18th Annual
Maine Water Conference

March 14, 2012
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

Table of Contents

MAINE WATER CONFERENCE

The Maine Water Conference was founded in 1994 by the Senator George J. Mitchell Center 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: Maine Rivers: Finding Common Waters
Session B: Recent Research in Northern and Western Maine Ecosystems
Session C: Citizen Participation in Natural Resource Science
Session D: Freshwater Fish Habitat Research and Restoration
Session E: Evaluating Restoration Outcomes of the Penobscot River Restoration
Session F: Pollutants and Remediation: New Approaches and Green Solutions

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

11:00am **Plenary Session — Welcome & Introduction**
Laura Lindenfeld, Conference Co-chair, Department of Communication and Journalism, University of Maine

11:05am **Todd Norton, Edward R. Murrow College of Communication, Washington State University**
University/Community Partnerships for Complex, Place-based Water Management

11:40am **Introduction**
Maggie Shannon, Conference Co-chair, Executive Director, Maine Congress of Lake Associations

11:45am **Ken Wagner, Water Resource Services**
Seeing the Big Picture: Options and Limits for Management of Lakes

12:20pm **Poster Award Presentations**
Lynne Lewis, Poster Chair, Bates College
Robert Lent, U.S. Geological Survey

12:30pm **Lunch**

1:30pm **Afternoon Concurrent Sessions**
Session C: Citizen Participation in Natural Resource Science
Session D: Freshwater Fish Habitat Research and Restoration
Session E: Evaluating Restoration Outcomes of the Penobscot River Restoration
Session F: Pollutants and Remediation: New Approaches and Green Solutions
Session G: The Influence of Climatic Changes on Maine Water Resources
Session H: Water Monitoring Results: Implications for Land Use and Conservation
Session I: Lake, Stream and Wetland Water Quality

2:30pm **Afternoon Break – Auditorium**

3:00pm **Afternoon Concurrent Sessions** (continued)

Plenary Session

11:00AM WELCOME & INTRODUCTION

Laura Lindenfeld

Associate Professor, Dept. of Communication and Journalism and Margaret Chase Smith Policy Center, University of Maine

Laura Lindenfeld holds a Ph.D. in Cultural Studies from the University of California, Davis.She co-leads a research team on Maine's Sustainability Solutions Initiative (SSI) that develops and tests strategies for collaborating with stakeholders and communities and seeks to understand how these "knowledge-to-action" strategies can help create solutions to pressing sustainability issues. Her research focuses on interdisciplinary approaches to linking the production of scientific knowledge with action in Maine's communities, with a focus on civic engagement, science communication, and collaboration.

11:05AM TODD NORTON

The Edward R. Murrow College of Communication, Washington State University

UNIVERSITY/COMMUNITY PARTNERSHIPS FOR COMPLEX, PLACE-BASED WATER MANAGEMENT

Management of water resources is one of the more complex contemporary environmental issues, transcending scientific, political, social, economic, legal and cultural boundaries. Total water supply is impacted by geography, land use and cover, climate change and variability, as well as interactions between ground and surface water. Water demand is driven by a host of physical and social factors from temperature to cultural views of green landscapes. In the face of finite supplies, demand management is essential for getting more use out of the same or dwindling amounts of water, which will require paradigm changes in attitudes and behaviors. Complicating this is the relative separation between university and public agency research expertise regarding resource management practices, as well as classroom activities and public policy.

The Spokane Coeur d'Alene corridor highlights the need for university and community managers to work together to respond to these complex issues. This talk addresses the challenges and significant opportunities that come along with these partnerships, including within the institutions themselves, among entities in public sectors, and especially when university and public sector personnel collaborate. Key insights are provided into crossing disciplinary boundaries, organizational cultures and differing orientations to problems.

As an Assistant Professor in the Edward R. Murrow College of Communication, and Division of Governmental Studies and Services, ***Todd Norton*** *works on multi-jurisdictional water management issues throughout the Pacific Northwest. His research focuses on sustainability dynamics for water resources in rapidly urbanizing and climatically sensitive regions. Todd works with community and university partners, integrating multiple disciplines and types of expertise to address the complexities of managing water in the Pacific Northwest. He spends most of his time working in interdisciplinary teams, which incorporate hydrology, environmental studies, engineering, and a range of social sciences, as well as agency and community-level water managers and resource programs. The goal of these projects is to analyze feedbacks among social and biophysical processes within the system in hopes of generating findings which are both scientifically and practically useful. Todd is a native of the Great Lakes region and currently lives in Washington state with his wife, Amy, and son, Sean.*

11:40AM INTRODUCTION

Maggie Shannon

Executive Director, Maine Congress of Lake Associations

Maggie Shannon is the Executive Director of the Maine Congress of Lake Associations (Maine COLA), a

statewide nonprofit membership organization dedicated to protecting Maine lakes, ponds and watersheds through science, education, and advocacy. One of COLA's programs is an annual forum, the Maine Lakes Conference, which brings lay lake activists together with experts for a day of information exchange and networking. Maggie is a board member and Past President of the Belgrade Lakes Association, and a member of the board and Executive Committee of the Belgrade Regional Conservation Alliance (BRCA). She was awarded the Spirit of America Foundation Award for Volunteerism by Belgrade in 2007, and the People's Choice Award by the Natural Resources Council of Maine in 2007 "for her dedication to the work of COLA and the inspiration she provides others."

11:45AM KEN WAGNER

Water Resource Services

SEEING THE BIG PICTURE: OPTIONS AND LIMITS FOR MANAGEMENT OF LAKES

Human activities in watersheds tend to raise nutrient inputs to lakes by an order of magnitude, while typical best management practices reduce inputs by no more than two thirds and often no more than half. This creates an imbalance whereby eutrophication is fostered and many designated uses are not well supported. Additional watershed management options of more recent origin have the potential to do better than historic efforts, including fertilizer control and low impact development techniques, but in-lake management methods are often necessary to meet water quality and use goals. Long-term inputs to lakes can foster productivity problems even when measured inputs seem acceptable, through sediment-water interactions. Phosphorus inactivation, aeration and mixing strategies, and several other approaches have the potential to support uses, even if all desirable water quality goals cannot be met. Human presence presents limits and trade-offs, and programs that mandate rehabilitation of damaged aquatic systems may divert funds better spent on protection of less impacted systems. Keys to successful lake management include putting protection first, effective monitoring to detect problems early, and decisive action in the watershed or lake to maintain desired features when problems arise. Being institutionally up to the challenge is at least as important as having a grasp of the scientific and economic factors governing environmental management.

***Ken Wagner** holds degrees from Dartmouth College and Cornell University. He has over 30 years of experience working on a variety of water resources assessment and management projects. In 2010 he started Water Resource Services, a small company with a focus on water supply protection and lake management consulting. He is a former President of the North American Lake Management Society and the current Editor in Chief of Lake and Reservoir Management, a peer-reviewed journal.*

12:20PM POSTER AWARD PRESENTATIONS

Presentation of poster awards by Lynne Lewis, Poster Chair, Bates College, and Robert Lent, U.S. Geological Survey

12:30PM LUNCH

Session A

Maine Rivers: Finding Common Waters

In November 2011, the Kennebec Estuary Land Trust in coordination with the Sustainability Solutions Initiative partners from Bates, Bowdoin and the USM brought together over 100 individuals who are connected in the future of the Androscoggin and Kennebec rivers. The goal was to identify priorities for these two rivers and the barriers to implementation of restoration projects. One outcome of the symposium was an inventory of initiatives currently being carried out throughout the watersheds. This session will provide a brief overview of the fall symposium and current research that has been conducted to date. This session is an interactive session in which participants will craft a series of shared goals for the two watersheds, and have the chance to connect with others currently engaged and interested in river restoration projects.

SESSION CHAIRS

Carrie Kinne, Kennebec Estuary Land Trust

Carrie Kinne is the Executive Director of the Kennebec Estuary Land Trust located in Bath, Maine. At the helm the land trust has made a commitment to engage with interested partners to conserve land, improve water quality, and restore habitat in the Kennebec Estuary and Lower Kennebec River. Carrie graduated from the University of Maine and has lived and worked in Maine all her life. Her career has focused primarily in the area of fundraising where she has spent over twenty-five years working with a variety of non-profits across the state.

Karen Wilson, Department of Environmental Science, University of Southern Maine

Karen A. Wilson is an assistant research faculty with the Department of Environmental Science and a scientist in the Aquatic Systems Research Group at USM. She is currently teaching ESP 341 Limnology and will teach ESP 303 Wetlands Ecology in the spring of 2006. Karen has a Ph.D. in Limnology/Zoology from the University of Wisconsin-Madison where she studied the long-term impacts of an invasive crayfish on lake communities. Since receiving her degree, Karen has taught at a small liberal arts college in the Midwest and worked as a post-doctoral fellow at the Department of Zoology, University of Toronto, and the Ontario Ministry of the Environment, Toronto, Ontario. Karen's current research focuses on freshwater-marine linkages and anadromous alewife populations, saltmarsh restoration and impacts on marsh-marine linkages, freshwater crayfish in Maine.

Eileen Sylvan Johnson, Department of Environmental Science, Bowdoin College

Eileen Sylvan Johnson is the Program Manager/GIS Analyst and Lecturer in Environmental Studies at Bowdoin College. Her interest is in the area of Geographic Information Systems (GIS), and how GIS can contribute to an

understanding of coupled environment and human systems. She facilitates community based research within the Environmental Studies Program and has a particular interest in stakeholder engagement and knowledge-action systems. Eileen holds a BS degree from Cornell University, a Masters of Regional Planning from the University of Massachusetts, Amherst and is currently a doctoral student at the University of Maine in Ecology and Environmental Sciences, and affiliated with Maine's Sustainability Solutions Initiative.

8:30AM – 10:00AM SESSION OVERVIEW

INTRODUCTION

PRESENTATIONS

Karen Wilson
University of Southern Maine, Portland, Maine
Linking research to action. An overview of what research can tell us about the potential for the Androscoggin and Kennebec Rivers.

Eileen Johnson
Bowdoin College
Many goals - one vision for the Androscoggin and Kennebec Rivers. An overview of the status of river restoration projects and programs

DISCUSSION

Session B

Recent Research in Northern and Western Maine Ecosystems

Maine's less populated western and northern areas host habitats of high interest, but their remote locations often preclude extensive research and monitoring. Some of these areas, especially the subalpine and alpine sites, are likely to be impacted by climate change in the coming decades, stimulating interest in building baseline data for future comparison. In addition, these remote watersheds and their associated flora and fauna provide valuable comparisons to more developed watersheds in other parts of the state. This session will focus on current work in these remote watersheds, including ecological research, watershed and lake dynamics, challenges and opportunities related to establishment of new monitoring programs, and/or results from long-term studies in these watersheds.

SESSION CHAIR

Julia Daly, Department of Geology, University of Maine at Farmington

Julia Daly is an Associate Professor and Forrest P. Dexter III Chair in Geology at the University of Maine at Farmington. Her research interests are in the response of high elevation watersheds to climate change and better understanding the stratification mechanisms of lakes in these watersheds.

8:30AM – 8:55AM

Adam J. Baumann*[1]*, *Jeffrey S. Kahl*[2]*, Thomas R. Boucher*[3]*, Kevin J. McGuire*[4]
1 University of New Hampshire, Water Resources Research Center, NH; a.j.baumann@unh.edu
2 James W. Sewall Company, Old Town, ME; steve.kahl@sewall.com
3 Plymouth State University, Plymouth, NH; tboucher1@plymouth.edu
4 Virginia Tech, Water Resources Research Center, Blacksburg, VA; Kevin.mcguire@vt.edu

CHANGES IN SURFACE WATER CHEMISTRY IN MAINE HIGH ELEVATION LAKES IN RESPONSE TO THE 1990 CLEAN AIR ACT AMENDMENTS

The 1990 U.S. Clean Air Act Amendments (CAAA) set target reductions for both sulfur and nitrogen emissions to reduce acidic deposition and improve the biological status of low alkalinity surface waters in the United States. The Maine High Elevation Lake Monitoring (HELM) project was designed to complement assessments from other acid rain monitoring programs in the northeast that had underestimated the number of acidic lakes. HELM

lakes are more susceptible to the effects of acid deposition than lowland lakes typically included in other surveys because they receive higher amounts of precipitation, and the watersheds are less able to neutralize acidic inputs because of steep slopes, shallow soils, and resistant bedrock. Since 1986, decreases in HELM surface water SO_4^{-2} concentrations of 1.6μeq/L/yr. combined with lesser decreases in base cations (0.68 μeq/L/yr.) have led to increases in ANC (0.58μeq/L/yr.) and decreases in hydrogen ion (-0.05μeq/L/yr.). These improvements have led to a 50% decrease in the number of acidic (ANC < 0) HELM lakes since 1986-87, and a 10% increase in the number of lakes projected to resist spring acidification (baseflow ANC > 30). Toxic inorganic aluminum comprises 9% less of the total aluminum in HELM lakes today than in 1986-87, possibly due to the decrease in acidity and a 0.03mg/L/yr. increase in DOC which complexes inorganic Al. At current rates of change in both surface waters and deposition, we predict a recovery scenario for 2025 in which HELM lakes reach a background 24μeq/L SO_4^{-2} and non-dystrophic lakes have pH ≥ 6 and ANC ≥ 30μeq/L as depositional SO_4^{-2} becomes undetectable.

9:00AM – 9:25AM

Sarah J. Nelson*[1]*, *Jeffrey S. Kahl[2], Adam J. Baumann[3], Kenneth B. Johnson[4]*
1 University of Maine, Senator George J. Mitchell Center and Department of Plant, Soil, and Environmental Sciences, Orono, ME; sarah.nelson@umit.maine.edu
2 Sewall Company, Old Town, ME; steve.kahl@sewall.com
3 University of New Hampshire, Water Resources Research Center, NH; a.j.baumann@unh.edu
4 Husson University, Bangor, ME; johnsonk1@fc.husson.edu

RUGGED SHORES AND CLEAR WATERS: INTERPRETING BIOGEOCHEMICAL RESPONSE TO ENVIRONMENTAL STRESSORS USING THE LAKES AND PONDS OF MAINE'S BAXTER STATE PARK

Conserved lands provide a setting where biogeochemical response to non-point source stressors can be evaluated through time without being confounded by land-use change. Lakes and ponds within Baxter State Park (BSP) (209,501 acres) include some of the most remote ponds in Maine, many of which are at high elevation (>600 meters). The database spans 1978-2010 and includes 'snapshot' surveys and long-term monitoring. Many of these lakes have been sampled as part of Maine DEP and US EPA-funded research that is evaluating surface water response to the 1990 Clean Air Act Amendments (CAAA), and temporal trends in lake chemistry. This allows us to compare response in these lakes to other northeastern lake sets. In contrast to lakes in Acadia National Park (ANP) and high-elevation sites in Western Maine, BSP lakes tend to be relatively neutral (pH ~6.5-7.0) and low in dissolved organic carbon (~2 mg/L). However, many of the high elevation BSP sites have low conductivity and low acid neutralizing capacity characteristic of dilute, bedrock-dominated watersheds. This talk will present results of new statistical analyses of BSP surface water chemistry and compare trends in lake acidification or 'recovery' to those reported for ANP (a similar lake dataset with different landscape context and a coastal influence), and those reported throughout the Northeast. The results will be used to determine effective sampling strategies that might use the rich lake set within BSP for future geochemical and climate assessments.

9:30AM – 9:55AM

Julia Daly, *Ben Engel, Sara Adams*
Dept. of Geology, University of Maine at Farmington, Farmington, ME; dalyj@maine.edu

CONTROLS ON LAKE STRATIFICATION IN HIGH ELEVATION LAKES OF WESTERN MAINE

High-resolution water temperature data collected in fifteen high elevation lakes in western and central Maine reveal three types of summer stratification: 1) strongly stratified, 2) weakly stratified with extended periods of

mixing in late summer, and 3) moderately stratified and subject to short duration mixing events during summer months. The short duration mixing events are identified in simultaneous records at multiple sites, and correlate with the passage of high pressure systems over the region. Because each mixing event results in a net temperature increase of water on the bottom of the pond, the density contrast between the surface and the bottom is reduced, weakening the stratification and lowering the threshold for mixing during later weather events. The type of stratification correlates best with water transparency, and we are now beginning to examine the relationship between water color, dissolved organic carbon, and bedrock geology of each watershed. The water temperature data is collected year-round, and shows that, although these ponds may diverge in summer behavior, the onset of winter stratification is nearly simultaneous across all sites, corresponding to an abrupt and sustained drop in air temperature.

Session C

Citizen Participation in Natural Resource Science

Citizens in Maine are increasingly involved in a range of natural resource science activities, including testing lake water quality, mapping invasive species, documenting bird abundance, and identifying potential wildlife crossings. Presentations in this session will share research from citizen science activities in natural resource contexts. Projects may include but are not limited to those that analyze the reliability of data produced through citizen science, Science Technology Engineering and Math (STEM) learning outcomes, citizen-scientist collaboration models, and general lessons learned and best practices for program development and implementation.

SESSION CHAIRS

Laura Lindenfeld, University of Maine Department of Communication & Journalism and Margaret Chase Smith Policy Center

Laura Lindenfeld holds a Ph.D. in Cultural Studies from the University of California, Davis. She co-leads a research team on Maine's Sustainability Solutions Initiative (SSI) that develops and tests strategies for collaborating with stakeholders and communities and seeks to understand how these "knowledge-to-action" strategies can help create solutions to pressing sustainability issues. Her research focuses on interdisciplinary approaches to linking the production of scientific knowledge with action in Maine's communities, with a focus on civic engagement, science communication, and collaboration.

Bridie McGreavy, University of Maine Department of Communication and Research Assistant, Sustainability Solutions Initiative

Bridie McGreavy is a doctoral student in the Department of Communication and Journalism and a Research Assistant with Maine's Sustainability Solutions Initiative at the University of Maine. Her graduate research focuses on collaboration models and science communication and she is particularly interested in the ways people understand and make decisions about science information. Prior to joining the UMaine community in 2010, Bridie served as the conservation and education director for Lakes Environmental Association in Bridgton, Maine.

Session C: Citizen Participation in Natural Resource Science

MORNING SESSION

8:30AM – 8:55AM

***Jennifer Jespersen**, Laura Diemer*
FB Environmental Associates, Portland, ME ; jenj@fbenvironmental.com;
laurad@fbenvironmental.com

UTILIZING LOCAL VOLUNTEERS TO ORGANIZE AND IMPLEMENT A SUCCESSFUL FACE-TO-FACE SEPTIC AND STORMWATER SURVEY

Over the past several years, there has been an increase in the amount of algae in both Lake Wentworth and Crescent Lake in Wolfeboro, NH. The Lake Wentworth Foundation and the Town of Wolfeboro received a 319 Grant for High Quality Waters to develop a Watershed Management Plan for Lake Wentworth/Crescent Lake. A septic survey was designed to collect baseline information about the current state of septic systems within 250 feet of all waterbodies in the watershed, and to identify sources of stormwater runoff. The primary goals of the survey were to estimate phosphorus loading from developed areas in the watershed, and to educate watershed citizens about NPS pollution and how it affects lake water quality. The survey was led by FB Environmental Associates (FBE) with assistance from 21 resident volunteers over the course of 11 days in August and September 2011. Volunteers from organized “shores” around the lakes served as a point of contact for the survey, hand-delivering postcards to their neighbors several days in advance, and spending several hours to a full day working with FBE to conduct the door-to-door survey. Absentee landowners received the survey by mail, email, and were offered an optional on-line survey. With volunteer assistance, this project resulted in a 54% and 88% success rate for the septic and stormwater survey, respectively. Results of the survey were used to estimate total phosphorus loading to the lakes from septic systems in the shorezone. The educational value of this face-to-face survey was extremely high.

9:00AM – 9:25AM

***Jeffrey Vieser,** Teresa Johnson, Jessica Jansuwicz, Gayle Zydlewski*
School of Marine Sciences, University of Maine, Orono, ME; Jeffrey.vieser@maine.edu;
teresa.johnson@maine.edu; jessica.jansujwicz@maine.edu; gayle.zydlewski@maine.edu

COOPERATIVE RESEARCH ON FISHES AND TIDAL POWER IN COBSCOOK BAY

Cobscook Bay is renowned for its strong tidal flows and has become a site of intense interest for marine hydrokinetic (MHK) device developers. The prospect of development brings with it an abundance of questions that need to be answered before, during, and after potential installations. Our research, in cooperation with local fishermen, focuses on generating baseline data of fish presence and general distribution throughout Cobscook Bay. Such data are important for understanding broad scale changes resulting from anthropogenic changes, such as the introduction of MHK devices. The impacts of these changes cannot be predicted, and as a result they pose challenging issues for those involved in decision-making related to MHK development. To address these uncertainties, we are working with community members to document fish presence and spatial distribution throughout the bay for two years. Before sampling began, we brought this research problem to the local fishermen to

gather information on how best to capture the diversity of the bay. Their knowledge combined with our initial ideas resulted in an approach that targeted a variety of habitats to document annual and seasonal presence and distribution of fishes. All data are being shared with local fishermen throughout the research process. Drawing on interviews and participant observation, we assess the impacts of including fishermen and other community members in our research, including the perceived benefits and challenges with this approach to better understand the benefits of balanced cooperation and involving community members in scientific research.

9:30AM – 9:55AM

Catherine R. Bevier*[1]*, *Maggie S. Shannon*[2]*, Jake Lukach*[3]*, Ruthie Hawley*[3]
1 Department of Biology, Colby College, Waterville, ME
2 Maine Congress of Lakes Association, Belgrade Lakes, ME
3 Colby College, Waterville, ME

COLLABORATIONS FOR EFFECTIVE LAKE MONITORING AND OUTREACH

The Belgrade Lakes region of central Maine is a popular destination for year-round and seasonal residents and summer tourists. Recently, declining water quality and documented infestations of invasive aquatic plants in three of the Belgrade Lakes have concentrated the concerns of property owners, local businesses, and conservation organizations on lake protection. Fortunately, this seven-lake region has also been the focus of research among Colby faculty and students for over 30 years, often in collaboration with five local lake associations and the Belgrade Regional Conservation Alliance. Recently, these local conservationists and the Maine Congress of Lake Associations (Maine COLA) have partnered with scientists at Colby College to investigate the causes of declining water quality, to engage citizens in stewardship of the lakes, and to strengthen efforts to mitigate infestations and contain the further spread of invasive plants. Education will play a key role in achieving these objectives. Using the Vital Signs Program of the Gulf of Maine Research Institute, Colby and Maine COLA will teach students in grades 5-8 to collect and properly record observations on the Vital Signs database. Vital Signs is the tool we will use to help students record data collected from their hands-on EYES ON THE WATER plant identification training. This in turn will help local groups monitor areas at high risk of infestation in all Belgrade Lakes. Students at watershed middle schools will participate in this project which will culminate hands-on plant identification and lake learning activities aboard floating classrooms owned by Colby and Maine COLA.

AFTERNOON SESSION

1:30PM – 1:55PM

Esperanza Stancioff*[1]*, *Beth Bisson*[1]*, Abraham Miller-Rushing*[2]*, Medea Steinman*[3]
1 Maine Sea Grant, University of Maine, Orono, ME; esp@maine.edu; beth.bisson@maine.edu
2 Acadia National Park, Schoodic Education & Research Center, Bar Harbor, ME; abe_miller-rushing@nps.gov
3 University of Maine Cooperative Extension, Franklin, ME; medea.steinman@maine.edu

SIGNS OF THE SEASONS: A MAINE PHENOLOGY PROGRAM - WORKING TO ENHANCE THE PARTICIPATION OF A DIVERSE VOLUNTEER COMMUNITY WHILE PROVIDING QUALITY DATA TO SCIENCE PARTNERS

Signs of the Seasons is an environmental monitoring and climate change education program for Maine citizens of all ages. Through the program, citizens contribute to scientists' understanding of the local effects of global climate change by observing and recording the phenology (seasonal changes) of common plants and animals living in their communities. The University of Maine Cooperative Extension and Maine Sea Grant coordinate the program in partnership with the Schoodic Education and Research Center at Acadia National Park, the USA National Phenology Network, Maine Audubon, the U.S. Fish and Wildlife Service in Maine, and Maine Maritime Academy. In this presentation, we will provide an overview of: (1) the program structure and educational materials we have developed to support a diverse community of volunteer participants with different educational needs and motivation for program participation; (2) the role of our program advisory committee of educators and collaborating scientists in balancing scientific and educational objectives and communicating with our volunteers; and (3) our relationship with the USA National Phenology Network for online data management and analysis, and using/developing standard monitoring protocols for nationwide data compatibility.

2:00PM – 2:25PM

Scott Williams, *Roberta Hill*
Maine Volunteer Lake Monitoring Program, Auburn, ME; scott.williams@mainevlmp.org

THE ROLE OF CITIZEN SCIENCE IN MONITORING THE HEALTH OF MAINE LAKES: A SUCCESSFUL FOUR DECADE EXPERIMENT

Formed in 1971, Maine's Volunteer Lake Monitoring Program (VLMP) is the longest standing statewide citizen lake monitoring program in the U.S., as well as one of the largest, with more than 1,000 active certified volunteers monitoring approximately 500 lakes statewide. The VLMP trains, certifies and provides technical support to volunteers throughout Maine who gather a wide range of scientific information on the health of Maine lakes. Volunteers are trained to monitor indicators of water quality, watershed health and function, and to screen lakes for invasive aquatic flora and fauna. A substantial percentage of what is known about Maine's lakes and ponds is the result of years of commitment by VLMP volunteers, many of whom have been active in the program for a quarter century, or more. With several thousand bodies of water spread across a large geographic area, VLMP founders recognized that it would only be financially feasible to gather and track long-term trends in Maine's lakes if the public could be engaged in the process. Moreover, in order for "citizen science" data to be credible and effective, and for the program to be sustainable, strict quality assurance protocol would be required at all levels of information gathering. During its four-decade history, the VLMP has encountered and successfully overcome a number of challenges, while experiencing nearly continuous growth and expansion of the number of volunteers and lakes in the program, and the indicators of lake health monitored. Maine's VLMP has been internationally recognized for its innovation, effectiveness, and leadership, as well as for its unique contribution to the increasingly important endeavor of citizen science.

Session C: Citizen Participation in Natural Resource Science

2:30PM – 3:00PM

BREAK— AUDITORIUM

3:00PM – 3:25PM

Hannah Webber*[1]*, *Bill Zoellick[1], Sarah Nelson[2], Beth Bisson[3]*
1 SERC Institute, Winter Harbor, ME; hannah@sercinstitute.org
2 Senator George J. Mitchell Center, University of Maine, Orono, ME; sarah.nelson@umit.maine.edu
3 Maine Sea Grant, University of Maine, Orono, ME; beth.bisson@maine.edu

A FRAMEWORK FOR PARTNERSHIP: SUPPORTING SCIENTIFIC RESEARCH GOALS AND FORMAL EDUCATION

For the past five years the Schoodic Education and Research Center (SERC) Institute, with partners the Senator George J. Mitchell Center and Maine Sea Grant at the University of Maine, has engaged high school teachers and students in fieldwork to collect samples and data used in a study of spatial patterns of mercury (Hg) and methylmercury (MeHg) across the northeastern U.S. This program's success in producing useful scientific research data and achieving formal science education outcomes has resulted in new funding for both the scientific work and the education work. Core elements of the framework that are essential to the success of this kind of participatory science are: (1) structuring research designs to ensure that data collected by students are scientifically useful; (2) promoting and supporting student research questions that differ from the research undertaken by working scientists; (3) developing pedagogical strategies to guide student research; and (4) supporting peer review and publication or presentation of student research. An integrated research project in a formal education setting requires strong partnerships between researchers and teachers. Development and maintenance of such partnerships generally falls outside the purview of both teachers and scientists. Creating durable partnerships requires facilitated collaboration with sustained teacher-scientist interactions and teacher professional development. We present the Acadia Learning Project's framework as a case study in facilitated collaboration lessons learned and new directions.

3:30PM – 3:55PM

Leslie Latt
Wayne Conservation Commission, Wayne, ME; lslltt@aol.com

THE WAYNE AND READFIELD VERNAL POOL MAPPING PROJECT: A COMMUNITY ENDEAVOR

Natural resource protection and private property rights often knock heads. In 2007, a law regulating development in a 250 foot consultation zone around Significant Vernal Pools was implemented with the burden of determining a pool's significance placed on the landowner. "Significant" vernal pools are those with exceptional wildlife value judged in part by counting egg masses of obligate amphibian species. To reduce the burden on landowners, the Wayne and Readfield Conservation Commissions partnered with Kennebec Land Trust and the University of Maine at Orono to offer free surveys of potential vernal pools in the two towns. High quality color infrared aerial photographs of potential vernal pools were acquired and local citizen scientists were trained to identify and count amphibian egg

masses. Greater than 540 potential vernal pools were identified and 110 landowners took advantage of free surveys. This proactive approach conserves a valuable natural resource, minimizes frustrations for landowners, provides a valuable educational opportunity for local residents and fosters cooperation between towns and agencies.

Session D

Freshwater Fish Habitat Research and Restoration

Although many of Maine's native coldwater fish species historically thrived throughout a diversity of aquatic habitats, over 30% of lake subwatersheds today maintain greatly reduced native populations due to impacts from non-native fishes and habitat degradation from land-use changes, forestry and agricultural practices, and urbanization. This session focuses on recent efforts to enhance the quality of native fish habitats using many new site-specific restoration techniques and a better understanding of pond and stream habitat dynamics. Topics include stream and pond eco-hydro-geomorphic interactions, riparian influences, in-channel restoration, fish population studies, nutrient assessment, and water quality as habitat.

SESSION CHAIRS

Barbara S. Arter, Diadromous Species Restoration Research Network, Senator George J. Mitchell Center, University of Maine

Barbara S. Arter serves as the Science Information Coordinator for the University of Maine's Diadromous Species Restoration Research Network as well as a senior watershed specialist for BSA Environmental Consulting. Ms. Arter holds degrees in forest management and riparian forest ecology. After twenty years of college teaching, research management, and administration, Ms. Arter currently focuses her efforts on strengthening collaborative watershed conservation, restoration, and planning throughout the state of Maine. For the past fifteen years she has provided consultation to numerous state and federal agencies and conservation organizations on the topics of fish habitat restoration, watershed science and planning, bay management, landuse planning, and water quality assessment.

Merry Gallagher, Division of Fisheries and Hatcheries, Maine Department of Inland Fish and Wildlife

Merry Gallagher is a stream ecologist with over 15 years experience in stream survey methodology, native fish ecology, and landscape/GIS data analysis. She has worked for the MDIFW as a Research Biologist since 2001. She oversees a statewide effort to survey and assess stream habitats, document wild brook trout populations and improve the general knowledge regarding the distribution of Maine's native fishes. Merry manages MDIFW's stream survey database and has overseen the effort to convert historically collected fisheries data into GIS compatible formats. She is Maine's representative for the Eastern Brook Trout Joint Venture and the Northeast Rivers and Streams Technical Committee. Merry has a B.A. in Biology from the State University of New York-Albany and a M.S. in Zoology from the University of Maine.

Benjamin Naumann, Fisheries Biologist, Natural Resources Conservations Service

Ben Naumann is a native Mainah', where he received most of his higher education from the Downeast school of hard knocks. However, he received a B.S. degree from Unity College and a M.Sc. at the University of Guelph in Ontario, Canada. He has worked in various fisheries positions from Alaska to Maine and in between. In the last three years, he has worked with Project SHARE (Salmon Habitat and River Enhancement) on stream connectivity and habitat enhancement projects. Currently he is the Fisheries Biologist for the NRCS (Natural Resources Conservation Services) and is working on stream connectivity and habitat enhancement projects within the Pleasant River Watershed of the Penobscot River Basin.

MORNING SESSION

8:30AM – 8:55AM

John Field[1]***,*** *Robert Richter*[2]
1 Field Geology Services, Farmington, ME; jfield@field-geology.com
2 Nextera Energy, Hallowell, ME

STREAM RESTORATION ON COLD STREAM AND ENCHANTED STREAM NEAR THE FORKS, ME

Stream restoration was undertaken on Cold Stream and Enchanted Stream near the Forks, ME to improve aquatic habitat on two streams severely degraded by a legacy of log drives. As a result of log drives, both streams were artificially straightened with boulders and wood removed from the channels, leaving few pools or little habitat complexity. The streams are reforming meanders naturally as wood and boulder obstructions become established in the channel. Complete natural recovery was inhibited by the presence of berms and dam fill blocking access to the adjacent floodplains. With energy focused in the channel, the natural retention of wood in the channel is difficult and habitat improvements not sustained. Restoration efforts on the streams have focused on the removal of constraints preventing floodplain access and the introduction of wood and boulders in the channels. Boulder weirs and sills have been constructed in such a way to encourage flow to be diverted into the banks and on to the floodplain in order to encourage meander formation along the straightened channels. The reestablishment of floodplain access has allowed flows to access side channels and recreate meanders naturally. The restoration of Cold Stream and Enchanted Stream demonstrates the value of mimicking natural channel processes as an effective approach for improving aquatic habitat on streams heavily altered by a long history of log drives.

9:00AM – 9:25AM

Stephen M. Coghlan Jr., *Paul D. Damkot*
Department of Wildlife Ecology, University of Maine, Orono, ME; stephen.coghlan@umit.maine.edu;

EFFECTS OF LARGE WOODY DEBRIS ADDITION ON BROOK TROUT AND IN-STREAM HABITAT IN WESTERN MAINE

We tested effects of large woody debris (LWD) addition on habitat and wild brook trout in twelve 1st – 2nd order streams in the Mahoosuc Range of western Maine. In 2007 and 2008, we treated ~2 km

stretches of six streams at a rate of 40 LWD pieces/200 m; six streams served as reference sites. Brook trout sampling occurred twice yearly and habitat surveys occurred yearly. We sampled all streams 1–3 times prior to, and 5–8 times subsequent to, LWD addition. Natural abundance of LWD was low (mean ± 2 S.E.: 1.1 ± 0.6 pieces/200m). Two years after LWD addition, treatment sites contained twice the abundance of LWD as reference sites (19 ± 3.6 pieces vs. 8.5 ± 2.8), but abundance of pools did not differ (12 ± 1.5 vs. 13 ± 1.7 pools/200 m). Brook trout density (range: 0.02 ± 0.001 fish/m^2 to 0.47 ± 0.15) and biomass (range: 0.3 ± 0.15 g/m2 to 6.1 ± 2.9) was highly variable over time and among sites, and effects of LWD were not clear. In five of six treated sites, trout abundance and density declined sharply after treatment but recovered above pre-treatment levels three years subsequent, but metrics in most reference streams also increased. By the 4th year post-treatment, there were few differences between treated and reference sites. A longer time series is necessary to evaluate the efficacy of LWD addition, but these results suggest little impact on brook trout.

9:30AM – 9:55AM

Paul Damkot, *Stephen M. Coghlan, Jr.*
Department of Wildlife Ecology, University of Maine, Orono, ME; paul.damkot@umit.maine.edu;

THE INFLUENCE OF RIPARIAN FOREST CHARACTERISTICS ON ALLOCHTHONOUS INVERTEBRATE INPUT AND BROOK TROUT (*SALVELINUS FONTINALIS*) DIET IN HEADWATER STREAMS

The importance of terrestrial invertebrates as an energy subsidy for stream dwelling salmonines has been acknowledged widely. However, relatively little research has been conducted to examine the connection between riparian vegetation and allochthonous invertebrate input. We investigated the influence of riparian forest characteristics on invertebrate infall in seven headwater streams of western Maine and northeastern New Hampshire across a gradient of deciduous and coniferous stand dominance. Additional riparian vegetation metrics included canopy closure, understory cover and ground cover. We used principal component analysis to collapse riparian data into independent variables representing variation in riparian forest structure. These data, along with weather variables wind and rain, were then used to test for differences in the availability and consumption of allochthonous invertebrates. We collected terrestrial and aerial (i.e. winged adult) invertebrates using pan traps, drifting invertebrates using drift nets, and brook trout diet samples by gastric lavage. Sampling was conducted during three time intervals in the summers of 2008 and 2009: late May/early June, mid-July, and late August. We found that streams with high PC1 scores (deciduous dominated stands with low canopy closure and high ground cover) had significantly higher terrestrial invertebrate infall and consumption, while aerial invertebrate availability and consumption was influenced by both riparian conditions and wind. These results suggest that while riparian forest structure may have an impact on allochthonous energy input, environmental factors may be equally as important in determining the benefit to brook trout populations.

AFTERNOON SESSION

1:30PM – 1:55PM

Douglas B. Stewart
Stantec Consulting, Topsham, ME; doug.stewart@stantec.com

EAST BRANCH OF GREENLAW BROOK RESTORATION

During base closure activities at the former Loring Air Force Base in Limestone, Maine, contaminated sediment was removed from a 2.5-mile section of the East Branch of Greenlaw Brook, a high value brook trout (*Salvelinus fontinalis*) stream, and 35 acres of associated floodplain wetlands. The sediment removal removed approximately 132,000 cubic yards of contaminated sediment. Stream and wetland restoration immediately followed each stage of the removal action. The 2.5-mile stream restoration consisted of reconstructing the stream channel using gravel and boulders from a nearby quarry and woody materials from site clearing and grubbing. Stream structures were installed to create diverse aquatic habitat and included wing deflectors, log deflectors, log banks, cover logs, and cover boulders. Restoration of the floodplain wetland habitat consisted of re-soiling the site with native topsoil and confirming that wetland hydrology was adequate for the planned assemblage of wetland communities. Installed terrestrial habitat restoration features included coarse woody debris and vertical snags salvaged from site clearing. Revegetation of the site included transplanting over 20,000 trees and shrubs from other areas at the former base. The site was seeded with annual rye grass to establish herbaceous cover and mulched with a weed free straw of wetland hay. Following 10 years of intense long-term monitoring, the stream channel remains stable, the native brook trout population has been restored, and the stream supports a variety of other fish and aquatic fauna. The wetland communities provide habitat for many wetland-dependant species, and the wetland functions and values have been successfully restored.

2:00PM – 2:25PM

Deane VanDusen, Charles Hebson
Maine Department of Transportation, Environmental Office, Augusta, ME; deane.vandusen@maine.gov

IN THROUGH THE OUTLET: GETTING TO CULVERT RULES FOR THE STATE OF MAINE

The development by Maine DEP of new culvert rules that better promote effective fish passage has followed a frustrating and tortuous path. The old culvert rules were generally conceded to be vague and ineffective, with the result that Federal regulations were the primary vehicle for achieving fish passage in culvert projects. In 2010 Maine DEP made two attempts at rules that were better aligned with current understanding of the issue. Both attempts failed in the stakeholder process amidst irreconcilable differences between environmental objectives, cost, and the real difficulties that municipalities would face in compliance. The State Legislature subsequently directed Maine DOT to facilitate a new stakeholders process towards resolving the question of state standards for culvert design. MaineDOT is approaching this from the perspective of a comprehensive Aquatic Resources Management Strategy (ARMS), kicked off in November 2011. This approach was pioneered in the Pacific Northwest

and is new to Maine. The aim is to place culvert expectations in the wider context of statewide aquatic resources. We report on our experience to date and implications for the development of new state culvert rules.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

***Wesley Ashe*[1]** *(M.S. Student), Stephen Coghlan[1], Joan Trial[2], Joseph Zydlewski[3]*
1 Department of Wildlife Ecology, University of Maine, Orono, ME; wesley.ashe@umit.maine.edu; stephen.coghlan@umit.maine.edu
2 Maine Department of Marine Resources, Dept. of Sea-Run Fisheries and Habitat, Bangor, ME; joan.trial@maine.gov
3 USGS, Maine Cooperative Fish & Wildlife Research Unit, Orono, ME; jzydlewski@usgs.go

ATLANTIC SALMON (*SALMO SALAR*) GROWTH AND SURVIVAL AS AN INDICATOR OF HABITAT QUALITY IN TRIBUTARIES OF THE MACHIAS RIVER WATERSHED

The Machias River, located in downeast Maine, harbors one of the few remaining wild populations of Atlantic salmon (*Salmon salar*) in the U.S. and provides a model system for investigating the productive capacity of headwater streams currently inaccessible to wild juvenile salmon because of impassable culverts. In spring 2010 and 2011, we scatter-stocked salmon fry in twenty study reaches and quantified growth and survival across multiple environmental gradients. In late summer, fry abundance per 100m reach averaged 40 and 62 individuals (2010 and 2011, respectively) and ranged from 0 to 225 fry. Mean mass of fry at time of capture was 1.5 g and 1.6 g, and ranged from 0.6 to 2.7g; whereas mean length at time of capture was 54.0 mm and 55.5 mm and ranged from 40.5 to 70.4 mm. Apparent survival among sites ranged between 0 and 50.5%, with yearly means of 13.7 and 13.4%. Mean density was 0.33 and 0.32 fry/m^2 and ranged from 0.00 to 1.21 fry/m^2. Mean biomass was 0.46 and 0.55 g of salmon tissue/m^2 and ranged from 0.00 to 2.15 per reach. Of the habitat variables measured, temperature, brook trout density, interstitial space availability, coarse wood abundance, percent detritus and percent cobble were correlated most strongly with growth and survival. We anticipate results that will validate the importance of headwater streams as critical nursery and rearing habitat for juvenile salmon, thus providing the impetus toward culvert removal and the reestablishment of watershed connectivity.

3:30PM – 3:55PM

Karen Wilson*[1]*, *Graham Sherwood*[2]
1 Department of Environmental Science, University of Southern Maine, Gorham, ME; kwilson@usm.maine.edu
2 Gulf of Maine Research Institute, Portland, ME; gsherwood@gmri.org

YOU ARE WHAT YOU EAT: USING STABLE ISOTOPES TO ASSESS FRESHWATER AND MARINE FOOD WEB CHANGE IN RESPONSE TO DAM REMOVAL

A primary objective of the Penobscot River Restoration Project is to improve anadromous fish passage between the upper reaches of the river and the nearshore marine environment. Increased connectivity is expected to positively impact resident biota in both marine and freshwater environments in part by providing food web subsidies from the adjacent ecosystem. In the freshwater system, spawning anadromous fishes (e.g., river herring) are expected to add marine-derived nutrients to lakes and rivers. In the marine system, it is expected that juvenile anadromous fishes out-migrating from freshwater nursery habitat will be consumed by nearshore marine predators (e.g., cod). In order to quantify linkages between these two systems, we are using stable isotopes to estimate energy flows before (this study) and after (future study) dam removals. Stable isotope studies are based on the idea that "you are what you eat" because isotope signatures of consumers reflect the isotope values of their prey, which in turn can be used to infer food chain level and habitat associations (in this case marine vs. freshwater). Pre-dam removal data collected in 2009-2011 shows strong isotopic distinctions between the freshwater and marine food webs. We found intriguing intermediate signatures in roving nearshore marine predators such as mackerel who are known to eat out-migrating juvenile river herring. This approach provides reliable and cost effective indicators of food web change in response to dam removals.

Session E

Evaluating Restoration Outcomes of the Penobscot River Restoration Project: An Assessment of Pre-dam Removal Conditions

To improve fish passage, several dam removal projects in Maine have been initiated in recent years. The Penobscot River Restoration Project is the largest scale effort in the region and among the more innovative, and holds great promise for improving access to hundreds of miles of river habitat for imperiled species such as river herring, shortnose sturgeon, and Atlantic salmon. Substantial progress has recently been made toward characterizing pre-dam removal conditions in the Penobscot River and adjoining components of the Gulf of Maine. This session includes presentations from researchers working in the Penobscot River watershed who are assessing fish passage, the ecosystem effects of dams, ecosystem restoration, and related socioeconomic issues.

SESSION CHAIRS

Rory Saunders, National Marine Fisheries Service, NOAA

Rory Saunders is a fisheries biologist who focuses on ecological relations among diadromous fish populations, particularly those impacted by anthropogenic perturbations. His recent areas of focus include developing and implementing monitoring strategies for the Penobscot River Restoration Project and the Sedgeunkedunk Stream restoration project; the development of an ecosystem survey in the Penobscot estuary; the development of NOAA's fish passage improvement strategy for endangered Atlantic salmon Maine; and serving on the U.S. delegation to the North Atlantic Salmon Conservation Organization (NASCO).

Charlie Baeder, Penobscot River Restoration Trust

Charlie Baeder joined Penobscot River Restoration Trust as science and monitoring coordinator after working in river and fisheries restoration, and in land conservation. He has worked on river and habitat connectivity issues including culvert replacement and dam removal projects, barrier surveys, the Maine Interagency Stream Connectivity Work Group, and on efforts to pass a culvert bill in the Maine Legislature. Prior to conservation, he worked in project management and in human resources. He attended Colby College where he earned degrees in Sociology and in Human Development.

Session E: Evaluating Restoration Outcomes

MORNING SESSION

8:30AM – 8:55AM

Oliver Cox
Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Bangor, ME; oliver.n.cox@maine.gov

PRE-DAM REMOVAL TRENDS IN ATLANTIC SALMON (*SALMO SALAR*) ADULT RETURNS TO THE PENOBSCOT RIVER

The Penobscot River has been a strong hold for Atlantic salmon (*Salmo salar*) in New England since 1969, accounting for 66% of documented adult returns. The Penobscot River has been monitored near head-of-tide for over 40 years to document age, origin, and return rates of Atlantic salmon and to collect brood stock for the stock enhancement program. A trapping facility was first established at the Bangor Dam in 1969 and relocated located at the Veazie Dam in 1978 following the breach of the Bangor Dam. Long-term trends on the number of returning adults, return rates, and population demographics will be presented.

9:00AM – 9:25AM

Ian Kiraly[1] *(student), Stephen Coghlan Jr.*[1]*, Dan Hayes*[2]*, Joseph Zydlewski*[3]
1 University of Maine, Orono, ME; ian.kiraly@umit.maine.edu; stephen.coghlan@umit.maine.edu
2 Michigan State University, East Lansing, MI; hayesdan@msu.edu
3 U.S. Geological Survey, Maine Cooperative Fish & Wildlife Research Unit, Orono, ME; jzydlewski@usgs.gov

QUANTIFYING THE STRUCTURE OF FISH ASSEMBLAGES IN THE PENOBSCOT RIVER IN ORDER TO ASSESS CHANGE DUE TO DAM REMOVAL

The Penobscot River once provided spawning and juvenile rearing habitats to migratory fish. The construction of dams blocked migrations of these fish and fragmented habitats, changing the structure of fish assemblages throughout the river. The Penobscot River Restoration Project (PRRP) is anticipated to increase passage of anadromous and resident fishes and improve the connectivity among currently fragmented habitats. The purpose of this study is to quantify and characterize fish assemblages in the lower ~70 kilometers of the Penobscot River so we can quantify changes that occur post-dam removal. Boat electrofishing surveys were conducted during 2010 and 2011, in both the early summer and fall. During most seasons, we employed two different sampling designs. Fixed sampling was conducted along eleven pre-established transects (1000 meter). Stratified-random sampling was conducted along multiple randomly selected transects (500 meter) per stratum, within nine strata. Sampling effort for each design was sufficient to adequately assess fish assemblages, and neither design provided significantly different results. Fish assemblage structure differed by strata, especially with increasing distance upstream. Many diadromous fishes were restricted to tidal waters below Veazie Dam, although Atlantic salmon, sea lamprey, and American eel were captured or observed upstream. Species richness was relatively high below Veazie Dam, but was consistently low in the

stratum above the dam. Smallmouth bass, chain pickerel, and white sucker were well distributed throughout the river, along with a variety of smaller fish species, many of which exhibited spatial, seasonal, and annual patterns in abundance.

9:30AM – 9:55AM

***James Hawkes*[1], *Gayle Zydlewski*[2], *Joe Zydlewski*[3], *Graham Goulette*[1], *John Kocik*[1]**
1 NOAA Fisheries, Orono, ME; James.Hawkes@noaa.gov; Graham.Goulette@noaa.gov
2 School of Marine Sciences, University of Maine, Orono, ME; gayle.zydlewski@maine.edu
3 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME; jzydlewski@usgs.gov

ACOUSTIC TELEMETRY: AN ESTABLISHED MONITORING TOOL FOR ASSESSING PRE-DAM REMOVAL CONDITIONS FOR DIADROMOUS FISHES OF THE PENOBSCOT RIVER

Acoustic telemetry is a modern research tool that allows researchers to remotely monitor tagged animals. Passive fixed position receiver networks collect temporal data to provide information on migration behavior, routes, areas of high mortality as well as seasonal activity patterns of individual animals. The National Oceanic and Atmospheric Administration, University of Maine and United States Geological Survey have deployed an extensive array of more than 100 telemetry receivers in the Penobscot River, estuary and Bay each year since 2005. This array has been used to monitor several diadromous fish species, including Atlantic salmon and shortnose sturgeon that are protected under the US Endangered Species Act. Additionally, with the Penobscot River Restoration Project in early planning phases, research on pre-restoration fish ecology was particularly important. As a result, data collected since 2005 have been used for risk assessment of proposed in-stream construction and repair or removal activities which may threaten fish during migration periods or sensitive periods during their life history. Additionally, these data provide documentation of habitat use of fish prior to dam removal and other proposed restoration activities. Once dam removal has occurred we will be able to identify any changes of habitat use, behaviors and migration corridors as species are reintroduced to areas that have been inaccessible for decades.

AFTERNOON SESSION

1:30PM – 1:55PM

***Matthew Altenritter*[1], *Gayle Zydlewski*[2], *Kevin Lachapelle*[1], *Matthew Wegener*[2], *Michael Kinnison*[1], *Joseph Zydlewski*[3]**
1 School of Biology & Ecology, University of Maine, Orono, ME; matthew.altenritter@umit.maine.edu
2 School of Marine Sciences, University of Maine, Orono, ME; gayle.zydlewski@maine.edu
3 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME; jzydlewski@usgs.gov

SHORTNOSE STURGEON OF THE PENOBSCOT RIVER

The presence of shortnose sturgeon the Penobscot River was confirmed in 2006. Since this time, seasonal movement patterns and use of the upper river (near the first dam) have been documented using

acoustic telemetry. Two methods, mark-recapture and acoustic imaging, have been used to independently estimate abundance. Mark-recapture estimates have been made during summer and fall when tagged shortnose sturgeon are not observed migrating in or out of the Penobscot River. During winter, shortnose sturgeon also form dense aggregations (located via telemetry) that can be estimated using acoustic imaging and spatial interpolation. Winter data analyzed for 2010 using a kriging spatial interpolation produced a preliminary estimate of 681 individuals (446-1506 95% CI), comparable to previous fall mark-recapture estimates of 641 individuals (399-1074 95% CI) for 2008 and 602 individuals (410-911 95% CI) for 2009. Similar data will be presented for fall/winter 2011. Currently, spawning of shortnose sturgeon is undocumented in the Penobscot River, although the presence of both late stage females and suitable spawning habitat have been documented. Movements of these fish to the Kennebec River may indicate a complex reproductive migration pattern. Characterizing the movements, reproductive patterns, and population size of shortnose sturgeon in the Penobscot River provides a baseline for assessing the impact of the Penobscot River Restoration and will inform the status of sturgeon populations throughout the Gulf of Maine.

2:00PM – 2:25PM

P.J. Erbland*[1]*, *Gayle Zydlewski*[1]*, Joseph Zydlewski*[2]*, J.E. Hightower*[3]
1 School of Marine Sciences, University of Maine, Orono, ME; patrick.erbland@maine.edu; gayle.zydlewski@maine.edu
2 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME; jzydlewski@usgs.gov
3 U.S. Geological Survey, North Carolina Cooperative Fish and Wildlife Research Unit, Raleigh, NC

ESTIMATING PENOBSCOT RIVER FISH PASSAGE USING FIXED LOCATION SONAR

Dam removals and passage improvements by the Penobscot River Restoration Project are anticipated to improve connectivity and access for diadromous fish species in New England's second largest river. In order to assess changes in the fish community, we are using fixed location, side-aspect acoustics to estimate the number of fish passing a designated location below the head of tide on the Penobscot River. Our methods are similar to other North American efforts, however strong (3 m) tidal flux and tight restrictions on capture sampling (due to federally listed species) pose unique challenges. Since May of 2010 two Biosonics DTX, 200 kHz, split beam transducers, have been mounted on opposite sides of the river (rkm 35), sampling perpendicular to flow (excluding months of ice cover). Complementary sampling with Dual Frequency Identification Sonar (DIDSON) is being used to validate split beam data. DIDSON data also provide realistic imaging such that physical and behavioral characteristics may be used for taxonomic discrimination. Initial analysis indicates pulses of upstream moving fish following spring freshets and suggests these movements predominately occur between peak ebb and low tide. Methods will be discussed and fish passage estimates from the 2010 and 2011 field seasons will be presented in the context of documented environmental cues and clues to migration.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Michael O'Malley, *J. Stevens, R. Saunders, C. Lipskey, J. Kocik*
NOAA Fisheries, Orono, ME; Michael.O'Malley@noaa.gov

PRE-DAM REMOVAL MONITORING OF PENOBSCOT ESTUARINE FISH AND ZOOPLANKTON USING MOBILE SPLIT-BEAM HYDROACOUSTIC METHODS

We tested the feasibility of using multifrequency split-beam hydroacoustic techniques to evaluate the spatial and temporal variability of fish and zooplankton distribution in the Penobscot Estuary, Maine, prior to dam removals. We conducted mobile transects using downward-looking SIMRAD EK60 split-beam (38 and 120 kHz) to provide acoustic target strength and biomass distributions throughout the estuary. Using Sv dB differencing techniques to distinguish fish and zooplankton, we produced biomass (NASC) and single target detection target strengths estimates over large spatial and volumetric scales to investigate changes in distribution. Fish biomass and target strength distributions showed variation temporally during the survey period (May-June and Nov-Dec 2011) and spatially through the estuary on survey dates. Coordinated acoustic and pelagic trawl surveys conducted to perform validation experiments revealed that fish length frequencies and single target detections from hydroacoustics follow similar bi-modal distributions. Target strengths were assigned to sizes of fish and specific species following validation work. For example, in the trawl surveys on 06/21/2011, >90% of trawl catch were made up of *Alosa pseudoharengus*, *Alosa sapidissima* and *Alosa aestevalis*, allowing us to assign fish size/species to target strength on that date. Dam-removal upstream will likely cause changes in estuarine communities, and an expansion of methods to investigate changes in fish and zooplankton over larger spatial and temporal scales is warranted. The multifrequency split-beam method can provide fish and zooplankton biomass data over larger scales for relatively small investment over the long term.

3:30PM – 3:55PM

Edward P. Ames[1]***,*** *Karen Wilson*[2]*, Theo Willis*[2]
1 Penobscot East Resource Center, Stonington, ME; Bowdoin College, Brunswick, ME; ted.ames7@gmail.com
2 University of Southern Maine, Portland, ME

HISTORICAL ALEWIFE PREDATION BY FOUR GADIDS, ATLANTIC COD (*GADUS MORHUA*), HADDOCK (*MELANOGRAMMUS AEGLEFINUS*), WHITE HAKE (*UROPHYSCUS TENUIS*), AND POLLOCK (*POLLACHIUS VIRENS*) IN MUSCONGUS BAY AND PENOBSCOT BAY

Recent studies document increasing precipitation and streamflow in the Northeastern United States throughout the 20th-21st centuries. Low flow quantiles like the annual minimum and median flows have increased significantly over the period on many New England rivers with dominantly natural streamflow, as have annual peak discharges—especially for smaller, more frequent floods. In order to better investigate the high frequency flooding trends (events occurring at least once every five years), this study analyzes the partial duration flood series for 23 of these New England rivers. The study rivers have continuous records through 2006 and an average period of record of around 70 years, with a minimum of 59 years and a maximum of 81 years. Eighteen rivers show positive trends in flood

magnitude using the Mann-Kendall non-parametric trend test. Six of these trends are significant at $p<0.1$. We also investigate a potential hydroclimatic shift in the region around 1970. Twenty-two rivers show increased numbers of partial duration series floods per year in the post-1970 period when comparing pre- and post-1970 records using the non-parametric Wilcoxon rank sum test. Thirteen of these increases are significant at $p<0.1$. On average, each river has approximately one more flood per year above the gauge threshold value. Because frequent floods are important channel-forming flows, these results have significant implications for channel and floodplain geomorphology, as well as aquatic habitat.

Session F

Pollutants and Remediation: New Approaches and Green Solutions

This session will present new developments in environmental remediation technologies and applications to contaminated water and land. This includes topics related to green remediation, waste water treatment, brownfields re-development, and new policies. Case studies directly related to these topics will be included.

SESSION CHAIRS

John Peckenham, Senator George J. Mitchell Center and Maine's Sustainability Solutions Initiative, University of Maine

John M. Peckenham is the Director of the Maine Water Research Institute and Assistant Director of the Senator George J. Mitchell Center at the University of Maine. He works as part of the Maine Sustainability Solutions Initiative on topics such as drinking water quality and public water supply, natural groundwater contaminants (such as arsenic and antimony), water resource management, remediating contaminated water and soil, and science education and outreach. He is a managing partner of Maine Water Security, LLC (drinking water security company) and is a Water Quality Consultant (Maine Certified Geologist). John is a Graduate of Bates College (Geology) and Dalhousie University (Geology and Geophysics).

John Ahern, Department of Chemistry, University of Maine

John Ahern is an environmental chemist from the rural town of Boxborough, Massachusetts. He obtained his Bachelor's degree in Environmental Science and Chemistry at Wheaton College and is cuurently in his second year of graduate school at the University of Maine for a Ph.D. in Chemistry. He found a good fit with the Patterson research group which specializes in evironmental monitoring via fluorescence spectroscopy. His thesis research aims to develop more rapid and cost-effective methods of breaking down petrochemical pollutants. He and fellow group member Jim Killarney have established a small business known as Fluorometrics that develops sensors and PARAFAC models to analyze surface water contamination.

Session F: Pollutants and Remediation

8:30AM – 8:55AM

***Andrew Carpenter*[1], *Scott Minor*[2]**
1 Northern Tilth, Belfast, ME; Andrew@northerntilth.com
2 Kennebunk, Kennebunkport and Wells Water District, Kennebunk, ME

FREEZE-DRYING WATER TREATMENT RESIDUALS: LOW COST PROCESSING TO IMPROVE RECYCLING OPTIONS

There are very few existing recycling programs for the semi-solid residuals generated during the treatment of drinking water in New England states. Aluminum sulfate, sometimes referred to as "alum" is commonly used as a flocculent in the treatment of drinking water. Because of the ability of aluminum sulfate to sorb phosphorus, much of the national research on recycling options for alum-containing water treatment residuals (WTRs) has focused on using the materials to reduce phosphorus availability in over-manured soils. Since 2003, Northern Tilth has worked with the Kennebunk, Kennebunkport and Wells Water District (KKWWD) to develop and manage a WTR recycling program in which their alum-containing WTR has been successfully used as a component in manufactured topsoils. The manufactured topsoil is used both by KKWWD and local contractors in place of stripped topsoil for landscaping projects.

After observing the improved physical properties of WTRs exposed to winter conditions, KKWWD developed a freeze-drying bed that relies on low winter temperatures to change the physical characteristics of their WTR from axel grease-like consistency, to a dry, soil-like product with a texture similar to coffee grinds. This processing innovation has improved the marketability of the manufactured topsoil which in turn has helped keep costs low for this unique recycling program. This presentation will focus on the development of the WTR recycling program from field trials to full-scale implementation, including topsoil recipe development and physical and fertility-based considerations of the manufactured topsoil.

9:00AM – 9:25AM

***John Ahern*[1], *Howard Patterson*[1], *Gregory Hall*[2]**
1 Department of Chemistry, University of Maine, Orono, ME; john.c.ahern@umit.maine.edu
2 Science Department, United States Coast Guard Academy, New London, CT

INVESTIGATION OF THE PHOTOCATALYTIC DEGRADATION OF CRUDE AND REFINED OILS WITH TiO_2 AND TiO_2/AG SUPPORTED ZEOLITES VIA PARALLEL FACTOR ANALYSIS

Nearly 3000 oil spills are reported to the Maine Department of Environmental Protection annually, mostly from overfilled fuel tanks and overturned tanker trucks.(Maine DEP Reports 2002-2006). This March a tanker overturned and spilled over 1000 gallons of diesel into the Pleasant River in Maine endangering a local salmon hatchery. Fish hatcheries are very sensitive to petrochemicals so it is essential to have a reliable way to break them down and to prevent their reintroduction to the environment after recovery operations during a future spill. The effectiveness of novel zeolite substrates doped with metals for the photocatalytic degradation of crude and refined oils at the ppm (µg/ml) level in fresh water samples has been assessed in a series of laboratory experiments. The dopants in the zeolites include TiO_2 with different stoichiometric amounts of Ag. Photodegradation kinetic experiments

have been performed using an excitation resolved synchronous scan fluorescence technique that the Patterson group has developed. Also, the photodecomposition products have been analyzed using Excitation Emissions Matrix (EEM) spectroscopy as well as GC-MS. Chemometric techniques including parallel factor analysis provide information about the kinetics of degradation of the different classes of organic compounds in oil and how different zeolites aid in this degradation. Data gathered thus far has shown degradation dependence on UV and zeolite exposure. The results will be used to develop the ideal zeolite catalyst system for the assisted photodegradation of crude and refined oils in fresh waters. This is an ongoing investigation.

AFTERNOON SESSION

1:30PM – 1:55PM

Allan H. Horneman, *Daniel B. Carr*
Sanborn, Head & Associates, Inc., Portland, ME; ahorneman@sanbornhead.com

IN-SITU REMEDIATION OF CHLORINATED SOLVENTS IN FRACTURED ROCK – APPROACH INFORMED BY DISCRETE FRACTURE NETWORK (DFN) INVESTIGATIONS AND PILOT STUDIES

This presentation will discuss findings of bench and field pilot testing of remedial alternatives at a fractured sedimentary rock site contaminated by chlorinated volatile organic compounds (CVOCs), principally trichloroethene (TCE) and its breakdown products. This is one of the few sites where the DFN approach has been employed by a U.S. based consulting firm.

Remediation of CVOCs in fractured rock has historically been addressed using technologies requiring relatively large energy inputs, intensive operations and maintenance, and perhaps relatively long, near interminable operating periods. However, these approaches have only had limited success in reducing groundwater concentrations due to matrix diffusion effects and other factors. Even where source zone remedies have been attempted, long-term migration control has been necessary to limit perceived risks associated with downgradient transport.

Pilot studies of enhanced biochemical degradation at this site have documented that even a modest one-time mass injection of carbon source amendment in a portion of the source area stimulated a two order of magnitude reduction in groundwater TCE concentrations for an extended period in the vicinity of the injection zone with more limited but still substantial improvements in downgradient water quality. The downgradient improvements coincided with a shift to geochemical conditions more conducive to biochemical degradation and transport of volatile fatty acids and bromide tracer.

We will present how the DFN investigation established a design basis for pilot testing. The findings support that stimulation of intrinsic processes is protective and more sustainable than alternatives such as groundwater extraction and treatment or in-situ thermal desorption.

Session F: Pollutants and Remediation

2:00PM – 2:25PM

Brian Bachmann, *Keith Taylor*
St. Germain Collins, Westbrook, ME; brianb@st.germaincollins.com

GREEN REMEDIATION OF PETROLEUM CONTAMINATED GROUNDWATER USING OXYGEN INJECTION IN WESTERN MAINE

Typically in Maine, petroleum contamination is remediated utilizing techniques that don't take into account energy consumption or the overall "carbon footprint" of the remedial option. Soil excavation is the most common method, while groundwater extraction and treatment is used for sensitive groundwater resources. Trucking contaminated soil has the obvious environmental impacts of fuel consumption and air emissions. Pump and treat groundwater systems consume large amounts of electricity for pumps and filters, and often generate wastes that requires special disposal.

At a site in western Maine, St.Germain Collins designed and implemented a green technology for groundwater treatment that consumed no electricity, generated no waste, and had a carbon footprint limited to vehicle use for periodic site visits. This system was based on the fact that petroleum hydrocarbons in groundwater are degraded by microbes naturally present in the subsurface. Biodegradation is often limited by a lack of oxygen, and to accelerate the process, St.Germain Collins installed a ten well oxygen injection system.

The effectiveness of the system was monitored by sampling five wells known to be contaminated. Before system startup, groundwater impacts were dominated by volatile petroleum hydrocarbons (VPH) with a high of 11,961 ug/L. After six months of operation, VPH at the same location was reduced to 4,599 ug/L. A similar pattern was observed across the Site with no significant rebound observed two months after system shutdown. Because of its effectiveness and minimal environmental impact, oxygen injection should be considered as a viable remedial method for petroleum contaminated groundwater in Maine.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

LaMarr Clannon
Maine NEMO, South Portland, ME; lcannon@maine.rr.com

LID POLLUTANT REMOVAL AND POTENTIAL COST SAVINGS: IT WORKS BETTER AND COSTS LESS

This presentation highlights results from the UNH Stormwater Center evaluation of several traditional BMP and LID systems for pollutant removal and cost of installation, and includes additional material from Antioch University and Virginia Commonwealth University on case studies comparing the cost of traditional stormwater treatment with LID methods on projects ranging from small subdivisions to CSO sewershed retrofits. Results show that LID techniques are superior for pollutant removal, perform well in cold climates and can save developers money in stormwater treatment.

3:30PM – 3:55PM

***Daniel J. Kary*[1], *Kathleen P. Bell*[2], *Shaleen Jain*[3], *Brian McGill*[4]**

1 Ecology and Environmental Science, University of Maine, Orono, ME; dankary@gmail.com

2 School of Economics, University of Maine, Orono, ME; kpbell@maine.edu

3 Department of Civil and Environmental Engineering, University of Maine, Orono, ME; shaleen.jain@umit.maine.edu

4 School of Biology and Ecology, University of Maine, Orono, ME; mail@brianmcgill.org

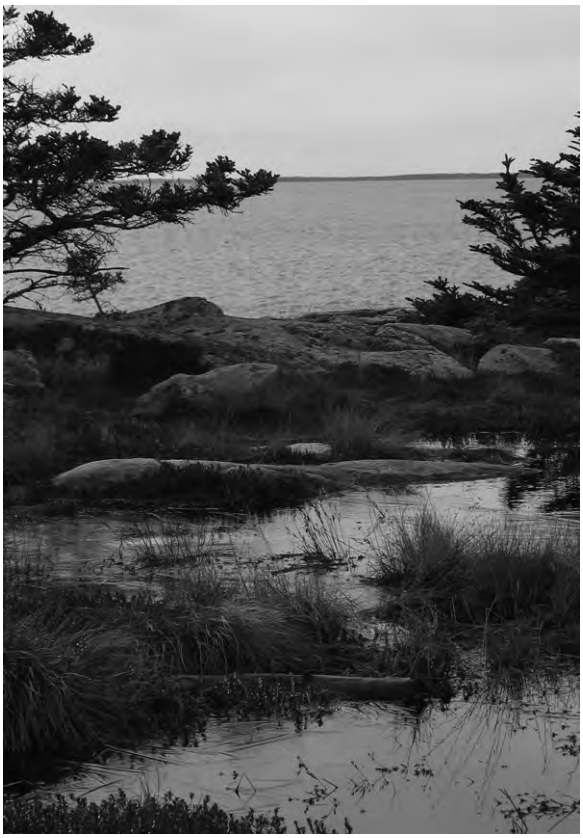
SIMULATING RESIDENTIAL DEVELOPMENT AND STORMWATER RUNOFF UNDER ALTERNATIVE POLICY SCENARIOS

Landscape changes from residential development lead to changes in water runoff patterns that may degrade water resources through altered hydrologic regimes and increased pollution.Water resource managers often seek to mitigate these impacts, but policy choices are complicated by uncertainty regarding how alternative strategies influence future outcomes. Economic models provide a framework for quantifying the landscape effects of policies that influence landowner decisions. Our objective was to develop and describe a method that links an econometric simulation model to a simple stormwater runoff model in order to estimate hydrologic outcomes of alternative land use policies. As an application of this method, we investigated how changes in a zoning regulation, minimum lot size, affects simulated residential construction and stormwater runoff in the city of Ellsworth, Maine. Our model results suggest that increased minimum lot sizes in the Branch Lake watershed lead to decreases in future residential construction and stormwater runoff within that watershed. However, our model also predicted increased construction and runoff in neighboring watersheds not subject to the increased zoning restriction (based on the assumption that neighboring watersheds will make up for the decreased housing supply in the restricted watershed). With this investigation we demonstrated one way in which our model can be used to gauge impacts of alternative policies and also highlighted the importance of regional planning in water resource management. This research was based upon work supported by the Maine Agricultural and Forestry Experiment Station, U.S. EPA, and the National Science Foundation (award # EPS-0904155).

Session G

The Influence of Climatic Changes on Maine Water Resources

Several published studies have shown the influence of historical climatic changes on the hydrology of the northeastern United States, including Maine. This session includes presentations that further define the impact of climatic changes in Maine, including analyses of historical lake ice-out and water quality trends, and modeling of future flood flows. The design of climate sensitive data collection networks will also be presented.



SESSION CHAIRS

Robert Lent, U.S. Geological Survey, Maine Water Science Center

Robert Lent has been a hydrologist with the U.S. Geological Survey (USGS) since 1990. Since 1998, he has served as the Director of the USGS Maine Water Science Center, where he oversees the scientific program. Trained in geology and geochemistry, Robert holds Ph.D. from the University of New Hampshire, as well as a M.S. from North Carolina State University. Recently, he has been coordinating the development of framework for a New England hydro-climatic monitoring network. In recent years he has also participated in several regional and national activities, including the Northeast Climate Assessment, the National Fish Wildlife and Plant Climate Adaptation Plan (OEQ), North Atlantic Landscape Conservation Cooperative (USFWS), and the New England Interstate Water Pollution Control Commission climate monitoring committee.

Glenn Hodgkins, US Geological Survey, Maine Water Science Center

Glenn Hodgkins has been working as a Hydrologist with the U.S. Geological Survey (USGS) since 1990. Much of his recent research has focused on historical trends in water-related variables such as river flows, river ice, lake ice, and snowpack, and on their relation with climatic variables; he is lead author or co-author on 29 journal articles and USGS publications in this area since 2002. Glenn received his Bachelors Degree in Civil Engineering from the University of Maine and Masters Degree in Engineering from Purdue University.

1:30PM – 1:55PM

Robert W. Dudley, Glenn A. Hodgkins
U.S. Geological Survey, Maine Water Science Center, Augusta, ME; rwdudley@usgs.gov, gahodgki@usgs.gov

HISTORICAL AND POTENTIAL FUTURE MODELED FLOOD FLOWS IN FOUR COASTAL MAINE RIVERS

Global climate models indicate annual precipitation and air temperature in the northeastern U.S. are projected to increase during the next century. Determination of the magnitude of peak streamflows is important for the safe and economical design of bridges and culverts. The USGS, in cooperation with Maine DOT, investigated potential future changes in peak flows at four basins in coastal Maine on the basis of projected changes in air temperature and precipitation. To calculate potential future peak streamflows at these basins, historical temperature and precipitation in the basins were adjusted to encompass projected climate-related changes. These adjusted meteorological data were input to Precipitation-Runoff Modeling System (PRMS) watershed models of the four basins and annual peak flows were output for each change scenario. PRMS-computed peak flows resulting from the adjusted meteorological data were then compared to unadjusted (historical/calibrated) PRMS-computed peak flows. Annual daily maximum peak flows change in different directions, depending on whether temperature or precipitation is adjusted; increases in air temperature lead to decreases in peak flows whereas increases in precipitation lead to increases in peak flows. In many cases where temperature and precipitation both increase, small (less than 25 percent) increases or decreases in annual peak flows result. The decrease in modeled peak flows with increasing air temperature, given no change in precipitation, is caused by decreases in winter snowpack.

2:00PM – 2:25PM

Kristin E. Strock[1], *Jasmine E. Saros[1], Sarah Nelson[2]*

1 School of Biology and Ecology and Climate Change Institute, University of Maine Orono, ME; Kristin.Ditzler@umit.maine.edu

2 Senator George J. Mitchell Center and Department of Plant, Soil, and Environmental Sciences, University of Maine, Orono, ME; sarah.nelson@umit.maine.edu

WHY CLIMATE MATTERS IN RECOVERY FROM ACIDIFICATION IN NORTHEASTERN US SURFACE WATERS

In New England, lake chemistry data from U.S. EPA long-term research and monitoring projects have been used to evaluate trends in surface water acidification and evidence for recovery in acid-sensitive regions in response to the Clean Air Act Amendments. The 2003 assessment of the success of the Clean Air Act Amendments documented sulfate (SO_4) declines in many surface waters but the response in acid neutralizing capacity (ANC) was not as expected, and varied among systems. A confounding factor in evaluation of these trends and expected response is variable weather, with major episodic excursions in surface water geochemistry driven by extreme events. We combined multi-variate and time-series statistical techniques to analyze acid-relevant surface water chemistry from a set of 400 lakes across Maine and New England. Trends in SO_4, ANC and dissolved organic carbon

(DOC) were related to watershed characteristics and climate variables over the past three decades by coordinating data analysis of legacy lake and streamwater data from US EPA long-term research and monitoring projects. New England lakes are some of the most affected by acidification and exhibiting some of the broadest variability in the DOC signal. DOC is one of the most important regulators of aquatic ecosystems, and also has important implications for drinking water treatment. Hence, clarifying the response of lake water SO_4 and DOC to extreme weather events, watershed characteristics, and SO_4 deposition is needed to interpret long-term assessments of success in meeting Clean Air Act Amendment goals in a region experiencing rapid changes in climate.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

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

CLIMATE RESPONSE NETWORK – STREAMWATER DISSOLVED ORGANIC CARBON AND TEMPERATURE

The U.S. Geological Survey, Maine Water Science Center has begun collecting water samples for analysis of dissolved organic carbon and measuring water temperature continuously at a network of streamflow gauging sites in Maine. These monitoring programs are designed to support and enhance the established Climate-Response Network in Maine where several hydrologic variables are regularly monitored and analyzed. Some of the sites in each network overlap with sites in other networks but each network includes some sites that are unique. Site selection was based on the availability of long-term records, ongoing data collection in support of other independent projects, and locations that were representative of Maine's hydrologic climate-response regions. Riverine dissolved organic carbon (DOC) concentrations and fluxes, and water temperatures are indicator variables that can be used to assess integrated watershed responses to climate variability. DOC integrates carbon cycling processes in terrestrial and aquatic ecosystems that have been shown to respond to changes in temperature, hydrologic conditions, wetland abundance and connectivity, and changes in vegetation and soils. Water temperature is related to air temperature and timing of snowmelt and is a key variable that defines habitat suitability for native and invasive species. These DOC and water temperature networks have been in operation for a little more than one year. In this presentation, preliminary data will be presented to illustrate the range of DOC and temperature spatial and temporal variability and individual watershed characteristics.

3:30PM - 3:55PM

Luther F. Schalk, Robert M. Lent, ***Glenn A. Hodgkins***
U.S. Geological Survey, Maine Water Science Center, Augusta, ME; gahodgki@usgs.gov

SPATIAL AND TEMPORAL CHANGES IN LAKE ICE-OUT DATES – IMPLEMENTING A NEW ENGLAND HYDROLOGIC CLIMATE RESPONSE NETWORK

The USGS Maine Water Science Center has developed a framework for a New England hydrologic climate response network designed to provide indication of changes in the seasonal hydrologic conditions for resource management. Lake ice-out dates are a key variable for detecting those changes. Lake ice-out dates are the annual Julian dates when winter ice cover leaves a lake. Previous work in New England has shown a strong correlation between ice-out dates and winter air temperatures.

Lake ice-out dates for at least 50 years are available from 43 lakes in New England. Each lake was mapped and attributed by 10-year average ice-out date for every decade between 1881 and 2010 in which it had at least six records. All lakes and climate response units demonstrated temporal change toward earlier ice-out dates, reflecting regional temporal change toward warmer winters.

Using inverse-distance weighting, a surface was generated from all available average date points in each decade. The contour corresponding to Julian date 120 (chosen to be common to all decades) was delineated along each surface, and its centroid was found. The 120-day centroid was found to move by decade throughout western Maine, thereby spatially quantifying the regional change in lake ice-out dates over time. During warm periods, the centroid moved north-northeast; during cool periods, it moved south-southwest. Over 130 years, it moved about 100 miles NNE.

Session H

Water Monitoring Results: Implications for Land Use and Conservation

We undertake water quality monitoring for many reasons that includes connecting land use practices to the health of our waters. Everybody wants more data and the goal of monitoring might be to: better understand the impact of our rural or urban landscape; determine water quality status; identify pollution sources; or prepare a watershed restoration plan. This session will cover salt, biological monitoring, wetlands, bacteria, threshold detection and potentially look at how much monitoring is enough, with a special focus on connecting land use practices to water quality and conservation.

SESSION CHAIR

Melissa Evers, Maine Department of Environmental Protection

Melissa Evers works as a fisheries and aquatic biologist, including work with charismatic mega fauna, the Atlantic salmon, in Maine's undeveloped rivers. Her current challenges in Maine DEP's Division of Environmental Assessment include developing pollution assessments or TMDL's for Maine's degraded and undervalued streams.

1:30PM – 1:55PM

Tom Danielson, *Doug Suitor, Leon Tsomides, Jessica Balukas*
Maine Department of Environmental Protection, Augusta, ME; thomas.j.danielson@maine.gov

IMPERVIOUS COVER THRESHOLDS FOR MAINE STREAM MACROINVERTEBRATES

Recent studies have documented the impacts of urbanization and increased impervious surfaces on the condition of streams. Urbanization can alter stream hydrology, geomorphology, temperature, chemistry, and composition of biological communities. The Biological Monitoring Program is completing its study of the effects of urbanization and impervious cover (IC) on Maine's stream macroinvertebrates. We sampled benthic macroinvertebrates from 148 sample locations across the state ranging from minimally impaired to urban. We delineated watersheds upstream of sample locations using ArcMap and calculated % urban and % IC for each watershed. We compared IC estimates generated with two spatial layers with 5 m and 1 m resolution. The spatial resolution of IC layers matters. In general, the finer

resolution IC data produced larger % IC estimates in rural areas and smaller estimates in urban areas. Effects on the macroinvertebrate community are observable at low amounts of IC (<3%). We identified % IC thresholds for Class AA/A, B, and C streams that can be used as targets when developing stream restoration or land use plans. In addition, we calculated % developed and % IC for riparian corridors of 23, 50, 100, 200, and 400 m. Location of IC in a watershed matters. In general, watersheds with development close to the streams had poorer quality macroinvertebrate communities than streams with intact riparian corridors.

2:00PM – 2:25PM

***Steve Kahl*[1], *Rob Roseen*[2]**

1 Sewall Company, Old Town, ME; steve.kahl@sewall.com
2 UNH Stormwater Center, Durham, NH

THE 2010 REPORT OF THE NEW HAMPSHIRE STORMWATER COMMISSION: THE END OF PIPES AND PONDS

Stormwater is widely recognized as one of the leading causes of water quality pollution and habitat degradation. The New Hampshire legislature established the New Hampshire Stormwater Commission in 2008 to identify issues and find socially-acceptable solutions for reducing impacts from stormwater runoff. After two years of study, the commission reported back with a variety of recommendations that addressed the underlying issues leading to stormwater, improvements to stormwater management, and reducing barriers to implementation of better management methods. The commission's main findings and recommendations are that: stormwater is only the symptom; impervious surfaces represent the disease that needs to be mitigated; imperviousness is probably more of an issue for flood frequency and magnitude than projections from climate change; policy must recognize that property owners are responsible for their own stormwater and the impacts; low impact development solutions for reducing imperviousness are less expensive to build and to maintain than traditional stormwater management methods; stormwater utilities, which are common nationally except in New England, provide a fair and effective mechanism to fund stormwater projects that will protect water quality.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Arthur Astarita
RCAP Solutions Inc., Peaks Island, ME; Aastarita@rcapsolutions.org

USE OF PRIVATE WELL WATER TESTING RESULTS HELP DETERMINE AQUIFER QUALITY, IDENTIFICATION OF FUTURE PUBLIC WATER SOURCES AND LAND-USE PLANNING MECHANISMS

Approximately 25% of New Englanders rely on private water wells. Away from the population centers such as New York and Boston, as high as 40% depend upon domestic wells. Some towns do not

have any, or sometimes very limited, public water and wastewater infrastructure. Increasingly, rural home buyers are inheriting well water and onsite wastewater systems without the knowledge of historical performance or previous experience for their operations or maintenance.

In Maine, RCAP Solutions worked with a town that actually appropriated funds to conduct aquifer health analysis for themselves. Private well water tests were obtained and analyzed to determine base-line contamination typical of an area. This information led to improved and focused water testing routines, indications of contamination sources and helped determine filtering and treatment options. GIS-supported water source protection by the use of data overlays show how potential public aquifers, wildlife habitats and recreational areas could coincide.

A win-win-win opportunity exists. Regardless of public water service existing, town officials wanted a detailed, ongoing review of their aquifer distribution and health to improve placement and category planning of various developments. Additionally, homeowners understood what contaminates to test in their water to ensure their health and consequently realize they have the responsibility of a “very small utility” operator. And lastly, financial institutions can benefit from this information to improve fair market value judgments of their mortgaged assets.

3:30PM - 3:55PM

***John Hopeck**, Mark Holden, Christian Halsted*
Maine Department of Environmental Protection, Augusta, ME; john.t.hopeck@maine.gov

SPATIAL ANALYSIS AND RISK MODELING OF ROAD SALT IMPACTS ON RESIDENTIAL WATER SUPPLY WELLS

This study expands on previous work by assessing the effect of road salt on residential well water quality in seventy-seven areas spatially distributed throughout Maine. The current research confirms the dependence of chloride concentration on slope and distance from road, includes additional factors in the analysis, and suggests a general method of risk analysis. Chloride-concentration data were obtained from pre-construction well sampling conducted by Maine DOT from 2003 through 2008; the risk model uses data from 968 wells, with outliers removed (after normalizing the data). Spatial analysis tools in ArcMap were used to consider the effects of source proximity, slope, slope direction, simplified hydrologic soil groupings, surficial geology, and bedrock geology on chloride concentration. The set of all normalized data shows a distribution pattern of chloride concentrations with distance from the road centerline, with highest concentrations occurring on the downslope side but within 75 feet of the centerline of the road. Distributions of chloride data from different sites appear to be skewed downhill as function of the slope; slopes were compared from one degree to greater than seven degrees in this analysis. Other significant differences are observed when sites were sorted by locally dominant hydrologic soil groups of A+B and C+D. Analysis of the significant factors is incorporated in an ArcMap application developed by DEP GIS to predict relative risk of chloride contamination.

Session I

Lake, Stream, and Wetland Water Quality

What's New with Maine's Inland Waters? Maine's lakes, streams and wetlands are jewels on our landscape providing us with opportunities for recreation/relaxation, and wildlife with essentials for survival. As our understanding of these complex, fragile ecosystems improve, we can make better decisions about protecting our waters. This session includes results of recent research, which will help with future protection strategies.

SESSION CHAIR

Linda Bacon, Maine Department of Environmental Protection

Linda Bacon graduated from UMaine's Botany and Plant Pathology M.S. program with a course concentration in aquatic ecology in 1987, has been a lake biologist with Maine DEP since 1988, and is currently enrolled in UMaine's Ecology and Environmental Science Ph.D. program. Linda is the quality assurance advisor to the Maine Volunteer Lake Monitoring Program, the state's lake data manager and has been involved in numerous applied lake research projects. Her current interests include paleolimnology, lake assessment, Hg dynamics in lakes and lake watersheds, and use of biological indicators to determine lake condition.

1:30PM – 1:55PM

Ian M. McCullough*[1]*, *Cynthia S. Loftin*[2]*, Steven A. Sader*[3]
1 Department of Wildlife Ecology, University of Maine, Orono, ME; ian.mccullough@maine.edu
2 U.S. Geological Survey, ME Cooperative Fish and Wildlife Research Unit, Orono, ME
3 School of Forest Resources, University of Maine, Orono, ME

REMOTE MONITORING OF REGIONAL LAKE WATER CLARITY WITH SATELLITE IMAGERY

Water clarity is an ideal metric of regional water quality because clarity can be accurately and efficiently estimated remotely on a landscape scale. Remote sensing is useful in regions containing many lakes that are too expensive to monitor regularly using traditional field methods. Field-assessed lakes generally are easily accessible and may represent a spatially-irregular, non-random sample. We developed a

remote monitoring program for Maine lakes using Landsat Thematic Mapper (TM) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery. Similar Landsat-based procedures have been implemented for Minnesota and Wisconsin lakes, however, we improved existing methods by incorporating physical lake variables and landscape characteristics that affect water clarity on a regional scale. No published studies exist using MODIS data for remote lake monitoring owing to the low spatial resolution (500 m) (Landsat = 30 m), however, daily image capture is an important advantage over Landsat (16 days). We estimated water clarity of large lakes during 1990-2010 using Landsat imagery (1,511 lakes) and during 2001-2010 using MODIS imagery (80 lakes). We calibrated linear regression models using visible blue and red spectral data and volunteer-gathered secchi disk data collected near concurrently with satellite image capture. Landsat is useful for long-term monitoring of lakes > 8 ha and MODIS is applicable to annual and within-year monitoring of large lakes (≥ 400 ha). These methods can be used to supplement field-based monitoring and to detect spatial and temporal patterns in regional water clarity and potential downward shifts in trophic status.

2:00PM – 2:25PM

Jeanne L. DiFranco*[1]*, *Beth Connors*[1]*, Thomas J. Danielson*[2]*, Leonidas Tsomides*[2]

1 Maine Department of Environmental Protection, Portland, ME; jeanne.l.difranco@maine.gov; beth.connors@maine.gov

2 Maine Department of Environmental Protection, Augusta, ME; thomas.j.danielson@maine.gov; leon.tsomides@maine.gov

A MACROINVERTEBRATE MODEL TO PREDICT ATTAINMENT OF TIERED AQUATIC LIFE USE CRITERIA FOR MAINE WETLANDS

The Maine DEP Biological Monitoring Program assesses the condition of rivers, streams and freshwater wetlands by evaluating resident aquatic macroinvertebrate and algal communities. River and stream biomonitoring data have been used for many years to inform a variety of resource management activities and regulatory programs, supported by the development of numeric biological criteria based on sound statistical modeling. In recent years, requests to the Biomonitoring Program for assessments of wetland water quality and ecological condition have significantly increased. In response, DEP biologists developed a linear discriminant model (LDM) to assess freshwater wetland macroinvertebrate communities by predicting attainment of tiered aquatic life use criteria described in Maine's water quality standards. Sites included in the LDM are typically lacustrine and riverine fringe wetlands having emergent and/or aquatic bed vegetation. DEP also developed macroinvertebrate inference models for selected environmental stressors, individual taxa tolerance values, and a community level invertebrate tolerance index. Maine has narrative biological criteria for all surface waters, including wetlands, but previously relied on expert judgment to interpret the criteria for wetlands. The LDM will serve as the basis for wetland-specific numeric criteria, and greatly enhances the ability of the Biomonitoring Program to provide data users with consistent, standardized assessments of wetland condition and impacts from human activities. Numeric biological criteria will also help DEP to fully integrate wetlands into its water quality monitoring and assessment program and fulfill federal requirements for wetland monitoring, assessment and water quality standards under the Clean Water Act.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Miguel Barajas, *Jason Duff, Melissa Smith, Shane Poppas (undergraduate environmental science students); Faculty Mentors: Joseph Staples and Karen Wilson*
University of Southern Maine, Portland, ME; kwilson@usm.maine.edu

BIOMONITORING OF HEAVY METALS IN THE TIDAL KENNEBEC RIVER SYSTEM USING BLUE MUSSELS, *MYTILUS EDULIS*

Previous research suggests that industrial processes of the 19th and 20th centuries have resulted in drastic changes to Maine's rivers due to increased inputs of chemicals into the river systems (Islam and Tanaka, 2004; Lichter et. al., 2006). Although in the last few decades the water quality of Maine's rivers has improved, heavy metals still persist in the environment (Larsen and Gaudette, 2010). To assess the amount of heavy metals in the tidal Kennebec River system, we collected sediments and utilized the blue mussel, *Mytilius edulis*, as a bioindicator of heavy metals. We hypothesized that concentrations of heavy metals in *M. edulis* would be lower than NOAA National Status and Trends Musselwatch Program. Through XRF analysis, it was observed that As, Ni, Cu, and Zn were found to be in low-medium ranges of concentrations when compared to NOAA data. Due to high variability, concentrations of Hg, Pb, Cd and Sn could not be determined. Although the concentrations determined in this study were found at low levels when compared to NOAA data, the fact remains that heavy metals are presently entering the river system. Our data supports the hypothesis of Larsen and Gaudette (2010) that due to the ebb-tide dominated flow of the Kennebec River; the majority of suspended particles in the water column are being flushed out into the Gulf of Maine. We may therefore conclude that heavy metal deposition in the tidal portion of the Kennebec River system is temporary and minimal.

3:30PM - 3:55PM

Nate Whalen
Portland Water District, Standish, ME; nwhalen@pwd.org

SWIMMING BEACH BACTERIA MONITORING ON SEBAGO LAKE

The Portland Water District (PWD) uses Sebago Lake as a drinking water source to serve nearly 20% of the Maine population. The water quality is good enough to receive a "filtration waiver" from the Federal Safe Drinking Water Act. This means that the water is treated but not filtered which results in significant savings for the customers. To maintain this filtration waiver, PWD must demonstrate adequate control of the water source.

One way we control the lake is through a "no bodily contact zone" within 2 miles of the intakes. Bacteria monitoring shows the importance of keeping people away from the intakes. *E.coli* levels at swimming beaches are significantly higher than in the "No Bodily Contact Zone." Results show that bacterial levels increase when people are in the water.

Poster Session

The Senator George J. Mitchell Center and the U.S. Geological Survey have sponsored a juried student poster competition 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 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

Lynne Lewis, Bates College

Lynne Lewis received her Ph.D. in economics from the University of Colorado in 1994 after finishing a two-year dissertation fellowship at the Environmental and Societal Impacts Group at the National Center for Atmospheric Research. Currently, she is working on a research grant focused on valuing the potential benefits from dam removals and river restoration and has also worked extensively on the economics of transboundary water resources, tradable permits for pollution control and the valuation of environmental amenities and disamenities within watersheds and coastal zones. She currently serves on the Board of Maine Audubon, the Penobscot River Science Steering Committee and the Advisory Board of the Maine Water Resource Research Institute.

UNDERGRADUATE POSTER ABSTRACTS

Amy A. Anderson, *Collin Roesler*
Bowdoin College, Brunswick, ME; croesler@bowdoin.edu

MEASURING NUTRIENT DYNAMICS OPTICALLY: TOWARDS AN UNDERSTANDING OF THE IN SITU RELATIONSHIP BETWEEN NITRATE AND PHYTOPLANKTON

Understanding the role of nutrients in phytoplankton dynamics requires synoptic measurements of nutrient concentrations and phytoplankton biomass. The Satlantic ISUS nitrate sensor utilizes the ultraviolet absorption features of nitrate against a background of other dissolved species to estimate the nitrate concentration. This has worked well in open ocean settings away from temporally-varying

high concentrations of colored dissolved organic matter (CDOM). Here we present an approach of deconstruction of the UV absorption spectrum into contributions by dissolved salts, terrestrially-derived organic matter and nitrate. A linear model is proposed that yields the concentrations of each component from simple spectrophotometric analyses. The model is tested in a dynamic coastal sound with strongly varying concentrations of salts, dissolved organic matter and nutrients. The sensitivity of the observations to the optical density of the samples in the ultraviolet is discussed. The utility of this approach is twofold: (1) archival UV CDOM absorption spectra can be re-analyzed to retrieve nitrate concentrations and; (2) tuning of the absorption reconstruction invoked by the Satlantic ISUS sensor can provide more robust estimates of nitrate in high CDOM coastal waters.

Hunter Corson, *Dan Buckley*
University of Maine at Farmington, Farmington, ME; buckley@maine.edu

WATER CLARITY IN SOME SMALLER PONDS IN THE RANGELEY LAKES REGION

The Rangeley Lakes region is one of the premier recreational areas of Western Maine. Much of the recreational and economic activity in the region is focused around the local lakes, rivers and streams. Two of the region's ponds, Haley and Quimby, have historically had impaired water quality and a few others may be exhibiting declining water clarity. In Haley, a major cause of the impairment was the dumping of municipal sewage treatment effluent directly into the pond. This practice ceased some time ago but transparency values have not recovered. Quimby Pond has had a history of variable water clarity with recent algal blooms. Current research is underway to better understand the forces effecting water clarity within the region and why the response of individual lakes is so different. UMF faculty and student interns are working with the Rangeley Lakes Heritage Trust, which has been coordinating local volunteer efforts in monitoring water quality in conjunction with the Maine Volunteer Monitoring Program, to providing improved shoreline and depth maps for these lakes. They are also delineating shoreline land use within a 250 ft buffer of the water using ortho-rectified aerial photographs and GIS software. This analysis along with photographic records of the entire shoreline taken in 2011 for seven of the region's lakes and ponds is an important tool for planning future development and the possible remediation of existing erosion problems.

Kristin Stanhope, Tyler Weisberger, Michelle Georgia, *James Killarney, Howard Patterson*
Department of Chemistry, University of Maine, Orono, ME; howardp@maine.edu; james_killarney@umit.maine.edu

FLUORESCENCE QUANTIFICATION OF EE2 IN FISH BILE

The synthetic estrogen found in most contraceptive pills, 17-α-ethinylestradiol (EE2), has been contributing to the contamination of water systems and has been linked to the decline in fish populations due to feminization. Even in minute concentrations, EE2 induces certain gene expression pathways in fish, such as the production of the egg yolk precursor protein vitellogenin. Looking at the expression of vitellogenin is the standard biological indicator of exposure to estrogenic endocrine disruptor chemicals (EDCs). This detection technique is unable to indicate exactly which estrogenic EDC or EDCs are present. Another commonly used technique is gas-chromatography mass spectrometry (GCMS). GCMS is able to identify the specific compounds found in fish tissue, though it is expensive, time consuming, and can require toxic reagents. Our objective is to use fluorescence spectroscopy in conjunction with PARAFAC statistical modeling to develop a new technique for EE2 detection. By scanning

samples taken from fish bile spiked with EE2 or from fish exposed to EE2, and using three-dimensional fluorescence, the EE2 peak is recorded within a bile background signal. PARAFAC can then reduce the background fluorescence from the bile by matrix decomposition, so that the EE2 peak may be easily visualized and ideally quantified. We currently have data in the form of matrices and graphs and are working on the PARAFAC analysis. This new technique will be beneficial due to its specificity for EE2 detection, while not producing harmful waste and remaining inexpensive. Supported by USEPA STAR Fellowship # FP917137.

Catherine Johnston, *Riker Wikoff, Daniel Lowinger, John Lichter, Guillermo Herrara*
Department of Economics, Bowdoin College, Brunswick ME; jlichter@bowdoin.edu

ECOLOGICAL AND ECONOMIC RECOVERY OF THE KENNEBEC AND ANDROSCOGGIN RIVERS, ESTUARY, AND NEARSHORE MARINE ENVIRONMENT

Human activities in the Kennebec and Androscoggin watersheds led to a collapse of the ecosystem in the second half of the twentieth century. Since then, water quality was able to rebound much faster than biotic components of the system. Improvements are still underway for populations of submerged aquatic vegetation, macroinvertebrates, and fish. Biology research this summer focused on mapping vegetation and surveying anadromous fish populations in the Kennebec estuary. The mapping data were added to a time series describing vegetation change over the past 50 years in Merrymeeting Bay, and the results indicate a significant increase in vegetation cover in the bay between 1998 and 2011. Juvenile shad and river herring travel through the bay on their way to the Atlantic and submerged aquatic vegetation provides habitat for these important species. Weekly beach seines provided information on use of the bay by juvenile alosids and other fish species. Preserved stomach contents will be used to study juvenile alosid diet and promote an understanding of food web interactions in the river system. In addition, economics research examined the valuation methods used in river restoration, including hedonic pricing theory, travel cost method, and benefits transfer. The economics research culminated in running focus groups on the subject of Maine rivers with participants from across the state. The results from the focus groups will be used to develop a contingent valuation survey that values different scenarios of river restoration.

Malia Kawamura, *D. Whitney King*
Department of Chemistry, Colby College, Waterville, ME; dwking@colby.edu

THE USE OF THE DYNAMIC RESERVOIR SIMULATION MODEL TO PREDICT THE EFFECT OF CLIMATE FORCING ON THE THERMAL STRUCTURE OF CENTRAL MAINE LAKES

The seasonal stratification of Maine lakes is one control on the hypolimnetic oxygen flux that regulates deep water hypoxia and the internal cycling of nutrients. This project examined the correlation between field data and model predictions of thermal structure and water clarity in East Pond, North Pond, and Great Pond from 2008 to 2011. Temperature data was collected at 10-minute intervals throughout the summers using HOBO sensors placed at one-meter intervals from the bottom to the top of each lake. The Dynamic Reservoir Simulation Model (DYRESM) was used to create one-dimensional hydrodynamic models of the temperatures in all the lakes as a function of time over the period of thermocline formation to fall turnover. The DYRESM models agree well field observations. Using

the model, the sensitivity of Secchi depth, wind speed, and air temperature on lake stratification has been established. Additionally, the effect of anomalous weather relative to a meteorological reference year has been analyzed. The success of the DYRESM model at predicting stratification and mixing events in East Pond, North Pond, and Great Pond suggests that it can be used to predict the impact of future climate changes on these lake ecosystems.

***Natalie Marceau*[1], *Kevin Simon*[1] *and Adria Elskus*[1,2]**
1 School of Biology and Ecology, University of Maine, Orono, ME; aelskus@usgs.gov
2 U.S. Geological Survey, Leetown Science Center, S.O. Conte Anadromous Fish Research Laboratory, Maine Field Office, University of Maine, Orono, ME

EFFECTS OF THE FUNGICIDE AZOXYSTROBIN ON THE GROWTH OF THE AQUATIC CRANE FLY *TIPULA SPP*

Fungicides used to kill or inhibit the growth of fungi in agricultural products could be altering aquatic ecosystems. Microorganisms, such as bacteria and fungi, help decompose leaves in streams, making the organic substrate more accessible to large consumers such as leaf-shredding insects and are themselves an easily-assimilated source of carbon. Fungicide runoff into streams could disrupt ecosystem function by decreasing the microbial growth needed for leaf shredder consumption. One of the most commonly used fungicides in agriculture, including Maine potato farms, is azoxystrobin. We used aquatic mesocosms to test the effects of azoxystrobin on leaf fungi and on larva of leaf-shredding aquatic crane fly *Tipula ssp*. We hypothesized that azoxystrobin would inhibit the growth of Tipula by decreasing the amount of fungi on the leaves and in larval guts. Pint-sized containers with 120 mL of stream water, a maple leaf naturally colonized with microorganisms, one *Tipula* larva and azoxystrobin (5000, 150, and 10 pptrillion), vehicle (acetone), or no treatment were incubated for 27 days at 11ºC in the dark. Dosing solutions were renewed every other day. Azoxystrobin had no effect on *Tipulid* ecological efficiencies (relative growth rate, consumption index, assimilation efficiency), but unexpectedly increased leaf microbial respiration rates by 5%. We did not determine if this increase was due to bacteria, fungi or both. We conclude that azoxystrobin has no effect on the aquatic crane fly *Tipula* larva at environmentally relevant doses, but may increase growth of leaf microbial communities, a finding that warrants further study. Supported by the USGS Toxic Substances Hydrology Program.

Josie Thiele, ***Katherine Murray,*** *D. Whitney King*
Department of Chemistry, Colby College, Waterville, ME; dwking@colby.edu

DYNAMIC INTERACTIONS BETWEEN THERMOCLINE DEPTH AND INTERNAL NUTRIENT LOADING IN CENTRAL MAINE LAKES

Phosphorus is the limiting nutrient for algal growth in many Maine lakes. Recent work by Kopacek et al. (2001, 2005), Lake et al. (2007), Norton et al. (2008) and Wilson et al. (2008, 2010) has shown that internal nutrient loading is directly related to the sediment composition with significant quantities of phosphorus sequestered through binding with either aluminum or iron. Aluminum binds phosphate over a range of redox conditions. However, phosphorus bound to iron is susceptible to reductive dissolution leading to significant hypolimnetic phosphorus release and increased algal growth.

Hypolimnetic oxygen concentrations and sediment metal concentrations are important for understanding internal nutrient loading dynamics.

This work reports the phosphorus, aluminum, and iron concentrations in sequential extractions of sediments from East Pond, North Pond, Great Pond, Long Pond, and Snow Pond, in the Belgrade Lakes watershed. Sediment samples were collected over a horizontal transect of lake depth to capture sediment chemistry across seasonally oxic, hypoxic, and anoxic sediments. This allowed evaluation of nutrient flux for sediments that were historically oxic but may become increasingly hypoxic due to changing thermocline depth. Small increases in internal nutrient flux can drive a positive feedback in which the thermocline becomes shallower due to decreased light penetration driven by increase phytoplankton growth. A shallower thermocline depth leaves a greater surface area of sediment subject to hypoxic conditions. Data will be presented for sediment compositions for all the aforementioned lakes with a detailed analysis of Great Pond sediment geochemistry to illustrate the potential of this feedback mechanism.

Randy S. Perkins, *Andrew Reeve*
Department of Earth Sciences, University of Maine, Orono, ME; asreeve@maine.edu

MODELING CONTAMINANT TRANSPORT AND PREFERENTIAL FLOW PATHS IN A HOMOGENEOUS POROUS MEDIUM

As the Maine Department of Environmental Protection seeks to update its guidelines regarding remediation for petroleum-contaminated sites in Maine, it is necessary to understand how contaminants advect throughout the system. From this understanding, contaminant concentrations, as a function of travel time, distance from contamination source, groundwater velocity, and dispersivity, can be modeled. It can be intuitively hypothesized that contaminants moving through groundwater will not be uniformly transported away from the point source, and will have a tendency to preferentially “finger” their way through the system. The objective of this research is to prove that such fingering exists while simultaneously determining an appropriate dispersivity constant for the experimental porous medium.

To observe advection, a 15-foot by 4-inch vertical Darcy tube was constructed to simulate a saturated, homogeneous aquifer. Eight sections of four ports were placed lengthwise along the tube that provided both a means of measuring hydraulic gradient and collecting samples of an injected salt (NaCl) slug into the system. By recording the specific conductivity of the samples, the contaminant front was tracked and dispersivity was calculated using the Ogata-Banks solution for contaminant concentration.

The result of this was twofold: it showed preferential fingering of the contaminant front of two calculated velocities (6.1e-5m/s, 7.4e-5m/s) and appropriate dispersivity constants (8.7e-7m^2/sec, 1.1e-6m^2/s, respectively) were determined. Fingering may have been due to air bubbles in the system, which a coarser medium would mitigate. Additional experiments should also look to consider transport of petroleum contaminants through the system.

Matt Ramos, *Phil Camill*
Bowdoin College, Brunswick, ME; pcamill@bowdoin.edu

DYNAMICS OF CARBON EXPORT FROM MAINE WATERSHEDS TO THE GULF OF MAINE

Coastal ecosystems are highly influenced by the presence of organic matter in the form of carbon,

nitrogen and phosphorus. Dissolved and particulate organic carbon (DOC/POC) are produced in terrestrial ecosystems and transported to the coast by rivers and streams through runoff processes. Carbon mobilization and transport is expected to change drastically in the near future due to changes in land use, temperature, and precipitation. The changing flux of carbon to the coast will alter the biogeochemistry of coastal ecosystems affecting their functionality, including the severity and frequency of harmful algal blooms and the productivity of local fisheries. To better understand how the changing flux of carbon will alter coastal ecosystems in Maine, we must first investigate the processes that factor into carbon mobilization and transport. I'm looking at how carbon export from terrestrial ecosystems into Maine's major river systems (Androscoggin/Kennebec, Penobscot, and St. John) changes from spring thaw to summer, how direct measurements of DOC/POC correlate with optical proxies, estimating the flux of carbon to the Gulf of Maine, and how these values compare to what is known from satellite-based estimates of carbon delivery to the coastal ocean.

GRADUATE POSTER ABSTRACTS

Mussie Beyene, *Shaleen Jain*
Maine's Sustainability Solutions Initiative and Dept. of Civil and Environmental Engineering, University of Maine, Orono, ME; Mussie.Beyene@umit.maine.edu; shaleen.jain@maine.edu

SPATIO-TEMPORAL PATTERNS OF ICE-COVER VARIABILITY AND CHANGE IN MAINE (1950-2008)

Maine is a "land of lakes". The physical, chemical and biological processes and attributes of these systems are sensitive to climate change as are the values placed on these aquatic systems by humans. Two overarching considerations shaped our thoughts; first, the wide array of limnological processes and phenomena expected to be influenced by climate changes; and, secondly, the heterogeneity or differences in responses expected among water bodies.

Seasonal lake ice cover is a common physical property of temperate lakes that shapes the physical, chemical and biological processes even into the summer. Recent evidence suggests that with the current warming trend, ice cover duration in cold temperate region lakes is progressively shortening altering both the social and ecological interactions with and within the lake. To analyze its effect and develop conservation plans and probable future scenarios in Maine, the first steps will be to structure the link between climate and the historical lake ice phenology patterns. In this poster, both the spatial and temporal pattern of ice breakup variability from 1950-2008 of 18 lakes in Maine are examined

During 1955-1977, ice breakup was relatively late for most of the years which suggest that it was a period of cool winter conditions, but after 1977, this trend shifted dramatically and a period of early ice out began. The 80s, 90s and 2006 were years where lakes had historical early ice out dates. The results also suggest that the response of lakes to changes in winter conditions is not the same state wide and is in line with regional climatic zones. Lakes along the coastal and southern interior of Maine were more sensitive to winter variations than their counterparts in the northern interior.

Christiaan Bond, *Andrew Reeve*
Department of Earth Sciences, University of Maine, Orono, ME; christiaan.bon@maine.edu; asreeve@maine.edu

MODELING GROUNDWATER AND MECHANISMS FOR FREE PHASE GAS VARIABILITY IN A MAINE PEATLAND

Northern Peatlands cover more than 350 million ha and are an important source of methane and other biogenic gases contributing to climate change. Free phase gas (FPG) accumulation and episodic release has recently been recognized as an important mechanism for biogenic gas flux from peatlands. It is likely that gas production and groundwater are interconnected: groundwater flow influences gas production by regulating nutrient supply and geochemical conditions while FPG influences groundwater flow through a reduction in peat permeability. We hypothesize that short-term increases in pressure gradients between pore fluids and the atmosphere episodically trigger FPG release. Additionally, we hypothesize that flow patterns and nutrient cycling are influenced by a well-documented esker and associated pool system near Caribou Bog, ME. Monitoring well clusters have been installed and surveyed using dual frequency GPS in the central portion of Caribou Bog. A groundwater map, created from GPS data and hand measurements of well cluster hydraulic head, shows preferential flow towards the esker and associated pool system. Three well clusters were equipped with data logging pressure transducers to monitor long-term head and atmospheric pressure data. Preliminary data yield short term fluctuations in pressure data suggesting FPG emission from deep and shallow peat. A groundwater model is being developed in MODFLOW to simulate groundwater flow patterns within Caribou Bog to assess the influence of the esker and pool system on the peatland hydrology.

Judy Colby-George[1]***,*** *Kathleen Bell*[2]*, Charles Colgan*[3]*, Timothy Waring*[2]
1 Maine's Sustainability Solutions Initiative, Ecology and Environmental Science, University of Maine, Orono, ME; judy.colbygeorge@maine.edu
2 School of Economics, University of Maine, Orono, ME; kpbell@maine.edu; timothy.waring@maine.edu
3 Muskie School of Public Service, University of Southern Maine, Portland, ME; csc@usm.maine.edu

USING AGENT-BASED MODELS TO ENGAGE WITH STAKEHOLDERS

Stakeholder engagement is central to sustainability science, an emerging field that challenges researchers to produce useful knowledge for solving societal problems and to co-produce this knowledge with stakeholders. Numerous sustainability challenges, including multiple water resource issues, involve disconnections between individual and cumulative impacts. Therefore, improvements in methods for communicating and engaging with stakeholders about such impacts have great potential to foster sustainability research and solutions. This research explores multiple questions related to the extent to which agent-based models can support improved stakeholder engagement. We are pursuing these questions in the context of an ongoing, Maine-based research project of changing urban systems. Working with stakeholders, we are studying options for using models to advance understanding of landscape change in the Bangor and Portland Metropolitan Areas. At present, we have designed an agent-based model that relates landscape-scale change to individual, land-owner choices, supporting visualization of: (1) complex connections between individual- and landscape-scale events; and (2) implications of alternative policy scenarios and behavioral assumptions. Results to date support an

iterative research approach, mixing modeling, stakeholder engagement, and research design. The Maine Water Conference offers an excellent opportunity for advancing our approach and getting valuable feedback from diverse stakeholders, researchers, and professionals.

Abraham Dailey*[1]*, Paul Bourget*[1]*, *Firooza Pavri*[2]
1 Muskie School of Public Service, University of Southern Maine, Portland, ME; Abraham.dailey@maine.edu
2 Department of Geography-Anthropology, University of Southern Maine, Gorham ME

LAND USE AND IMPERVIOUS SURFACES ACROSS THE SUB-WATERSHEDS OF THE SEBAGO LAKE WATERSHED

Freshwater resources provide vital societal and ecosystem services. Rapid changes due to economic development within the watersheds of lake systems influence water quality and their capacity to meet present and future needs. A recent study identified the Sebago Lake watershed as among the top five most vulnerable watersheds of the northeastern United States to development activity owing to the large proportion of privately held land. Given Sebago Lake's importance as a source of public water supply to numerous southern Maine communities, monitoring land use changes within its watershed can help provide timely and appropriate conservation alternatives that support the sustainability of this system. Using a landscape ecology approach and the tools offered by remote sensing analyses and Habitat Priority Planner, this study assesses land use and impervious surfaces across the sub-watersheds of the greater Sebago Lake basin. We use recent data from NASA's Landsat Thematic Mapper satellite and census data to compare and contrast landscape patterns of fragmentation and imperviousness across Sebago Lake's sub-watersheds. Our results suggest a greater fragmentation of forest and green-cover parcels in sub-watersheds that observe more intense development activity. Often these activities are concentrated in proximity to lake shore fronts and increase stresses to water systems.

Haley M. Engelberth*[1]*, *Mario F. Teisl* [2]*, Caroline L. Noblet*[2]*, Kathleen P. Bell*[2]*, Andrew E. Smith*[3]*, Eric Frohmberg*[3]*, Kevin J. Boyle*[4]
1 Ecology and Environmental Science, School of Economics, University of Maine, Orono, ME; Haley.Engelberth@maine.edu
2 School of Economics, University of Maine, Orono, ME; teisl@maine.edu; caroline.noblet@umit.maine.edu; kpbell@maine.edu
3 Maine Center for Disease Control and Prevention, Maine Department of Health and Human Services, Augusta, ME; Andy.E.Simth@maine.gov; Eric.Frohmberg@maine.gov
4 Department of Agricultural and Applied Economics, Virginia Polytechnic Institute and State University, Blacksburg, VA; kjboyle@vt.edu

IMPROVING FISH CONSUMPTION ADVISORIES FOR AT-RISK WOMEN IN MAINE

This study evaluates the effectiveness of Maine Center of Disease Control and Prevention's (CDC) mercury advisory aiming at informing at-risk women, those of childbearing age, about the benefits and risks of fish consumption. Maine's mercury advisory targets this group because eating fish provides health benefits, particularly during pregnancy; however, nearly all fish contain at least some methylmercury which can impair human health. Thus, the advisory aims at informing women about

high-risk and low-risk fish with the goal of inducing a switching behavior while minimizing an overall reduction behavior.

Maine CDC's centerpiece for risk communication regarding mercury is the distribution of a brochure to healthcare providers that describes safe eating guidelines for fish. To evaluate the advisory's success; a mail survey was administered to a random sample of 1,250 women that recently gave birth with a response rate of 62%. The questionnaire consisted of 80 questions intended to assess awareness of the advisory, receipt of the brochure, and changes in fish consumption behavior. The most important finding indicates the advisory induced appropriate switching behavior; women reading the advisory decreased their consumption of high-risk fish and increased their consumption of low-risk fish.

Presently, another study is evaluating Maine CDC's new mercury advisory. The advisory was updated to include more information on benefits, such as Omega-3s, and examples of commercial fish low in mercury. A mixed-mode survey is currently evaluating the effectiveness of the new advisory and aims to answer the research question of why women are changing their fish consumption behaviors.

***Robert Hogg*[1], *Stephen M. Coghlan Jr.*[1], *Joseph Zydlewski*[2], *Cory Gardner*[1,2]**
1 University of Maine Department of Wildlife Ecology, Orono, ME; robert.hogg@umit.maine.edu; stephen.coghlan@umit.maine.edu; cgardner@geiconsultants.com
2 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME; jzydlewski@usgs.gov

BARRIER REMOVAL IN SEDGEUNKEDUNK STREAM: SEA LAMPREY RECOLONIZATION AND IMPLICATIONS FOR ATLANTIC SALMON HABITAT RESTORATION

Sedgeunkedunk Stream, a 3rd-order tributary to the Penobscot River, historically supported several anadromous fish species including sea lamprey and Atlantic salmon. However, two small dams constructed in the 1800s reduced or eliminated spawning runs entirely. In 2009, efforts to restore marine–freshwater connectivity in the system culminated with removal of the lowermost dam making 5-km of lotic habitat accessible to anadromous fish. Sea lamprey utilized accessible habitat prior to dam removal and were chosen as a focal species to characterize recolonization. During sea lamprey spawning runs of 2008 through 2011 (pre- and post-dam removal), individuals were marked with PIT tags and their activity was tracked with daily recapture surveys. Mark-recapture histories indicated a four-fold increase in the abundance of spawning sea lamprey with population estimates rising from 59 ± 6 (95% CI) pre-dam removal (2008) to 223 ± 35 and 248 ± 25 post-dam removal (2010 and 2011 respectively). In order to assess the effect of sea lamprey nest building on microhabitat, areas with and without nests were compared. Fine sediment accumulation, proportion of embedded particles, stream-bed depth and velocity profiles shifted in areas where nests were built. Nest building increased stream-bed complexity, while reducing fine sediment accumulation and proportion of embedded particles in mound microhabitats. Such changes persisted into the fall and may improve Atlantic salmon spawning habitat quality. These changes may also benefit resident drift-feeding fishes. Thus the recolonization of Sedgeunkedunk Stream by sea lamprey may have lasting effects on stream community dynamics.

Daniel Kekacs[1], *Monica Plante[1], Paula Mouser[2], Jean MacRae[1], C.T. Hess[3], Andrews Tolman[4], Robert Marvinney[4]*
1 Civil and Environmental Engineering, University of Maine, Orono, ME
2 Civil, Environmental, and Geodetic Engineering, The Ohio State University, Columbus, OH
3 Department of Physics and Astronomy, University of Maine, Orono, ME
4 Drinking Water Program, Maine CDC Division of Environmental Health, Augusta, ME
5 Maine Geological Survey, Augusta, ME

GEOCHEMICAL ANALYSIS OF THREE GROUNDWATER SUPPLY WELLS WITH ELEVATED URANIUM CONCENTRATIONS

Naturally occurring radionuclides, such as uranium, are present in low concentrations in many granitic geological formations in Maine. Mineral dissolution processes, microbial activity, and changes in nutrient loading promotes the release of this toxic metal in groundwater aquifers that serve as public and private water supplies. Human consumption of groundwater containing elevated uranium (U) concentrations and its radionuclide daughter product, radon, increases the risk of kidney damage and lung cancer. To investigate possible links between uranium concentration, aqueous geochemistry, and microbial activity, 39 samples were taken at multiple depths from three private wells near Augusta known to contain uranium. Water was pumped under low flow conditions (200 mL/min) to minimize drawdown from regions outside the desired sampling depth. Maximum U concentrations in the three wells were 14, 103, and 224 µg/L. Comparison of total and dissolved U concentrations suggests uranium is present primarily in its dissolved, oxidized form (U(VI)). In the well with the highest levels of uranium, total U, dissolved U, and total iron (Fe) increased by a factor of 15 at a depth of 165 feet above sea level. Dissolved iron, however, decreased by a factor of 25 across this same interval, indicating a switch from a dissolved, reduced form (Fe(II)) to particulate (probably Fe(III)) form. Trends in total and dissolved metals may indicate the presence of bedrock fractures or a shift in microbially-mediated reduction-oxidation processes influencing metal solubility and mobility. Future work will include analysis of the microbial community and a statistical assessment of microbial-geochemical conditions.

William Laliberte, *James Killarney, Howard Patterson*
Department of Chemistry, University of Maine, Orono, ME; william.laliberte@umit.maine.edu

USE OF AG-Y ZEOLITE TO ENHANCE THE PHOTODEGRADATION OF PPCPS IN NATURAL WATER

Pharmaceuticals and personal care products (PPCPs) as well as pesticides enter natural water sources through many paths. Not all of these compounds are removed during wastewater treatment, and the full health risks of multiple chemical species at varying concentrations interacting with each other are not known. Photodegradation naturally occurs in most of these species, but dissolved organic carbon (DOC) that is found ubiquitously in natural water interferes with this process. Silver doped zeolite (Ag-Y) has been found to reduce the effect of DOC as the DOC is adsorbed onto the zeolite surface instead of binding to the PPCPs. In order to better understand this reaction, the PPCPs 17α-ethinylestradiol and bisphenol-A were studied in both laboratory conditions and natural water both with and without Ag-Y zeolite. Samples were exposed to UV light to simulate the effect of sunlight in natural systems. Fluorescence spectroscopy was used to observe the change in signal intensity of the

PPCPs at different stages of degradation, as signal intensity is related to the compound's concentration. The addition of DOC to a sample of each compound in pure water showed no significant change in signal increase or decrease, suggestion little binding occurred with the compound and DOC. After Ag-Y zeolite was added, signal intensity decreased in all samples regardless of DOC concentration or UV light exposure. Ag-Y zeolite appears to enhance the rate of photodegradation of these compounds, though the exact mechanism is still being analyzed.

Vanessa Levesque[1]*, Kathleen Bell*[2]*, Aram Calhoun*[1]
1 Department of Wildlife Ecology, University of Maine, Orono, ME; vanessa.r.levesque@maine.edu; calhoun@maine.edu
2 School of Economics, University of Maine, Orono, ME; kpbell@maine.edu

DO MAINE MUNICIPALITIES CONTRIBUTE TO SUSTAINABILITY? IDENTIFYING THE TYPES AND DRIVERS OF LOCAL SUSTAINABILITY POLICY

Sustainability science typically stresses efforts that simultaneously promote social, economic and ecological well-being. While most studies examine Federal and State sustainability policies, municipal contributions to this effort are often overlooked. Because local government actions have a direct effect on community conditions, the extent to which municipalities adopt policies that lead to sustainability is significant. This study has two goals: (1) to determine what types of policies adopted by Maine municipalities likely lead to sustainability; and (2) to identify the community characteristics most likely to influence the adoption of sustainability policies. The study area includes all incorporated Maine municipalities. A key step in this analysis is to accurately identify social, economic and environmental policies adopted by Maine municipalities that contribute to sustainability. While existing studies provide guidance for appropriate policy measures, it is imperative that they are relevant to the Maine context. As such, this poster provides an interactive component to encourage conference participants to adjust our measures.

Patterns of adoption of sustainability policies are analyzed using descriptive, spatial and statistical approaches. Local biophysical, socio-economic and institutional characteristics most likely to drive the adoption of sustainability policies are compiled. Future work will utilize multivariate regression analysis to explain the variation in municipal adoption of sustainability policies, and to test relationships to community characteristics. This study will enable Maine policy makers to better measure municipal sustainability efforts, reveal opportunities for networking and outreach, and identify drivers influencing the adoption of sustainability policies.

Danielle M. Martin[1]***,*** *Andrew Reeve*[1]*, Sean Smith*[1,3]*, Matt Legere*[2]
1 Department of Earth Sciences, University of Maine, Orono, ME; danielle.martin@umit.maine.edu; asreeve@maine.edu; sean.m.smith@maine.edu
2 Civil and Environmental Engineering, University of Maine, Orono, ME
3 Maine's Sustainability Solutions Initiative, University of Maine, Orono, ME

A DECISION SUPPORT TOOL FOR WATER RESOURCES MANAGEMENT IN SEBAGO LAKE

Sebago Lake supplies drinking water to approximately 200,000 people in southern Maine and is a multi-use natural resource. Lake level management is currently an issue of debate amongst parties

invested in the lake; government agencies, industry, residents, commercial businesses, lake associations and environmental groups. The lake level is controlled by Eel Weir Dam at the outlet of the Presumpscot River. Natural hydrologic fluxes that contribute to lake levels are not well quantified, thus relationships between these fluxes and variations in lake levels are not fully understood. A lumped parameter, surface runoff computer model entitled GR4J (Perrin et al., 2001) is currently being coded and calibrated and will provide insight into relationships between natural hydrologic fluxes, atmospheric conditions, precipitation, and variations in lake levels in conjunction with discharges from the dam. Solinist Pressure Transducer Data Loggers were installed in eight tributaries to record water temperature and level at twenty minute intervals, and a weather station was installed at the Portland Water District to collect precipitation and atmospheric data. Stream gaging in the eight tributaries is being conducted to produce rating curves which are being used to convert recorded water levels to continuous discharge values for the model. The model is linked to a web-interface for use by interested parties for observation of lake level simulations using real data. The model is being used to run different lake level management plan scenarios and is intended to be used as a tool in future lake level management decision making processes.

Katie Norris[1]*, Madeleine Mineau*[1]*, Jasmine Saros*[2]*, Stephen Coghlan, Kevin Simon*[1]
University of Maine, Orono, ME; katie.norris@umit.maine.edu; madeleine.mineau@umit.maine.edu; jasmine.saros@maine.edu; stephen.coghlan@umit.maine.edu; kevin.simon@maine.edu
1 School of Biology and Ecology, University of Maine, Orono, ME; kevin.simon@umit.maine.edu
2 Climate Change Institute, University of Maine, Orono, ME; jasmine.saros@maine.edu
3 Department of Wildlife Ecology, University of Maine, Orono, ME; stephen.coghlan@umit.maine.edu

DO ANADROMOUS ALEWIFE INFLUENCE NUTRIENT LIMITATION IN LAKES AND STREAMS?

Anadromous alewife *(Alosa pseudoharengus*) runs in Maine have declined over the past 150 years due to damming. As a link between marine and freshwater environments alewife potentially subsidize streams and lakes with nutrients via excretion, gametes and carcasses. Currently, the magnitude of the effect of reintroducing alewives to freshwater systems is still not well understood, and quantifying this will help inform resource managers and agencies to better manage these systems. We evaluated the potential role of alewife as nutrient subsidies by examining the nutrient limitation status of lakes and outlet streams in drainages with and without alewife access before, during and after alewife runs. Nutrient diffusing substrates and microcosm bags were used in streams and lakes respectively, to test for nitrogen, phosphorous or co-limitation of primary producers. Streams were generally more nutrient limited by nitrogen than lakes. Only four out of all 14 lake-stream systems had matched limitation patterns. While some streams did exhibit a shift from co-limitation to nitrogen limitation following alewife runs, and/or a decrease in the magnitude of limitation, this was not consistent across all alewife systems and also occurred in some non-alewife systems. These trends may be due to a brief nutrient pulse unmeasured by the methods used, small alewife runs, or a masking effect by seasonal changes. However, because of their dynamic lifecycle and historical importance, the restoration of alewife populations to freshwater systems in Maine is of both ecological and economic importance.

Zhong Pan[1]*, Aria Amirbahman*[1]*, Howard Patterson*[2]
1 Department of Civil and Environmental Engineering, University of Maine, Orono, ME; zhong.pan@umit.maine.edu; aria@umit.maine.edu
2 Department of Chemistry, University of Maine, Orono, ME; howardp@maine.edu

PHOTOCATALYTIC DECOMPOSITION OF PHARMACEUTICALS AND PERSONAL CARE PRODUCTS (PPCP) IN NATURAL WATER USING SILVER-DOPED ZEOLITES

Pharmaceuticals and personal care products (PPCP) are a diverse group of contaminants of emerging concern in U.S. water supplies. Their continuous input and occurrence in natural waters from human and animal excretions, incomplete treatment of waste water and improper disposal of unused or expired medicine, generate potential human health risk and environmental harm. Due to the wide array of chemical structures and properties associated with the PPCPs, no one single treatment can remove them all. Additionally, there is relative little research on the removal of PPCPs under natural environmental conditions. Therefore, there is an evident need for effective and practical water remediation techniques to remove PPCPs from natural and drinking water. This study tests a novel system involving zeolites doped with silver ions that can accelerate the photocatalytical decomposition of several PPCPs. We monitor the decomposition rate of the PPCPs using fluorescence spectroscopy and analyzing the data using parallel factor analysis (PARAFAC). We are finding that the silver-doped zeolites significantly accelerate the photodecomposition of PPCPs and their mixtures. Future work involves the detection of photodecomposition products using gas chromatography-mass spectroscopy (GC-MS), and the feasibility assessment of using this technology for water and wastewater treatment.

Anna Springsteen, *Jean MacRae*
Sustainability Solutions Initiative, Department of Civil and Environmental Engineering, University of Maine, Orono, ME; Anna_Springsteen@umit.maine.edu; Jean_Macrae@umit.maine.edu

WATERSHED-WIDE WATER QUALITY RESPONSES TO PRECIPITATION

This work focuses on the effects of large precipitation events on water quality in Sebago Lake watershed. Previous work has shown the importance of spring precipitation in driving variations in year-to-year summer water quality. To gain a better understanding of how precipitation events may be contributing to water quality in other nearby lakes, most of which lie in the upper watershed, we took long-term water quality monitoring data for 17 lakes in this watershed over the last two decades and averaged this data within average spring precipitation years and within high spring precipitation years. We mapped overall water quality and water quality variation and also looked for any spatial dependencies across the watershed. We found significant differences between low and high precipitation years, though the response was not always decreased water quality. Sebago Lake water quality declined three times as much as other lakes in the watershed, highlighting the sensitivity of this lake to weather events.

Blair P. VanderLugt[1], *Kathleen Bell[2]*
1 Resource Economics and Policy, University of Maine, Orono, ME; blair.vanderlugt@gmail.com
2 School of Economics, University of Maine, Orono, ME; kpbell@ maine.edu

LAND-USE DYNAMICS, NEIGHBORS, AND BOUNDARY SPANNING

Land-use dynamics are recognized by the National Research Council as one of eight grand challenges in environmental sciences. Human decisions about how to use and manage land can have far-reaching effects on social and environmental systems. Water quality, water quantity, ecological services, wildlife habitat, soil erosion, and recreation opportunities can all be affected by these decisions. Yet, there is limited understanding of how individuals make these decisions, especially in the urban-rural interface, a rapidly changing and significant part of the landscape in Maine and beyond. This knowledge gap detracts from actions focused on achieving various sustainability goals. Our research strives to fill this knowledge gap by improving understanding of landowner decision-making across the urban to rural gradient. In collaboration with colleagues from Oregon State University, we are exploring how Maine and Oregon landowners make land-use and management decisions. We are specifically interested in the extent to which "neighboring" actions influence land use and management decisions and whether or not these neighbor-to-neighbor spillovers vary across actions and over space. At this stage of our research, we are designing and pre-testing a survey questionnaire that will be used for primary data collection. Results to date reveal interesting patterns in how individuals think about current and future land use and management activities and the influence of neighboring actions. Our research has broader implications for the management and spanning of boundaries between land owners; between land owners and regional and state land managers; and between scientists, land owners, and land managers.

Clare Westervelt, *Andy Reeve*
Department of Earth Sciences, University of Maine, Orono, ME; claire.westervelt@maine.edu; asreeve@maine.edu

CELL-BASED SIMULATION OF PEAT ACCUMULATION IN NORTHERN PEATLANDS

Northern peatlands, including peatlands in Maine such as Caribou Bog, contain nearly one third of soil carbon. Depending on the response of these peatlands to global temperature change, they could function as either carbon sources or carbon sinks. There are several steady-state analytical models that predict carbon accumulation rates in peatlands. However, these models do not fully take into account the spatial or temporal variability of peatlands. Two-dimensional peat accumulation models are being constructed using a discrete cell-based approach. These models allow greater variability in input parameters such as production rate, decay rate, and topography. Current simulations are idealized two-dimensional cross sections of a peat basin. Initially, cells in a Cartesian grid are used to define the surface topography before peat development. Simple rules, based on the conditions of surrounding cells, are used to simulate the production and decay of peat within this static basin. Preliminary models produce peatland structures that resemble patterned peatlands, but do not match field-based production rates. Additional work is underway to produce more realistic profiles for a peat deposit. We plan to link these cell-based models to hydrologic models and evaluate feedbacks between peat growth, decay, and groundwater flow processes. These simulations will provide insight

into the role of peatlands as sinks for carbon gasses and their potential response to changes in hydrology related to climate or land-use changes.

PROFESSIONAL POSTER ABSTRACTS

Derek Olson[1], Barbara S. Arter[1], *Karen Wilson[2]*
1 Senator George J. Mitchell Center, University of Maine, Orono, ME: derek.olson@umit.maine.edu; barbara.s.arter@umit.maine.edu
2 University of Southern Maine, Portland, ME; kwilson@usm.maine.edu

INVESTIGATING VARIABILITY OF NORTH ATLANTIC ALEWIFE (*ALOSA PSEUDOHARENGUS*) POPULATIONS BY INTEGRATING HISTORIC RUN DATA WITH CLIMATIC, GEOGRAPHIC, AND LANDSCAPE DATA

The goal of the Diadromous Species Restoration Research Network (DSRRN) is to advance the science of diadromous fish restoration and promote state-of-the-art scientific approaches to multiple-species restoration at the ecosystem level. This is achieved through local and regional networking, scientific meetings, and workshops designed to facilitate the study of questions fundamental to diadromous fish ecology and restoration. In May 2011, a DSRRN workshop, titled “Variability of North Atlantic Diadromous Fish Populations: Establishing Reference Points for Restoration Assessment,” brought together 34 fisheries, habitat, and climate specialists to investigate variability in alewife populations over time and among watersheds. Participants from over 15 different agencies, institutions, and organizations were asked to share alewife data with other workshop participants and to collaborate on analyses and manuscript preparation as products of this workshop. Unlike classic approaches to species assessment which focus on population numbers, this study will focus on variability (e.g., relative standard error, CV, quintiles of variability, and/or other measures of variance) of population characteristics (e.g., number, size, run timing, age structure, survival) over time and space. We will use variability measures as response variables for blocks of data (e.g., group of years, group of rivers within a year). This will be achieved by integrating spatial climate, landscape, and geographic (GIS) data (e.g., drainage area, order, channel gradient, climate, flow, velocity, geology, elevation, slope, and landcover) with alewife run parameters (e.g., freshwater run size, run timing, harvest, length, age, juvenile index, and sex ratio). We anticipate reporting the results from this study at the final DSRRN Science Meeting in 2013.

Charles Baeder
Penobscot River Restoration Trust, Augusta, ME; csbaeder@penobscotriver.org

STATUS OF BASELINE SCIENCE MONITORING FOR THE PENOBSCOT RIVER RESTORATION PROJECT

In June 2009, the National Oceanic and Atmospheric Administration (NOAA) announced it would invest $6.1 million through the American Recovery and Reinvestment Act of 2009 (Recovery Act) to help rebuild the sea-run fisheries of Maine’s Penobscot River. A grant to the Penobscot River Restoration Trust will fund removal of the Great Works Dam. It has also 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 the dam at Howland. Understanding the effec-

tiveness of dam removal requires systematic project monitoring and data reporting. Toward that end, a diverse group of government agency staff, academic researchers, and non-profit representatives established the Penobscot River Science Steering Committee (PRSSC) and developed a conceptual framework for monitoring. Concurrently, the Gulf of Maine Council on the Marine Environment (GOMC) sponsored a similar effort to develop regional guidance for stream barrier removal monitoring. NOAA was represented in both of these efforts, and their priorities for Recovery Act funding were aligned with metrics identified as both "core" to the PRSSC monitoring framework, and "critical" within the GOMC guidance. This includes monitoring of: (1) fish community structure and function, passage at barriers, assembly of diadromous species at the seaward-most dam, and import of marine derived nutrients and organic matter; (2) monumented river cross-sections to document vertical and horizontal channel adjustments; (3) sediment grain size distribution at the above cross-sections to document changes in bed material; (4) photos taken quarterly at permanent stations to provide a visual record of riparian vegetation and channel configuration; (5) basic water quality for assessing and understanding changes in fish habitat use, population numbers, and community structure; (6) benthic macroinvertebrate community structure as an indicator of aquatic ecosystem habitat quality; and (7) wetland and riparian plant communities. This baseline monitoring will provide an objective basis for evaluating restoration outcomes. Baseline monitoring field work has largely been completed and final reporting is expected to be completed in summer 2012. The first dam removal – Great Works Dam – is scheduled to be completed in fall 2012.

Chris Davis, *Jon Eaton, Erin Spencer Mullen, Larry Pritchett and Henry Rines*
Georges River Tidewater Association, Thomaston, ME; cdavis@midcoast.com

EVALUATION OF TIME SERIES AND WATER COLUMN PROFILE WATER QUALITY PARAMETERS FOR THE DEVELOPMENT OF A WATER QUALITY MONITORING PROGRAM WITHIN THE TIDAL WATERS OF THE ST. GEORGE RIVER, MAINE

The Georges River Tidewater Association is a group of citizen volunteers that formed in 1988 in response to chronic pollution problems in the St. George River estuary. Its mission is to protect and restore the Georges River estuary through advocacy, public education, and water quality monitoring. During the summer months of 2002 and 2003, a baseline water quality survey was conducted at 13 stations along the uppermost 14 kilometers of this tidal estuary. Biweekly vertical profiles were taken at high water, low water or at dawn to assess levels of dissolved oxygen, chlorophyll a, temperature and salinity between the surface and bottom. More recently, between 2007-2011, continuous bottom summertime water quality monitoring for two mid-estuary stations provided considerable insight with respect to the tidally induced temporal variability for dissolved oxygen, chlorophyll a, temperature, salinity and pH. Results of these studies were used to design the sampling scheme as part of an expanded volunteer water quality monitoring program to begin in Spring 2012.

***Alex Haro*[1], *Robert Dudley*[2], *Michael Chelminsky*[3]**
1 S.O. Conte Anadromous Fish Research Laboratory, U. S. Geological Survey, Turners Falls, MA; Alex_Haro@usgs.gov
2 Maine Water Science Center, U.S. Geological Survey, Augusta, ME
3 Stantec, Topsham, ME

COMPUTATIONAL FLUID DYNAMICS – HABITAT SUITABILITY INDEX (CFD-HSI) MODELING AS AN EXPLORATORY TOOL FOR ASSESSING PASSABILITY OF RIVERINE MIGRATORY CHALLENGE ZONES FOR FISH

We developed two-dimensional computational fluid hydraulics – habitat suitability (CFD-HSI) models to identify and qualitatively assess potential zones of shallow depth and high velocity that may present passage challenges for five major anadromous fish species in a 2.63 km reach of the main stem Penobscot River, Maine, as a result of a dam removal (Great Works Dam) downstream of the reach. Suitability parameters were based on distribution of fish lengths and body depths and transformed to cruising, maximum sustained, and sprint swimming speeds. Zones of potential depth and velocity challenges were calculated based on the hydraulic models; ability of fish to pass a challenge zone was based on the percent of river channel that the contiguous zone spanned and its maximum along-current length. Three river flows (low, medium, and high) were modeled to simulate existing hydraulic conditions, and hydraulic conditions simulating removal of a dam at the downstream boundary of the reach. Potential depth challenge zones existed only for the low flow regime under a dam removal scenario for larger species (sturgeon, shad, and salmon); higher flows under both scenarios increased the number and size of potential velocity challenge zones, especially for smaller species. The two dimensional CFD-HSI model has utility in demonstrating gross effects of flow and hydraulic alteration, but may not be as precise a predictive tool as a three-dimensional model. Passability of the potential challenge zones also cannot be precisely quantified for two- or three-dimensional models due to unvalidated assumptions and incomplete data on fish swimming performance and behaviors.

Glenn Hodgkins
U.S. Geological Survey, Maine Water Science Center, Augusta, ME; gahodgki@usgs.gov

HISTORICAL CLIMATE CHANGE IN NEW ENGLAND: THE IMPORTANCE OF RECORD LENGTH IN ESTIMATING MAGNITUDE OF CHANGE

Many studies have shown that lake ice-out (break-up) dates in the Northern Hemisphere are useful indicators of late-winter/early-spring climate change. Trends in lake ice-out dates in New England, USA, were analyzed for 25, 50, 75, 100, 125, 150, and 175 year periods through 2008. More than 100 years of ice-out data were available for 19 of the 28 lakes in this study. The magnitude of trends over time depends on the length of the period considered. For the recent 25-year period, there was a mix of earlier and later ice-out dates. Lake ice-outs during the last 50 years became earlier by 1.8 days/decade (median change). This is a much higher rate than for longer historical periods; ice-outs became earlier by 0.6 days/decade during the last 75 years, 0.4 days/decade during the last 100 years, and 0.6 days/decade during the last 125 years. The significance of trends was assessed under the assumption of serial independence of historical ice-out dates and under the assumption of short and long term persistence. Several indices of large scale atmospheric circulation patterns (such as the

North Atlantic Oscillation) and sea-surface temperatures were tested for correlation with the historical ice-out dates, but these indices explained 11% or less of the interannual variability of the ice-out dates.

Alice Kelley*[1]*, *Daniel Belknap[1], Andrew Heller[1], Charles Baeder[2], Mathias Collins[3]*
1 Department of Earth Sciences and Climate Change Institute, University of Maine, Orono, ME; akelley@maine.edu; andrew.r.heller.gmail.com
2 Penobscot River Restoration Trust, Augusta, ME; csbaeder@penobscotriver.org
3 NOAA Restoration Center, Gloucester, MA; mathias.collins@noaa.gov

PRE-DAM REMOVAL GEOMORPHIC MONITORING ON THE PENOBSCOT RIVER, MAINE

Dams change the geomorphic and biologic characteristics of watersheds. Frequently, removal is seen as an effectve way to restore lost habitats and rebuild ecological communities. The largest of these projects on the North American East coast is currently being under taken in Maine. The Penobscot River Restoration Project plans to remove two dams and build a fish by-pass on the Penobscot River, in an effort to restore 11 species of sea-run fish, while maintaining energy production. The removal of the first dam is scheduled for summer of 2012. In anticipation of dam removal, geomorphic monitoring was undertaken at monumented river cross-sections within the dam removal area to provide baseline data on channel bathymetry, sediment size, and bank conditions. Data collection included repeated, seasonal photographic surveys, bathymetric surveys at each cross section, video-based channel sediment characterization, bank geomorphology studies, and geophysical characterization of impoundment sediment thickness. Data collected have been uploaded to Google Earth, a freely available interactive satellite imagery display and mapping program, as a means of displaying information and providing public access to spatially referenced data. Over the two-year monitoring period, few changes were noted in river bathymetry or bank characteristics. Channel sediment characterization revealed that, within the study area, the Penobscot River channel in both flowing and impounded reaches is dominated by coarse sediment with a predominately sand matrix. This is in striking contrast to fine-grained sediment storage noted in many impoundments, and is interpreted to be an artifact of the region's complex Late-Pleistocene and Holocene geological history.

Robert M. Lent, *Luther F. Schalk, Glenn A. Hodgkins, Robert W. Dudley and Thomas G. Huntington*
U.S. Geological Survey, Maine Water Science Center, Augusta, ME; rmlent@usgs.gov; lschalk@usgs.gov; gahodgki@usgs.gov; rwdudley@usgs.gov; thunting@usgs.gov

FRAMEWORK FOR A USGS HYDROLOGIC CLIMATE-RESPONSE NETWORK IN NEW ENGLAND

The USGS Maine Water Science Center has developed a framework for a New England hydrologic climate-response network (NEHCRN) designed to provide early warning of changes in the seasonal hydrologic conditions. Climate-related hydrologic changes on New England's hydrologic systems during the last century are well documented, and have been shown to be sensitive to changes in air temperature and precipitation. Identification and monitoring of relevant hydrologic indicators provide important baseline information against which future climate-related changes can be measured.

The framework of the NEHCRN consists of four major parts: (1) identifying homogeneous climate-response regions; (2) identifying hydrologic components that are sensitive to climate variation and key indicators of those components to be included in a hydrologic climate-response data network; (3)

developing a mechanism for data management and regularly reporting findings; and (4) establishing locations for intensive investigations including additional hydrologic monitoring and development of watershed models for process-based studies.

Components used to develop the framework NEHCRN have at least one key variable for which substantial historical data are available. The initial components are streamflow, lake ice, snowpack, and groundwater. The key variables include center-volume of spring runoff, 7-day summer low flow, annual flow, lake ice out date, and rain/snow ratio. The proposed framework divides New England into three climate-response regions; these large regions are further divided into fourteen smaller units that follow major river-basin boundaries and have relatively homogeneous climates. Finally, two basins in each climate-response region would be identified for process-based hydrologic and ecological studies.

Mark Lickus[1]***,*** *Ryan Hodgman*[2]*, Steve Tibbetts*[1]
1 Maine Department of Transportation, Augusta, ME; mark.lickus@maine.gov; stephen.w.tibbetts@maine.gov
2 Maine Department of Transportation, Scarborough, ME; ryan.hodgman@maine.gov

MONITORING THE PERFORMANCE OF POROUS ASPHALT ON MAINE MALL ROAD IN THE LONG CREEK WATERSHED, SOUTH PORTLAND, MAINE

In 2009 Maine DOT installed porous asphalt (PA) on a 0.3 mile stretch of Maine Mall Road in South Portland as part of a $1.4 million ARRA-funded highway reconstruction project. This heavily travelled section of Maine Mall Road (AADT 16750) lies within priority catchment E-02 identified in the Long Creek Restoration Plan. Maine DOT included PA in the project as a stormwater BMP retrofit in partial fulfillment of its obligations as a participating landowner under the General Permit in the Long Creek Watershed Management District. In 2011 Maine DOT began a pilot project to assess the feasibility of monitoring this high traffic location and to begin to collect data on the performance of PA as a water quality BMP. Using a paired watershed approach to monitoring, the performance of a small area of PA will be compared to a nearby reference (control) section of conventional pavement on Gorham Road with similar area, traffic volumes (AADT 18000) and a closed drainage system conducive to monitoring. In September 2011, hydraulic flumes were installed within a catch basin at each site to enable measurement of flow and selected water quality parameters. A small weather station was set up nearby to collect rainfall, air temperature, and barometric pressure data. Preliminary water quality data (temperature, pH, DO, conductivity, turbidity) was collected during portions of two rain events in September and October with similar rainfall totals, durations, peak hourly rainfall intensities, and antecedent conditions. Grab samples were taken during the October event and analyzed for TSS and for total Cu, Zn and Pb. Preliminary results to date show that the PA site typically had greater lag times and reduced peak flows compared to the conventional pavement site. Water quality results were more variable but generally show temperature and pH were similar; DO, TSS, turbidity and metals were higher at the conventional pavement site; and conductivity was higher at the PA site. Maine DOT plans to resume monitoring both sites during the 2012 field season.

Charles Hebson, Mark Lickus, John Perry
Maine Department of Transportation, Augusta, ME; charles.hebson@maine.gov; mark.lickus@maine.gov; john.perry@maine.gov

CULVERT REHABILITATION AND FISH PASSAGE: IRRECONCILABLE DIFFERENCES?

In 2002, the Maine Department of Transportation (Maine DOT) developed its original Fish Passage Policy and Design Guide, followed by a substantial revision in 2004, in an attempt to meet regulatory requirements and natural resource needs, while delivering safe, cost-effective and timely transportation projects. Although recent regulatory changes have largely superseded these efforts, a number of culvert rehabilitation projects that utilized sliplining or invert lining were developed and constructed under the policy. Fish passage can be especially difficult to restore in rehabilitated culverts and additional measures are usually needed in order to establish passage under specified conditions. Typical measures utilized by Maine DOT have included both internal and downstream grade control structures such as baffles, weirs, rock ramps, and pool-weir fishways. The typical design procedure to address fish passage through rehabilitated culverts begins with a hydraulic analysis to check the performance of the proposed culvert. Appropriate mitigation measures are then selected in order to achieve adequate water depths and velocities that will pass the target fish species. Target species in Maine are primarily brook trout, Atlantic salmon, and alewives. Designs are based on the assumption that by eliminating perched outlets and matching hydraulic conditions in the culvert to the range of critical fish passage flows, fish passage is likely to occur. Post-construction monitoring of selected rehabilitation projects has documented both successful passage in some culverts and identified deficiencies in others. Maine DOT is currently evaluating as-built site conditions and planning to retrofit those previously rehabilitated culverts that still present a barrier to passage.

Sarah J. Nelson[1], *Medea H. Steinman[2], Molly Schauffler[3], Bill Zoellick[2], Hannah M. Webber[2]*
1 University of Maine, Senator George J. Mitchell Center and Department of Plant, Soil, and Environmental Sciences, Orono, ME; sarah.nelson@umit.maine.edu
2 SERC Institute, Winter Harbor, ME; medea@sercinstitute.org
3 University of Maine, Maine Center for Research in STEM Education and Climate Change Institute, Orono, ME; mschauff@maine.edu

BUT WHAT WAS YOUR HYPOTHESIS? A SCIENCE DATA LITERACY ASSESSMENT FOR HIGH SCHOOL STUDENTS HIGHLIGHTS DIFFICULTIES IN CONNECTING DATA TO INQUIRY-BASED RESEARCH QUESTIONS

Two types of data analysis, comparing groups and investigating correlation, provide the foundation for high school students to analyze scientific data. In the Acadia Learning project, which brings scientific inquiry-based research into classrooms through scientist-teacher-student partnerships, we noted students lacked the background and skills to use these two types of analyses. We designed an assessment and administered it to 220 students across four high schools in Maine. The instrument used a sample data set and research question for each of the two skill areas. Goals were to: (1) characterize student difficulties in representing data; and (2) determine whether teacher professional development about data literacy improves student work. Results suggest that comparing groups is more difficult for students; >60% of respondents created a graph that did not sort data into groups, and <10% of stu-

dents created a version of the 'correct' graph. For the correlation item, 36% of students created an unrelated graph, but 39% created the ideal graph, suggesting more practice or better understanding of correlation-type questions. When teachers who had participated in data literacy professional development presented lessons targeting these two topics, student scores improved significantly (Chi square analysis, $p<0.05$). This study has highlighted student misconceptions and aided science teacher understanding of the types of data literacy skills students need to practice. We also demonstrated that a focus on data literacy can lead to better student understanding of graphs as evidence in scientific inquiry.

Kirsten Ness
Portland Water District, Standish, ME; kness@pwd.org

ZOOPLANKTON MONITORING ON SEBAGO LAKE

Zooplankton are an important component of food webs in lake ecosystems. Zooplankton species assemblages and abundances vary depending on lake productivity as well as the presence of planktivorous fish species. The Portland Water District has been monitoring zooplankton at two sites in Sebago Lake since 2005: the outlet of the Songo River; and over the drinking water supply intake pipes in Lower Bay. Zooplankton are sampled monthly from May to October and analyzed for species assemblages and abundances. The major divisions of zooplankton: cladocerans, copepods, and rotifers are all present in Sebago Lake and they vary in abundance seasonally and annually. At both sample sites, cladoceran species are present in lower abundances as compared to copepods and rotifers. Because sampling has only occurred since 2005, the data provide a good baseline for the zooplankton populations in Sebago Lake. PWD will continue to sample zooplankton to better characterize potential changes in zooplankton populations in Sebago Lake over time.

Amanda Olsen[1], *Elisabeth Hausrath[2], Eileen Yardley[1], Michael Bodkin[1], Kimberly Negrich[1]*
1 Department of Earth Sciences, University of Maine, Orono, ME; amanda.a.olsen@maine.edu; eileen.spinney@maine.edu; michael.bodkin@maine.edu; kimberly_negrich@umit.maine.edu
2 Department of Geoscience, University of Nevada, Las Vegas, NV; Elisabeth.Hausrath@unlv.edu

MOBILITY OF TRACE METALS RELEASED FROM SERPENTINITE

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

The goal of this study is to understand at what rate serpentinites release heavy metals, and in particular Cr, to ground and surface waters. Specifically, we will answer: 1) How quickly are heavy metals released from serpentinites via chemical weathering?; 2) Are heavy metals disproportionately partitioned into soils, groundwater, or surface waters during chemical weathering?; and 3) Are these heavy metals transported via groundwater, and do levels of heavy metals exceed WHO recommended maximum contaminant levels? Preliminary results suggest that Cr is depleted relative to the bedrock in

soils. Chromium is found below the WHO recommended maximum contaminant level of 100 µg/L in both soil water (2-15 µg/L) and nearby Torrey Pond (<2 µg/L). Future work will install a well on-site to determine Cr concentrations in groundwater.

Eileen Sylvan Johnson[1], Douglas Suitor[2]
1 Environmental Studies Program, Bowdoin College, Brunswick, ME; ejohnson@bowdoin.edu
2 Division of Environmental Assessment, Maine Department Of Environmental Protection, Augusta ME; douglas.suitor@maine.gov

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 main stem rivers, this poster provides the first synthesis of shifts in tributaries and main stem classification along specific river systems in 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.

Roger Wheeler
Molly Ockett Middle School, Fryeburg, ME; rwheeler@msad72.k12.me.us

MAINE FISH ANTHOLOGY PROJECT – GAINING AN HISTORICAL UNDERSTANDING OF MAINE'S FISH ECOSYSTEM HISTORY

The continual construction of dams built without adequate fish passage during Maine's colonial times and the following industrialization era denied access of anadromous fishes (i.e. salmon, shad, and alewives) to most inland lakes and rivers. Maine rivers and lakes, were once accessible and greatly contributed to one of the world's finest fisheries once found in the Gulf of Maine. In the many records of Maine history lies numerous writings about the presence of anadromous fish in the rivers and their watersheds. This historical record is attributed to many citizens and public officials over several hundred years who continually battled to restore the anadromous fish to their former inland range. The Maine Fish Anthology Project's (MFAP) mission is to enable students, researchers and the public to access, via the internet, the assimilated research and, or, to contribute to the anthology. The potential sources of information include government reports, court records, State archives, diaries, and newspapers. The project research also includes any historical documentation of water flow, Maine's coastal fishing industry and the terrestrial and marine ecosystems associated with the anadromous fishes.

The poster explains development of this project, work with non-profit organizations and provides a few examples of transcribed or retrieved documents with a brief summary of their content and how interested persons and schools may participate in the MFAP.

***Mark Whiting*[1],*William Otto*[2], *and Jacob van de Sande*[3]**
1 Maine Department of Environmental Protection, Bangor, ME; mark.c.whiting@maine.gov
2 University of Maine at Machias, Machias, ME; william.otto@maine.edu
3 Downeast Salmon Federation, Columbia Falls, ME; Jacob@mainesalmonrivers.org

ACID RAIN MITIGATION AND FISH RESTORATION USING CLAM SHELLS

Many years of acid rain and intensive commercial forestry have depleted base cations from the soils of some of Maine's most sensitive watersheds (Miller, 2006). For some streams, this translates to a major loss of buffering capacity. Project SHARE is currently using clam shells from Maine's seafood industry as a calcium carbonate source to mitigate stream acidity and restore brook trout and Atlantic salmon. In 2010, two metric tons of shells were added to Dead Stream – Bowles Lake Stream, a tributary to the Machias River. In 2011, we put another two tons into Dead Stream, and for the first time put two tons in the Bowles Lake Stream and six tons in an un-named tributary to Bowles Lake Stream. Brook trout sampled within a 200 m study reach increased from 13 in 2009 (baseline study) to 100 in 2011. The interpretation of this increase in fish abundance is tempered by the fact that culvert upgrades, salmon stocking, and coarse woody debris additions are also taking place in the watershed.

Ethel Wilkerson, *John Gunn*
Manomet Center for Conservation Sciences, Brunswick, ME; ewilkerson@manomet.org; jgunn@manomet.org

THE CLEAR WATER CARBON FUND—A NEW MODEL FOR CONSERVATION

The Clear Water Carbon Fund is a new program that uses the sale of voluntary carbon offsets to finance riparian reforestation projects in Maine and Vermont. Planting trees near streams achieves multiple benefits including sequestering carbon from the atmosphere, improving water quality, protecting recreational opportunities, and supporting local economies. This project is unique because it utilizes the carbon market to finance water quality protection efforts and seeks to support ecosystem benefits (e.g. clean water, habitat, recreation opportunities) with private investments. In Maine alone, the Clear Water Carbon Fund raised enough capital in 2011 to reforest approximately two acres of riparian areas. This poster will provide an overview of the Clear Water Carbon Fund as well as summarize key lessons learned during the development and administration of this project including how to verify and ensure legitimacy of carbon sequestration and water quality protection.

Qiang Yang[1,2]*, Paul Smitherman*[3]*, Charles T. Hess*[3]*, Charles W. Culbertson*[4]*, Robert G. Marvinney*[5]*, Yan Zheng*[1,2]

1 Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY
2 Queens College and Graduate Center, City University of New York, Flushing, NY
3 University of Maine, Department of Physics, Orono, ME
4 USGS, Maine Water Science Center, Augusta, ME
5 Maine Geological Survey, Augusta, ME

URANIUM AND RADON IN BEDROCK AQUIFERS IN MAINE: ONE FAMILY, TWO TALES

Granitic rocks in general contain higher uranium and thus groundwater from such fractured bedrock aquifers may also contain elevated uranium. In Maine, 5% of well water samples from a statewide data compilation contained > 30 µg/L of uranium, the U.S. EPA's Maximum Contaminant Level (MCL). In 13 towns of central Maine, 62 (or 8%) of 789 water samples contained > 15 µg/L of uranium, the WHO guideline level, and 30 (or 4%) of 789 samples displayed uranium > MCL. Elevated uranium concentrations are spatially strongly associated with the granites. There are also associations between uranium and sulfur, arsenic, molybdenum, fluoride, cesium in groundwater samples from central Maine. Logistic regression models found that groundwater pH, calcite dissolution and redox conditions are the most important factors controlling uranium distribution in fractured granite aquifers at local scales.

Radon is a decay product of uranium, so areas with high uranium are potentially also at risk for radon. In the statewide dataset, up to 1/3 of the wells have radon > 4000 pci/L, an EPA proposed regulation level for drinking water. In central Maine, 226 (or 29%) of 789 well water samples showed > 4000 pci/L of radon. Higher radon concentrations in groundwater were found associated with the higher metamorphic grades of bedrock. However, no apparent correlation between groundwater radon and geochemical parameters was found. Radon distribution in fractured bedrock aquifers might be more influenced by the release rate, residence time and groundwater flow paths in the interconnected fracture networks.

Notes

thank you

The Maine Water Conference Organizing Committee wishes to thank the following sponsors for their support.

Senator George J. Mitchell Center & Maine's Sustainability Solutions Initiative

U.S. Geological Survey

Maine CDC Drinking Water Program

Maine Department of Environmental Protection

Maine Geological Survey

Portland Water District

Maine Water Utilities Association

University of Maine Cooperative Extension

Maine Volunteer Lake Monitoring Program

Maine WasteWater Control Association

Maine Congress of Lake Associations

Senator George J. Mitchell Center
5710 Norman Smith Hall · Orono · Maine 04469-5710 · ph: 207/581-3244 · fx: 207/581-3320