depend to a greater or lesser extent on data collected by others. Such a strategy for indicator development reduces monitoring costs, but it poses other challenges. Data collection programs rise and fall depending on policy priorities, changes in personnel and vagaries of funding. Data collection methods change over time, or they may not directly address our needs. The timing of data collection, especially for infrequently collected (expensive) data, may not coincide with publication schedules. Every few years we dedicate significant staff time to locate, gather and analyze available data that bears on each indicator. We rely on in-house data analysis, mapping, and scientific skills to interpret and present the data in a form that is technically sound, yet accessible to the general public. As we consider ways to strengthen our monitoring program, we strive to strike an appropriate balance between technical rigor, ability to detect trends, provide solid technical and scientific support for policy making, and clearly articulate a narrative that describes environmental change in Casco Bay and its watershed.

9:00AM – 9:25AM

Christine Tilburg[1], Adria Elskus[2], Kathryn Parlee[3], Susan Russell-Robinson[4]
1 Gulf of Maine Council, EcoSystem Indicator Partnership; ctilburg@securespeed.us
2 US Geological Survey and University of Maine, Orono, ME; aelskus@usgs.gov
3 Environment Canada; kathryn.parlee@ec.gc.ca
4 Susan Russell-Robinson, USGS; srussell@usgs.gov

THE INTERSECTION BETWEEN INDICATORS AND THE GULF OF MAINE

Since 2004 a community of ecosystem indicator developers for the Gulf of Maine and its watershed has been at work to better understand the Canada-United States region-wide system for seven theme areas: coastal development, climate change, contaminants, eutrophication, aquatic habitats, fisheries, and aquaculture. The Gulf of Maine Council on the Marine Environment (GOMC) is actively identifying and delivering priority indicators through the EcoSystem Indicator Partnership (ESIP) which is comprised of more than 100 expert advisors from local, state and federal governments, academics and partners from non-government organizations. Using a consensus-based process, the group selected priority indicators for the theme areas using criteria based on data availability throughout the region and indicator sensitivity to stressors and changes in human activity. ESIP, with support from Environment Canada, Fisheries and Ocean Canada, U.S. Geological Survey, and U.S. Environmental Protection Agency, has conducted status and trends analyses for five sets of indicators: aquaculture,

aquatic habitats, climate change, contaminants, and eutrophication. The wealth of data collected is provided via focused Fact Sheets and the Indicator Reporting Tool (www2.gulfofmaine.org/esip/reporting) which enables local managers to make choices based upon sound science for their own system and the greater region.

1:30PM – 1:55PM

Susan Davies
Liberty Aquatics, Liberty, ME; spdbh@gwi.net

USE OF BIOLOGICAL ASSEMBLAGES AS INDICATORS OF ECOLOGICAL STATUS IN EUROPE AND THE UNITED STATES

Preservation of healthy aquatic assemblages is an objective of both the U.S Clean Water Act (CWA) and the Water Framework Directive (WFD) of the European Union. Many parallel challenges, and solutions, exist between the U.S. and the EU, towards use of biological indicators and criteria. But fundamental differences in governance structures have resulted in important differences between the two continents. The U.S CWA bestows most authority over water quality standards to the fifty States, resulting in unevenness of target biological goals as described in each states water quality standards. In contrast, in comparison to the U.S, the EU has established much greater “top-down” control and standardization over permissible biological quality goals, and allowed technical approaches. WFD Intercalibration establishes the comparability of bioassessment results of the 27 Member States, for phytoplankton, phytobenthos, invertebrates, and fish, in rivers, lakes and coastal waters. Comparison of sampled assemblages in the EU is against boundaries established from extant reference conditions, wherever available. If reference conditions have been lost then expectations for “good ecological status” are inferred from modeling, or via reference to historical records. A scientific peer review of the EU biological intercalibration exercise concluded in 2012. Most participating MSs received approval of their Intercalibration results from the European Commission.

2:00PM – 2:25PM

John Peckenham[1], Teresa Thornton[2]
1 Senator George Mitchell Center, University of Maine, Orono, ME; jpeck@maine.edu
2 Oxbridge Academy,Palm Beaches, FL; teresa.thornton@maine.edu

INDICATORS OF GROUNDWATER QUALITY: UNDERSTANDING TRENDS AND UNCERTAINTY

Groundwater is the source of drinking water for many. In rural communities it is likely the sole source. In general, individuals and rural communities have little knowledge of groundwater and the relationship between land uses and drinking water quality. We developed a groundwater testing and education project (GET WET!) to study emergent trends in water quality indicators. This project serves as a vehicle to establish a baseline for specific indicators, as well as, for education and community-based collaborative research. Participants across Maine and other states have tested drinking water from private wells to quantify: pH, conductivity, chloride, hardness, dissolved metals, and nitrate. The results from over 1400 unique records show emergent trends in these indicators. The spatial and temporal patterns have been used to inform communities about water quality. The presentation will include

groundwater quality results and trends observed in three Maine communities. The trends observed are complex (noisy) and utilization of these data must properly account for uncertainty. We will present methods being developed to manage intrinsic uncertainty in the interpretation of trends.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Linda C. Bacon[1], Aria Amirbahman[2], Stephen A. Norton[2], Barry F. Mower[1]
1 Bureau of Land and Water Quality, Maine DEP, Augusta, ME; Linda.C.Bacon@Maine.gov; Barry.F.Mower@Maine.gov
2 University of Maine, Orono, ME; aria@umit.maine.edu; norton@maine.edu

WHY THE DIFFERENCE? ENVIRONMENTAL FACTORS INFLUENCING FISH TISSUE MERCURY CONCENTRATIONS IN TEMPERATE LAKES

Increased loadings of mercury (Hg) from non-point sources have translated to Hg contamination in freshwater fish and resulted in consumption advisories across the U.S. and eastern Canadian provinces. Hg deposition from atmospheric sources is declining; however the legacy of 100 years of deposition across the landscape will persist for decades or longer. Hg concentrations in fish are not uniform in lakes across Maine but differ by species and water chemistry characteristics, particularly those which support bacterial methylation of Hg, which increases bioavailability and results in bioaccumulation to toxic levels higher in the food chain. Evidence suggests that trophic status is also a mediator in this process, thus samples of trophic drivers (i.e., nitrogen, phosphorus, iron, aluminum, dissolved organic carbon, and pH) were obtained along with fish tissue samples from White Perch (Morone americana) during 2010 and 2011 from approximately 75 Maine lakes. Results indicate a linear relationship between epilimnetic total mercury and methyl mercury (R2 of 0.54); further analysis indicates that dissolved organic carbon, elevation and alkalinity influence fish tissue Hg concentrations. These results provide insight into inter-lake variation that could be considered should future modifications be made to Maine's blanket fish consumption advisory.

3:30PM – 3:55PM

David Kalenak, Emmanuel Boss
School of Marine Sciences, University of Maine, Orono, ME; dskalena@syr.edu; emmanuel.boss@maine.edu

BIOINDICATORS AND OTHER LIMNOLOGICAL FEATURES IN THE PELAGIC REGION DERIVED FROM THE INHERENT OPTICAL PROPERTIES OF LAKE WATER

Increased loadings of mercury (Hg) from non-point sources have translated to Hg contamination in freshwater fish and resulted in consumption advisories across the U.S. and eastern Canadian provinces. Hg deposition from atmospheric sources is declining; however the legacy of 100 years of deposition across the landscape will persist for decades or longer. Hg concentrations in fish are not uniform in lakes across Maine but differ by species and water chemistry characteristics, particularly those which support bacterial methylation of Hg,

which increases bioavailability and results in bioaccumulation to toxic levels higher in the food chain. Evidence suggests that trophic status is also a mediator in this process, thus samples of trophic drivers (i.e., nitrogen, phosphorus, iron, aluminum, dissolved organic carbon, and pH) were obtained along with fish tissue samples from White Perch (Morone americana) during 2010 and 2011 from approximately 75 Maine lakes. Results indicate a linear relationship between epilimnetic total mercury and methyl mercury (R2 of 0.54); further analysis indicates that dissolved organic carbon, elevation and alkalinity influence fish tissue Hg concentrations. These results provide insight into inter-lake variation that could be considered should future modifications be made to Maine's blanket fish consumption advisory.

Session C

Stayin' Alive: How are Water and Environmental Education, Outreach, and Citizen Science Groups Succeeding in Times of Lean Budgets?

How can non-profit, government, and academic groups continue to deliver water science information to stakeholders, students, and lifelong learners in the face of dwindling funding and competing priorities? For this session, talks will outline best practices in engaging various publics in learning about and stewarding water resources, as well as examples of successful messaging strategies and delivery mechanisms.

SESSION CHAIR:

Gordon Russell

The Lower Penobscot Watershed Coalition

Gordon Russell retired from the U.S. Fish and Wildlife Service in 2006. He started with the FWS in 1978, and spent his career in New Hampshire and Maine, most recently as the supervisor of the Maine Field Office in Old Town. In addition to his managerial responsibilities, Gordon specialized in fisheries restoration and related issues at hydroelectric dams throughout the state. He was very involved in the negotiations that led to the agreements on dam removals and improved fish passage on the Penobscot River. Gordon continues to be involved in environmental issues on the Penobscot River, and currently chairs the Lower Penobscot Watershed Coalition. He is also an officer and board member with the Penobscot Valley Chapter of Maine Audubon, and volunteers with the Island Heritage Trust on Deer Isle.

8:30AM – 8:55AM

Robert Sanford, *Amy Webb (student); Jackie Allen (student); Amanda Martin (student); Margret Welch (student);*
University of Southern Maine, Portland, ME; RSanford@usm.maine.edu

UNIVERSITY OF SOUTHERN MAINE STORMWATER TRAIL

Rain that falls on the University of Southern Maine's (USM) Portland campus flows into the city's combined sewer overflow system, which empties into Casco Bay. Contaminants from Portland's impervious surfaces and sewer systems are introduced into the Casco Bay Estuary and watershed. The lack of awareness about these issues adversely impacts the community and surrounding areas. Our objective is to create awareness about the importance of integrated storm water management by modeling different ways to reduce the amount of storm water that enters the combined sewer overflow system. We propose to achieve this by constructing a storm water awareness trail on campus. A sign at the beginning of the trail will offer visitors a brief summary of the ways in which storm water impacts the health of the estuary, watershed, and community. Improvements will be made at several sites along the trail and signs will be used to explain various problems and solutions.

When implemented, this project will increase awareness about the issues surrounding storm water runoff. The trail will educate visitors about the impact that storm water has on the community and surrounding areas while showing individuals and businesses alike how they can apply green infrastructure to solve storm water management problems. By modeling storm water management techniques the USM Storm Water Trail will show the community how and why implementing those techniques can improve their lives, their community, and the health of the estuary and watershed.

9:00AM – 9:25AM

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

LESSONS IN COLLABORATION

In 2003, the DWP completed assessments of risks to public water sources in Maine, with a lot of help from public water systems. We were surprised to find that the biggest risk to safe and secure drinking water was future development near water sources. With hindsight, we shouldn't have been surprised. Most water systems had carefully chosen the cleanest, least threatened source they could afford to develop. What they hadn't been able to do, with a few notable exceptions, is control all the land that provided that source with clean water. As Maine's population dispersed from town centers to the country in the last thirty years, much of that development encroached on water supply areas. Neither water systems nor the Drinking Water Program have the tools or authority to manage land use and development, short of buying land. Once the Assessment results sank in, we increased our efforts to find allies who could help us and water systems ensure safe and secure drinking water for future generations. We looked for entities with common interests in clean water, and in land uses that help generate clean water. Developing alliances like this is a long process, and almost a decade later, we're still

working on it. Since source protection is a voluntary, incentive-based program, much of our state-level work is focused on finding partners with resources and common cause with water systems. The Agency used the National Source Water Collaborative as a tool to engage local affiliates.

9:30AM – 9:55AM

Barbara Arter
Senator George J. Mitchell Cente, Diadromous Species Restoration Research Network, University of Maine, Orono, ME; barbara.arter@umit.maine.edu

WHAT HAVE YOU DONE FOR ME LATELY? STRATEGIZING FOR ORGANIZATIONAL SUCCESS

The success and sustainability of any conservation organization lie not just in its ability to raise funds but also in its ability to stay relevant. The most successful organizations have several qualities in common such as coalition building, mission flexibility, community leadership skills, strong networking and communications, and the ability to provide the community with timely uncomplicated solutions. Although some traditional funding streams are no longer available, others have opened up, but only those organizations which are flexible and creative will be able to take advantage of these opportunities. Arter has over 20 years of experience in collaborative capacity building in conservation and habitat restoration, and in this presentation she will review lessons learned in information transfer, networking, coalition building, solution design, and creative funding from many of Maine's successful organizations.

Session D

The State of Maine's Water Resources

This session will include talks regarding current science and management issues in water resources, including but not limited to: protected systems; geochemistry, ecology, and biology of lakes, streams, and wetlands; watershed management.

SESSION CHAIR:

Peter Lowell
Lakes Environmental Association, Bridgton, ME; lakes@megalink.net

Peter Lowell has served as Executive Director of the Lakes Environmental Association since 1972. He has been a Code Enforcement Officer and has won DEP and EPA awards for lake protection. Overseeing a year-round staff of five and a seasonal staff of thirty, he has developed the state's Courtesy Boat Inspector Program, local parks, and numerous shoreland zoning upgrades. Peter is a graduate of Colby College.

8:30AM – 8:55AM

Thomas Parr
University of Maine, Maine's Sustainability Solutions Initiative,Orono, ME; thomas.parr@maine.edu

DISTINGUISHING URBAN BIOGEOCHEMISTRY: THE FINGERPRINTS OF URBANIZATION ON DISSOLVED ORGANIC MATTER QUALITY IN MAINE USA

Conversion of land cover to urban use is an accelerating global phenomenon. From 2000-2030 the increase in population will expand urban land cover by an estimated 1,527,000 km^2. This increasing urban footprint induces a suite of biogeochemical changes impacting stream ecosystem structure, function, and services.

To understand this impact, we examined the seasonal abundance and composition of dissolved organic matter (DOM), nutrients, and common cations in 116 small streams along a gradient of urbanization (0-60% watershed impervious cover, IC), in Maine, USA. Dissolved organic carbon concentration showed no clear relationship to watershed urbanization. UV/Vis and fluorescence metrics of organic matter composition indicate a shift from humic compounds to smaller more labile compounds with increasing urbanization. Fluorescence indices further show a shift in DOM source from allochthonous toward autochthonously derived compounds. Concentrations of base cations (Ca2+, Mg2+, K+, Na+) increased with increasing impervious cover. An Na:Cl ratio of 1 suggests that road salt applications may be responsible for mobilizing base cations into streams. There was a strong negative relationship between humic-like DOM components and Ca2+ (R^2=0.3-0.5, $p<0.01$) across streams. Incubations of DOM samples amended with CaCl2 showed strong flocculation of humic DOM.

9:00AM – 9:25AM

Bjorn Lake[1], Jim Hart[2], Jeff LaCasse[2]
1 Kleinschmidt Associates, Pittsfield, ME; Bjorn.Lake@KleinschmidtUSA.com
2 Kennebec Water District, Waterville, ME; Jim.Hart@roadrunner.com; jlacasse@kennebecwater.org

LAKE MANAGEMENT STRATEGIES FOR INTERNAL PHOSPHORUS REDUCTION IN CHINA LAKE

Excess phosphorus (P) in China Lake has been identified as the cause of water quality degradation over the past few decades. To address this problem, three in-lake restoration techniques were investigated: hypolimnetic withdrawal using an existing Kennebec Water District intake, chemical treatment using alum, and optimizing the lake drawdown to increase P export from China Lake. The proposed strategies for internal phosphorus reduction considered economic, regulatory, and environmental constraints. The results of this study show the benefit of both a new drawdown plan and alum treatment. However, hypolimnetic withdrawal is unlikely to significantly increase the export of P from China Lake compared to surficial withdrawals.

This study recommends changing the lake level order to commence the drawdown in October to an over winter lake level target of 191.6 feet National Geodetic Vertical Datum (NVGD) which is 1.5 feet lower than the existing lake level. This change in lake level order will increase the export of P by approximately 200 kg yr-1. This equates to around a fifth of the loading reduction goal for China Lake. In contrast, using the alum strategy, an internal P reduction of 900 to 1850 kg yr-1 for the whole lake is expected. Alternatively, treating just the East and North Basins will result in substantial cost savings ($1.8M) with similar effectiveness (545 to 1115 kg yr-1). The longevity of the alum treatment is expected to last at least 13 years based on previous case studies of other restorations and published sedimentation rates for China Lake.

Session D: The State of Maine's Water Resources

9:30AM – 9:55AM

Ethel Wilkerson[1], Austin Troy[2], Erin Gray[3]
1 Manomet Center for Conservation Sciences, Plymouth, MA; ewilkerson@manomet.org
2 Spatial Informatics Groups/University of Vermont; Burlington, VT; Austin.Troy@uvm.edu
3 World Resources Institute, Washington, DC; egray@wri.org

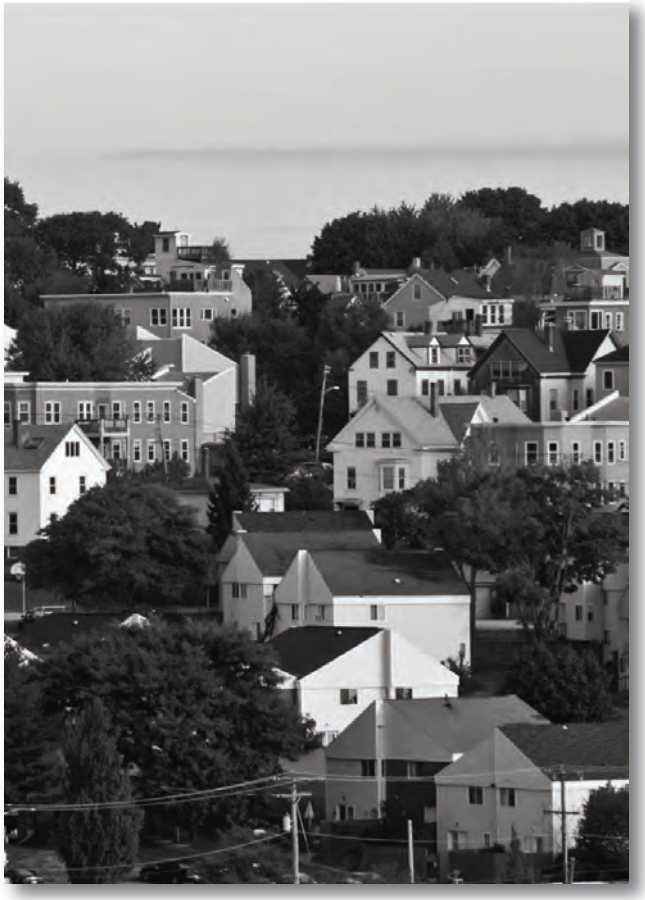
SHOW ME THE MONEY: QUANTIFYING NATURAL CAPITAL AND GREEN INFRASTRUCTURE IN MAINE

Clean water is not only important to fish and wildlife but critical to public health, local economies, and quality of life in Maine. However, despite the wide-ranging importance of clean water to society the protection of this natural resource is not typically viewed in an economic context. This presentation will summarize two recent studies that quantified the economic value of water resources in Maine as well as a case study of a project that uses a new funding strategy to finance watershed restoration. We will first present the findings of an economic valuation of natural processes for the state of Maine. This study estimated the economic value of ecosystem functions and benefits including regulating disturbance, atmospheric gases, and nutrients and soils, recreation value, and water supply and regulation. This study found that the economic value of the estimated 2.4 million acres of wetlands in Maine tops 5 billion dollars per year. We will also summarize a study that quantified costs of a drinking water supply in Sebago Lake by maintaining adequate forest cover to supply clean water and building a new and upgraded drinking water treatment plant. This 'green versus gray' infrastructure analysis found that protecting forests and incentivizing sustainable forest management had a 60% cost savings over building a new drinking water treatment plant. In addition, we will present a case study of the Clear Water Carbon Fund, a program that uses carbon offset market as a strategy fund watershed restoration in three watersheds in Maine.

Session E

What's a Town to do? Municipal Decision-making about Water Resources in an Environment of Constant Change

Not only does the policy environment change, but the physical environment changes as well. This session will focus on the moving target of municipal decision making in both realms: for example, changing stormwater regulations for cities and towns in Maine; as well as municipal strategies and needs for dealing with emerging topics like climate change adaptation.



SESSION CHAIR

Forrest Bell
FB Environmental Associates, Portland, ME; info@fbenvironmental.com

Forrest Bell is the founder and owner of FB Environmental Associates headquartered in Portland, ME. In this capacity, he oversees all operations at FB Environmental. Forrest is a regional leader in managing watershed planning, assessment, and restoration projects. Since 2001, he has directed more than 140 successful projects for clients including federal and state natural resource agencies, municipalities, and non-profit organizations. He enjoys every opportunity to work with New England communities to help improve and protect their valuable water resources.

8:30AM – 8:55AM

Robert G. Gerber, **Michael Abbot**
Ransom Consulting, Inc., Portland, ME; robert.gerber@ransomenv.com, michael.abbott@ransomenv.com

IMPROVED FLOOD INUNDATION MAPPING TECHNIQUES TO AID MUNICIPALITIES IN DEVELOPMENT PLANNING AND EMERGENCY PREPAREDNESS – CASE STUDIES IN KENNEBUNKPORT AND FALMOUTH, MAINE

Modern tools available for floodplain mapping have improved the efficiency and quality of flood inundation analysis. It is now possible for hydrologists to produce flood maps that are a significant

improvement over the FEMA Flood Insurance Rate Maps (FIRMs) prepared in the late 1980s and early 1990s. Municipalities can use these new maps to develop detailed land use plans and to prepare for the impacts of flooding on roadways and low lying residential and commercial properties. Ransom Consulting, Inc. of Portland, Maine was contracted by two municipalities – Kennebunkport and Falmouth, Maine – to remap flood inundation limits for several inland stream networks within the boundaries of those towns. We used ArcGIS 3D and Spatial Analyst to process Digital Elevation Models (DEMs) from new high resolution LIDAR topographic data, develop streamflow networks and delineate NRCS hydrologic soil groups. Watersheds were subdivided according to control points established by the modelers at stream junctions and road crossings that defined hydrologic reaches. Hydrographs were then generated for each subwatershed using traditional hydrologic methods for 100-year Type 3 storms produced by the ACIS Northeast Regional Climate Center. The stream model HEC-RAS provided stream routing and backwater calculations for the flood analysis. The final product of this effort was a set of detailed flood inundation polygons for each stream network, including flooding elevation and velocity data. Our presentation will highlight the benefits and limitations of the methods we used and provide insight for towns and consultants to consider in improving their floodplain maps.

9:00AM – 9:25AM

Jennifer Jespersen, Tricia Rouleau
FB Environmental Associates, Portland, ME; jenniferj@fbenvironmental.com, triciar@fbenvironmental.com

UTILIZING BUILDOUT ANALYSES TO GUIDE MUNICIPAL PLANNING AND PROTECT WATER RESOURCES

Municipalities are often faced with finding a balance between the economy and the environment. On one hand, new growth leads to an increased tax base and new jobs; yet with growth, comes decisions about how to protect the natural resources that often sustain these same communities. A buildout analysis provides information about how much land is currently available for development, how much new development can theoretically occur based on current growth rates and zoning standards, and how a town's appearance could potentially change over time. FB Environmental has worked with watershed groups and municipalities in both Maine and New Hampshire to estimate impacts that new development may have on local water resources using GIS-based buildout analyses. These analyses, combined with a review of municipal ordinances, have provided municipal officials with information about how their current regulations and standards will shape future development within their towns. Map outputs from a buildout analysis provide graphic and eye-opening presentations over 5-10 year increments. Nutrient loading estimates are an added model feature to determine what environmental changes may be expected for lakes and streams based on current zoning standards. By looking to the future, and predicting the impact that new development will have on water resources, municipalities can make more informed decisions regarding where and how new development should occur, improve existing standards, or develop new standards to be more protective of water resources. These critical planning tools can help towns and cities find the right balance between growth and the environment.

Session E: What's a Town to Do?

9:30AM – 9:55AM

Fred Dillon
Stormwater Program Coordinator, South Portland, ME; fdillon@southportland.org

A SAMPLING OF APPROACHES FOR MAKING APPRECIABLE IMPROVEMENTS TO LOCAL WATER RESOURCES

Maine currently has 28 municipalities that are identified by the DEP as "small MS4s" (municipal separate storm sewer systems) and are therefore required to implement management programs to mitigate the adverse effects of polluted stormwater runoff into local receiving waters. DEP has also designated 31 streams in the state as "urban impaired" because surrounding development has degraded water quality in violation of environmental standards. Consequently, the communities through which these streams flow must develop plans to restore aquatic health.

Complying with stormwater management and watershed restoration regulations can be expensive. The communities affected by these requirements can benefit considerably from strategically planning for the protection and restoration of local water resources – particularly given municipal budget constraints and a continuously evolving regulatory environment. This presentation will examine a number of Maine's MS4 and urban impaired stream communities to provide an overview of the various approaches being used to address local water quality concerns.

Session F

Fisheries Habitat and Passages

Stream and lake connectivity and habitat quality are ongoing issues of concern for fisheries scientists and resource managers. In this session, we will report on new research and management strategies related to culverts and dams, passage improvement, and fisheries and foodweb studies in systems ranging from impassible to unimpaired to restored.

SESSION CHAIR

Tara Trinko Lake

Fisheries Biologist, NOAA Fisheries Service, Orono, ME; tara.trinko@noaa.gov

Tara Trinko Lake is a fisheries biologist with NOAA Fisheries in Orono, ME. She received a BS (Zoology) from the University of Wisconsin-Madison and MS (Ecology and Environmental Sciences) from the University of Maine. Her work focuses on management of endangered and threatened species such as salmon, sturgeon, and river herring along the Atlantic coast.

8:30AM – 8:55AM

John Perry

Maine Department of Transportation, Augusta, ME; john.perry@maine.gov

STREAM SIMULATION IN THE DOT WORLD: THE CHALLENGES, THE CONSTRAINTS, AND THE COSTS

At Maine Department of Transportation (DOT) the push towards larger steam crossings is ever growing, enforced largely via recent revisions to federal permitting and Endangered Species Act interpretations. This has created significant challenges to the Department including scour and other design

issues, logistics and site constraints, rights-of-way obstacles, and impacts to the traveling public–issues not typically encountered at other sites in Maine where stream simulation has been ongoing. Additionally, the costs incurred by MaineDOT with building larger crossings are not comparable to costs incurred by these other entities. With this presentation MaineDOT hopes to add perspective by relating some of the constraints a state transportation agency faces in fitting 1.2 Bank Full Width (BFW) crossings into a large transportation capital investment program.

However, MaineDOT has started building larger crossings designed using the hydraulic-based method similar to that developed by the Federal Highway Administration HEC-26. These crossings are much larger than MaineDOT has historically built and we are in the process of collecting preliminary data on fish and aquatic organism passage, as well as other physical characteristics within the crossings. These crossings are seen as a compromise to providing passage over a much wider range of flows than traditional DOT structures, yet at a cost lower than 1.2 BFW open bottom crossings. An overview and preliminary findings of several of these structures will be discussed.

9:00AM – 9:25AM

Zachary Hope, Theodore Willis, Karen Wilson
Department of Environmental Science, University of Southern Maine; Portland, ME; zachary.hope@maine.edu

CHALLENGES FOR RIVER HERRING UPSTREAM MIGRATION IN A POST-INDUSTRIAL LANDSCAPE

In New England, river herring (*Alosa pseudoharengus* and *A. aestivalis*) ascend falls and other natural and altered features that appear to exceed their measured swimming ability. Upstream fish passage at a site is dependent upon factors including swimming characteristics of the fish species and seasonal hydraulic conditions. Engineered fish passage designs tend to be conservative in terms of maximum flow speeds, heights of hydraulic drops, and holding area turbulence, but for the fish more subtle or basic hydrodynamic and hydrologic characteristics may be key to ascending an obstacle. We asked whether detailed survey work and GIS computer modeling could predict what pathway a river herring might take over an obstruction. In 2012 we surveyed several natural and anthropogenic obstructions with a robotic total station, including Sheepscot Falls, Mill Stream in Dresden and Presumpscot Falls, to develop detailed maps of geology and hydrology. ArcGIS was used to build surfaces and network path analysis was employed to determine possible passage routes based on slope and gradient. HEC-RAS was used to model flow conditions through these pathways. HEC-RAS results for natural barriers were compared to those for nearby designed fish passage facilities. River herring swimming ability exceeds the basic fish passage design criteria, but conditions at older fish passage facilities may be more demanding than what is found at falls because of low heterogeneity in the structures.

Session F: Fisheries Habitat and Passage

9:30AM – 9:55AM

***Slade Moore*[1], *Alex Abbott*[2]**
1 Maine Coastal Program/Gulf of Maine Council on the Marine Environment, Augusta, ME; smoore@maine.gov
2 US Fish and Wildlife Service, Gulf of Maine Coastal Program, Falmouth, ME; alexoabbott@hotmail.com

THE MAINE STREAM HABITAT VIEWER: AN ONLINE TOOL FOR RESTORATION AND CONSERVATION

The Stream Habitat Viewer was created by the Maine Stream Connectivity Work Group to provide a starting point for towns, private landowners, and others to integrate habitat considerations for stream-dependent species into their planning. The Viewer accomplishes that by displaying habitats for species like Atlantic salmon, wild eastern brook trout, sea-run rainbow smelt, and alewife, which have featured importantly in Maine's economy, ecology, and way of life. The Viewer also displays locations of dams and public road crossings, which can act as barriers to the movements of fish and wildlife and also degrade habitat. For the highest priority habitats, technical assistance and limited funding is available to offset the cost of replacing barriers like aging road crossings and re-establishing fish passage at dams. The Viewer uses that information to bring people together in ways that restore and conserve Maine's natural heritage while looking for opportunities to ease the financial burdens of road and dam owners.

Session G

Intensity, Frequency, and Variability: How is Maine's Changing Climate Affecting Water Resources?

This session will focus on the effects of climate change on Maine and regional surface waters. Topics in this session include: the effects of warming on lake stratification, eutrophication, algae blooms, and fish die-offs; the effects of extreme climate events on episodic lake acidification and increasing concentrations of dissolved organic carbon; temporal trends in groundwater levels; and long-term trends in annual precipitation, runoff, and evapotranspiration.

SESSION CHAIR

Tom Huntington

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

Dr. Thomas (Tom) Huntington received his Ph.D. at the University of Kentucky in 1984. Earlier in his career he worked at Dartmouth College and the University of Pennsylvania. He is currently a research hydrologist with the U.S. Geological Survey at the Maine Water Office of the New England Water Science Center. He has worked with the USGS since 1990. In recent years his research has focused on carbon cycling at large river basin scales and on hydrologic responses to climate change. Together with colleagues he has studied historical and future projected hydrologic responses to climate change in the northeastern United States with emphasis on potential effects on forest and aquatic ecosystems. His earlier research focused on studying biogeochemical processes in small watersheds to understand the effects of forest management practices, land use change, and acidic deposition on carbon and nutrient budgets. He has authored or co-authored >45 papers in peer-reviewed scientific journals and a similar number in various USGS peer-reviewed scientific report series.

Session G: Maine's Changing Climate

1:30PM – 1:55PM

David Courtemanch[1], Linda Bacon[2] and Scott Williams[3]
1 The Nature Conservancy, Brunswick, ME; david.courtemanch@tnc.org
2 Maine DEP, Augusta, ME; linda.bacon@maine.gov
3 Maine Volunteer Lake Monitoring Program, Auburn, ME; scott.williams@mainevlmp.org

THE CHANGING PHENOLOGY OF LAKE STRATIFICATION: EUTROPHICATION, ALGAE BLOOMS, AND FISH DIE-OFFS

Lake stratification develops in the spring as surface water warms from increasing solar radiation and warming air temperatures relative to lake area and lake volume, persisting into the fall until declining surface temperatures equilibrate with subsurface temperatures. Therefore, the onset of stratification can be expected to occur earlier and last longer based on projections for warmer atmospheric temperatures, reduced snow cover, and a shorter duration and depth of ice cover. Early onset can increase the duration of stratification, thus increasing the extent and period of anoxia in subsurface waters, creating greater dissolution of iron-bound phosphate in sediments. Rapid warming can result in a shallower epilimnion with steeper thermocline gradient, decreasing the epilimnion to hypolimnion volume ratio thereby reducing the dilution capacity of diffused phosphorus released from the sediments into the phototrophic zone. In 2012, anomalous early spring weather provided a glimpse of how a warming Maine climate may affect lake water quality in the future. Two aberrant algae bloom events were documented on Georges Pond and Abrams Pond in Hancock County where such altered stratification characteristics were observed. Additionally, Lake Auburn in Androscoggin County experienced a die-off of lake trout when the entire thermocline and hypolimnion became anoxic at least a month earlier in the year, eliminating all coldwater refugia for this species.

2:00PM – 2:25PM

Kristin Strock[1], Jasmine Saros[2], Sarah Nelson[3]
1 UMaine School of Biology and Ecology, Climate Change Institute, Orono, ME; Kristin.Ditzler@umit.maine.edu
2 Climate Change Institute, Orono, ME; jasmine.saros@maine.edu
3 Senator George J. Mitchell Center, Orono, ME; sarah.nelson@umit.maine.edu

THE EFFECTS OF EXTREME CLIMATE EVENTS ON LAKEWATER CHEMISTRY: IMPLICATIONS FOR "BROWNIFICATION" IN MAINE LAKES

In the Northeast U.S., there has been a widespread decline in sulfur emissions and deposition as a result of Clean Air Act Amendments. Over this same time period, extreme precipitation events have increased in frequency in the Northeast by over 61 percent. Disentangling climate and anthropogenic drivers of change in the influx of watershed subsidies to surface waters is an ongoing concern that has important implications for lake management and environmental policy. Most notably, increased dissolved organic carbon (DOC) concentration, or "brownification," has been observed in many regions of the Northern Hemisphere. These changes have been attributed to both declining sulfur deposition and climate-mediated drivers. Long term monitoring of Maine lakes documents variable trends in DOC over

the past three decades. To explore the effects of extreme climate events on DOC trends, we paired weather data collected from watershed-scale climate models with surface water geochemistry collected by US-EPA monitoring programs over the past three decades. Multivariate statistical analyses described episodic changes in geochemistry and identified subsets of lakes that respond to specific events: episodic acidification during drought; increased input of DOC during wet years; and lakes that appear unaffected by climate extremes. Clarifying the response of DOC, a pivotal regulator of aquatic ecosystems, to extreme weather events across gradients of landscape position and atmospheric deposition, is increasingly important for policy and management decisions as the frequency of extreme events continues to increase in this region.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Robert Dudley, Glenn Hodgkins
US Geological Survey New England Water Science Center, Augusta, ME; rwdudley@usgs.gov, gahodgki@usgs.gov

HISTORICAL GROUNDWATER TRENDS IN NORTHERN NEW ENGLAND AND RELATIONS WITH STREAMFLOW AND CLIMATIC VARIABLES

Water-level trends spanning 20, 30, 40, and 50 years were tested using month-end groundwater levels in 26, 12, 10, and 3 wells in northern New England (Maine, New Hampshire, and Vermont), respectively. Groundwater levels for 77 wells were used in interannual correlations with meteorological and hydrologic variables related to groundwater. Trends in the contemporary groundwater record (20 and 30 years) indicate increases in groundwater levels in all months for most wells throughout northern New England. The highest percentage of increasing 20-year trends were in February through March, May through August and October through November. Forty-year trend results were mixed, while 50-year trends indicated increasing groundwater levels. While most monthly groundwater levels correlate strongly with the previous month's level, monthly levels also correlate strongly with monthly streamflows in the same month, and correlations of levels with monthly precipitation are less frequent and weaker than those with streamflow. Groundwater levels in May through August correlate strongly with annual (water year) streamflow. Correlations of groundwater levels with streamflow data and the relative richness of 50-100 year historical streamflow data suggest useful proxies for quantifying historical groundwater levels in light of the relatively short and fragmented groundwater data records presently available.

Session G: Maine's Changing Climate

3:30PM – 3:55PM

Thomas Huntington[1], Michael Billmire[2]
1 US Geological Survey, Augusta, ME; thunting@usgs.gov
2 Michigan Tech Research Institute, Ann Arbor, MI; mgbillmi@mtu.edu

TRENDS IN RUNOFF, PRECIPITATION, AND EVAPOTRANSPIRATION FOR RIVER BASINS DRAINING TO THE GULF OF MAINE IN THE UNITED STATES

Climate warming is projected to result in increases in total annual precipitation in the northeastern United States. However, increases in precipitation will not necessarily result in increases in streamflow, because increasing evapotranspiration could counteract the effect of increasing precipitation. This study was conducted to examine these competing trends in the historical record for major rivers draining to the Gulf of Maine. Twenty two basins having > 70 years of measured runoff were included in the analysis. Annual average air temperature increased over the period of runoff record for ninteen out of twenty-two basins. Precipitation increased in all basins, with increases ranging between 8 and 25 percent. Runoff increased in all basins, with increases ranging between 9 and 34 percent. Evapotranspiration (calculated as precipitation minus runoff) increased in seventeen basins and decreased in five basins. Annual average temperature and annual average precipitation were positively correlated for most of the largest basins. Annual average evapotranspiration was weakly positively correlated with annual average temperature. The lack of a more consistent and steeper increase in ET over time was unexpected but could be explained by various factors including changes in wind speed, cloudiness, and (or) patterns of forest growth. For the period 1926-2010, for the nine largest non-nested river basins precipitation increased by about 12 percent (1.5 mm yr-2) while runoff increased by about 24 percent (1.7 mm yr-2).

Session H

Nonpoint Source and Emerging Contaminants: What is it, where's it coming from and how do we clean it up?

Not only does the policy environment change, but the physical environment changes as well. This session will focus on the moving target of municipal decision making in both realms: for example, changing stormwater regulations for cities and towns in Maine; as well as municipal strategies and needs for dealing with emerging topics like climate change adaptation.

SESSION CHAIR

LaMarr Clannon

Maine NEMO, Augusta, ME; lcannon@maine.rr.com

LaMarr Clannon was born and raised in Alaska, where people often feel that space and natural resources are limitless. She has a background in Chemistry and Environmental Engineering, and has lived in Maine for the last 11 years. LaMarr has worked on water quality issues her entire career, with Soil and Water Conservation Districts, the Maine Department of Environmental Protection, and as Coordinator of the Maine NEMO (Nonpoint Education for Municipal Officials) program, sharing her passion for clean water with land use decision makers. Her big motivator is Lily, her five year old daughter, who wants to be able to eat the fish she catches in Maine. LaMarr also provides information on Low Impact Development and training for the development community, and facilitates between the scientific community and municipalities addressing water quality issues.

1:30PM – 1:55PM

Keri Kaczor

University of Maine Cooperative Extension/Maine Sea Grant, Orono, ME; keri.kaczor@maine.edu

STRATEGIES TO IDENTIFY, ELIMINATE AND PREVENT SOURCES OF BACTERIAL POLLUTION IMPACTING COASTAL WATER QUALITY

Tourism is an integral component of the Maine economy and spending related to beaches is estimated to be over 500 million annually (Levert, 2009). Yet elevated fecal bacteria levels impair coastal waters,

leading to health advisories on valued beaches. Rivers, streams and storm drains often transport pollutants from upland areas to the surf zone. Identification and remediation of harmful bacteria sources requires enhanced monitoring and in-depth studies beyond the immediate shoreline area.

Maine Healthy Beaches brings together partners at all levels with a focus on sharing resources and solving problems. Strategies used to address bacterial contamination include utilizing the pollution source tracking toolbox approach, studying local circulation patterns to determine the fate and transport of contaminants, utilizing Geographical Information Systems to identify sub-watersheds likely impacted by human sources, sanitary surveys and local prevention efforts. Partnering on applied research and source-tracking studies, transferring data to usable information to act upon, providing training and technical support, has built local capacity to address pollution issues.

2:00PM – 2:25PM

Joshua Katz
Maine Department of Transportation, Augusta, ME; joshua.katz@maine.gov

ROAD SALT – AN OVERIEW OF HISTORY, PRACTICE, AND ENVIRONMENTAL IMPACTS

The chemistry of salt and the place of salt in human history are outlined. Past and present practice of salt for winter road safety, including the search for alternatives, is described. The fate of salt in the environment, with an emphasis on groundwater is discussed. Research on environmental impacts of road salt is summarized. Challenges of remediation of salt impacted wells are explored. Possible paths forward that combine safety with less salt use are explored.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Laurel A. Schaider
Silent Spring Institute, Newton, MA; schaider@silentspring.org

PHARMACEUTICALS AND OTHER EMERGING CONTAMINANTS IN PUBLIC AND PRIVATE DRINKING WATER WELLS ON CAPE COD, MASSACHUSETTS

The presence of pharmaceuticals, endocrine disruptors, consumer product chemicals and other organic wastewater compounds (OWCs) in groundwater, surface water and drinking water raise concerns about human and ecological health. Unconfined sand and gravel aquifers are especially vulnerable to OWC contamination, especially in areas where septic systems are prevalent. Silent Spring Institute has studied sources and movement of OWCs in groundwater and ponds on Cape Cod, Massachusetts, which has a sole source aquifer and where 85% of residents rely on onsite wastewater treatment. This presentation will summarize results from recent Silent Spring Institute studies of OWCs in 20 public and 20 private drinking water wells on Cape Cod. The most frequently detected chemicals include sulfamethoxazole (antibiotic), carbamazepine (anticonvulsant), acesulfame (artificial sweetener), and several perfluorinated chemicals (from nonstick and stain resistant products). The

maximum concentrations of sulfamethoxazole and phenytoin (anticonvulsant) matched or exceeded the highest levels in other studies of U.S. drinking water. Wells with higher levels of nitrate and boron, which are both chemical markers of wastewater, and public wells with more residential development in their recharge areas tended to have more frequent detections and higher concentrations of OWCs.

3:30PM - 3:55PM

Lucner Charlestra

U.S. Environmental Protection Agency, Atlantic Ecology Division, Narragansett, RI; charlestra.lucner@epamail.epa.gov

PESTICIDES IN MAINE SURFACE WATERS: SOURCES, POTENTIAL ENVIRONMENTAL AND HUMAN IMPACTS, AND MONITORING APPROACHES

Pesticides are defined as chemicals used by humans to destroy or control pests. Most pesticides are complex organic molecules either natural or man-made, but the latter greatly predominate. A variety of pesticides are used in agricultural fields in the Pleasant and Narraguagus River watersheds (Maine, USA) to increase crop production by controlling weeds, insects and diseases. However, these pesticides may enter surface waters through aerial drifts, overland flow and contaminated ground water. The Pleasant and Narraguagus Rivers are within the geographic range of the Gulf of Maine Distinct Population Segment (GOMDPS) of Atlantic Salmon (Salmo salar) and contain critical spawning and rearing habitat. Thus protecting water quality and habitat in these Atlantic salmon rivers has been a priority in Maine for a long time. This presentation will provide an overview of the source and behavior (i.e., fate and transport) of the pesticides used in these agricultural watersheds and their potential impact on human and ecological health. I will also discuss the results of field surveys comparing current in-stream pesticide monitoring techniques (i.e., traditional grab sampling) with a novel passive sampling approach, using the Polar Organic Chemical Integrative Sampler (POCIS). This has important implication for the estimation of time-weighted average concentration of contaminants in water, as a fundamental part of the ecological risk assessment process.

Session I

Restoration Potential and Barriers in Maine Rivers: Knowledge to Action

Many factors contribute to the success (or need for) river restoration. In this session, we explore multi-disciplinary approaches to understanding the societal, economic and ecological potential for river restoration using river herring as the link between habitats and economies, with the intent of providing guidance and ideas to interested communities.

SESSION CHAIRS

Karen Wilson
University of Southern Maine, Portland, ME; kwilson@usm.maine.edu

Karen A. Wilson, Ph.D. is an assistant research professor at the University of Southern Maine and an aquatic ecologist trained at the University of Wisconsin-Madison. She is actively engaged in using restoration to better understand community and ecosystem ecology and vice versa. In recent years, she has worked on food web dynamics associated with dam removals and studied the ecological role of river herring in freshwater and nearshore marine systems. Karen is the Research Coordinator for the Diadromous Species Restoration Research Network, an NSF funded project that strives to facilitate collaboration and science focused on the restoration of diadromous fishes.

1:30PM – 1:55PM

Karen Wilson
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WHEN PERCEPTIONS BECOME REALITY: RIVER RESTORATION POTENTIAL IN MAINE AND THE ROLE OF LEGACIES

Until the 1970s, the Kennebec and Androscoggin rivers followed similar industrial trajectories, with the rivers valued for little more than open sewers for effluents until the decline in the economic importance

of these traditional river corridor industries. From the 1970s onward, the social, economic and ecological state of these rivers diverged, with people along the Kennebec embracing its potential as an ecological and recreational amenity, while many along the Androscoggin continued to see the system as degraded and undesirable. In this project we have used these perceived differences to better understand the social, economic, ecological, and institutional drivers of resilience of river systems – either in the positive sense that allows recovery of these systems to an ecologically functional and economically beneficial state, or in the negative sense that preconceptions and assumptions lead to feedbacks which prevent recovery. Our group has used a wide range of ecological and fisheries investigations to characterize the ecological state of these rivers, inventory formal and informal groups associated with the rivers and conduct stated preference stakeholder surveys to help explain the ability or failure to achieve restoration. To integrate these multi-disciplinary approaches we have been modeling potential restoration scenarios using river herring as the link between habitats and economies, with the intent of providing guidance and ideas to interested communities.

2:00PM – 2:25PM

Beverly Johnson
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THE INFLUENCE OF ALEWIVES ON THE BIOGEOCHEMICAL CYCLING OF NITROGEN IN NEQUASSET LAKE, WOOLWICH MAINE

The anadromous alewife (Alosa pseudoharengus) contributes marine-derived nutrients (MDN) in the form of nitrogen to freshwater lakes via excretion and mortality as they migrate upstream during the spawning season. The focus of this study is to determine the degree to which MDN are imported into Nequasset Lake, utilized by plankton, and incorporated into the sedimentary record. Alewife fish counts were performed and water was collected by the Kennebec Estuary Land Trust (KELT) throughout the 2012 spawning season. The waters were analyzed for nutrient concentrations (TDN, NO3-, and NH4+, PO43-, and dissolved silica). Additionally, samples of water, plankton and seston from the surface and the bottom of Nequasset lake and discharge and water samples from the four major inlet streams were collected on a monthly basis from April through October, 2012.

During peak alewife migration, TDN concentrations at the top of the fish ladder were correlated to fish count, indicating that the fish were importing nitrogen into the lake. The δ15NNO3- in the middle of the lake and the surface plankton were enriched in 15N during the spawning period relative to the other time periods analyzed. Our preliminary interpretations suggest that the assimilation of MDN in the middle of the lake may be occurring, but continued analysis of samples currently in hand is necessary to determine the relative importance of other sources of isotopically enriched nitrogen (via streams) into the lake.

2:30PM – 3:00PM

BREAK — AUDITORIUM

Session I: Maine Rivers - Knowledge to Action

3:00PM – 3:25PM

Guillermo Herrera
Bowdoin College, Brunswick, ME; gherrera@bowdoin.edu

A BIOECONOMIC ANALYSIS OF THE BENEFITS OF RIVER RESTORATION TO COASTAL FISHERIES

River systems in Maine (USA) once supported abundant populations of anadromous river herring, but these populations have been reduced by industrial pollution as well as dams and other obstructions of fish passage. Some of these river systems have experienced recovery, and policy initiatives (such as dam removal or constraints on emissions) have the potential to restore river herring populations in the direction of their historical levels. We seek to characterize and quantify the potential downstream benefits of such restoration actions. While river herring might have intrinsic, or existence, value, and may also augment populations of game fish (e.g., striped bass and bluefish), we focus here on the indirect value of river herring in the nearshore marine environment, where they serve as a forage fish for potentially valuable (if severely depleted) commercial groundfish populations. We employ a bioenergetic, or food-web, model to project the potential benefits of increase river herring populations in a system where the predators (groundfish) have an array of prey items to choose from. The realized benefits of restored river herring populations will depend critically on the management regime prevailing in the groundfish resource; in particular we examine the potential benefits of managing the nearshore resource as a distinct substock of the larger groundfish population. Given the prospective carrying capacity of a restored habitat for river herring, we can estimate an upper bound for the resulting economic benefits.

3:30PM - 3:55PM

Eileen Johnson
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TRANSLATING KNOWLEDGE TO ACTION: USING A BOUNDARY APPROACH TO CONNECT RESEARCHERS TO STAKEHOLDERS

A dimension of this river restoration research project is the identification and incorporation of mechanisms to translate research results into meaningful action. The research team has worked closely with stakeholders throughout the process of framing and carrying out research. Initial research included identifying effective ways in which stakeholders receive information from researchers and stakeholders' preferences for engagement throughout the research process. This talk provides an overview of the results of this initial research and a discussion of how this work is being framed within the emerging field of boundary management. Boundary management describes approaches for better linking science to action through managing the science – policy and researchers – stakeholders interface (Clark et al., 2011). Boundary management includes use of the models as a boundary object (Star, 2010), the role of boundary workers in facilitating research (Clark et al., 2011), and the institutionalization of these relationships through the formation of a boundary organization (Guston, 2001). This talk

will outline how the research is contributing to the field of boundary management within the context of river restoration through examining the role of each of these approaches, the role of the modeling scenarios as a boundary object, the role of students as boundary workers or agents in achieving identified shorter term research and action goals, and the potential for establishing a river institute as a boundary organization.

Poster Exhibition

High School, Undergraduate and Graduate Juried Poster Exhibition

The Senator George J. Mitchell Center 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

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

John Peckenham is the Director of the Maine Water Institute and the Assistant Director and Senior Research Scientist at the Senator George J. Mitchell Center.

HIGH SCHOOL POSTER ABSTRACT

Kriti Lall
Castilleja School, Palo Alto, CA

GENE EXPRESSION ANALYSIS OF THE PROPOSED ARSENITE OXIDASE IN BSL-9: A BACTERIAL SOLUTION TO THE GLOBAL ARSENIC WATER PROBLEM

Arsenicosis is a widespread disease caused by drinking water with high arsenic concentrations. Current methods for purifying this water are costly and inefficient; arsenite-oxidizing bacteria, however, offer a solution. Arsenite is carcinogenic and found widespread in water, whereas arsenate is less toxic and easily removed from water. By converting arsenite to arsenate, arsenite-oxidizing bacteria, such as the non-pathogenic, anaerobic strain BSL-9, offer a practical, inexpensive approach to eliminate arsenic from water. The gene that is thought to be behind BSL-9's arsenic metabolism is arxA. The purpose of this study is to investigate this fact: if arxA is indeed an arsenite oxidase in BSL-9, it could lend valuable information in water bioremediation. Three growth curves were conducted with BSL-9 to determine its proper-

ties, and cell pellets collected from the last growth curve were used in gene expression analysis, which was conducted using RT q-PCR. After gene expression was determined, the trend observed was that after the cultures were spiked with arsenite, the gene expression of arxA increased. More trials need to be conducted to verify this trend, but according to the data, arxA shows high probability of being the arsenite oxidase gene in the bacteria strain BSL-9. As a result of this research, BSL-9 can be used in a bioreactor that would remove toxic arsenite from water, a more effective and inexpensive approach than current methods for purifying water with arsenic.

UNDERGRADUATE POSTER ABSTRACTS

Emily Arsenault, Marianne Ferguson, Colin Cummings, Monica Davis, Drew Mealor, Corey Reichler, Russell Cole, Cathy Bevier
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INFLUENCE OF SHORELINE DEVELOPMENT ON RIPARIAN HABITATS IN THE BELGRADE LAKES

Residential development of shore land areas can negatively affect land composition, habitat, structure, and biological diversity. The objective of our research was to examine the influence of different degrees of shoreline development on the riparian habitats of Great Pond, East Pond and North Pond. Undeveloped reference sites, buffered developed sites, and unbuffered developed sites were identified along the shoreline. Surveys were conducted to compare shoreline tree cover and composition, the degree of disturbance of natural vegetation, shoreline stability and erosion, buffer width, and tree size. Reference sites had greater tree cover and more saplings than buffered and unbuffered sites. We found that reference sites have a slightly lower stability than buffered sites, because the shoreline of buffered properties is maintained. Disturbance of tree and shrub cover and the shoreline was lowest at reference sites and highest at unbuffered sites. Mean buffer width was significantly greater at buffered and reference sites compared to unbuffered sites. The results of our research allows us to report to landowners that low impact development can result in minimal changes in riparian habitats compared to undisturbed reference sites, which are needed to maintain healthy lake ecosystems.

Emily Arsenault, Marianne Ferguson, Colin Cummings, Monica Davis, Drew Mealor, Corey Reichler, Russell Cole, Cathy Bevier
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THE INFLUENCE OF SHORELINE DEVELOPMENT ON THE LITTORAL ZONE IN THE BELGRADE LAKES

Residential development of shoreland areas can negatively affect water quality, shoreline structure, and biological diversity. The goal of our study was to investigate the influence of shoreline development on the littoral zone of Great Pond, East Pond and North Pond. Undeveloped reference sites, buffered developed sites and unbuffered developed sites were identified along the shorelines of these lakes and surveys were conducted to compare abiotic and biotic characters. Abiotic features included sediment size, distribution, and the degree to which rocks were embedded in the substrate. Biotic

characters included aufwuchs cover and density on the substrate, woody debris abundance and size, and macroinvertebrate abundance and diversity. Reference sites had greater tree cover and higher tree diversity, and more woody debris present than developed sites. Aufwuchs cover was indirectly proportional to the degree of shoreline and tree line disturbance. Rocks were embedded to a greater degree at unbuffered sites than at residential sites with maintained buffered. Embedded rocks and aufwuchs distribution influence macroinvertebrate composition.

Miguel Barajas[1], Theo Willis[1], Karen Wilson[1], Brandon Kulik[2]
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RUNNING THE GAUNTLET: SMALLMOUTH BASS PREDATION ON RIVER HERRING IN THE KENNEBEC/ANDROSCOGGIN RIVER SYSTEMS

The non-native smallmouth bass, (*Micropterus dolomieu*), a highly active predator, was introduced in Maine in the late 1800's in an attempt to replace the less active predator but over-harvested brook trout, and have now firmly established themselves in Maine rivers. Smallmouth bass have been documented preying on river herring (*Alosa pseudoharengus* and *Alosa aestivalis*), a native forage fish, during its out-migration into marine systems, but the magnitude of this predation is unknown. In order to better manage restoration efforts of river herring and understand the food web impacts of smallmouth bass, we conducted a diet study along the Kennebec/Androscoggin River systems (Kenn/Andro). Monthly from May-October in 2011 and 2012, the Kenn/Andro systems were sampled for smallmouth bass using hook and line capture techniques. Stomach contents were collected using non-lethal methods, and the fish were returned to the water alive. The stomach contents were identified to a general taxonomic level for analysis and construction of simulations with the Wisconsin bioenergetics model. Temporal and spatial trends of diet distributions indicated that river herring are a seasonally important component of the smallmouth bass diet. Diet data were combined with smallmouth bass Kenn/Andro abundance data collected by the Midwest Biodiversity Institute & Kleinschmidt Associates to estimate the total river herring biomass eaten by smallmouth bass during the out-migration season.

Tyler Case, Dan Buckley
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INFLUENCE OF LAKE AND WATERSHED SIZE ON WATER QUALITY IN SEVEN LAKES AND PONDS IN THE RANGELEY REGION

This study focuses on measures of water quality and thermal regimens of lakes relative to lake morphology and watershed characteristics. Physiographic measurements of the watersheds of seven lakes and ponds in the Rangeley Lakes Region were used to better understand the current state of water resources in a historically significant area. The Rangeley Lakes area is internationally known for its native brook trout fishery, a natural resource that is vital to the economic viability of this rural area in western Maine. Knowledge accumulated in research such as this facilitates effective action from policy makers enforcing sustainability initiatives that protect water resources leading to a benefit for human development and biological diversity. Ordination and linear regression techniques are used to

analyze the importance of factors relative to water quality. Parameters used in statistical analyses include: lakeshore development within a 250' buffer, phosphate concentration, area of watershed, lake surface area, average and maximum depth, dissolved oxygen profile with depth and bathymetry.

Chester Chiao[1], Beverly Johnson[1], Philip Dostie[1], Theodore Willis[2]
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THE EFFECTS OF THE 2012 ALEWIFE MIGRATION ON NUTRIENT DYNAMICS IN NEQUASSET LAKE, WOOLWICH MAINE

Anadromous fish, such as alewives (*Alosa pseudoharengus*) provide an important link between coastal watersheds and the Atlantic Ocean along the Gulf of Maine. Alewives contribute marine-derived nutrients (MDN) in the form of nitrogen to freshwater lakes via excretion and mortality as they migrate upstream during spawning season. The focus of this project is to determine the degree to which MDN were imported into Nequasset Lake, Woolwich Maine. Nequasset watershed provides drinking water to the city of Bath and three other communities in Maine. Every spring, alewives return to Nequasset Lake to spawn, accessing the lake through a fish ladder adjacent to the water control dam. Water samples were collected from the top of the fish ladder, and from the four major stream inlets, and analyzed for nutrient concentrations (TDN, NO3-, NH4+) to construct a nitrogen budget. Additional samples were collected for δ15NNO3- analysis from April to August to trace MDN from the alewives. TDN concentrations at the top of the fish ladder were correlated to fish counts, indicating that the fish were importing a significant amount of nitrogen into the lake. Furthermore, the δ15NNO3- of the lake shows an enriched signal during the spawning period, perhaps reflecting the presence of MDN in the middle of the lake. Increases in MDN have the potential to affect lake productivity as it is immediately available for uptake by primary producers and may have a profound effect on the lake's ecosystem.

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TWO DECADES OF LANDSCAPE CHANGE ACROSS THE SEBAGO WATERSHED

The field of landscape ecology provides a framework to systematically consider landscape changes resulting from economic development and growth. Sebago Lake's importance as a source of public water supply to numerous southern Maine communities necessitates vigilant monitoring efforts. Monitoring allows for timely and appropriate conservation interventions and alternatives, which can in turn support the sustainability of this system. This study uses Landsat data from 1987 and 2009 to provide a spatially explicit analysis of large scale land use and cover changes across the Sebago watershed. We use the Habitat Priority Planner toolkit to map and compare patterns of fragmentation over the study period. Our results suggest a greater fragmentation of forest and green-cover parcels

across the watershed and more intense development activity around the vicinity of Sebago Lake and in the lower regions of the watershed. Residential and economic development activities across two decades have resulted in significant land use and cover changes across the region.

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USING ACOUSTIC TELEMETRY TO BETTER UNDERSTAND POST-SPAWNING MIGRATORY BEHAVIOR OF ALOSA PSEUDOHARENGUS

The alewife (*Alosa pseudoharengus*) is known to play a pivotal role in the food web of the Penobscot River and near shore marine ecosystems. The Penobscot River Restoration has the potential to restore millions of alewife to the watershed just as the species is under review for listing under the Endangered Species Act. However, little is known regarding the behavior of this species prior to or after they leave natal lakes. Acoustic telemetry is technology that can be used to track the movement of tagged fish in order to provide insight into behavior of individuals in a river through both temporal and spatial lenses. Over the summer of 2009, using the telemetry array deployed by NOAA and UMaine, sixteen alewives were caught, had pingers implanted orally, and were released into the Penobscot at four sites between Veazie Dam and Brewer. The goals of this study were to determine if acoustic telemetry could be used to track reproductive age alewife during spawning migration and collect data on their behavior during out-migration after spawning. Preliminary results indicate that the pingers were successful in tracking the individuals without significantly disturbing their health or migratory ability. Fish were tracked for an average of 37 days; two fish were tracked for less than two days, while two appeared in the array for over 80 days. Passage over Veazie Dam may have been one source of mortality. Preliminary results also suggest that movement was affected by tidal cycle and time of day.

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LIFE ON THE EDGE: BIOTIC AND ABIOTIC PRODUCTION AND KINETICS OF HYDROGEN PRODUCTION ALONG THE CHEMICAL GRADIENT

Leptothix is an iron-oxidizing bacteria that is ubiquitous in both marine and terrestrial environments. Living on a chemical gradient where reduced iron comes in contact with oxygen, these organisms use iron as an energy source and as a building material for stocks and sheaths made of iron oxide. The purpose of this research is to define the chemical environment in which organisms grow—specifically, the rate at which iron (II) is oxidized into iron (III) and the reactive oxygen species (ROS) that are produced when oxygen is reduced. ROS, such as hydrogen peroxide, oxidize both iron and potentially carbon, which presents a possible source of simple carbon compounds for growth. An acridinium ester (AE)-based chemiluminescence method was optimized for the analysis of hydrogen peroxide measurements in high iron (II) environments. Using this analytical system, the hydrogen peroxide was measured at multiple fresh water seeps containing significant iron (II). The measurements indicate that unexpectedly high concentrations of hydrogen peroxide exist in these seeps suggesting dissolved organic material in these samples is accelerating iron (II) oxidation and producing large fluxes of per-

oxide. In addition, elevated kinetic rates were observed in laboratory cultures. This indicates that the hydrogen peroxide is highly dynamic and largely dependent on the interplay between water flow, heterogeneous soil iron chemistry, and the mixing of atmospheric oxygen into the seep flows.

Catherine M.C. Herr[1], Phillip deMaynadier[2], Jonathan Mays[3], Trevor Persons[2], Beth Swartz[2]
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THE MAINE AMPHIBIAN AND REPTILE ATLAS PROJECT: TRACKING MAINE'S HERPETOFAUNA FOR 26 YEARS.

Amphibians and reptiles have several life history characteristics that make them more sensitive to certain threats than other vertebrates, including low mobility, extreme site fidelity, a requirement for both water and land, and (for amphibians) a permeable skin vulnerable to pollution, acidity, elevated temperatures, and UV radiation. Maine is home to 36 species of frogs, salamanders, snakes, and turtles. Keeping track of their distribution and status is the job of the Maine Amphibian and Reptile Atlas Project (MARAP). Started in 1986 as a cooperative project between Maine Department of Inland Fisheries and Wildlife (MDIFW), Maine Audubon, and the University of Maine MARAP is likely the longest, continuous wildlife atlas in the State, with contributions from hundreds of citizen volunteers. Informed largely by MARAP, the University of Maine Press published a book in 1999 summarizing the state of knowledge of this group entitled Maine Amphibians and Reptiles, edited by Malcolm Hunter, Aram Calhoun, and Mark McCollough. MDIFW continues to manage this atlasing project with a comprehensive database on the distribution of all 36 species. Though most of this work is opportunistic, over 6,600 entries from approximately 600 volunteers have now been logged statewide. There is much still to learn regarding the distribution and ecology of Maine's cryptic ectotherms, and we encourage members of the public to continue sharing their observations with MDIFW.

Daniel Orlando, Marc Daigle, Benjamin Hepler, Alyssa Beers, Amanda Boudreau, Nathan Dent, Lauren Metts, Andrea Miller, Kristen Pinciak, Emily Russo, Rae Vander Werf
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A HYDROGEOLOGICAL INVESTIGATION OF WATER QUALITY AROUND THE UNITY WASTEWATER LAGOONS

The objective of this class research project was to conduct a hydrogeological and water quality investigation on behalf of the Unity Utilities District (UUD) and determine if the town's wastewater lagoons were leaking. The wastewater facility in Unity, ME was built in 1974 and designed to handle local effluent which enters into a series of two settling lagoons. After treatment, wastewater is pumped into a control facility prior to being discharged into 25-Mile Stream. The lagoons treat wastewater through settling of solids and microbial activity. Seven piezometers were installed around the lagoons to assist in the determination of hydraulic head and to extract groundwater samples. Water quality variables including caffeine, nicotine, *E. Coli*, and sodium were compared between the wastewater lagoons,

groundwater in piezometers, and private wells in town. Topographic surveying was conducted to determine the elevation of the wastewater lagoons, groundwater levels in piezometers, and 25-Mile Stream to establish hydraulic gradient and hydraulic head values. Slug tests were performed to determine hydraulic conductivity and to calculate groundwater flow rates. Prior to water quality sampling, piezometers were pumped and allowed to recharge. All water testing was performed by a certified lab and results were compared to allowable levels determined by the Environmental Protection Agency (EPA) and established guidelines. Using hydraulic head measurements and Geographic Information Systems (GIS), equipotential lines were mapped to create groundwater flow models. Our water quality analyses indicate the wastewater lagoons are not leaking.

William Pooler, Margret Welch
Robert Sanford - faculty advisor
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A GIS STUDY OF THE PRESUMPSCOT WATERSHED COORDINATING WATER QUALITY WITH ZONING SETBACKS AND BUFFER ZONES

This project is a study of water quality for rivers and streams in the Presumpscot watershed in Cumberland County, Maine. A model was created that analyzes water quality data based on zoning setbacks and shoreline buffers. Geographic points gathered by Maine's Department of Environmental Protection and the University of Southern Maine were used to build the model's base map in GIS (Geographical Information Systems). The map includes a visual representation of zoning setbacks and buffer zones that will improve identification of high risk areas in Cumberland County. These high-risk locations identified will be used for water resource management planning.

Amy Webb, Jackie Allen, Amanda Martin, Margret Welch
Robert Sanford - faculty advisor
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UNIVERSITY OF SOUTHERN MAINE STORMWATER TRAIL

As the leading source of pollution to our nation's coastal waters, stormwater runoff carries toxins that degrade marine water quality. The city of Portland uses combined sewer overflow systems (CSO's) to direct stormwater and sewage to the Portland Water District's treatment plant. During heavy rain events the treatment plant can reach maximum capacity. The excess untreated waste water is dumped into designated sites, including Casco Bay. The objective of this project is to preserve the ecological integrity of the bay by reducing the amount of runoff from campus while promoting public awareness.

We have created a stormwater trail designed to address the areas on campus that are most affected by runoff. The design uses green infrastructure, natural forms of erosion control, runoff directional techniques, and rainwater harvesting systems to promote the use of sustainable stormwater control. By maximizing collection efforts the design will reduce irrigation, and future needs for the maintenance and operational costs of managing runoff. We have also accounted for ecosystem preservation and

enhancement through the use of native vegetation and the removal of impermeable surface. With an estimated reduction of over 40,000 gallons annually to the CSO's, this design uses otherwise grey water for a sustainable cause. By visually displaying the problem with innovative solutions we hope to offer multiple ideas that can be used throughout the community.

GRADUATE POSTER ABSTRACTS

John Ahern[1], Wei Fan[2], Hong Je Cho[2], Howard Patterson[1]
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USE OF TiO_2 AND AG-DOPED NANO-SCALE ZEOLITES AS PHOTOCATALYSTS IN THE PHOTODEGRADATION OF PHENOL IN NATURAL WATERS

The Patterson research group has utilized novel catalysts for the removal of phenol from natural waters. Phenol is a well-known pollutant in natural systems and is highly toxic. TiO_2, Ag and zeolites are well established as means of degrading organic contaminants including phenol. This study used low-silica nano-scale zeolites with very high surface areas and large pore sizes to best adsorb phenol. These zeolite supports increase the catalytic potential of the metals in the presence of UV light. The concentration and location of the TiO_2 and Ag clusters on the zeolites was tuned to augment the photocatalysis. The method was effective in reducing phenol concentrations in water down to benign doses within minutes. For the first time metal doped zeolites have been used to reduce phenol concentrations by 99% with just an hour of UV exposure time. A second order mechanism is derived for the photocatalysis of phenol using metal-doped zeolites.

Tim Baker[1], Regina Smith[1], Sam Foster[1], Shaleen Jain[1], Michael Scott[2]
1 Civil and Environmental Engineering, University of Maine, Orono, ME
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COMBINING ENVIRONMENTAL EDUCATION AND COMPUTATIONAL THINKING

Environmental sustainability rests on a holistic understanding of the interconnected human and natural systems. Watershed education in middle school curriculum provides a unique opportunity to explore creative learning and problem solving. We will share our work in a Montessori school setting, wherein the use of Scratch Programmable Media was used to increase student interest and support multi-faceted learning. We have focused on four interrelated aspects of computational thinking: a. computational learning concepts; b. programming fundamentals (logical and decision blocks etc.); c. appropriate use of art and sounds within the rich programmable media environment; and d. simple watershed sustainability questions, wherein individual and team-based learning can be facilitated. Through select case studies involving watershed issues, the university student-led team worked closely with faculty to implement a pilot program with a group of nine Montessori school students.

Bridie McGreavy[1], **Emma Fox**[2], Jane Disney[2], Molly Miller[3], Laura Lindenfeld[4], Linda Silka[5], Chris Petersen[6]

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A COLLABORATIVE MODEL FOR CONSERVATION ACTION PLANNING: GROUP COMMUNICATION AND PARTNERSHIP DEVELOPMENT FOR ECOLOGICAL AND ECONOMIC RESILIENCE IN FRENCHMAN BAY

We use a collaborative research model to support the Frenchman Bay Partners' efforts to use a conservation action planning process to sustain working waterfront livelihoods and promote ecological and economic resilience of the Bay. The study of communication among partners and other bay users helps us describe the complexity of collaboration and make strategic decisions to improve the ways in which we work together. We describe the collaborative conservation action planning model and share results related to group communication and stakeholder engagement within this process. We emphasize the role of communication competence, decision making, organizational structure and the processes of language alignment in partnership development. Finally, we describe the process and outcomes related to two capacity building sessions between different natural resource user groups in which group members negotiated conflict and developed mutual agreements for multi-species restoration and harvesting. Our communication research seeks to contribute to the development of a shared vision and engaged community essential to the resilience of Frenchman Bay.

Melinda Neville[1], **Kate Beard**[2]

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BIOGEOCHEMICAL INFORMATICS FOR REUSE AND MODELING OF LEGACY MERCURY DATA

The mercury (Hg) monitoring legacy in the Northeastern United States spans three decades and many different ecosystem pools, but the diverse nature of Hg data makes comparison across studies difficult. The ability to measure whole ecosystem changes in Hg contamination in response to policies regulating Hg is often limited, and researchers have difficulties comparing results or utilizing the wealth of legacy Hg data more broadly. Commonly, there are several methodological and contextual barriers to comparing disparate monitoring efforts, despite apparent similarities. For Hg contamination, there is often an assumed common understanding of some terms, assumptions about relationships, implicit, or different specification of the landscape settings, and imprecise or ambiguous spatial context specification of observation units that hinder the ability to make logical linkages between study results. Studies utilize data from varied contextual settings and characterize relationships in different ways making these relationships difficult to associate across multiple projects. These relationships and supporting

data connections to these relationships can benefit from more formal definition. Domain-specific ontologies provide a way to explicitly capture knowledge about specific scientific domains, and support consistent and unambiguous representations of entities and relationships within domains. An ontology formally specifies representation of entities along with their properties and relations, and defines a common vocabulary that can be shared between researchers. In this research, we are developing ontologies to facilitate disparate data integration, dissemination and comparison for Hg monitoring in freshwater ecosystems. The developed ontologies will allow Hg data to be placed in the context of the Hg biogeochemical cycle and linked to contextual characteristics of the observation settings. We will discuss the challenges of working with disparate spatiotemporal data, and the applied techniques that facilitate its use in evaluating ecosystem risk and resilience to Hg pollution.

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PHOTOCATALYTIC ACTIVITY OF TiO_2-DOPED ZEOLITE ON THE REMOVAL OF 17α-ETHINYLESTRADIOL (EE2) IN WATER

Pharmaceutical and personal care products including 17α-ethinylestradiol (EE2) have become an emerging concern in U.S. water supplies because of limited design and ineffective techniques in wastewater treatment plants (WWTPs). A novel photocatalyst, TiO_2-doped Low Silica X zeolite (TiO_2/LSX), was synthesized to study the kinetics of degradation of EE2. Various techniques including, FTIR, XRD, BET surface analysis and ICP-AES were applied to characterize this new material. The effects of different UV light intensities, initial EE2 concentration, and catalyst dosage on the EE2 removal efficiency were studied. The results demonstrated a higher EE2 removal efficiency (more than 90% conversion after 20 min of UV irradiation) than in the presence of UV irradiation alone, or TiO_2-free LSX or zeolite-free TiO_2. TiO_2-doped LSX also has the additive advantage of not aggregating and is easier to separate from a suspension, characteristics that are not observed in pure TiO_2 suspensions that are commonly used in catalyzed UV irradiation technology. The novel TiO_2-doped zeolite system we developed in this study will provide a promising application for the UV disinfection processes in water and wastewater systems in the future.

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VALIDATION OF ATMOSPHERIC CORRECTION AND CHLOROPHYLL-A RETRIEVAL METHODS IN LAKES USING A 3-YEAR ARCHIVE OF FULL-RESOLUTION MERIS SATELLITE DATA

Satellite remote sensing is a potentially useful tool for large scale monitoring of inland waters in the UK, but methods of atmospheric correction and constituent retrieval must first be validated. Five atmospheric correction procedures and seven chlorophyll-a retrieval algorithms were tested over four UK lakes of varying size, shape, and trophic status using Medium Resolution Imaging Spectrometer (MERIS) satellite data from 2009-2011. Chlorophyll-a algorithms included empirical and semi-analyti-

cal methods, in particular focusing on NIR-red 2 band and 3 band algorithms. The non-parameterised 2 band ratio and 3 band equation were also analysed. Algorithm results were validated against in situ sampling data and atmospheric correction procedures were evaluated based on their reflectance spectra. It was found that adjacency effects affect the smaller lakes and that the Improved Contrast between Ocean and Land (ICOL) processor, which corrects for adjacency effects, was effective at improving both atmospheric correction and chlorophyll-a retrieval results. ICOL Case 2 Regional (C2R) processed images of Loch Leven produced the best chlorophyll-a retrievals overall (R2 = 0.86; RMSE = 6.83 mg/m3), with the NIR-red Hunter et al. (2010) semi-analytical model using C2R reflectances and ICOL also performing well across all lakes.

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COLLABORATIVELY DEVELOPING BEST MANAGEMENT PRACTICES FOR ROAD SALT APPLICATION IN MAINE

Research demonstrates that collaborations are beneficial because they can lead to improved decision-making, strengthen social networks (Trachtenberg & Focht, 2005), and promote mutual understanding (Walker, 2007). In working with the Maine Salt Management Taskforce this poster explains the engaged research approach we used to understand and facilitate conversations around best management practices (BMP) for the reduction of road salt application in Maine, at both state and local levels. Through Taskforce meetings, focus groups, and interviews, we were able to gain insight to the BMP's used in Maine. In order to get a sense of salt reduction practices as a whole, we conducted an online document review of key winter-climate states in the United States and various Canadian Provinces. The research resulted in the identification of primary BMP's of: effective application; various technologies; training programs; storage and handling; and truck maintenance. Researching these specific areas of BMP's at a national and local level can help determine the social-ecological impacts of road salt and key decision-making considerations. Through a collaborative research process with the taskforce we are co-producing knowledge about road salt management. We are finding that this process is critical for ensuring a mutual understanding of the ecological, social, and economic impacts of salt, developing a realistic and locally-informed process for road salt management and establishing statewide partnerships.

PROFESSIONAL POSTER ABSTRACTS

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INVESTIGATING THE IMPACT OF POLLUTANTS IN STREET DUST ON THE LONG CREEK WATERSHED, SOUTH PORTLAND, ME: COLLABORATIVE RESEARCH BETWEEN USM, CCSWCD, AND LCWMD

This collaborative undergraduate research project between USM, Cumberland County Soil & Water Conservation District (CCSWCD) and Long Creek Watershed Management District is dedicated to exploring the concentrations, trends, and fate and transport of chloride, metals, and PAHs (polycylic aromatic hydrocarbon) in street dust and their effects on sediment and surface water quality within the Long Creek Watershed. Data from street dust and catch basin samples collected from numerous locations in Long Creek, including four monitoring sites indicate that high levels of carcinogenic PAHs (cPAHs) as well as copper, zinc, and chromium are present in street dust samples. Levels of cPAHs were above the residential Maine Remediation Action Guidelines (RAGs). This project investigated the effectiveness of periodic street sweeping on contaminant accumulation in street dust in the watershed, and the extent of contamination in surface water and sediment from street dust.

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PRELIMINARY RESULTS OF BASELINE SCIENCE MONITORING FOR THE PENOBSCOT RIVER RESTORATION PROJECT

The National Oceanic and Atmospheric Administration (NOAA) invested $6.1 million through the American Recovery and Reinvestment Act of 2009 to help rebuild the sea-run fisheries of Maine's Penobscot River through a grant to the Penobscot River Restoration Trust, with $5 million directed toward removal of Great Works Dam, completed in November 2012. The remainder of the award and subsequent NOAA funding – a total of $1.5 million to date – has funded baseline scientific monitoring to track physical, chemical and biological changes in the river following the removal of Great Works and Veazie dams, and the decommissioning and bypass of Howland Dam. This included monitoring of: fish community structure and function, upstream and downstream fish passage at dams, assembly of diadromous species at the seaward-most dam, and import of marine derived nutrients and organic matter; vertical and horizontal channel adjustments at river cross-sections; sediment grain size distribution at cross-sections to document changes in bed material; riparian vegetation and channel configuration through photos taken at permanent stations; basic water quality; benthic macroinvertebrate community structure; and wetland and riparian plant communities. We summarize preliminary findings, and highlight the enormous opportunity provided by the Penobscot Project for fisheries agencies, academia, and the general public to better understand the ecological effects of large-scale dam removals and the cultural and economic benefits of fisheries restoration.

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PHARMACEUTICAL AND PERSONAL CARE PRODUCTS AS INDICATORS OF HUMAN INFLUENCE IN MAINE STREAMS

Pharmaceuticals and Personal Care Products (PPCP) have been found in a number of streams selected for testing by Maine DEP, Maine Healthy Beaches and U.S. EPA in 2011 and 2012. The term PPCP encompasses a class of compounds present in natural waterways that originate as consumable products deposited in our household sewage. This project tested for a subset of eight compounds that the EPA calls 'Source Tracking Agents' and includes: acetaminophen, blood pressure pharmaceuticals, caffeine and nicotine metabolites. We primarily looked for compounds that have been metabolized or passed through the human body as indicative of domestic sewage. Detection of these compounds is used to identify potential sources of fecal contamination in streams with bacteria concentrations that exceed Maine's Water Quality Standards. The stream values ranged from highly contaminated sites to heavily wooded sites with little human influence. The PPCP results corroborated previous bacteria sampling results, but there were exceptions and context is an important factor when an interpreting these results. Detection occurred at most sites, even remote sites, which confirms regional observations in the Northeast that low levels of PPCP's are ubiquitous. These results are used to establish baseline levels of PPCP's relative to Maine waters and distinguish between human and wildlife sources of bacteria, since only bacteria of domestic origin violates Maine's Water Quality Standards.

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REGULATING PHOSPHORUS AT LOCAL LEVEL: A CASE STUDY

One of the best ways towns can ensure that new development projects do not harm area waterbodies is to have new projects meet the standards outlined in the state's phosphorus control manual. The Maine Department of Environmental Protection uses these guidelines to review larger projects but towns with pristine waterbodies often opt to have these regulations apply to smaller projects that are reviewed at the local level.

Although Lakes Environmental Association (LEA) has invested substantial effort looking over proposals and helping developers understand and apply these rules within our six-town service area, there was little time spent evaluating how well the projects were constructed on the ground.

After observing two subdivisions constructed without the required phosphorus management practices, LEA undertook an inventory of all the major projects that came before planning boards in Harrison, Bridgton and Naples within the last seven years. The plans were summarized and photographed and details on all the stormwater control measures were carefully scrutinized. Out of all the projects reviewed, 91 had stormwater controls and LEA did field evaluations on 73 of these sites.

During our review we found that nearly a third had errors or omissions in the phosphorus plans. Field evaluations revealed 60% of the developed projects had problems related to their stormwater controls and frequently the stormwater controls proposed on the plans were never constructed.

This poster summarizes these findings and propose possible solutions for towns in Maine that have adopted these provisions into their Subdivision and Site Plan review ordinances.

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TRACKING CHANGES IN MAINE'S WATER CLASSIFICATION PROGRAM: FOLLOWING TWENTY FIVE YEARS OF WATER CLASSIFICATION IN MAINE

Passage of Maine's Water Classification Law of 1987, marked Maine as one of the first states in the nation to adopt a set of narrative standards that established baseline characteristics for biological integrity tied to a tiered water classification system. Maine maintains four distinct water quality classifications for rivers (AA, A, B, and C) that designate the minimum level of water quality intended for each body of water. The classification directs management of the water body in order to achieve its designated level of water quality (MRSA Title 38 §464-468). Until recently, the only record of reclassification was captured in the legislative language associated with the reclassification process. Building upon an earlier project that mapped shifts along the two major rivers, the Androscoggin and Kennebec, this poster provides the first synthesis of shifts in tributaries and main stem classification along river systems throughout Maine. Discrete changes described in the law were mapped using ArcGIS to show both temporal and spatial shifts as a result of classification. Mapping changes in water classification since 1987 provides an overview of shifts in these systems over the past 25 years and provides a visual display of progress achieved to date. Spatial analysis of the reclassification process also provides the first opportunity to quantify differences across watersheds. The results show distinct differences in progress achieved among Maine's river systems.

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USING A FOCUS AREA APPROACH TO RESTORE WATERSHED-SCALE STREAM CONNECTIVITY

The Maine Department of Marine Resources, the Maine Department of Inland Fisheries and Wildlife, the Natural Resources Conservation Service (NRCS), the U.S. Fish and Wildlife Service, and Keeping Maine Forests initiated a cooperative aquatic stream restoration and enhancement effort in 2011. The effort focused on implementing on-the-ground stream restoration projects in the Penobscot River basin. The primary goals of this initiative are to: 1) restore geomorphic characteristics and function of

Maine's lotic systems and, 2) enhance in-stream habitat complexity and connectivity to benefit diadromous fishes, including Atlantic salmon, and resident species, including brook trout, at a watershed scale. With thousands of problem culverts in the Penobscot River Basin, NRCS and partners are using the Pleasant River sub-watershed as a "focus area" for this restoration initiative. The poster provides a summary of the focus area approach, progress of the cooperative effort, restoration challenges, and the creative avenues taken to get projects moving forward.

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WATERSHED MODEL PERCEPTIONS IN THE SEBAGO LAKE REGION

The Sebago Lake Team – an interdisciplinary research team formed within the University of Maine's Sustainability Solutions Initiative – is developing virtual watershed models that will allow users to simulate watershed changes. The Sebago Lake watershed is one of the more vulnerable drinking water sources in the Northeast due to the numerous and sometimes conflicting demands and preferences of stakeholders in the area. In addition to providing drinking water for the greater Portland area, Sebago Lake is used for recreation, hydro power generation, and tourism. Its watershed is experiencing development pressures. A diverse group of stakeholders influence watershed policy; however, there are currently few resources available that would allow them to predict how issues such as changes in land use, dam operation, and climate change affect water quality. If environmental models are to be accepted by diverse stakeholders, the models must be created and used in a transparent process. Our research objectives were to identify expectations and needs that stakeholders have related to the model, and key factors that influence stakeholder acceptance of the modeling tools as an unbiased and accurate analytical device. Although participants agreed on the usefulness of models in general, they were uncertain about the practical applications and usability of the watershed model. Stakeholder groups disagreed on the effectiveness of sharing the watershed modeling efforts with the general public, their levels of trust in groups that would operate the model, and the potential parameters that they would include in the model. Continued research is needed to define the discrepancies in model perceptions, and to facilitate communication between stakeholder groups.

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ECOSYSTEM LEVEL RESPONSE TO LIMING OF MAINE SALMON STREAMS

Project SHARE (Salmon Habitat and River Enhancement) is using clam shells as a calcium carbonate supplement to mitigate stream acidity and restore Atlantic salmon. In 2010, two metric tons of shells were placed in Dead Stream. In 2011, the treatment was increased to ten tons. In 2012, the project was expanded to other tributaries of the Machias River: Bowles Brook, Honeymoon Brook, Canaan Brook, and First Lake Stream. In Dead Stream, water chemistry improved by approximately one pH unit, and fish were more abundant. In May of 2012, leaf packs were placed into clam shell Treated (Dead Stream site 1) and Untreated (Dead Stream site 2 and Honeymoon Brook) sites and sampled from June – October. Acid-sensitive mayflies and amphipods were abundant at the Treated site while stoneflies, caddisflies and chironomids were abundant at all sites. Leaf processing rates were significantly different ($p = 0.0244$) between Untreated sites (weight loss ranged ~0.6% to 1% per day) and the Treated site (1.7% to 2% per day). By adding buffering capacity, a more favorable environment for microbes was created. This boost to the bottom of the food chain benefitted leaf processers, especially scrapers and shredders, and contributed to the improved fishery.

Notes

Notes

thank you

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