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***** Training Contact Hours (TCHs) are available for these sessions from the Maine CDC Drinking Water Program.*

***#** Credits are pending for these sessions from the American Planning Association American Institute of Certified Planners (APA AICP).*

Maine Sustainability & 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.

In 2014, the conference expanded to become the Maine Sustainability & Water Conference, adding a number of sustainability-focused sessions to the conference as well as sessions with a joint focus on water resources and sustainability. This annual conference attracts over 350 attendees and provides an important networking opportunity for participants.

Conference Agenda

7:30AM Registration, Continental Breakfast, Poster & Exhibit Viewing — Auditorium

8:30AM Morning Concurrent Sessions

Session A: Ocean Acidification *(Penobscot Room*)

Session E: Urban Sustainability & Climate Change (*Kennebec Room*)

Session F: Developing Water Supplies in Challenging Environments (*Howard Room*)

Session G: Citizen Science in New England (*Cumberland Room*)

Session H: Sebago Lake – A Trillion Gallons of Challenge (*Piscataquis/ Sagadahoc Room*)

Session I: Sustainable Engagement with the Food System (*Washington/York Room*)

Session K: Models and Practices for Municipal Water Resource Management (*Arnold Room*)

Session L: Sustaining Maine's Water Resources (*Fort Western Room*)

10:30AM Morning Break & Poster Session — Auditorium

11:30AM Plenary Session — Auditorium

12:30PM Lunch — Auditorium

1:30PM Afternoon Concurrent Sessions

Session B: Safe Beaches & Shellfish Beds (*Kennebec Room*)

Session C: Communities Facing Climate Change Adaptation (*Fort Western Room*)

Session D: Stream Connectivity (*Piscataquis/Sagadahoc Room*)

Session F: Developing Water Supplies in Challenging Environments (*Howard Room*)

Session G: Citizen Science in New England (*Cumberland Room*)

Session J: Sustainability of Maine's Working Forest (*Penobscot Room*)

Session K: Models and Practices for Municipal Water Resource Management (*Arnold Room*)

Session M: Rivers: Streamflow Quantity and Quality (*Washington/York Room*)

2:30PM Afternoon Break — Auditorium

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

4:00PM Conference Close

Plenary Session

11:30AM Welcome & Introduction

David Hart, Director, Senator George J. Mitchell Center for Sustainability Solutions

David Hart is director of the Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine. He is also leader of the Sustainability Solutions Initiative and a professor in the School of Biology and Ecology. He earned his PhD in Ecology from the University of California at Davis. David came to the University of Maine in 2006 seeking to create innovative, solutions-driven programs combining interdisciplinary research teams with diverse stakeholders. His belief in the power of university-stakeholder partnerships and engaged research is based on more than three decades of experience collaborating with business and industry, all levels of government, and local-to-global NGOs.

11:35AM Whitney King

Miselis Professor of Chemistry, Colby College

How can we stop loving our lakes to death? Building a Community-Based Action Plan to Keep our Lakes Golden

The Belgrade Lakes chain is typical of many Maine watersheds providing exceptional recreational value, a close-knit community, and millions of dollars in economic activity. Declining water quality is threatening many of our iconic Maine lakes. Developing sustainable solutions for the Belgrade Lakes has required community partnerships to define the change in lake ecosystem function, agree on a plan for collective action, and implement broad-based watershed restoration projects.

This spring Whitney King completes his 25th year at Colby College. Trained as a chemical oceanographer, Whitney teaches General Chemistry, Environmental Chemistry, and Analytical Chemistry courses. He has served as Chemistry Department Chair, Science Division Chair, and as a member on numerous college committees. Whitney and his research students develop and build analytical instruments for the analysis of metals and reactive oxygen species in natural waters. These instruments allow fundamental studies of redox reactions at the ocean/atmosphere, sediment/water, and plankton/water interfaces critical in defining biogeochemical cycles in aquatic environments. Over one hundred research groups in over fifteen countries now use these instruments. In 2002, Whitney co-founded Waterville Analytical to meet the commercial demand for this specialized instrumentation.

Ongoing research projects include collaborations with the Wells and Tripp groups at the University of Maine to develop novel sensors for iron in the ocean, and the Emerson group at the Bigelow Institute for Ocean Sciences on the dynamics of hydrogen peroxide production by iron oxidizing bacteria. Whitney was also the principal investigator on an NSF-EPSCoR funded project investigating the impacts of human development on the Belgrade Lakes watershed. The Belgrades work has benefitted from a dynamic, collaborative team of eight Colby faculty, over fifty students, and six conservation organizations.

12:20PM Poster Award Presentations

Presentation of poster awards by David Hart, Director, Senator George J. Mitchell Center and Robert Lent, Director, USGS New England Water Science Center, Maine Office

12:30PM Lunch

Session A

Ocean Acidification – What is it, what have we learned, what are the critical knowledge gaps, and what can we do about it?

Improving our understanding of Maine's susceptibility to ocean acidification (OA) is of the utmost precedence. With nearly 90% of Maine's fisheries landing by value from shell producing species, the potential implications of OA are sobering. Predictions of continuing declines of pH raise questions about the long-term viability of these fisheries. One recommendation for local action to mitigate acidification of coastal waters coming out of the recent Legislative Study Commission on OA included the need to identify and reduce nutrient loading and organic carbon from sources determined to cause or contribute to OA. The goal of this session is to raise awareness about OA and present updates on research and monitoring, as well as remediation, mitigation, and adaptation strategies.

Session Chair

Susie Arnold
Island Institute, Rockland, ME; sarnold@islandinstitute.org

Susie Arnold is a Marine Scientist at the Island Institute in Rockland. She received a masters degree in Marine Policy and a doctoral degree in Marine Biology from the University of Maine. At the Island Institute, Susie works primarily on the impacts of climate change and ocean acidification on marine resources and fisheries dependent communities. She was an appointed member of the Legislative Study Commission on Ocean Acidification in Maine in 2014. Other areas of focus include science education with island schools, conducting cooperative research with fishermen, and working with community fisheries organizations.

8:30 – 8:55AM

Michael Devin
Maine House of Representatives; mick@mickdevin.org

Ocean Acidification: A Global Problem Being Addressed Locally

Ocean acidification is a global problem and associated with other phenomena impacting Earth. It is complex and most state and national governments are reluctant to address it, even as their fisheries and aquaculture industries

are impacted. The common belief is OA cannot be addressed locally. Several states, including Washington and Maine, reject this tenet and havemoved forward to create a political environment to address the issues associated with OA.

The 126th Legislature established *Maine's Commission to Study the Effects of Coastal and Ocean Acidification and Its Existing and Potential Effects on Species That Are Commercially Harvested and Grown along the Maine Coast*. Over the course of five months, the commission developed six goals to mitigate the impacts of OA on Maine's coastal and marine environment, which provide the basis for moving forward. Follow-on legislation has been introduced into the 127th Legislature. Additionally, Maine legislators are working to ensure all states and provinces that border the Gulf of Maine develop similar policies to address OA.

9:00 – 9:25AM

Mike Doan
Friends of Casco Bay, South Portland, ME; mdoan@cascobay.org

Sediment Acidification in Casco Bay

In lab studies, sediment with high acidity and low aragonite saturation state has led to reduced clam flat settlement and potential shell dissolution. Over the past few years Friends of Casco Bay has been exploring ways to measure coastal sediment pH and identify flats that may exhibit acidic conditions. Since 2011, a baseline of clam flat pH conditions has been established, and data has been collected on the relationship between pH and organic enrichment. More recently, spatial and temporal trends in sediment pH have been identified at one flat in Casco Bay, and sediment pH and sediment aragonite saturation state have been compared. Overall, the data suggests that clam flats in Casco Bay are showing signs of acidification.

9:30 – 9:55AM

Theodore Willis[1]; Jonathan Eaton[2], Celeste Mosher[2]
1 Environmental Science, University of Southern Maine, Gorham, ME; theodore.willis@maine.edu
2 Georges River Tidewater Association, Thomaston, ME; tidewaterassociation@gmail.com

Tracking Low pH Episodes in the Georges River Estuary; Ocean Acidification from the Land and Sea

Eutrophication and its contribution to poor water quality has been a concern in the St. George River Estuary since 2002. The estuary is a long, narrow drowned river mouth located between Port Clyde and Thomaston, ME, on the eastern edge of Muscongus Bay. River flows are a "trickle", except after storm events, so the tidal signal is strong well into the lower St. George River. Consequently, water turnover in the estuary requires upwards of 15 days to fully flush. This is a concern because the St. George Estuary hosts one of the most valuable softshell clam fisheries in the state of Maine. Volunteer based estuary monitoring in 2012 revealed low dissolved oxygen episodes related to rainfall events, and low pH episodes that did not correspond with rainfall events. Further investigation in 2013 and 2014 also indicated that low pH, on the order of 6.8 near the bottom, occurred in the lower estuary and lasted for over three weeks in late summer. Data from 2013 indicated that low pH episodes correlated most strongly with prolonged, strong SW winds. The long, narrow topography of the drowned river mouth extends underwater for several miles within Maine State waters, where depths may be 300 ft. Persistent winds combined with the Coriolis effect may create upwellings that bring deep water with high CO^2 content to the surface along the coast, where it produces pH readings well below levels predicted to impact bivalves and other shell forming organisms.

Session A - Ocean Acidification

10:00 – 10:25AM

Aubrey Strause[1], Robyn Saunders[2]
1 Maine Water Environment Association, Scarborough, ME; aubrey@verdantwater.com
2 Cumberland County Soil & Water Conservation District, Windham, ME; rsaunders@cumberlandswcd.org

Management of Nutrients in Point and Non-Point Sources in Maine

Maine's Commission to Study the Effects of Coastal and Ocean Acidification and Its Existing and Potential Effects on Species That Are Commercially Harvested and Grown along the Maine Coast has identified nutrient management and reduction as a critical component of mitigating the effects of ocean acidification in Maine.

Nutrients enter surface waters through a combination of point sources (such as wastewater treatment facilities and engineered stormwater systems) and non-point sources (such as agricultural runoff, residential application of fertilizer, and improper disposal of pet waste). Point and non-point sources across the State are regulated under a number of programs that have resulted in improvements to water quality in recent decades.

In this session, the authors will review the management of nutrients from point and non-point sources, with the purpose of providing insight into regulatory programs that are not well understood by the public. We will provide a context of the relative loadings of nutrients to surface waters derived from models across New England, identify current and proposed funding sources for these programs, identify outreach programs that are demonstrating improvements, and review proposals to expand or revamp regulatory framework.

Finally, we will review challenges facing municipalities as they seek to further reduce nutrients entering surface waters, including fiscal constraints, incomplete understanding of the issue by the general public, and the limits of technology for nutrient removal.

Session B

Safe Beaches & Shellfish

How are changes in coastal water quality affecting – or projected to affect – beaches and shellfish beds and what new tools, methods, data, and collaborative approaches are available to help anticipate changes, understand the impacts of these changes, and guide regional and local responses to these changes? This session focuses on water quality issues in coastal Maine and New Hampshire, with an emphasis on safe beaches and shellfish beds.

Session Co-chairs

Kathleen Bell
University of Maine and New England Sustainability Consortium; kpbell@maine.edu

Kevin Gardner
University of New Hampshire and New England Sustainability Consortium; kevin.gardner@unh.edu

Kathleen Bell specializes in environmental and public economics. She received her A.B. in Economics and Environmental Studies from Bowdoin College in 1990 and her Ph.D. in Economics from the University of Maryland in 1997. Kathleen and her students conduct research on public policy and economic development topics. At the University of Maine, she teaches economics, policy, statistics, and GIS courses. Her research interests include the use of markets, information, and technology to support private and public decision-making and the interactions among economic and environmental systems. She is a Co-PI on the NSF-funded NEST: Safe Beaches & Shellfish project. Kathleen focuses on strengthening Maine's economy and environment.

Kevin Gardner is a Professor of Environmental Engineering and Associate Director of the New Hampshire EPSCoR program. His research has focused on sustainability, including systems analysis work on biofuels for electricity generation, production of durable goods from waste biomass and other forms of carbon recycling, and reuse and recycling of post-industrial materials. Other work has examined the sustainability of communities from many different perspectives, and extensive work on exposure and risk associated with sediment-associated contamination in estuarine environments. He is a Co-PI on the NEST: Safe Beaches and Shellfish project, and strives to foster good collaboration across complex interdisciplinary projects

Session B - Safe Beaches & Shellfish

1:30 – 1:55PM

Kate Beard[1], Caroline Noblet[2], Kathleen P. Bell[2], Emma Fox, Abigail Kaminski, Tagwongo Obamsawin, Margaret Snell, and Frank Xu
1 School of Computing & Information Science, NEST, University of Maine, Orono, ME; beard@spatial.maine.edu
2 School of Economics, NEST, University of Maine, Orono, ME; caroline.noblet@maine.edu; kpbell@maine.edu; abigail.kaminski@maine.edu

Coastal Water Quality: Linking Insights from Analysis of Fecal Coliform Levels and Citizen Survey Responses

This presentation reports on an investigation of links between spatial patterns in water quality of Maine beaches and shellfish harvest areas with citizen perceptions and priorities for coastal management. We obtained water quality data from the Maine Healthy Beaches (MHB) program and the Maine Department of Marine Resources (DMR). We analyzed these data for spatial variation in the levels of water quality impairment. These patterns were then compared against spatial variation in survey responses. We surveyed a random sample of coastal Maine residents using a mixed-mode survey (paper/internet). We distributed the survey to 3,000 citizens in January 2015. Respondents were asked to identify priorities for coastal management, provide information on perceptions of water quality and benefits (implications) of excellent (poor) coastal water quality. Additionally, we asked participants about their support of coastal water quality improvement programs.

The combination of these unique data sets create an opportunity for our work to offer insights into similarities and potential differences between the science used to make coastal management decisions and citizens' preferences and perceptions. Identification of these patterns provides key information for improved communication about coastal water quality and more broadly for policies and projects affecting the coastal zone.

2:00 – 2:25PM

Abigail Kaminski[1], Avinash Rude[1], Kathleen P. Bell[1], Charles Colgan[2], Maggie Lynn[1], and John Peckenham[1]
1 University of Maine, Orono, ME; abigail.kaminski@maine.edu; kpbell@maine.edu;jpeck@maine.edu
2 University of Southern Maine, Portland, ME: colgan@maine.edu

Maine and New Hampshire's Coastal Beaches: Multiple Perspectives

Maine and New Hampshire have over 3,500 miles of coastline which attract large seasonal visitor populations and provide important sources of income for residents living and working in coastal communities. To assess coastal water quality, Maine and New Hampshire both monitor bacteria at their coastal beaches. Unsafe bacteria levels degrade ecosystems, threaten public health, and impact coastal economies and tourism. We share multiple perspectives on beach monitoring and management issues, calling attention to ways in which researchers can address emerging issues for these beach programs.

Maine Healthy Beaches provides a unified, quality- assured structure to monitor, assess, and notify the public of coastal beach water quality conditions. However, the tools and resources available to accurately assess the immediate public health risk and the complexities surrounding bacterial pollution are limited. Given the current and emerging challenges, the Maine Healthy Beaches Program seeks the expertise of researchers and agency partners to help inform beach management decisions and program initiatives.

With a goal of filling large information gaps about users of beaches, we gathered information from visitors to three beach systems (Wells-Ogunquit, Saco Bay Area, and New Hampshire Seacoast). Patterns in survey responses

reveal interesting differences and similarities across distinct groups of beach users and beach systems. Variations in use, along with differences in perceptions of water quality and the ways users seek out information about water quality, have important implications for the on-the-ground work of state beach programs and other diverse stakeholders.

Decision-support tools that incorporate site-specific spatio-temporal associations and historic water quality data also have the potential to assist beach managers in making faster and better-informed beach monitoring and advisory decisions. In response to interest in tailored decision tools, we employ historic data and statistical classification methods to identify bio-physical and human metrics correlated with high bacteria counts in coastal waters.

2:30 – 3:00PM

Break — Auditorium

3:00 – 3:25PM

Kohl Kanwit
Maine Department of Marine Resources, Augusta, ME; kohl.kanwit@maine.gov

Vibrio in Maine, an Increasing Risk for Bivalve Shellfish Growing Areas and Public Health

Bivalve shellfish pose a unique risk to human consumers for two reasons; 1. they are filter feeders and are capable of concentrating microorganisms and 2. they are predominantly consumed raw or lightly cooked. *Vibrios* are naturally occurring bacteria commonly found in marine waters. Several species of *Vibrio* are pathogenic and can cause gastroenteritis as a result of ingestion or septicemia as a result of a wound infection. Vibriosis became a reportable illness in 2007 and since that time, illnesses attributed to *Vibrio* have increased steadily. *Vibrio parahaemolyticus* (Vp) is the primary bacteriological concern for human health from the consumption of bivalve shellfish in the temperate regions of the US. In 2013, there were 104 Vp illnesses reported from 13 states resulting in growing area closures and three major product recalls. Maine has not yet had bivalve shellfish epidemiologically linked to a Vp outbreak, but several multisource illness reports lead to the conclusion that the pathogenic strain of Vp is in some Maine waters and is likely capable of making consumers ill. The Department of Marine Resources has recently collaborated with the oyster growers in the Damariscotta River to develop a *Vibrio* Control Plan. Strict time to temperature requirements in other Vp impacted states such as Washington and Massachusetts have resulted in reduced illnesses and safer product. An increased emphasis on the safety of bivalves in the warmer summer months is critical not only to the health of the consuming public, but also to the growing aquaculture industry in Maine.

3:30 – 3:55PM

Kelly Cole[1], Erin Urquhart[2], Damian Brady[1], Vaughn Cooper[2], Stephen Jones[2], Meghan Hartwick [2] and Jacqueline Lemaire[2]
1 NEST, University of Maine, Orono, ME; kelly.cole@maine.edu
2 NEST, University of New Hampshire, NH; erin.urquhart@gmail.com

Modeling Variation in Pathogenic Bacteria Concentrations in Coastal and Estuarine Waters

Estuaries and coastal waters are dynamic environments, subject to variable currents and mixing processes that produce high temporal and spatial variability in water properties relevant to hydrodynamics, water quality, and ecology. These environments are also increasingly vulnerable to adverse environmental, biological, and societal

change due to population growth, sea level rise, and climate change. In coastal regions such as the Great Bay estuary of New Hampshire and Maine, it has been documented that both the abundance and distribution of pathogenic *Vibrio parahaemolyticus* are increasing. The highly variable nature of these environments makes them notoriously difficult to survey and monitor. As conditions continue to change in poorly characterized and unpredicted ways, there is a vital need for more highly resolved monitoring and modeling networks in both space and time.

In this study, the Great Bay estuary is used as a "test bed" to which we will apply a novel pathogen modeling technique. A validated, coupled hydrodynamic-eutrophication model will be used to understand the temporal and spatial variability in bacterial pathogen concentrations. The model will be used both to understand pathogen fate and transport. The eutrophication model will be used to simulate important drivers of Vibrio such as chlorophyll, temperature, nutrients and salinity. This coupled mechanistic-empirical modeling framework will ultimately be used to identify the location and conditions that lead to 'hotspots' and 'cold spots' for Vibrio in Great Bay.

The advantage of this approach, is that it uses existing eutrophication modeling infrastructure that is widely available in water bodies that require computation of total maximum daily load. By leveraging this existing infrastructure, this approach could be applied to estuarine models globally. Illustrating links between sources and criteria violations will help stakeholders make opening/closing decisions in shellfish and recreational waters in the Gulf of Maine.

Session C

Communities Facing Climate Change Adaptation

What are the opportunities and challenges that Maine communities face in adapting to a changing climate? In this session participants will have an opportunity to hear how two towns are tackling these issues. What are the actions a community may take to reduce its vulnerability and increase resilience to the potential impacts of climate change? These towns are leaders in community involvement, team building, decision-making, and solution development.

The Maine Coastal Program provides funding and technical support to coastal municipalities interested in vulnerability assessment and climate adaptation planning. Projects to be discussed include an intermunicipal vulnerability assessment undertaken by the four towns surrounding Saco Bay, a county-wide approach to assessing vulnerability and developing adaptation options in Lincoln County, a marsh migration project based on community-driven goals and processes undertaken by six towns, and a downtown vulnerability study and development of adaptation options in the historic downtown of Damariscotta.

** TCH - Drinking Water Program available #APA AICP credits pending*

Session Facilitators

Esperanza Stancioff
University of Maine Cooperative Extension, Maine Sea Grant; esp@umext.maine.edu

Malcolm Burson
Conservation Law Foundation; MBurson@clf.org

Esperanza Stancioff, UMaine Extension and Sea Grant Associate Extension Professor, has worked since 1988 designing and implementing outreach, applied research and educational programs for high priority areas in marine and coastal ecosystems. She currently serves as lead for both organizations in climate change adaptation and as chair for the Maine Climate Adaptation Provider and NE Regional Sea Grant Climate Networks. Projects include a number of adaptation efforts focused on reducing climate-related impacts through infrastructure improvements and tailored decision-support tools to promote economic development and secure communities. She is also co-developer and co-coordinator of *Signs of the Seasons: A New England Phenology Program*.

Malcolm Burson currently serves as Public Policy Advisor to the Maine office of the Conservation Law Foundation. Previously, he was climate change program manager for Maine DEP; as such, he convened the stakeholder efforts for, and was primary author of *Maine's Climate Action Plan* (mitigation) in 2003, and the 2010 adaptation report to the Legislature, *People and Nature Adapting to a Changing Climate*.

Session C: Communities Facing Climate Change Adaptation

Session Panelists:

Michele Gagnon
Senior Planner, City of Ellsworth, Ellsworth, ME

Jon Carter
Town Manager, Wells, ME

Elizabeth Hertz
Director, Municipal Planning Assistance Program, Dept. of Agriculture, Conservation and Forestry

Brief presentations will be followed by an in-depth discussion and networking opportunities.

Session D

Stream Connectivity

This session will describe ecological and societal needs for better connections among our waterways, our oceans and streams, lakes, ponds, and floodplains. Starting with the base ecological need for up and downstream processes we will look at what impedes the movement of water, sediment, nutrient, key structure-forming material (like trees and rocks), as well as fish and other wildlife. We also have societal needs moving drinking water and waste-water from one place to another and for our extensive road networks to safely cross streams and rivers in a way that is cost-effective, yet robust enough to avoid catastrophic damage from normal and our increasingly abnormal storm flood-flows and tidal storm surges. Wherever there are roads and streams that are crossed by them there is greater than a 50:50 chance the road-stream crossing will be undersized and pose both environmental problems for streams and safety and maintenance problems for roads. From understanding the problems to focusing on solutions, this session will look at how Mainers are working together and with restoration practitioners around the country to get better at identifying the most problematic areas for stream ecosystems and societal needs and developing cost-effective lasting solutions.

** TCH - Drinking Water Program available*

Session Chair:

Joshua Royte
The Nature Conservancy; jroyte@tnc.org

Joshua Royte is the conservation planner for The Nature Conservancy in Maine, a global non-profit conservation group dedicated to protecting biodiversity around the world by protecting the lands and waters all things depend on. He focuses on mapping, prioritizing sites and strategies and measuring results of restoration and protection projects. His projects run from coordinating Maine stream survey crews, to barrier prioritization and global networking for increased planning and restoration for aquatic organism passage. Josh received his B.A. from Bard College and Masters' from Yale School of Forestry & Environmental Studies. Josh previously directed The Chesapeake Bay Foundation's Fox Island Center and was a planner for the National Capital Parks and Planning Commission.

Session D: Stream Connectivity

Session Panelists:

Mathias Collins
Restoration Center, National Marine Fisheries Service, NOAA

Jacob Aman
Wells National Estuarine Research Reserve

Ben Naumann
USDA Natural Resources Conservation Service

Michael Burke
Inter-Fluve, Inc.

1:30 – 4:00PM

Panelists will each provide a 10-minute introduction to their work on stream connectivity. This will be followed by a panel and audience discussion that will cover some of the following topics: What hinders restoration? What information needs do people have? What resource needs must be met (technical, non-federal cash)? What ideas can we generate for how to meet future needs better? Ideas and recommendations resulting from the session will be captured for further use.

Abstracts

Mathias J. Collins
Restoration Center, National Marine Fisheries Service, NOAA, Gloucester, MA; Mathias.Collins@noaa.gov

Connected rivers and roads: considering climate change in stream connectivity design

Road-stream crossings are essential components of transportation infrastructure networks. Yet undersized road-stream crossings are known to degrade riparian ecosystems by impeding fish and wildlife passage, sediment transport, streamflow, and other floodplain processes. There is also increasing recognition that undersized crossings are more failure-prone and undermine the resilience of human communities, especially in regions where climate change is expected to increase the magnitude and frequency of extreme precipitation and streamflow events. Thus ecosystem restoration practitioners, community planners, and transportation engineers have a shared interest in climate-informed road-stream crossing design and a stake in the active discussion in the research community about what methods are most appropriate for designing infrastructure for a changing climate. Traditional approaches for estimating design flows assume that the past is a good guide to the future. This is more formally known as a "stationarity" assumption, and presently there are no well-accepted non-stationary design flow estimation techniques. In this presentation Matt will briefly review observed and predicted hydroclimatic changes in the Northeast U.S. that have implications for road-stream crossing design and discuss a number of recently proposed stationary and non-stationary methods for estimating design flows in a changing climate. The perils of using dated precipitation or streamflow records for project design in New England will be emphasized. He will conclude by discussing special considerations and guidance for designing naturalized river channels, a component of some stream connectivity projects.

Session D: Stream Connectivity

Jacob Aman, Tin Smith, Kristin Wilson
Wells National Estuarine Research Reserve, Wells, ME: jacobaman@wellsnerr.org, tsmith@wellsnerr.org, kwilson@wellsnerr.org

Chipping Away at Stream Barriers in Southern Maine

Southern Maine has a long history of dam building dating back to the first grist mills constructed by European settlers in the 1600's. Many of these structures remain today, creating discontinuities in habitat throughout many small coastal streams in York County. At the same time, development is altering the watershed landscape resulting in adverse impacts to habitat for native species. The Wells National Estuarine Research Reserve waded into the struggle to reconnect stream habitat and improve conditions and over the past five years developed relationships with likely and unlikely partners to inventory stream barriers, secure diverse funding, implement restoration projects, and conduct monitoring. Progress is slow, but steady. Jacob will share the stories of the team's work to restore stream connectivity working at the local level as a small community based conservation organization, and associated challenges and successes that we have encountered along the way. Specific examples will include stream barrier surveys in three local watersheds, the removal of a small dam on Shorey's Brook in Eliot, the restoration of a disused fish ladder at the Kennebunk, Kennebunkport and Wells Water District filtration plant on Branch Brook in Kennebunk, ongoing work to remove a head-of-tide dam on a Kennebunk River tributary, and associated environmental monitoring work to track the recovery of target species.

Ben Naumann
USDA Natural Resources Conservation Service, Bangor, ME; ben.naumann@me.usda.gov

Impact of Culverts on Fish Movement

The Maine public is becoming increasingly aware of the importance of fish passage and the severe impacts undersized and improperly installed culverts are having on fish movements. To fix problem culverts effecting fish passage, culverts are being replaced with fish friendly structures. Initial cost for fish friendly structures can be alarming and limited annual budgets struggle to augment costs. Practitioners argue that fish friendly structures are cost effective solution overtime for road infrastructure however little analysis has been recently completed here in the state. This analysis examines two road stream crossing case studies common on the landscape, one forestry culvert and one municipality culvert. Estimated accumulative costs for road stream crossing structures included round culverts, arch culverts and bridges were carried out for a duration of 50 years and compared. Preliminary results show for round culverts when carried out 50 years are less economical then other structures overtime due to maintenance costs and replacements. Results also show new technologies, forestry ingenuity and regulations affect what structures are economical over time. The results of the structure comparison were expected however these structure comparisons can be used as a planning and outreach tool to help change perspectives of fish friendly structures to municipalities and private landowners.

Session D: Stream Connectivity

Michael Burke[1], Nick Nelson[2], and Marty Melchior[3]
1 Inter-Fluve, Inc, Damariscotta, ME; mburke@interfluve.com
2 Inter-Fluve, Inc, Cambridge, MA;
3 Inter-Fluve, Inc, Madison, WI;

Case Studies in Restoration of Ecological Connectivity through Culvert Rehabilitation

Stream and river networks in New England have been fragmented by transportation corridors for generations. Addressing the constraints imposed by each individual road crossing on the ecological function of the regional ecosystems is a nearly incomprehensible endeavor. Yet progress is being made, one road crossing at a time. A series of three to four case studies will be presented of culvert rehabilitation projects that have been successfully implemented in New England (case studies are primarily located in Massachusetts but have similar traits with sites in Maine). The case studies share a common thread of objectives that include restoration of habitat connectivity for a broad range of aquatic and terrestrial wildlife. They differ in the way that the constraints of each location needed to be addressed in the design and construction of the new facilities.

Session E

Urban Sustainability & Climate Change

Although Maine is best known for its rural character, the state does have urbanized areas that date back several centuries. Problems associated with past industrial usages, aging infrastructure, and stressors like changing weather patterns have brought new vulnerabilities to our attention. What are some of these vulnerabilities and how do they affect the sustainability of urban areas and our built infrastructure? New knowledge and techniques are needed to sustain Maine's built environment and diverse economy to help make us resilient to change and future extreme events. In this session we will look at some of the solutions to these problems that include many pieces that link across the landscape.

** TCH - Drinking Water Program available* *#APA AICP credits pending*

Session Chair

Nick Sabatine

Ransom Consulting, Inc.; nick.sabatine@ransomenv.com

Nick is a Principal/Vice President and Senior Geologist at Ransom with over 20 years of environmental consulting experience. He has been with Ransom for over ten years and is responsible for the leadership, management, and growth of the Portland office. Nick graduated from the University of Maine at Farmington in 1991 with a B.A. in Geology. He received a Masters of Environmental Law from Vermont Law School in 1992. Nick serves as Principal-In-Charge / Senior Technical Reviewer for Ransom's Belfast, Rockland, Lincoln County, Mid-Coast, Bath, SMPDC, and GPCOG's EPA Funded Brownfield Assessment programs and the Town of Dover-Foxcroft's Cleanup of the former Maine Leathers Tannery Site, Central Hall, and former Moosehead Mill projects. He currently serves as the Program Manager for the City of Gardiner's Brownfield Assessment program and he is responsible for the U.S. EPA Funded Cleanup of the former Old Town Canoe Factory site in Old Town, the Old Tannery in Saco, and the Wilton Tannery site in Wilton.

Session E: Urban Sustainability & Climate Change

8:30 – 8:55AM

D. Todd Coffin[1], Judith East[2]
1 WCCOG Brownfields Program, Woodard & Curran, Inc., Potland, ME; tcoffin@woodardcurran.com
2 Washington County Council of Governments, Calais, ME: jceast@wccog.net

The Power of Brownfields Redevelopment for Enhancing Sustainability, Resource Protection and Economic Growth in Rural Maine

Rural Maine is highly dependent on private water supplies, is host to the watersheds of Maine's wild Salmon Rivers, and is world-renowned for timber, blueberries, potatoes, lobster and recreation. All are inexorably linked to the health of the environment. Rural Maine also represents some of the most economically depressed areas of the State and Region, raising the stakes for the sustainability of this natural resource-based economy. For over a decade, redevelopment of underutilized commercial and industrial properties, or Brownfields, has been a cornerstone of economic growth in the state, from the western mountains to the Downeast coast. This presentation explores the powerful role of Brownfields redevelopment projects in protecting the environment, sustaining resources, and bolstering the economy of rural Maine. Case studies will be shared that highlight drivers for redevelopment in rural Maine, solutions for funding where dollars are scarce, and outcomes that raise the spirit.

9:00 – 9:25AM

Leila Pike
Ransom Consulting, Portland, ME; leila.pike@ransomenv.com

5' High and Rising: A Case Study of Determining Maximum Water Elevations in Tidal Rivers During 1% Annual Chance Coastal Storms

The downstream reaches of tidal rivers, and the river infrastructure within, will feel the effect of increasing storm frequencies and intensities brought on by climate change. This is a case study of determining flood levels within the downstream reach of the Kennebunk River during coastal storm surges, specifically 1% annual chance storms. HEC-RAS was used to create a river circulation model that incorporated mean annual freshwater flows and a variable head boundary at the mouth of the river representing total water levels during a hypothetical three-day "Northeaster" storm. The reversible flow model allows for the simulation of a build-up and dissipation of the surge with superimposed wave setup. Total water levels at the mouth of the river were calculated by estimating surge elevations based on tide gage data from past storm surges and adding wave setup calculated using SWAN1-D, a modeling software which incorporates wave attenuation along a long wave ray from deep water to the limit of the wave setup on land. Mean annual freshwater flows were determined by applying USGS regression equations. To complete the analysis, an STWAVE model was used within the river to account for the wave crest elevation above the maximum 100-year surge elevation in the river. The end result shows maximum water levels within the river as well as the effect of river constrictions on the flood flows.

Session E: Urban Sustainability & Climate Change

9:30 – 9:55AM

Charles Hebson
Maine Department of Transportation, Surface Water Division, Augusta, ME; charles.hebson@maine.gov

Pipe Dreams: Balancing Risk, Benefit and Cost for Workable Culvert Design

MaineDOT is on the frontline of dealing with climate change impacts. Inland assets such as bridges and culverts are the hard interface between infrastructure, climate and hydrology, while coastal structures are directly exposed to sea level rise and storm surge. Dealing with climate is fundamentally a decision-making exercise: How to allocate scarce resources most effectively with incomplete and uncertain information over a wide spectrum of asset criticality and vulnerability. MaineDOT has taken up this challenge on several fronts, by sponsoring ongoing research and data collection by USGS, participating in FHWA pilot programs, and developing new design policy that addresses the risk associated with climate change. Culverts present a particularly thorny problem: There are many thousands of them and they do not command the resources that are routinely assumed for larger bridge structures. MaineDOT is currently developing new culvert design policy that identifies risk, benefit, cost, and environmental aspects for these smaller structures, in the context of the limited resources that are available for these smaller structures. The resulting policy should benefit towns as well, since Maine municipalities own untold thousands of structures. This presentation will discuss MaineDOT's framework for culvert design that directs resources to where impacts of changing hydrology are most pronounced, as opposed to a blanket system-wide program of upsizing.

10:00 – 10:25AM

Judy C. Gates
Maine Department of Transportation, Surface Water Division, Augusta, ME; judy.gates@maine.gov

Translating Dreams to Reality: Assessing Risk in an Unpredictable World

In 2013, MaineDOT and several other DOTs from around the country undertook Climate Vulnerability pilot projects funded by the Federal Highway Administration. These pilots were focused on developing and implementing tools that to help identify critical transportation infrastructure and prioritize vulnerable assets in the face of rising sea levels and increasing frequency and intensity of coastal storm surge events. A year later MaineDOT has submitted its final report and it points to some speed bumps in reaching our collective goal of climate resiliency. According to our analysis, local hydrology, topography, and tidal and storm surge regimes demand a site-specific approach to benefit-cost analysis of alternative engineering structures. This is contrary to revealing a concrete design standard that, uniformly applied, would result in more resilient coastal infrastructure. Comparing different design solutions for each asset at the conceptual design phase poses not only the typical challenges associated with under-funded planning efforts, but may not even be feasible in the same timeframe as decisions on budgets and scheduling due to fiscal uncertainties. Site-specific analyses are data-intensive and our collective resources are spread thinner all the time, so it's critical to know that the information we are collecting is not only meaningful, but useful in decision-making. Our pilot results have led us to re-evaluate how MaineDOT might undertake climate-related, risk-based asset management with a two-step, "no regrets" approach that considers landscape context as well as structure-specific vulnerabilities.

Session F

Developing Water Supplies in Challenging Environments: Case Studies and Innovative Solutions

Although Maine has an abundance of clean water, there are many locations where finding adequate yield and/or water quality can be very difficult due to the geologic characteristics of a particular site or impacts from human activities. This session will focus on techniques that have been used in Maine and elsewhere in New England to tackle these problems and provide reliable drinking water supplies. Case studies will include alternative well construction and treatment techniques utilized to address low-yielding bedrock formations, saltwater intrusion, road salt and other contamination issues, naturally elevated minerals and radionuclides.

** TCH - Drinking Water Program available*

Session Chair

Mike Abbott
Maine CDC Drinking Water Program, Augusta, ME; michael.abbott@maine.gov

Michael Abbott is the Hydrogeologist and Water Resources Team Leader for the Maine CDC Drinking Water Program. Mike began his career with the U.S. Public Health Service in 1991 as a sanitation facilities engineer, then spent over 20 years as an environmental consultant specializing in water supply development, groundwater and surface water modeling, and investigation of contaminated groundwater sites. Mike earned his B.S. in Civil Engineering at Worcester Polytechnic Institute and M.S. in Geology at the University of Vermont. Mike is a Certified Geologist in Maine and New Hampshire, and holds a Maine Professional Engineer's license.

8:30 – 8:55AM

David Braley
Maine CDC, Drinking Water Program, Augusta, ME; david.braley@maine.gov

Regulatory Impacts of Water Supply Development in Challenging Environments

Many factors can result in difficulties developing water supplies including limited water availability, current land use and potential future development allowed by existing municipal zoning, past land uses that may have resulted

Session F: Developing Water Supplies

in groundwater contamination and naturally occurring contaminants. The state of Maine has programs to regulate the development of both private and public water supplies. Private wells are required to meet specific setback distances from subsurface wastewater disposal system components. Public water supplies must complete a comprehensive application which includes identification of potential sources of contamination, delineating wellhead protection areas and plans to manage or mitigate for potential or existing sources of contamination. Information submitted for both private and public water supplies is used by the state of Maine to make decisions regarding appropriate levels of risk and proper mitigation. All water supply development is subject to the requirements of several state and federal laws and regulations intended to protect public health and the environment. Navigating these regulatory requirements can be as challenging as the cultural and environmental difficulties encountered during water supply development.

9:00 – 9:25AM

Ike Goodwin
Goodwin Well & Water, Inc., North Turner, ME; igoodwin@goodinwellandwater.com

Squeezing More Water from Maine's Bedrock Aquifers

According to the 2010 US Census information, 60% of Maine's residents rely on groundwater to supply their homes. However, only 3.4% of the land area in Maine is covered by significant sand and gravel aquifers. Another 12.8% is covered by surface water. The remaining 83.8% of the state must rely on bedrock aquifers to supply their ground water.

Groundwater in Maine's bedrock aquifers is found only in fractures in the bedrock. Our bedrock has no primary porosity to absorb and hold ground water. In some locations, these fractures are abundant and provide good to excellent water yields. More frequently the bedrock fractures are few and far between and provide very low water yields, if any at all.For many years drillers realized if they could create new bedrock fractures that would radiate out from a bedrock borehole they might be able to connect to existing adjacent water bearing fractures and increase the yield of their new well.

After many attempts using dynamite and dry ice, with only limited success, we found a way to modify the "hydrofracking" process, common to the oil and gas industry, and use it successfully and economically to increase the yield of bedrock wells in Maine with an 85% – 90% success rate for single family residential homes.

Using various hydrofracking techniques it is now possible to not only make "dry" bedrock wells produce water but also significantly increase the capacity of those wells that already produce water naturally.

9:30 – 9:55AM

Bruce Fowler, Andrew Gobeil
Sevee and Maher Engineers, Cumberland, ME; baf@smemaine.com

Identifying potential yield collapse in bedrock wells and shallow springs by Inverse Step Testing

For the past decade, we' have been fortunate to witness favorable recharge conditions across most of Maine's bedrock wells and shallow springs, but we can remember the cries of "drought" or "dry well" that filled the headlines in the early 2000s. A purveyor's understanding of how bedrock wells respond to challenging recharge or demand conditions is critical to maintaining a safe well yield and, in turn, maintaining a reliable water supply system.

Session F: Developing Water Supplies

The safe yield of these often sensitive water sources is governed by the hydraulics of groundwater moving through bedrock fracture systems into bedrock wells or shallow springs. With the exception of some karst wells, which can exhibit high yields across a wide range of drawdown conditions, the yield within bedrock wells is typically non-uniform and declines as critical water-bearing fractures are dewatered. The safe yield in bedrock wells and shallow springs is commonly not identified through testing for critical threshold limits. Yet once these thresholds are exceeded, the well yield collapses.

Sevee and Maher Engineers, Inc. has developed an innovative way to assess bedrock well and fracture fed spring safe yields through a methodology called Inverse Step Testing. In our experience, Inverse Step Testing is a relatively inexpensive means for assessing well yield limits, and identifying and targeting drawdown thresholds that cannot be exceeded. Monitoring of identified drawdown thresholds has the benefit of avoiding a well yield collapse through controlled water use and the well damage that can occur with extreme drawdown events.

10:00 – 10:25AM

Joseph Ayotte
U.S. Geological Survey, New England Water Science Center, Augusta, ME; jayotte@usgs.gov

Reducing human exposure to arsenic in domestic drinking water by use of a novel design for shallow wells in the glacial aquifer

Domestic drinking water supplies in New England are dominated by wells drilled into fractured crystalline bedrock aquifers, which can contain geogenic arsenic. These wells are capable of providing reliable water supply by intersecting water-bearing fractures and providing storage of water in the borehole. However, water from many tens of thousands of these wells contains concentrations of arsenic that are harmful for human health – that is, greater than the U.S. Environmental Protection Agency's Maximum Contaminant Level of 10 micrograms per liter. Recent studies related to high arsenic concentrations in private bedrock aquifer wells suggest that as long as home owners are responsible for treatment to reduce concentrations, many wells will go untreated and there will always be human exposure.

A new shallow well design can potentially provide sustainable yields from surface glacial deposits, reduce concentrations of arsenic, and protect against exposure to harmful bacteria. The new design helps ensure sustainable yield by expanding the surface area through which water is collected; infiltration-limiting fill material above the well limits the downward movement of surface runoff. The size and shape of the well is governed by the hydraulic properties of the local glacial aquifer and the hydraulic gradient. Importantly, the geochemistry of groundwater in the shallow glacial aquifer (generally oxic and slightly acidic) inhibits the mobility of arsenic, resulting in low concentrations of arsenic in the groundwater. This novel design can reduce human exposure to arsenic in drinking water for thousands of private well owners without the need for sustained chemical treatments.

Poster Session & Lunch

Session F: Developing Water Supplies

1:30 - 1:55PM

Greg Smith[1], Jeffrey Musich[2]
1 *Wright-Pierce, Manchester, NH; greg.smith@wright-pierce.com*
2 Wright-Perce, Topsham, ME; jeff.musich@wright-pierce.com

Riverbank Filtration in New England: The Groundwater/Surface Water Hybrid

High yield groundwater sources have historically been developed adjacent to large water bodies. Riverbank filtration is a relatively new approach to developing high yield groundwater sources in New England where the well is constructed in close proximity to a surface water body instead of a direct surface water intake or a conventional vertical well. Multiple well technologies are applicable for bank filtration approach including horizontal wells, angle wells, and radial collector wells and can be used in soil formations where conventional vertical wells are not applicable. We will examine two case studies for Bank Filtration on the Merrimack River: The Hooksett West River LLC Site in Hooksett New Hampshire; and the Hill Site in Haverhill, MA. Well technologies, groundwater exploration including geophysical survey techniques, water quality, and regulatory issues will be discussed.

2:00 - 2:25PM

Peter Garrett[1], George Motycka[2], Annaleis Hafford[3]
1 *Emery & Garrett Groundwater Investigations, LLC, Winslow, ME; peter.garrett@eggi.com*
2 Castine Water Department, Castine, ME; karen@castine.me.us.
3 Olver Associates, Winterport, ME; annaleis@olverassociatesinc.com.

A Horizontal Well in a Thin Sand and Gravel Aquifer Adjacent to an Existing Reservoir, Castine, Maine

Castine has been challenged to provide a water supply due to its location on a rocky peninsula almost separated from the mainland. The Battle Avenue Ponds were constructed as reservoirs in the 1800s in an area of springs located on a hillside above the town center. The Ponds were used as a source of unfiltered water supply until the Drinking Water Act required filtration in the 1980s. Since then groundwater, primarily from bedrock wells, has been the source of supply. Stricter regulation of arsenic and radionuclides in the 2000s made operation of several of the bedrock wells problematic.

Detailed investigation of the geology of the Battle Avenue Pond property demonstrated the local existence of a sand and gravel aquifer, 10-foot thick (5-foot saturated), overlying marine clay. A 20-foot long horizontal test well was installed at the base of this aquifer in a trench excavation oriented parallel to one of the Ponds. The test well produced 10 gpm with 2-foot of drawdown. Water quality was excellent, except that, due to infiltration of Pond water, bacteria were persistent and micro-particulate analysis failed.

A horizontal production well, 440 feet long, was later installed in a separate trench excavation using construction materials approved for drinking water sources. It will serve as a collection gallery, gravity-draining to the site's pumping station. There it will be subject to treatment as a source of groundwater under the influence of surface water. The treatment plant is now in design and permitting.

Afternoon Break - Auditorium

Session F: Developing Water Supplies

3:00 - 3:55PM

Robert Gerber
Ransom Consulting, Portland, ME; Robert.Gerber@Ransomenv.com

Forty-Four Years of Advancement in Groundwater Studies

This is a review of how methods and tools for finding and studying groundwater have changed over the past 44 years. It is a review of the changes that have occurred broadly within the field of groundwater studies as well as the changes in the author's skill set with time. The presentation gives examples from each decade of work, illustrating how the new tools and computer programs of the decade made it possible to provide more complex analyses. The author's career progressed through: 1) finding high yield wells in sand and gravel; 2) determining the "safe yield" of these wells; 3) finding high-yield bedrock wells; 4) dealing with a variety of water quality issues including natural and man-made. The EPA made wellhead protection a major issue in the late 1980's and the issue became one of defining how much of the area of contribution to protect. A succession of water quality issues became topics of study and learning with the current hot topic being arsenic. Most recently, the DEP's Ch. 587 In-stream Flow Rule has made the study of well water withdrawal on stream flow depletion a major focus of study. Although the cost of field data gathering has generally increased with time, the cost of data analysis and prediction have decreased, with the result that fewer field data are collected, more office analysis is performed with the aid of public domain data, and the overall cost of studies has decreased in real dollars.

Session G

Citizen Science in New England: Exploring Innovations in Collaborative Resource Management, Education, and Research

This session seeks to bring together people working in different organizations (academic, state, and non-governmental) to share insights about innovations in citizen science. We encourage a diversity of perspectives, and are particularly interested in new technologies for monitoring and communication that enhance citizen science capacities for data collection, quality assurance, and sharing across broad geographic areas. We are interested in presentations that combine practical suggestions for program development using new technologies with research applications and findings. We hope this session will serve as a catalyst for new and expanded collaborations among participants, both presenters and audience members, and improve the network of people and organizations who use citizen science in their work in New England and beyond.

Session Co-Chairs

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

Bridie McGreavy
New England Sustainability Consortium, University of Maine, Orono, ME; bridie.mcgreavy@maine.edu

Karen Wilson earned a M.S. and Ph.D. in Limnology/Zoology from the University of Wisconsin – Madison. She is a research faculty member in the Department of Environmental Science and Policy at the University of Southern Maine where she teaches courses with an emphasis on aquatic ecology. Karen has been working to bring more community-based research into her courses, drawing on examples from citizen science efforts. Her primary research focus is on marine-freshwater linkages as typified by alewife, an anadromous fish with a strong presence in Maine and a long history of interactions with citizen scientists.

Bridie McGreavy is a postdoctoral researcher with the New England Sustainability Consortium and the Senator George J. Mitchell Center for Sustainability Solutions. She received a Ph.D. in Communication and Sustainability Science from the University of Maine in 2013. Her research focuses on interdisciplinary collaboration, community-based conservation, shellfish management, and resilience within linked social-ecological systems. She serves on Lakes Environmental Association's Board of Directors and is helping to develop the Maine Lake Science Center, a sustainability science network that aims to enhance the use of science in decision making for the sustainability of Maine lakes.

Session G: Citizen Science in New England

8:30 – 8:55AM

Bridie McGreavy[1], Aram Calhoun[2], Vanessa Levesque[3], Jessica Jansujwicz[3]
1 New England Sustainability Consortium, Senator George J. Mitchell Center for Sustainability Solutions University of Maine, Orono, ME: bridie.mcgreavy@maine.edu
2 Wildlife, Fisheries & Conservation Biology, University of Maine, Orono, ME; calhoun@maine.edu
3 University of Maine, Orono, ME: vanessa.r.levesque@maine.edu; jessjans@roadrunner.com

Citizen Science and Natural Resource Governance: Applying a Resilience Framework to Vernal Pool Policy Innovation

In this presentation, we apply a resilience lens to a 15-year case study of citizen science and vernal pool regulation in Maine, USA. We describe how citizen science improved adaptive capacities for innovative policies related to vernal pool regulation. We identified four core elements associated with the citizen science program that promoted adaptive capacities including how citizen science efforts: (1) generated knowledge about the system; (2) enhanced networks across scales and communities of expertise; (3) promoted multiple forms of leadership for program and policy development; and (4) allowed the identification of and capacity to act within narrow windows of opportunity. If citizen science program leaders intend to promote adaptive governance and social-ecological systems resilience, we recommend that they create a system for internal project evaluation and learning; use the citizen science collected data in scientific publications; encourage the emergence of diverse forms of leadership; pursue resources for program sustainability; and pay close attention to how informal network characteristics and leaders promote program flexibility and innovation over time. Thus, through this presentation we intend to highlight the value of resilience thinking for citizen science program design and research applications.

9:00 – 9:25am

Joseph K. Staples
Dept. of Environmental Science, University of Southern Maine, Gorham, ME; jstaples@usm.maine.edu

Sentinel Forest: A Case for Deploying Remote Ground-Based Environmental Sensor Networks for Monitoring Ecological Change within Forested Watersheds

In this presentation I will summarize ongoing efforts by the Department of Environmental Science & Policy at University of Southern Maine (USM) and the USDA Forest Service to establish a remotely monitored publically accessible research forest on the USM Gorham campus. The site is located in the upper reaches of the Tannery Brook watershed and is dominated by eastern hemlock (*Tsuga canadensis L.*) and eastern white pine (*Pinus Strobus L.*). The design of the USM research forest is based on the ongoing USDA Forest Service Smart Forest initiative that seeks to provide access to real-time environmental sensor data online. Current sensors deployed in the USM site include air temperature, precipitation, relative humidity, wind speed, light intensity, soil temperature, and moisture. Potential uses of the USM research forest include education, public outreach, and the illustration of how forests may serve as sentinel ecosystems for monitoring the influence of climate related stressors on water quality in headwater systems and other downstream resources. Here I present a case for extending the concept of sentinel ecosystems beyond select aquatic, marine, or wetland systems to include terrestrial ecosystems.

Session G: Citizen Science in New England

9:30– 9:55AM

Karen H. Bieluch[1], Jason Smith[2], Theodore V. Willis[2], Linda Silka[3], Laura Lindenfeld[4]
1 Environmental Studies Program, Dartmouth College, Hanover, NH; karen.h.bieluch@dartmouth.edu
2 Department of Environmental Science, University of Southern Maine, Gorham, ME; jason.m.smith@maine.edu; theodore.willis@maine.edu
3 Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME; silka@maine.edu
4 Department of Communication and Journalism and the Margaret Chase Smith Policy Center, University of Maine, Orono, ME; laura.lindenfeld@umit.maine.edu

Volunteer River Herring Monitoring Programs in Maine and Massachusetts: Lessons Learned about Running Volunteer Programs and Citizen Scientists' Monitoring Experiences

Sustaining Maine's (ME) and Massachusett's (MA) river fisheries involves participation of diverse actors, including fishers, scientists, citizen scientists, nonprofitss, and local, state, and federal managers. River herring (alewife and blue back herring), anadromous species that move annually between marine and freshwater, intersect with multiple stakeholders because humans interact with them on and off-shore. Volunteer citizen scientists play an important role in gathering data about the fishery to inform river herring restoration and management. However, facilitating volunteer programs that collect fisheries data, including recruiting and retaining volunteers, is complicated. In 2014, researchers explored topics most relevant to running volunteer programs and the attitudes of volunteers. Project activities included interviewing river herring monitoring coordinators from ME and MA to discover common best management practices and distributing an online survey to volunteers to gauge motivations and barriers to citizen science participation. Initial results show that coordinator-volunteer communication throughout the monitoring season and making monitoring fun and easy are critical to the immediate and continued success of a program. Survey results showed that volunteers are motivated to participate because they are concerned with protecting their local ecosystems and want to contribute to and improve management of it; volunteers also were positive about their ability to affect management and conservation through volunteering. A case-study count was established in southern Maine that will continue into 2015 to apply survey and interview lessons. An exploratory study involving interviews and participant observation will be conducted at the case-study run to assess volunteer experiences pre- and post-program changes.

10:00 – 10:25AM

Scott Williams, Roberta Hill
Maine Volunteer Lake Monitoring Program, 24 Maple Hill Road, Auburn ME ; scott.williams@mainevlmp.org; roberta@mainevlmp.org

Citizen Lake Science in Maine

Maine has some of the cleanest, clearest lakes in North America; it also has one of the oldest and most robust statewide citizen-based lake monitoring programs in the US. Since 1971, the Maine Volunteer Lake Monitoring Program has trained thousands of volunteers to monitor a wide range of indicators of water quality, assess watershed health and function, and screen lakes for invasive aquatic plants and animals. Much of what is known about Maine lakes has been directly derived from data collected by VLMP citizen lake scientists.

Session G: Citizen Science in New England

Roberta and Scott will share the VLMP's recipe for success, including a look at the organization's innovative decentralized-leadership structure and other strategies used to ensure continued program growth and sustainability in the midst of challenges. They will also highlight some of the ways in which VLMP's citizen lake scientists have become integral to cutting-edge lake research in our state.

Poster Session & Lunch

1:30 – 1:55PM

Jeremy Miller[1], Adrienne Pappal[2]
1 Wells National Estuarine Research Reserve,Wells, ME; jmiller@wellsnerr.org
2 Massachusetts Office of Coastal Zone Management, Boston, MA; adrienne.pappal@state.ma.us

MIMIC: Using Citizen Scientists to Monitor the Spread of Marine Invasive Species in the Gulf of Maine

The Marine Invader Monitoring and Information Collaborative (MIMIC) is a network of trained volunteers and scientists who monitor marine invasive species throughout the northeastern United States. MIMIC is coordinated by the Massachusetts Office of Coastal Zone Management with support from the U.S. Fish and Wildlife Service, the Northeast Aquatic Nuisance Species Panel, and local monitoring organizations that recruit and train volunteers, like the Wells National Estuarine Research Reserve. The purpose is to detect newly-introduced species as well as changes in the abundance and distribution of established non-native species. MIMIC provides an opportunity for the general public to: (1) actively participate in an invasive species early-detection network, (2) identify new marine invaders before they spread, and (3) improve our understanding of the behavior of established invaders. Volunteers range from school-aged children to seniors and all are trained in an adapted visual rapid assessment protocol and proper identification of marine invertebrate species before participation in the field. Monitoring occurs monthly from June through October at eightestablished sites from York to Portland, ME. Data are uploaded to the Massachusetts Ocean Resource Information System (MORIS) where they are available to scientists and managers. A total of 243 species reports have been documented so far. Both host organizations and volunteers benefit from this shared experience as valuable biological data is collected in and around the host organizations boundaries and volunteers are educated about the impacts of invasive species and how they can help stop the spread of these invaders.

2:00 – 2:25pm

Alyson Eberhardt[1]**,** Malin Clyde[2]
1 *University of New Hampshire Cooperative Extension, NH Sea Grant, Durham, NH; Alyson.Eberhardt@unh.edu;*
2 University of New Hampshire Cooperative Extension, The Stewardship Network: New England, Durham, NH;Malin.Clyde@unh.edu

Increasing Capacity for Science: Use of Collaborative Networks for a Whole That is Larger Than the Sum of Its Parts

Many citizen science efforts are increasing capacity to do science through crowd-sourcing and technology innovations. We propose that citizen science programs can also increase capacity through investments in collaboration among organizations, volunteers, and program staff. Effective citizen science programs require staff time, strong communication with volunteers, and adequate funding. While collaboration can be time-intensive, it can be a critical tool for increasing the capacity of organizations and researchers to answer scientific questions, collect data, and

get work done. We describe two related collaborative networks being employed at the University of New Hampshire to expand research capacity, increase pools of trained volunteers, and improve science and stewardship outcomes among a diverse group of partner organizations in New Hampshire and beyond. The Coastal Research Volunteer (CRV) program provides an interface where volunteers are trained and matched with researchers to work on coastal research projects. By relying on one citizen science coordinator to support many, diverse projects, this "time-share" citizen science model allows local scientists to stretch limited financial support and capacity while creating a dynamic community of citizen volunteers. The Stewardship Network: New England (The Network) is a broader-scale effort of which CRV is a collaborating partner. The Network mobilizes volunteers to care for and study lands and waters in and around New Hampshire. Collaborating with over 75 different partner organizations since its launch in 2014, The Network provides a collective volunteer management system for partners, including an online calendar, registration system, weekly e-bulletins, and opportunities to share student interns across organizations.

Afternoon Break - Auditorium

3:00 – 3:25PM

John Peckenham[1], Teresa Thornton[2]
1 Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME; jpeck@maine.edu
2 Oxbridge Academy of the Palm Beaches, Palm Beach, FL; teresathorntonphd@gmail.com

Getting To Know Your Groundwater: Results From 10 Years of GET WET!

The Groundwater Education Through Water Evaluation and Testing (GET WET!) project was started ten years ago to evaluate the effects of sand and gravel mining on private wells. Since that time the project has been used to study local drinking water problems in rural communities throughout New England, New York, and Florida. This project has produced a variety of outcomes and outputs. This includes the analysis of more than 1,500 individual water well samples and several analyses of how the citizen-science process works. We will present summary results that show how the GET WET! project has built trust and water networks in communities, produced spatial and temporal maps of local groundwater quality, established local groundwater monitoring networks, provided a mechanism to increase groundwater awareness, provided a connection between schools and communities, and established a STEM pathway for K-12 students. We will also describe the elements needed to make this project work in different settings.

3:30 – 3:55pm

Linda Silka
Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME; silka@maine.edu

Drawing Lessons from Diverse Citizen Science Efforts

Sufficient citizen science now exists that this is an opportune time to take a measure of the lessons that are emerging that may be applicable to Maine. Emerging lessons speak to questions such as: 'How are citizen science efforts being organized and carried out?' 'What topics have been successfully studied through citizen science?' 'What

problems seem to lend themselves to a citizen science approach?' 'Which technologies are being adopted and which seem to be the most helpful?' 'What makes some citizen science efforts more effective than others?' and 'What barriers stand in the way of effective citizen science and how are these barriers being overcome?' This presentation will briefly summarize lessons from seven diverse citizen science initiatives that vary in topic, approach, scope, goals, and scale and that are taking place in cities (Milwaukee and New Orleans), states (Maine, Massachusetts, and Wisconsin), and countries (Ecuador and Peru). The emphasis will be on what we can learn that could be useful to Maine.

Session H

Sebago Lake – A Trillion Gallons of Challenge

The drinking water source for 200,000 people, Sebago Lake is one of Maine's most important natural resources. While the lake has excellent water quality, it is one of the state's most popular recreation destinations and the 300,000-acre watershed is mostly privately owned. This session will cover topics including water quality, partnerships at work in the Sebago Lake watershed, and threats to water bodies and/or land in the watershed.

** TCH - Drinking Water Program available #APA AICP credits pending*

Session Chairs

Brie Holme and Kirsten Ness
Portland Water District, Portland, ME; bholm@pwd.org; kness@pwd.org

Brie Holme is a water resources specialist at the Portland Water District and has been involved with lake protection on Sebago Lake since 2003. She oversees the outreach programs, monitors water quality in the lake and streams, designs storm-water solutions, and inspects lake front properties for regulatory compliance. Brie holds a degree in Environmental Studies and Biology from Mount Holyoke College.

Kirsten Ness is a water resources specialist with the Portland Water District where she focuses on watershed protection, water quality monitoring, and environmental outreach around Sebago Lake. She also co-chairs the Maine Water Utilities Association's Public Awareness Committee. She received her B.A. in Biology with a Concentration in Environmental Science from Colby College and her M.S. in Ecology and Environmental Science from the University of Maine. Her graduate research focused on the effects of shoreline development on selected lakes in downeast Maine.

8:30 – 8:55AM

Paul Hunt, Kirsten Ness
Portland Water District, Portland, ME; phunt@pwd.org; kness@pwd.org

Hello, My Name is Sebago Lake

Sebago Lake is one of Maine's most important natural resources because it is used by so many for so much. The lake holds nearly a trillion gallons of water, and almost everyone in Cumberland County lives near it, plays on it,

or drinks it. The Portland Water District utilizes the lake as a public drinking water supply, and it is one of only about 50 surface water supplies in the country so clean that it doesn't require filtration. The Sebago Lake watershed is 436 square miles in size, extends from Standish to Bethel, and includes land in 23 towns. Despite being a multi-use lake, Sebago Lake water quality is outstanding. Though the lake is clean today, it faces many challenges including invasive species, disputes over lake level, significant shoreline development, conversion of forested watershed land to developed land, and the presence of an oil pipeline in the watershed. Protecting the lake and addressing these challenges requires the cooperation and support of numerous partners. This presentation will provide an introduction to Sebago Lake and its watershed, describe some of the challenges that confront it, and discuss the partnerships that help protect it.

9:00 – 9:25AM

Colin Holme, Amanda Pratt
Lakes Environmental Association, Bridgton, ME; colin@leamaine.org; amanda@leamaine.org

High Resolution Monitoring in the Upper Sebago Lake Watershed

For the past four decades, the Lakes Environmental Association (LEA) has been sampling lakes and ponds in the upper Sebago Lake watershed using traditional, field-based water quality monitoring techniques. In 2013, LEA began deploying small HOBO pendant temperature sensors in several waterbodies and then greatly expanded the program in 2014. These battery-operated sensors capture and store a whole season's worth of temperature data and allow a much more detailed understanding of water column structure. The sensors also allow for a longer field season on a limited budget. The presenters will discuss how these sensors were funded, deployed, retrieved and what was used to analyze and present the data. Also in the summer of 2014, LEA deployed a fully automated water monitoring buoy on Highland Lake which was outfitted with temperature and oxygen sensors from the surface to the bottom, a fluorometer and light attenuations sensors. The buoy provided real-time data on oxygen, temperature, clarity, and algae populations and is part of the growing network of Maine buoys as well as the worldwide Global Lake Ecology Observatory Network (GLEON). The presenters will discuss their findings after the first year of deployment, which include a detailed "fingerprint" of oxygen depletion over time and correlation to LEA's long-term, field based monitoring program.

9:30 – 9:55am

Firooza Pavri, Paul Morris, Jared Lank
University of Southern Maine, Gorham, ME; fpavri@usm.maine.edu; paul.n.morris@maine.edu; Jared.lank@maine.edu

Land Use and Land Cover Patterns for the Sebago Lake Watershed Using Landsat Operational Land Imager

Sebago Lake's importance as a source of public water supply to numerous southern Maine communities requires vigilant monitoring efforts. Monitoring allows for timely and appropriate conservation interventions and alternatives, which can in turn support the sustainability of this system.This study uses Landsat Operational Land Imager data from summer 2013 to provide a spatially explicit analysis of large-scale land use and cover patterns across the Sebago watershed. The field of landscape ecology provides a framework to systematically consider landscape patterns resulting from economic development and growth. We use NOAA's Habitat Priority Planner toolkit to map

and compare patterns of landscape fragmentation across sub-watersheds within the larger Sebago basin. Our results suggest a greater fragmentation of forest and green-cover parcels across the watershed and more intense development activity around the vicinity of Sebago Lake and in the lower regions of the watershed. Residential and economic development activities have resulted in documentable land use and cover changes across the region.

10:00 – 10:25AM

Andrew Shultz
Maine Forest Service, Augusta, ME; Andrew.h.shultz@maine.gov

Profiles of Woodland Stewardship: The Portland Water District

In Standish, Maine, in the Presumpscot River watershed, the Portland Water District owns and manages forest land around Sebago Lake with one major goal in mind: clean drinking water. This "Profile of Woodland Stewardship" video will demonstrate the close connection between well-managed woodland and water quality.

The "Profiles of Woodland Stewardship" video series documents real-world, concrete examples of sustainable forest management. It features woodland owners and the people, both professional and others, who work and interact with them, telling their stewardship story in their own words. The landowners profiled are models; their woodlands are visible demonstrations of conservation applied on the ground.

The oral presentation around the video showing will focus on the availability of technical and cost-share assistance for woodland owners in the Presumpscot Watershed, starting with MFS District Foresters, and including referrals to private forestry consultants and professional timber harvesting contractors.

Session I

Sustainable Engagement with the Food System

Creating and maintaining sustainable food systems is a critical and growing challenge to global society. Population growth, demographic shifts, climate change, and income inequality impact the food system at all levels. Maine ranks first in New England in food insecurity; one in four of Maine's children are at risk. Building capacity in our universities and communities to foster engaged research—research that generates solutions to real-world problems - is crucial to fostering sustainable communities and responsive food systems. We are seeking oral papers and posters that demonstrate collaborative approaches on a range of topics related to Sustainable Food Systems including but not limited to: agricultural practices, production and distribution; marketing and consumption; food insecurity; as well as social, ethical, and political concerns.

#APA AICP credits pending

Session Organizers

François Amar, Mark Haggerty, John Jemison, Melissa Ladenheim, Linda Silka, Stephanie Welcomer
University of Maine, Orono, ME

Mark Haggerty is Rezendes Preceptor of Civic Engagement and an Associate Professor in the Honors College at the University of Maine. His research interests span the boundaries of sustainability, food systems and FairTrade. He actively participates in community and undergraduate student engaged research.

Linda Silka is a Senior Fellow at the Senator George Mitchell Center for Sustainability Solutions. She specializes in (a) building community-university research partnerships and (b) building communication strategies that assist people working from different perspectives in finding common ground to solve environmental problems.

Kate Sheridan is the Agriculture Organizer at Food AND Medicine, where she works with both farmers and community members to increase access to local food in the Bangor area. Kate has a Masters in Environmental Studies, with an emphasis in Sustainable Food and Agriculture Systems, from the University of Montana and has worked as a farmer, researcher, and educator within the food system.

Session I: Sustainable Engagement with the Food System

8:30 – 8:55AM

Tim Waring (Moderator)
University of Maine, Orono, ME; timothy.waring@maine.edu

Panelists: Mark Haggerty[1], John Jemison[1], Kate Sheridan[2], Linda Silka[1]
1 *University of Maine, Orono, ME; mark.haggerty@umit.maine.edu; linda.silka@umit.maine.edu; jemison@maine.edu*
2 Food AND Medicine, Brewer, ME; kate@foodandmedicine.org

Finding and Building on Opportunities for Community-University Engagement on Food Systems

Creating and maintaining sustainable food systems is a critical and growing challenge to global society. Population growth, demographic shifts, climate change, and income inequality impact the food system at all levels. Maine ranks first in New England in food insecurity; one in four of Maine's children are at risk. Building capacity in our universities and communities to foster engaged research—research that generates solutions to real-world problems—is crucial to fostering sustainable communities and responsive food systems. Our panel describes an exciting new initiative at the University of Maine designed to bring together faculty and students to work with partners on sustainable food systems. Built around the Honors Program—which brings together students from many disciplines to do research—this initiative is intended to increase the university's capacity to partner on this crucial sustainability topic. We will report on what has been achieved thus far and will consider the following questions: Maine is increasingly recognized as a major innovator in sustainable food systems. How can higher education be helpful in this important work? What are partners telling us that they see as possible roles for higher education? Students are an important resource but are at the university for a relatively short time: how do we learn to "hand off the baton" between students so that student involvement becomes an asset and not a burden for partners? How do we build a culture of encouraging learning across projects, disciplines, problems, and issues? We will provide examples of the current and proposed projects emerging from this work.

9:00 – 9:25AM

Riley Neugebauer
Real Food Challenge, Maine Farmland Trust, Belfast, ME; riley@farmtoinstitution.org

A Collaboration to Increase Local & Sustainable Sourcing for the UMaine System

Farm to Institution New England (FINE) is joining farmers, fishermen, students, as well as businesses and other non-profits in recognizing an opportunity to create opportunities for sourcing more Maine-grown and New England-grown foods within the University of Maine system. FINE focuses on increasing the amount of New England-grown food served in our region's institutions. Other organizations have also taken note of this opportunity. Maine Farmland Trust and other farmer advocacy groups are interested in supporting the development of additional markets for farmers in the state and Real Food Challenge is interested to leverage the power of youth and universities to create a healthy, fair and green food system.

One of the most important leverage points within our institutional food system is the contracting process, through which legally-binding agreements between distributors and/or food service management companies are negotiated and agreed upon by institutions and private companies. Food service contracts vary in their depth and breadth, but include many goals or stipulations related to the sourcing and procurement of food. The current food

service contract for the UMaine system will end in 2016, and the process to negotiate the next contract is underway. FINE and others are interested to better understand the opportunities and challenges for increasing the amount of local foods offered by UMaine by hearing the perspectives of dining staff, students, and faculty, as well as producers, distributors, and other food system advocates. We plan to join stakeholders in providing recommendations to the University Committee that will determine the next food service vendor. We also hope to begin building stronger supply chains for specific products that can respond to increased demand from our state's institutions in the next few years. Our presentation will highlight our efforts to date and any identified opportunities, as well as invite participation from additional stakeholders.

9:30 – 9:55AM

Geoff Gordon[1], Evan Rickert[2]
1 Orono Town Council, Orono, ME: gordon.geoff2@gmail.com
2 Town of Orono Planner, Orono, ME

A Food Hub as a Component of Regional Economic Sustainability

Agricultural policies and subsidies in the US have resulted in a dramatic shift in scale in agricultural production. Growers in most regions shifted to commodity grain production and local businesses serving fresh produce growers went out of business. Growers in warm weather climates pressed their competitive advantages and local producers of fresh market crops nearly disappeared from the economies of their regions. Those few that remained faced diminished market opportunities as a result of the loss of those local enterprises that provided post-harvest services. Distribution of food stuffs in the US is dominated by large national organizations whose efficient scale of operation eliminates the local producer from most market sectors.

That situation has begun to change at the behest of current market forces where the end point consumers are increasingly demanding access to locally produced food. Manifestation of that consumer interest can be seen in the appearance of local produce sections in large grocery chains and in many institutions and restaurants now setting self-imposed quotas for local foods in their food offerings. Gaining access to that restaurant and institutional market is at the same time a difficult challenge and an important opportunity for the local grower.

Post-harvest, fresh produce must be cleaned, cooled, packed, and shipped in order for it to be sold to distributors and wholesalers. Few local growers possess the capability to efficiently perform post-harvest functions, creating an insurmountable obstacle to reaching the market place. The remaining market access exists only in the form of end consumer direct market channels, which account for less than 1% of produce sales. The Food Hub concept arises in response to the need for post-harvest service providers who can generate the scale linkage between the small-scale producer and the institutional market. In that way Food Hubs enable a strong, diversified, and sustainable regional food system by providing an opportunity for the small-scale producers to reach the larger-scale institutional, food service, and retail market channels, where 99% of sales are found.

While some entrepreneurs have ventured into the Food Hub business, many more are needed. Attempts to recruit socially conscious investors with access to the patient capital necessary to establish those new Food Hub enterprises will be successful only if a convincing case of feasibility can be made. A demand-side analysis of the institutional, food service, and retail markets must demonstrate that the enterprise will be adequately sustained in order to realize the goal of having local agriculture serve as a significant contributing factor in a sustainable rural community.

Session I: Sustainable Engagement with the Food System

The Orono Economic Development Corporation is leading a consortium of Greater Bangor economic development organizations and municipalities in an effort to design an appropriate market analysis, determine the appropriate Food Hub model, and detail several other elements of a business plan. Consortium members, study design, funding efforts and planned dissemination of results are introduced and described.

10:00 – 10:25AM

Sara Trunzo
Veggie sfor All, Maine Farmland Trust, Belfast, ME; strunzo@mainefarmlandtrust.org

Veggies for All

Maine's agricultural sector is rapidly expanding. More young people move to Maine each year to pursue farming as a profession, and consumers are growing increasingly aware of the benefits of local purchasing. Despite the positive energy in the food movement, Maine still faces the harsh reality of limitations to food access. Over 15% of all residents live with food insecurity and 45% of Maine children are eligible for free and reduced lunch. In addition, Maine ranks as one of the "hungriest" states: 17th in the nation and 1st in New England. One rural, college town responded to this issue by creating a community-based, agriculture-centered approach to relieving emergency food needs, while supporting proactive efforts to address the root causes of hunger. Veggies For All (VFA), a project of Maine Farmland Trust, is a 4-acre discontiguous food bank farm located in Unity, Maine. VFA works to relieve hunger by growing vegetables for those in need while collaborating with ten food pantries to distribute nutritious, quality food to 1,500 food insecure, rural people in central Maine. Founded by beginning farmers in 2007, VFA has grown and distributed over 100,000 pounds of vegetables and engaged hundreds of volunteers in thousands of hours of service. This session explores the food bank farm model, the formation of strategic community and academic partnerships (specifically with Unity College) to increase impacts, methods of engaging college student leadership, best practices of grass roots food access work, and opportunities for the food and agriculture industry and individual businesses to benefit from improving low-income consumers' access to local food.

Session J

Sustainability of Maine's Working Forest in the Face of a Changing Climate: Varying Perspectives and Solutions

Maine is the most forested state in the US (90%) with the largest contiguous block of privately-owned commercial forestland in the nation (10 million acre) and an economy heavily dependent on sustainable management of this resource (~5% of state GDP). However, Maine is in an important climatic transitional zone, which may make the forest more vulnerable to changes in the future climate. In particular, there could be decreased viability of commercially important species, increased disturbance (e.g. pests, disease, drought), and reduced productivity. These factors must be considered in current and future forest planning decisions. This session will involve talks from various perspectives on climate change and the sustainable management of Maine's forest. Each talk will review the key issues and provide a framework for moving forward in the face of high uncertainty.

#APA AICP credits pending

Session Chair

Aaron Weiskittel
School of Forest Resources, University of Maine, Orono, ME; aaron.weiskittel@umit.maine.edu

Aaron Weiskittel is an Associate Professor of Forest Biometrics and Modeling as well as the Irving Chair of Forest Ecosystem Management at the University of Maine, School of Forest Resources. He received a Ph.D. and M.S. in Forest Resources at Oregon State University and B.S. in Natural Resources from Ohio State University. He has co-authored over 55 peer-reviewed publications and one textbook. He is knowledgeable in the areas of forest growth modeling, climate change, and forest sampling.

Session J: Sustainability of Maine's Working Forest

1:30 – 1:55PM

Erin Simons-Legaard[1], Kasey Legaard[1], Aaron Weiskittel[1], Caitlin Andrews[2], and Tony D'Amato[2]
1 School of Forest Resources, University of Maine, Orono, ME; erin.simons@maine.edu; kasey.legaard@maine.edu; aaron.weiskittel@maine.edu
2 Rubenstein School of Environment and Natural Resources, University of Vermont; caitlin.vermont@gmail.com; awdamato@uvm.edu

Future Distribution and Productivity of Spruce-fir Forests Under Climate Change in Maine: Implications for Current Forest Management Practices

The vast spruce-fir forest of the Northeast is of commercial and ecological importance. Climate change is expected to have a drastic influence on forest growth and productivity and disturbance dynamics. Spruce-fir forests are expected to be especially susceptible because this forest type is already at the extreme elevational and latitudinal limits of its range within the northern United States. However, most of the projections of future distribution and productivity are done using broad-scale climate-envelope models, which have multiple limitations. This project will apply the landscape disturbance and succession model, LANDIS-II, within a meta-modeling framework to evaluate the potential of climate change in this region. The meta-model will be used to produce long-term projections of spruce-fir distribution and productivity under varying climate and disturbance regimes. These simulations would allow for sensitivity evaluation of spruce-fir forest to climate and disturbance as well as identification of areas of potential refugia for this important forest type. This work would be of utmost importance as it would provide an understanding of future habitat and wood supply availability across the region.

2:00 – 2:25PM

Si Balch
Manomet Center for Conservation Science, Brunswick,ME; balch77@gmail.com

Improving Forest Management for Climate Change: The Climate Smart Land Network

Manomet Center for Conservation Sciences recently completed a series of forest site visits in the U.S. and Canada to discuss climate change impacts and management response with land owners and managers. Members of the Climate Smart Land Network (CSLN) report changes in temperature, precipitation and related changes in pest and disease impacts. These changes are impacting forest health, infrastructure and operations. This presentation will include an introduction to the CSLN, an overview of the site visit process, a synopsis of findings and a discussion of management response.

Afternoon Break - Auditorium

Session J: Sustainability of Maine's Working Forest

3:00 – 3:25PM

Bill Patterson
The Nature Conservancy, Brunswick, ME; wpatterson@tnc.org

Planning for the Future Forest: Development and Application of Long-Term Forest Plan in Northern Maine

In 1998, The Nature Conservancy in Maine bought 185,000 acres of forest bordering 40 miles of the St. John River. Since the purchase, the organization has embarked on a large-scale experiment to achieve multiple management objectives. This has required extensive planning, outcome assessment, and adaptive management. This type of forest planning and management is increasingly important due to a variety of factors (e.g. markets, climate change, disturbances). This talk will provide an overview of the opportunities and challenges for sustainable forestry and conservation in Maine's North Woods for large landowners.

3:30 – 3:55PM

Elizabeth Ollivier
The Trust to Conserve Northeast Forestlands, New Gloucester, ME; eollivier@tcnef.org

Master Logger – Enhancing the Health of the Working Forest through Exceptional Accountability

The wood basket of the Northeast is a rich and highly varied landscape of native plants, animals, fungi, insects, microorganisms, and complex biological processes. When allowed to flourish under the stewardship and innovations of our forestry and logging professionals, these lands can produce higher quality wood over the long term. The value of our working forests is strongly driven by the day to day harvest decisions of logging professionals and landowners.

The Trust to Conserve Northeast Forestlands (TCNF) is a 501(c)3 organization formed in 2003 to administer the Northeast Master Logger Certification (NEMLC) program. The NEMLC program was the recipient of the world's first SmartLogging certificate – an international harvest standard recognition by the Rainforest Alliance's SmartWood Program. TCNF and NEMLC represent loggers, landowners and suppliers throughout New England and New York.

The NEMLC Program offers third-party independent certification of logging companies' harvesting practices. The certification system is built around a standard and nine goals that guide Master Loggers in their work: Document Harvest Planning, Protect Water Quality, Maintain Soil Productivity, Sustain Forest Ecosystems, Manage Forest Aesthetics, Ensure Workplace Safety, Demonstrate Continuous Improvement, Ensure Business Viability, and Uphold Certificate Integrity. There are detailed harvest responsibilities with explicit performance standards under each goal. Field verifiers visit harvest sites to determine whether candidates are meeting and exceeding the standards required for certification. NEMLC is audited annually to maintain this certification. The content of the NEMLC Program is based on a common vision for the rural communities and forest resources of the Northeast.

Session K

Models and Practices for Municipal Water Resource Management

Municipalities across the state are grappling with a range of water resource management issues. This session will allow municipalities to share lessons learned, best practices, project results and an array of useful resources related to water resource management. The morning presentations will focus on specific practices that have assisted municipalities address stormwater management requirements, expanding in the last presentation to discuss ways to streamline the management of a range of municipal water resources by web-enabling municipal data. The afternoon focuses on efforts to reduce imperviousness and related impacts from nonpoint source pollution through the use of green infrastructure and ways to reduce the impacts of chlorides on local and regional water resources. The session ends with a discussion about ways to develop sustainable funding mechanisms to support this work, bringing together a panel to discuss stormwater utilities in Maine. The goal of the session is to provide municipal staff with ideas and guidance that they can consider applying in their local water resource-related planning and implementation activities.

** TCH - Drinking Water Program available* *#APA AICP credits pending*

Session Chair

Brenda Zollitsch
Bangor Area Stormwater Group; BMZConsulting@aol.com

Brenda Zollitsch, Ph.D. works in the areas of water resource research, policy, planning, collaboration building and management. She is both a policy analyst for The Association for State Wetland Managers, a national 501(c)(3) nonprofit organization working to integrate sound science into wetland and stream policy, and a consultant to collaborative environmental groups in the region that are "joining up" to address challenging water pollution issues. In her consulting role, she serves as a facilitator, strategic planner, and resource development guide. She has more than 20 years of professional experience in leadership positions, including as an executive director of a nonprofit foundation. Brenda was awarded her PhD in Public Policy in 2012 from the University of Southern Maine's Muskie School, where she specialized in environmental policy and the collaborative implementation of stormwater policy in the United States. She is currently working on inter-jurisdictional water pollution issues, collaborative environmental management and adaptive conservation planning for wetlands and streams.

Session K: Municipal Water Resource Management

8:30 – 8:55AM

Kristi Rabasca
Integrated Environmental Engineering, Cape Elizabeth, ME; krabasca@integratedenv.com

Models and Practices for Municipal Water Resource Management

Stormwater runoff is the leading cause of pollution of surface water bodies. Nationally, development regulations have become more stringent, requiring treatment for stormwater runoff quality as well as quantity. As a result stormwater treatment systems require more maintenance to ensure effective function. The 30 communities regulated by the General Permit for Stormwater Discharges from Separate Storm Sewer Systems (MS4s or Phase II communities) were required to pass ordinances requiring that developers and future property owners maintain these stormwater treatment systems.

However the logistics of getting a planner, planning board, code enforcement officer and in some towns, public works on board to ensure the maintenance is conducted can be tedious and confusing. The development road is a precarious one for those wanting to ensure stormwater structures are maintained. It begins when a developer steps into Town Hall to initiate permitting on a project, and extends to the time after the project has been completed (and changed hands a few times).

This presentation describes some of the ways that several communities are tracking their development sites and ensuring that maintenance will be done. The following items will be shared and described: specific language that can be used in ordinances; language for conditions of approval; notes for drawing; spreadsheets for tracking sites and maintenance certifications; and inspection forms.

9:00 – 9:25AM

Gretchen Heldmann[1], Ray Corson[2]
1*Corson GIS Solutions,Bangor, ME; gretchen@corsongis.com;*
2 Corson GIS Solutions, Portland, ME; ray@corsongis.com

Ways to Streamline Your Workflow by Making Your Spatial and Non-Spatial Water Resource Data Web-Enabled

Have you been thinking about ways to manage your water resource information? Have you been using only paper forms and files for a long time and worry about how those records would be re-created "if" something were to happen? Have you had your Excel spreadsheet go haywire one too many times? This presentation will cover ways to convert both non-spatial and spatial data into a hosted web-based platform, and will cover a variety of platform options both proprietary and non-proprietary. Successful paper to digital and web-enabled implementations by organizations across the state will be shared, along with live demos. Municipalities of all sizes are making the switch to hosted solutions – be it VoIP phones, web GIS maps, archiving paper documents, or using an app on a smartphone to gather data or report issues – is it time for you to consider this for your municipality?

Session K: Municipal Water Resource Management

9:30 – 9:55AM

Belle Ryder[1] Robert Osborne[2], Phil Ruck[3],
1 Town of Orono, Orono, ME; belle@orono.org
2 Town of Hampden, Hampden, ME; planner@hampdenmaine.gov
3 Stillwater Environmental Engineering, LLC, Orono, ME; pruck@stillwaterenv.com

Using Scenario-based Exercises to Prepare for EPA and DEP Stormwater Audits

Over the last two years, regulated municipalities working to be in compliance with stormwater permit requirements have been struggling to understand exactly what is expected in terms of preparation for audits. At the same time, what is required seems to be a moving target, with increasing expectations and involvement by EPA in terms of audits. To help municipalities prepare for potential audits, the Bangor Area Stormwater Group (BASWG) has designed a new interactive regional practice of preparing and testing compliance scenarios during monthly work sessions. These structured sessions involve the development of scenarios by DEP which are then shared with one or more volunteer municipalities. The volunteer municipality prepares a mock presentation about how it would respond to the scenario. DEP and the regional partners troubleshoot the procedures in place and methods/processes are discussed in terms of what works and what can be improved. An alternative to straight presentations of information or review of permit language, this process has opened an important new avenue for conversation between regulators and regulated, as well as improvements in municipal operations, tracking and documentation. This session will share details of the scenario process, examples of exercises and lessons learned.

10:00 – 10:25AM

Fred Dillon[1], Zach Henderson[2]
1 *City of South Portland, South Portland, ME; fdillon@southportland.org*
2 Woodard & Curran, Bangor, ME; zhenderson@woodardcurran.com

The MS4 Permit as a Driver for Integrating Local Water Resources Management

In late 2011, EPA's Nancy Stoner issued a memo to all Regional Administrators and Division Directors encouraging the promotion of an "integrated planning" approach for municipal wastewater and stormwater program activities. The primary motivation for this approach was to "put municipalities on a critical path to achieving the water quality objectives of the CWA by identifying efficiencies in implementing sometimes overlapping and competing requirements that arise from separate waste- and storm-water programs, including how best to make capital investments and meet operation and maintenance requirements." While most municipalities have yet to adopt the formal integrated planning approach as envisaged by EPA, there is an increasing recognition that community-wide water resource management is worthy of serious consideration.

Most of Maine's thirty Municipal Separate Stormwater Sewer System (MS4) communities also provide wastewater treatment services and are therefore subject to different permit requirements for both stormwater and wastewater operations. This regulatory division is similarly reflected by distinct organizational affiliations: the Maine Water Environment Association (MEWEA) currently represents the state's wastewater treatment facilities while a number of interlocal groups throughout the state represent MS4 communities. These divisions are now beginning to dissolve. Fred and Zach will discuss the variety of factors that are leading to a tighter alignment between wastewater, stormwater and other municipal program interests. They will also engage participants in offering additional suggestions for promoting a collaborative approach to protecting and restoring local water resources.

Session K: Municipal Water Resource Management

Poster Session & Lunch

1:30 – 1:55PM

LaMarr Clannon
Maine NEMO, Litchfield, ME; lamarrclannon@gmail.com

How Green Infrastructure Can Work in Your Maine Town

With case studies from Belgrade and Ellsworth that minimize stormwater runoff and chloride use, this presentation highlights examples of green infrastructure effectiveness in cold climates, how these types of projects have saved developers money, simple ordinance changes to encourage green practices, and how a stormwater utility can support green infrastructure. Green infrastructure works in Maine, removes pollutants better than traditional BMPs, can be cost effective, and better looking. Small ordinance changes can encourage green infrastructure in your town, saving developers money and providing resiliency in your town's stormwater system. Green infrastructure can be applied to all levels of development, from large commercial to the single family house lot that comprises the majority of development we see in Maine. No town is too big or too small for green infrastructure.

2:00 – 2:25pm

Brenda Zollitsch[1], Wynne Guglielmo[2], Mike Galdu[3]
1 Bangor Area Stormwater Group; BMZConsulting@aol.com
2 City of Bangor, Bangor, ME; wynne.guglielmo@bangormaine.gov
3 Town of Milford, Milford, ME; publicworks@milford.org

Developing Municipal Outreach Plans to Reduce Chloride Use in the Greater Bangor Urbanized Area

This session will share a new regional model for developing municipal chloride outreach plans. These plans are designed to train municipal leadership and on the ground staff about the need to reduce chloride pollution through changes to municipal operations and integrate selected chloride reduction BMPs into their winter maintenance practices. The project builds on years of work with a statewide collaborative of stakeholders, a project that has identified a range of impacts from chlorides and best practices to reduce the amount of chlorides and developed a manual of BMPs for voluntary municipal adoption. The BASWG is now using this manual to implement stormwater outreach compliance activities.

As a result of participating in this initiative, it is expected that partner municipalities will: 1) meet compliance requirements for the stormwater permit; 2) create a new avenue for sharing information about the impacts of chloride pollution; 3) be able to develop informed plans for chloride outreach and reduction that address individual MS4 circumstances, needs and priorities for snow and ice control activities; 4) design these plans in ways that reduce the amount chlorides entering regional waters; 5) be able to measure learning, implementation of BMPs and the amount of chloride used by each regulated entity that develops a plan.

The BASWG is pleased to share and make available all materials, presentations and templates developed as part of the project to session participants so that the effort may be transferable to any interested parties.

Session K: Municipal Water Resource Management

Afternoon Break - Auditorium

3:00 – 3:25PM

Tamara Lee Pinard, Damon Yakovleff, Kate McDonald
Cumberland County Soil & Water Conservation District, Windham, ME; tpinard@cumberlandswcd.org; dyakovleff@cumberlandswcd.org; kmcdonald@cumberlandswcd.org

The Pinch of Salt: Developing an Annual Chloride Load Estimate to Improve Management within the Long Creek Watershed

Salt usage has increased throughout cold regions as expectations for bare surfaces on parking lots, walkways, driveways, and roads have increased; "Safety is the ultimate driver." Transportation departments have implemented "bare roads" policies in an attempt to reduce highway accidents and fatalities, while private landowners use large quantities of salt on their parking areas and walkways to meet tenant expectations and address liability concerns. Salt usage impacts nearby terrestrial habitat, as well as water sources that receive direct runoff from impervious surfaces.

Watershed stakeholders throughout the United States have expressed interest in developing a model to address chloride contributions from both public and private sources. Since the Long Creek Watershed Management District (LCWMD) implements non-structural BMPs for 73% of impervious cover in the watershed, it is an excellent microcosm to evaluate methods to improve water quality.

This presentation will provide a summary of chloride analytical and near-continuously-monitored specific conductance data from seven sampling sites within the watershed; discuss the chloride management strategies implemented to date; and share the application of an annual chloride loading model, which will include the procedure, inventory of chloride types and applications, geospatial distribution of chloride load, opportunities identified for reduction, and information used to guide BMP retrofit design.

The goal of the Winter Maintenance program is to develop monitoring and BMP methodologies that are transferrable to other impaired streams suffering from salt impacts. This presentation will explore the work in Long Creek and provide suggestions and lessons learned for others wishing to implement similar programs.

3:30 – 3:55PM

Panel Discussion on Stormwater Utilities in the State of Maine

The need to identify and implement sustainable funding solutions for the rising costs of stormwater compliance in the State of Maine has led to the exploration, and in some cases development, of stormwater utilities. This session will discuss stromwater compliance funding options, focusing panel presentations by Maine municipalities developing or implementing stormwater utilities.

Specifically, panelists will share about their municipality's:

- Need and context for developing a stormwater utility
- Process and timeline
- Challenges and delays faced
- Ways challenges were overcome

Session K: Municipal Water Resource Management

- Lessons learned
- Recommendations for other municipalities considering developing a utility

This panel session will be structured to include time for question and answers with audience members, allowing municipalities who are considering the process to ask questions of those who have been through the process.

Session L

Sustaining Maine's Water Resources

Freshwater resources in Maine are extensive and highly valued. Human enjoyment and utilization of these water resources is important for aesthetic, cultural, and economic reasons. In the process of making these resources satisfy a human need, we have altered their intrinsic function in the landscape in terms of hydrology and ecology. The human alteration of the landscape is a process that we can try to control or manage. In this session we will explore the resilience of these water resources to human and climate agents of change. This session includes examples of management and behavior change methods to enhance resilience.

** TCH - Drinking Water Program available*

Session Chair

Chris Feurt

Wells National Estuarine Research Reserve; University of New England; cfeurt@wellsnerr.org

Christine Feurt works to sustain and restore linked social-ecological systems through the design, implementation and evaluation of collaborative interdisciplinary projects. Dr. Feurt uses a Collaborative Learning approach to engage stakeholders with diverse perspectives and missions to facilitate the application of science to decision-making and policy. She has worked for over ten years in coastal watersheds in the Gulf of Maine with the Wells National Estuarine Research Reserve. Dr. Feurt has been on the faculty of the University of New England and Director of the Center for Sustainable Communities for 18 years, focusing her work on sustainability science and undergraduate engagement in community based research. Dr, Feurt received her Ph.D. in Environmental Studies from Antioch University New England where her research focused on the use of cultural models and Collaborative Learning to implement Ecosystem Based Management.

Session L: Sustaining Maine's Water Resources

8:30 – 8:55AM

Christine Feurt[1], Robert Johnston[2], Verna DeLauer[2], Kristin Wilson[1] and Peter Wiley[3]
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Sustaining Ecosystem Services to Promote Human Well Being – Interdisciplinary Research to Assess the Value of Riparian Buffers

Riparian buffers and wetlands are a nexus for complex land use challenges where tradeoffs for ecosystem services must be evaluated. Coveted by developers and homeowners, people and property in these areas are vulnerable to flooding, shoreline erosion and sea level rise. Natural buffers have water quality value for their ability to effectively filter nonpoint source pollution and are the last line of defense for filtering stormwater runoff to estuaries. Ecologists recognize and value shoreline habitats for their complex roles in many ecosystem services, however the quantification of human benefits and tradeoffs, as well as the use of resulting information to guide policy, is often hindered by methodological gaps between economic approaches though which ecosystem services are defined and valued and ecological paradigms through which ecosystem processes are modeled. This presentation focuses on an innovative model for interdisciplinary research that integrates ecological, economic and communication research methodologies conducted within the Wells National Estuarine Research Reserve. Riparian ecosystem structure and function are being modeled using the ecological methods of the Index of Biological Integrity (IBI). The economic methodology of a choice experiment is being used to define and value riparian ecosystem services. A mental models approach is being used to assess stakeholder understanding of ecosystem services and tradeoffs and to develop explicit strategies for bridging communication barriers between academics of different disciplines and practitioners. This research is conducted collaboratively with a diverse group of local stakeholders whose management objectives for conservation and restoration include sustaining riparian ecosystem services.

9:00 – 9:25AM

Kristin R. Wilson[1], Chris R. Peter[2], Christine Feurt[1,3], Jacob Aman[1], Jeremy Miller[1], Tin Smith[1], Michele Dionne[1], Peter C. Wiley[4], Verna DeLauer, Robert J. Johnston[6]
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Riparian Buffers in Southern Maine Streams: Do They Matter Ecologically?

Riparian buffers enhance stream biodiversity and water quality by regulating inputs of light, organic matter, sediment and nutrients. The delivery of these ecosystem services is spatially explicit and dependent on buffer condition, however. This study examines sites along two streams (Branch Brook, Merriland River) in one southern

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Maine watershed that differ in buffer condition. To assess stream conditions, we recorded water temperature, pH, specific conductance, dissolved oxygen, turbidity, NO^{3-}, percent aquatic vegetative cover, stream bed percent cover, substrates, stream width and depth, stream gradient, velocity, discharge, large woody debris, bank condition, spawning areas and the locations of pools/riffles/runs and pool quality in 2011, 2012, and 2013. To characterize buffer quality, we recorded bank percent vegetated cover, air temperature, canopy cover, and soil nutrients (NO^{3-} and NH^{4+} using resin bags). To describe stream biota, we measured epibenthic algae using tiles, macroinvertebrate species using rock bags, and fish composition, abundance, and biomass via electronic fishing. Preliminary analyses reveal no major differences by buffer type across years for any biophysical parameter measured. Rather, the greatest differences occurred between streams.The Merriland River had significantly more large woody debris, less sand, more trees along its banks, fewer fish, a lower coldwater index of biological integrity, and fewer brook trout (*Salvelinus fontinalis*) than Branch Brook. These data suggest that differences in buffer quality are not as important as between stream differences in this Maine watershed. These data may inform interpretations of residents' economic valuation of riparian habitats and their mental models of this important ecotone.

9:30 – 9:55AM

Karl Honkonen[1], Keith Kanoti[2]
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2 Maine Forest Service, Augusta, ME; keith.kanoti@maine.gov

Utilizing Forestry Best Management Practices to Protect Maine's Water Quality

Maine's forests contain many miles of rivers and streams, acres of lakes, and numerous aquifer systems that provide drinking water for Maine residents. These waters also provide recreational opportunities and habitat for aquatic and riparian wildlife. Working cooperatively with Maine's forestry community to maintain water quality is a critical component of the Maine Forest Service (MFS) mission to sustain the health, diversity, and productivity of Maine's forests to meet the needs of present and future generations. MFS Forestry Best Management Practices (BMPs) developed with the input of the forest industry, allow foresters and loggers to protect the chemical, physical, and biological integrity of waterbodies during timber harvesting. BMPs may include stream crossings, water bars, drainage ditches and other practices aimed at reducing or eliminating water quality problems associated with forestry operations. Monitoring and tracking BMPs using a consistent method across all Maine lands demonstrates an agency-wide commitment to protect water quality and maintain aquatic resources. BMPs are used to control nonpoint source pollution consistent with the requirements of the Clean Water Act (CWA). MFS prefers a flexible, voluntary BMP approach over prescriptive regulation. MFS has conducted random, statewide monitoring of BMPs on timber harvesting operations since March 2000. Key findings include:

- 83% of crossings and approaches had BMPs applied appropriately or were avoided.
- BMPs were not applied on 8% stream crossings and approaches
- 91% of opportunities evaluated for sediment input found no sediment entered a waterbody
- When applied appropriately BMPs were effective at preventing sedimentation from entering waterbodies.

Session L: Sustaining Maine's Water Resources

10:00 – 10:25AM

Kate A. Warner (student)[1], Mario F. Teisl[2], Jasmine E. Saros[1]
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Assessing the Ecological and Economic Vulnerability of Maine's Drinking Water Resources to Extreme Precipitation Events

Approximately 64% of Maine's high quality drinking water comes from 46 lakes across the state. This high quality water is threatened by a rapidly changing climate, in particular, extreme precipitation events, which have increased in frequency in the Northeastern U.S. by 60-80% since the 1950s. Changes to these water resources may have significant impacts on Maine residents and economies. Analysis of a 30-year database of surface water geochemistry and watershed-specific landscape data for 84 remote lakes throughout the Northeast suggests increased concentrations of dissolved organic carbon (DOC) in lakes during extreme wet years. Increases in DOC, an important regulator of ecosystem function, can influence overall water quality and can have profound implications for drinking water treatment processes. A better understanding of aquatic ecosystem vulnerability and the implications of extreme events on drinking water resources are needed. Our goal is to assess the vulnerability of Maine's drinking water lakes to extreme precipitation events and subsequent increases in DOC. Ecological and economic criteria were used to select a representative subset of 12 Maine drinking water lakes. Ecological and economic comparative data from the 12 lakes will be presented in addition to plans for further experimentation and sampling to contribute to identifying and understanding the extent to which changing precipitation is altering the chemistry and consequently the biota of Maine's lakes. This research will help to inform the development of adaptation and management strategies for Maine's drinking water sources to ensure sustained high water quality.

Session M

Rivers: Streamflow Quantity and Quality

Rivers impact society in many ways including providing water for domestic, agricultural, industrial, recreational and aesthetic uses. Rivers are managed for a broad range of issues including hydropower and fish passage, flood-related hazards, TMDLs, and competitive water needs during periods of low flow. River systems also provide aquatic habitat for a variety of organisms and serve as a land-to-sea transportation network of many dissolved and sediment-related constituents including carbon, nitrogen, phosphorus, and contaminants. This session addresses status, trends, and societal impacts of streamflow quantity and quality in the northeastern U.S.

** TCH - Drinking Water Program available*

Session Co-Chairs

Robert Dudley, Tom Huntington
U.S. Geological Survey, Augusta, ME; rwdudley@usgs.gov; thunting@usgs.gov

Dr. **Thomas Huntington** received his Ph.D. at the University of Kentucky in 1984. Earlier in his career he worked at Dartmouth College and the University of Pennsylvania. He has worked with the U.S. Geological Survey since 1990. He is currently a research hydrologist at the Maine Water Office of the New England Water Science Center. In recent years his research has focused on carbon cycling at large river basin scales and on hydrologic responses to climate change. He has authored or co-authored 47 papers in peer-reviewed scientific journals and a similar number in various USGS peer-reviewed scientific report series.

Robert Dudley is a hydrologist with the USGS New England Water Science Center, Maine Office and has been with the USGS since 1992 where he's been involved in a variety of hydrologic and hydraulic studies. Ongoing and recent work involves investigation of statistical methods for forecasting groundwater levels in the U.S., investigation of trends in the national glacial aquifer system, and development of national streamflow climate change indicators in cooperation with USEPA.

Session M: Rivers: Streamflow Quantity and Quality

1:30 – 1:55PM

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

Maine StreamStats; a Tool for Calculating Basin Characteristics and Streamflow Statistics in Maine

This presentation will give a demonstration of Maine StreamStats, a U.S. Geological Survey web-based application that has recently been implemented for Maine in cooperation with the Maine Department of Transportation. Maine StreamStats computes consistent, unbiased, and defensible estimates of basin characteristics and streamflow statistics based on published regression equations and (or) long-term streamflow gaging data, at any user-selected rural stream location in Maine. StreamStats also allows users to trace flowpaths and identify stream reaches that are upstream and downstream from user-selected sites. Streamflow statistics computed in streamstats are useful for water-resources planning and management, and engineering design applications such as the design of bridges and culverts. Statewide streamflow statistics that are currently available for computation within StreamStats include peakflows, mean and median monthly and annual flows, the 7-day 10-year lowflow, and bankfull discharge in some regions of the state. As additional Lidar data, streamflow data and regression equations become available for Maine, they can be integrated into the application.

2:00 – 2:25PM

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

Climate Change and Flooding in New England

Annual-maximum streamflows throughout New England generally have increased during the last century. Projected changes in precipitation and air temperature will result in additional changes in the future. Statistical analyses and watershed modeling of historic floods can be used to identify important drivers of floods, such precipitation and snowpack. This presentation will review historical trends in New England flood flows and in important drivers of floods. Causal mechanisms of some large historical floods will be discussed. We will summarize and discuss studies that have modeled future high flows and floods. Initial results indicate a complex relationship between changes in precipitation and air temperature and changes in floods because of the large influence of snowmelt runoff on flood flows in northern New England.

Afternoon Break - Auditorium

3:00 – 3:25PM

Eileen Sylvan Johnson[1], Kathleen Bell[2], Jessica Leahy[2]
1 Bowdoin College, Brunswick, ME; ejohnson@bowdoin.edu
2 University of Maine, Orono, ME; kbell@maine.edu; jessica.leahy@maine.edu

The Social Dynamics of River Restoration

Our research examines the interaction between river water quality and regulatory levels, and responses within river communities to capitalize on river restoration achievements. Our investigation examines the spatial and temporal

dimensions of classification of Maine rivers over a 40-year history as established by Maine Water Classification Acts of 1965, 1979, and 1987. Using the Androscoggin and Kennebec Rivers as a case study to explore social response, we examine the establishment of riverside amenities such as parks and trails to increase public access and enjoyment of river systems along these corridors during this same time frame as well as changes in landscape characteristics along these river corridors. Our research incorporates results from a survey of policy stakeholders on perceptions of water classification levels and public response. By examining both restoration state and the emergence of parks and trails and green spaces along river corridors over the 40 year time frame since passage of the Clean Water Act, this research addresses the question as to whether amenities are established in response to water quality improvements or serve to build public support towards advocating for restoration measures. Despite historical differences in water classification levels, at present these two systems are comparable in the level amenity infrastructure and the predominance of green areas (forested, and vegetated areas) along the river corridor. However, we found important differences between the systems in terms of the pace of amenity development and landscape composition.

3:30 – 3:55PM

Jarrod Cicha, Andrew Reeve, David Lemery
School of Earth & Climate Sciences, University of Maine, Orono, ME; jarrod.cicha@maine.edu

Using Streambed Temperature Time Series and Pumping Tests to Characterize Groundwater and Stream Water Interaction in Northern Maine

Groundwaters and surface waters are environmentally and economically significant resources that are intimately interconnected. Groundwater inflow influences stream ecosystems, including fish habitat, and this inflow may be impacted by local groundwater extraction. Balancing ecosystem needs for groundwater with human demands on aquifers requires a clear quantitative understanding of groundwater interaction with surface water. As a result, groundwater influx to B-stream (Houlton, Maine) is being quantified. Time series of vertical temperature data from the streambed were collected at 10-minute intervals for 2-week periods, seven times through the summer of 2014. Two arrays of 24 data loggers were installed near the edge of B-Stream in a rectangular configuration to collect streambed temperature at depths of 0cm, 8cm, 16cm, and 24cm. Temperature oscillations decrease from 3-4^{o}C at the streambed to 0.5-1.0^{o}C at depths of 24cm. Vertical groundwater velocities were calculated using measured temperature data to calibrate a one-dimensional finite-difference heat transport model. Best fits were determined by minimizing the sum of squared temperature residuals while systematically adjusting vertical groundwater velocity and porosity used in each simulation. Vertical groundwater velocities were upward and ranged from 1e5m/s to 3e6m/s with normalized sum of squares averaging 0.220^{o}C and ranging from 0.163^{o}C to 0.296^{o}C. Hydraulic tests were conducted by pumping two bedrock wells located 10m and 35m from the edge of B-stream at rates of 2.8 to 5.7 liters/min. In the next phase of this project, temperature time series data will be evaluated in greater detail to determine the impact of hydraulic tests on vertical groundwater flow rates.

Poster Session

Juried High School, Undergraduate & Graduate Poster Session

The Senator George J. Mitchell Center for Sustainability Solutions and the U.S. Geological Survey have sponsored a juried student poster exhibition at the conference since 2000. Winners receive a cash award and their names are engraved on a plaque housed at the Mitchell Center.

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 10:30 – 11:30am.

Student presenters are indicated in bold type.

Poster Chair

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

John Peckenham is the Director of the Maine Water Resources Researcfh Institute and the Associate Director and Senior Research Scientist at the Senator George J. Mitchell Center for Sustainability Solutions.

High School Poster Abstracts

Andrew Moreira[1], Peter Van Walsum[2]
1 Old Town High School, Old Town, ME
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Recovering Acids From Water Through Extraction and Precipitation

One of the problems facing our world today is energy. As the supply of oil around the world decreases, we will need to look for new sources of fuel to power the modern world. While electricity generated by wind and solar are proving to be quite capable in powering homes and cars, some vehicles will still require oil-based fuel to run. A way to create oil without mining for it is the thermal deoxygenation (TDO) of organic salts. My research focuses on the creation of those organic salts through the reactions of divalent bases and organic acids.

This research is about finding an industrially viable way to convert organic acids into fuel. There are two phases in this process: extraction and precipitation. In the extraction phase, organic acid dissolved in water is mixed with the solvent ethyl acetate. (EtAc) This extraction phase prepares the solution for reaction with a divalent cation base. There were four different bases tested: magnesium hydroxide, calcium, hydroxide, calcium oxide, and calcium carbonate. Because the salts created in these reactions are not soluble in EtAc, they would precipitate out of solution. This was the precipitation phase. After precipitation, the EtAc is burnt off and dry organic salts are left over. These salts are then redissolved in water and analyzed for reaction completion. We found that there is an inverse relation between extraction efficiency and acid polarity. We also found that, in general, calcium hydroxide is the most effective base to use in the precipitation reaction.

Avery Waterman, Aidan Emerson, Adrianna Ames, Kaleb Campbell, Jessica Dückert
North Haven Community School, Courtney Naliboff, courtney.naliboff@gmail.com
**This poster series for exhibit only.*

Advertising Ocean Acidification

The purpose of these posters is to raise awareness of and provide possible solutions to ocean acidification by demonstrating simple things people can do to reduce their carbon footprint. The posters are part of ad campaigns which target specific age groups, use consistent imaging and are easily understood by a variety of audiences. Posters and accompanying video will be shown to target demographics and data regarding their effectiveness will be collected. Our hope is that these posters will give viewers a general understanding of ocean acidification and how to prevent it.

Undergraduate Poster Abstracts

Lloyd Anderson[1], Bailey Moritz[1], Michele LaVigne[1], Ruth Indrick[2]
1 Bowdoin College, Brunswick, ME; lbanders@bowdoin.edu; bmoritz@bowdoin.edu; mlavign@bowdoin.edu
2 Kennebec Estuary Land Trust, Bath, ME; rindrick@kennebecestuary.org

Mya arenaria and an Acidifying Ocean: Assessing the Carbonate System and Saturation State in a Phippsburg, ME Clam Flat

Increasing atmospheric CO^2 has led to the phenomenon and global concern known as ocean acidification: CO2 gas dissolved in the ocean increases surface ocean acidity. Over the past decade, a clam flat in Phippsburg, ME has been reduced to approximately a sixth of its former productive area. A possible explanation for this loss is acidification. By measuring porewater pH and alkalinity in the upper centimeter of mud along a transect spanning productive and unproductive areas within the flat, we were able to determine aragonite saturation state, an indicator of the susceptibility of *Mya arenaria* (soft shell clam) shells to dissolution. pH was measured in situ using glass electrode probes and alkalinity was determined in the lab using titration. Additionally, we analyzed clam shell structure on the SEM and measured aqueous calcium and nutrient concentrations in order to fully characterize the clams' environment. Average pH values within the flat ranged from 6.9-7.5, and average alkalinity ranged from 2200-2500 μeq/kg. Aragonite saturation state ranged from 0.13-1.07. Our results indicated that there was not a significant difference in carbonate chemistry between productive and unproductive areas of the clam flat. Therefore, ocean acidification does not appear to be the driving force behind the clams' decline. However, aragonite saturation state was consistently low (<1) at all sites, suggesting that *Mya arenaria* can survive in undersaturated conditions. Our measurements represent a "snapshot" of conditions in this clam flat because sampling was limited to

July, and a longer time series could elucidate seasonal fluctuations in carbonate chemistry.

Austin Coco, Jeri Fox
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The Role of Integrated Multi-Trophic Aquaculture in Sustainable Aquaculture Practices

Integrated Multi-Trophic Aquaculture (IMTA) is a new aquaculture practice based on culturing multiple species, each representing different trophic levels. This process has the potential to reduce waste produced from uneaten foods and metabolic waste by utilizing the unused nutrients and retaining the resources within the system. The results of this literature review show that IMTA can increase biomass and crop yield of aquaculture systems, and that there is some usage in the state of Maine; however, this usage is not entirely widespread currently, and is found predominantly in educational and research settings as opposed to commercial systems.

David Hague, Drew Fortin, Zachary Delorenzo, Brandon Perry-Hudson, William Seretta
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Improving the Design of a Cost-conscious, Multi-function Water Quality Sensor Probe for Freshwater Ecosystems. We need your help!

As the number of environmental issues amongst our watersheds increases, it is of growing importance to provide the caretakers of these resources a more accessible means of studying/monitoring them. Sensors, probes and measurement devices are currently very expensive and hard to get in a consolidated technology.

A group of undergraduate students working together as a part of a Sustainable Entrepreneurship course at the University of New England in Biddeford, Maine are using the human design process to create a product to answer the following questions: How might we design a product to lessen the cost and increase availability of remote data collecting sensors in freshwater watersheds? How might we make this product cheaper and more efficient so that users may be able to utilize them for important research/ecosystem monitoring? Some of the sensors we are looking to create include dissolved oxygen, conductivity, turbidity, and temperature. Prototype designs will be available for discussion and feedback with potential end users at the Maine Sustainability and Water Conference.. This interactive poster aims to solicit input to our design that will improve our final product.

The most important aspect of creating this poster is to collect data and feedback to advance what we need to do to create a product.

L.J. Hammer, Rudnicky, B.N., Smith, K.M., Sulikowski, J.A.
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Seasonal Fluctuations in Species Assemblage and Abundance of the Saco River Estuary, Maine

Coastal estuaries, such as the Saco River estuary (SRE), play an important role in the early life history of many marine and estuarine species in the Gulf of Maine. These dynamic ecosystems provide many important functions, including nutrient cycling, pollution filtration, sediment trapping, carbon storage, and buffering. Although the Saco River is the fourth largest river in Maine, knowledge on the fauna using this system is lacking. Thus, the main objectives of this project were to determine the species assemblage of the SRE and if abundance fluctuates seasonally. Modified lobster traps were set off the University of New England's (UNE) dock and checked daily between April –

November during the 2010-14 sampling seasons. Total length (mm) and relative abundance, using catch-per-unit-effort (CPUE), of species caught were recorded and compared on a monthly basis. To date, fourteen fish species and four crustacean species have been observed, including the commercially and recreationally important red hake (*Urophycis chuss*), as well as the invasive European green crab (*Carcinus maenas*) and European rock shrimp (*Palaemon elegans*). Additionally, preliminary results suggest that abundance and diversity of species fluctuates on relatively short (monthly) and long (annual) temporal scales. For example, Atlantic tomcod (*Microgadus tomcod*) abundance was consistent over the course of the study, while red hake were only present during a few months in altering years. As coastal development, fishing, and recreation continue to increase in this densely populated region further research is necessary for proper conservation and management of this ecologically important ecosystem.

Jason Lively, Amanda Olsen, Martin Yates, Daniel Lux
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Acid Mine Drainage Neutralization Capacity of Major Rock Types Found in Maine

Maine has a history of mining for metallic ores; the metals of interest, including gold and silver, are found in massive sulfide deposits. Massive sulfide deposits contain pyrite (FeS_2), chalcopyrite ($CuFeS_2$), as well as other minerals that include heavy metals such as lead, arsenic, and molybdenum which also bond to sulfur. Mining of massive sulfide deposits can be environmentally damaging as these minerals break down when exposed to the atmosphere. The reaction produces sulfuric acid, which can run off into nearby surface waters, lowering the pH and dramatically affecting ecosystems (Descostes, Vitorge, & Beaucaire, 2004)(Rimstidt & Vaughan, 2003). We ran a series of experiments to test the hypothesis that common rock types found in Maine could be facilitated as a way to remediate acid mine drainage. Experiments were carried out in batch reactors containing 1×10^{-3}, 1×10^{-4} and 1×10^{-5} molal sulfuric acid solutions along with five grams of eight rocks; a granite, calcareous turbidite, basalt, serpentinite, two schists of different composition, a meta-limestone and glacial till, to test each one's neutralization capacity. The pH was monitored and used to create a rate of hydrogen consumption.

The experiments show that the meta-limestone has the greatest rate of hydrogen consumption. This was as expected. The order progressing from greatest to least is as follows: meta-limestone (TL), basalt (EB) and serpentinite (DIS), calcareous turbidite (VF), the glacial till (BGMGT), and the granite (MWG) and two schists (WMS and EF respectively).

Chelsea Malacara, Robert Sanford, Joseph Staples
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On Developing a Smart Forest Site for Environmental Monitoring in Real Time

Citizen science ecological monitoring programs offer wide ranging and cost-effective opportunities for collecting ecological data and engaging public interest in STEM fields. Students and faculty in the Department of Environmental Science & Policy at the University of Southern Maine (USM) are currently installing a network of environmental sensors in a small eastern hemlock (*Tsuga canadensis*) forest adjacent the USM campus in Gorham Maine. Here we summarize challenges and achievements to date regarding the commercial and do-it-yourself (DIY) technologies as well as engaging public awareness to create an ecological monitoring site modelled after the USDA Forest Service Smart Forest initiative. The objectives for this project are to establish an ecological monitoring site in Gorham using commercial and DIY wireless environmental sensors to provide real-time data including air temper-

ature, precipitation, relative humidity, wind speed, solar radiation, soil temperature and moisture, stream flow in Tannery Brook, and webcams to monitor animal species density and plant phenological data. We are working to provide a model and other resources for implementation of commercial and residential environmental sensors that will be available to the public.

Tagwongo Obomsawin, Kathleen Bell, Caroline Noblet, Abby Kaminsky, Emma Fox
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A Statistical Report of Maine Residents' Perceptions of Water Quality Issues

The purpose of this poster is to illustrate the results of two surveys (one beach and one shellfish version) that were administered to Maine and New Hampshire coastal residents. This poster will focus on Maine residents, because our sample for New Hampshire residents is much smaller.

The results I will be displaying will stem from a few key questions asked to residents about water quality and the perception of water quality in Maine and other New England states. To many coastal residents, amenities such as beautiful scenery, clean waters, and working waterfronts are highly important. In Maine this is especially true, and the high value Mainers place on their coastal resources suggests a willingness to preserve it. As a large source of tourist and commercial revenue, it is highly important that law makers and coastal management programs are aware of citizens' perceptions of water quality issues, and their desire to fix them or leave them alone.

Some of our questions ask, "please rate the water quality of these New England states"(opinion based), "how important are the benefits of clean coastal water", "how important are problems stemming from poor coastal water quality", etc. Using Statistical Analysis Software, our team will attempt to show any interesting correlations between answers, and identify trends. Results will hopefully show interesting parallels between Mainers' perceptions of water quality and the importance they place upon it.

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Abiotic Influences on the Juvenile Fish Assemblage of the Saco River Estuary, Maine

Considered among the most productive marine environments within the Gulf of Maine (GOM), estuaries are known to provide habitat, resources, and shelter for diverse fish communities. These complex coastal ecosystems are physiologically challenging habitats due to large variations in abiotic parameters, such as temperature, salinity, dissolved oxygen, and pH. Although the fish community has been well studied in the Saco River estuary (SRE), no study to date has attempted to correlate seasonal fluctuations in fish abundance to environmental factors. The results suggest that the SRE exhibits large fluctuations in surface water temperatures (8-30°C), relative salinity (0-30ppt), and dissolved oxygen concentrations (4-12mg/L). In addition, the data suggests that abundance and diversity of juvenile fish species in the SRE fluctuates on relatively short (month) and long (annual) temporal scales. For example, throughout 2010-14, American sand lance (*Ammodytes americanus*) abundance was consistent throughout the study, while other species, such as large and smallmouth bass (*Micropterus sp.*), were only present during or directly after periods of high river discharge. Furthermore, fresh and oligohaline (0-5ppt) sampling events yielded 61% freshwater, 33% estuarine, and 6% marine fish species while mesohaline (5-18ppt) sampling events yielded 10%, 33%, and 56%, respectively, suggesting that salinity has the most influence on fish abundance. When this knowledge is combined with the idea that current threats to this region (e.g. climate change, overfishing, and pollution) can affect recruitment, understanding the dynamics of the SRE fish community is crucial to proper

conservation and management.

Erika Sawicki[1], Kenneth Wagner[2], Cynthia Simon[1]
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The Power of Internships

At the University of New England undergraduate courses in environmental studies provide a foundation for a career in environmental management. The curriculum includes an internship requirement for hands-on experience in the work environment where concepts learned in classes can be applied. Students may take a freshman/sophomore internship or a junior/senior internship. Each internship credit is forty hours on the job. As an "Environmental Science" and "Ocean Studies & Marine Affairs" double major, I was curious about how the internship experience would compare with classroom learning. After my freshman year in 2014, I completed a 4-credit summer internship with Water Resource Services Inc., an environmental consulting firm conducting water quality monitoring and management of New England lakes.

As an intern I worked under the direction of Dr. Kenneth J. Wagner, President of Water Resource Services Inc. I gained hands-on field experience through plant and plankton identification while surveying for algae blooms and the presence of invasive species. I expanded my classroom knowledge of water pollution by monitoring water quality and conducting sediment profiles. I satisfied my curiosity about how pollution problems are solved by observing and operating a phosphorus inactivation system designed to treat storm water run-off and improve lake water quality. The internship course curriculum helped to enhance and apply the concepts learned in classes while providing valuable skill building experiences outside the classroom. This experience provided me insight into a potential career field and helped to further focus my studies at UNE.

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An Exploration of Anarcho-Syndicalism as an Environmentally Sustainable Solution to the Current Anthropogenic Ecological Crisis

The absent-minded grow-or-perish imperative of today's capitalist economies, more specifically, todays really existing capitalist democracies (RECD) [1], is certainly the central contribution to the severity of the present ecological crisis. A vast array of the biosphere's thresholds that are concerned with the stability and sustainability of the climate as well as the unsustainable rise in the oceans acidification have been breached [2] as an anthropogenic consequence of the unnatural appetites of the most powerful RECD societies, which inhibits the business elite from considering systemic risk as well as economic externalities. Hence, the purpose of this project is concerned with combating the current unsustainability of our political and economical endeavors by way of employing the political philosophy of anarchism – that is, anarcho-syndicalism – as a means of liberating our selves from the shackles our global ecological crisis. Consequently, it has been realized that anarcho-syndicalism must be seriously reflected upon and considered by the members of our sovereign since it offers a pragmatic and philosophically sensible amount of promise as a solution to this problem, without being trapped by utopic ideals.

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Poster Session

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Collaborative Investigations of Social Vulnerability in the Era of Climate Change

As the climate in Maine changes, both the frequency and magnitude of precipitation events are expected to rise. Increased incidences of freezing rain storms in winter, heat events in summer, and storm surges all place residents of many coastal communities in danger of being isolated from emergency services and unable to reach a safe location in order to weather these hazards. Working in collaboration with staff from local, regional, and state agencies, students collected, analyzed, and presented data to inform adaptation strategies for midcoast Maine communities. Using social vulnerability (SoVI) (Cutter et al 2003) as a lens, this study utilized ArcGIS to analyze the vulnerability of Sagadahoc County residents as a case study in understanding residents' vulnerability to these specific environmental hazards. Building distances from public roads maintained through the MEDOT, town designated shelters, and buildings located along roads inaccessible to emergency services due to flooding were physical factors pertaining to winter precipitation, heat, and flood events respectively. Method of heat generation in homes, household access to a vehicle, population 65 years and older living alone, educational attainment, and population living in poverty were all social factors influencing vulnerability as well. These event specific vulnerability results for Sagadahoc County differ dramatically from the national SoVI index data indicating the unique impact Maine's location has upon its residents' susceptibility to environmental hazards. Understanding the distinctive locational characteristics resulting in vulnerability will be crucial to identifying and protecting citizens across Maine who might be in danger of such specific hazard events.

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A Survey Examining the Occurrence and Degree of Parasitism in Adult Female Mosquitoes by Aquatic Mites (*Acari: Parasitengona: Hydrachnid)* in Maine

In this presentation we summarize results from our 2014 survey examining the occurrence and degree of parasitism in adult female mosquitoes by aquatic mites in Maine. Samples were collected from southern, central, western, and northern sites. Over the course of this study 9,524 female mosquitoes belonging to 30 species were captured and identified. Overall, 6% of the mosquitoes trapped were parasitized by at least one mite. The most common mosquito species collected were female *Coquillettidia perturbans* (43%) with an 11.8% parasitism rate. Culex territans was the most highly parasitized species with a 15% parasitism rate, however, this species represented only 0.2% of all female mosquitoes captured. Data collected in this study provides a species level look into parasite-host dynamics between mosquitoes and aquatic mites in Maine. Future work will examine parasitism rates under different habitats and environmental conditions.

Graduate Poster Abstracts

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Poster Session

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Advancing Innovative Conservation Tools by Improving Knowledge of Decision-making on Private Lands

Managing natural resources on private lands is a significant conservation challenge. Extensive private ownerships (e.g., over 60% of lands in USA and over 90% in Maine) necessitate consideration of the effectiveness of conservation tools on these lands, and our research aims to improve conservation efforts by enhancing understanding of landowner heterogeneity and decision-making. Dividing landowners into classes based on conservation preferences can help determine which owner groups are amenable to conservation policies, and these groups can be better targeted for more efficient implementation. Economists and other social scientists are increasingly incorporating landowner classifications to account for heterogeneity in behavioral models, thereby improving their explanatory and predictive performance.

We test the extent to which models of behavior are improved by the addition of spatial data and recognition of heterogeneous landowners and natural landscapes. We combine data from a 2012 Maine landowner survey with spatial data on landscape features, human communities, land ownership, and public policies. Guided by the results of prior literature, we classified landowners using cluster analysis and developed discrete regression models of past and intended land management and development behaviors. Results suggest that the addition of spatial variables describing parcels and broader landscapes improves the fit of past and intended land management and development behavior models. Incorporating greater decision-making heterogeneity also improves the performance of these models. Understanding how landowner decision-making varies across individual landowners and landscape settings could improve conservation policy development and implementation by helping policy-makers better integrate landowner perspectives into conservation efforts.

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The Controls on Hypolimnetic Sediment Phosphorus Release In A New England Lake: Climate, Sediment Quality, and Changing Land Use

Lake Auburn, Maine is a historically oligotrophic lake serving as the main drinking water source to the Lewiston/Auburn communities. Recent years have shown decreasing water quality, evidenced by increasing epilimnetic total phosphorus (P) concentrations, increasing turbidity and the appearance of cyanobacteria. These conditions are especially concerning due to Lake Auburn's exemption from filtration by the EPA. The decline in water quality has been linked to widespread hypolimnetic summer anoxia, causing sediment P release. We investigated the importance of controls on sediment P release and the historical changes in land use that may have brought about changes in sediment P speciation. We determined sediment P speciation using sequential chemical extractions to quantify P associated with iron(III)(Fe) hydroxide, aluminum (Al) hydroxide and organic matter. Hypolimnetic sediment short cores were taken throughout Lake Auburn and from two upstream lakes. Chemical analyses were performed on water samples from the lakes and tributaries. Results show that Lake Auburn sedi-

ments are high in reducible Fe hydroxide (133 to 633 μmol g^{-1}) and relatively low in Al hydroxide (76 to 228 μmol g^{-1}). Previous research has shown that sediments with molar Al: reducible-Fe ratios <3 may act as a source of P under anoxic conditions; Lake Auburn sediment shows molar Al: reducible-Fe ratios between 0.2 and 1.7. Water analyses have shown tributary wetlands, created in the last century by dam emplacement and road construction, as a possible cause of increased Fe flux into the lake.

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A Web-based Tool for Grower Assessment of Native Bee Abundance in the Wild Blueberry Production Landscape

Wild bees are a critically important resource, and one of the central problems in promoting bee conservation is that their populations are difficult for stakeholders to see and assess. This research presents a participatory process for developing a novel web-based tool for stakeholders to visualize estimated bee abundance in the landscape around focal crops. Our aim is for this tool to be easily implemented, understandable, and accessible to all wild blueberry growers. Therefore, our research partners with growers. Their industry is heavily dependent on commercial honey bees, however honey bee numbers are declining and dependence on honey bees is increasing in risk. Wild bees are an important source of pollination, and growers that contribute to wild bee conservation near their fields will benefit from increased crop pollination. Development of our web-based tool includes an iterative, participatory process that will incorporate grower feedback about the tool's content and design. We are obtaining feedback at multiple forums: the annual Wild Blueberry Commission Advisory Board meeting, in-depth one-on-one sessions with six key informant growers chosen for their knowledge of different growers groups, a demonstration booth at the Spring wild blueberry growers meeting, and workshops at Blueberry Field Schools. The final version of the tool will help growers visualize the contribution of the landscape surrounding their fields as wild bee habitat and inform their decisions about land management to enhance crop pollination as well as wild bee conservation.

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Who Should Bear the Burden of Cost for Protecting Water Quality? Maine and New Hampshire Coastal Resident Perceptions about Financial Responsibility

Background/Purpose/Methods: The purpose of this study is to identify the perceptions, behaviors, and attitudes of coastal residents about the risks associated with beach recreation and shellfish consumption. We distributed a suite of mixed-media surveys to a random sample of ME (n=3960) and NH coastal residents (n=2040), where 50% of our sample received shellfish-related survey questions and 50% received beaches-related questions.

Results/Discussion: Our preliminary results indicate complex coastal resident perceptions and attitudes about the issue of financial responsibility for coastal water quality protection. When asked about their willingness to pay additional taxes to fund a Coastal Water Quality Improvement Program, we observe in ME, 67.45% of respondents

are willing to pay higher taxes to support a coastal water improvement; in NH, 71.72% are willing to pay higher taxes for the same program. Interestingly, few negative answers were unambiguous—many of those unwilling to pay higher taxes provided additional qualifying information such as their attitudes about the effectiveness of the state or local government, or their perception that visitors should be equally burdened by taxes to fund a coastal water improvement program. Our results also indicate that Maine residents generally feel responsible for coastal water quality improvement. Our preliminary attitudinal findings about responsibility have strategy implications for policymakers: framing is important. State and municipal partnerships which hold landowners accountable for their wastewater or runoff, but which also provide real financial support for mitigation efforts may garner more trust than discrete state or municipal programs enforcing clean water laws.

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Stream Dynamics in a Coupled Human-Climate-Postglacial Watershed

A river's flow regime is defined by patterns of discharge over time. These patterns are governed by runoff and routing processes controlled by the geology, biology, and climate of the contributing watershed. Modifications to these conditions and consequent flow regime shifts present a major challenge to the sustainability of water quality and habitat. Understanding the relations between these conditions and flow regime is necessary for the implementation of sustainable resource management.

This research examines flow regime characteristics and sensitivities in the Northwest River, a major tributary to Sebago Lake in southern Maine. Sebago Lake is the primary water supply for ~200,000 Maine residents, and despite extensive human interventions in the lake's watershed over the past three centuries the region remains predominantly rural and forested. However, projections indicate a change to more extensive development in future decades, which could have water quality implications for Sebago Lake and its tributaries.

This project examines the interactions between watershed conditions, surface flows, and stream channel conditions in the Northwest River. A distributed watershed model is used to evaluate scenarios defined by predicted land cover changes, hydraulic controls, and drainage network expansion. These scenarios represent modifications observed to be associated with development. Model calibration and validation is performed using four years of discharge data, and the water balance is used as an indicator. All scenarios result in alternations to flow and the sub-basin water budget. Future work will use these results along with channel measurements to evaluate stream bed dynamics in response to human activities.

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Characterizing the Utility of Plankton in *Vibrio parahaemolyticus* Surveillance

Shellfish and beach safety is a complex and multidisciplinary problem that encompasses public health, economics and local to federal government regulation. *Vibrio parahaemolyticus,* a naturally occurring bacterium in the marine and estuarine environment, has become a central health issue as outbreaks from New York to Massachusetts are becoming a yearly occurrence. Without effective tools to predict and avoid disease outbreak from contaminated shellfish, associated medical and regulation costs could have damaging and lasting impacts on the shellfish industry and

the communities that depend on them. Furthermore, as environmental conditions continue to change in poorly characterized and unpredicted ways, there is a vital need for spatially complete bacterial monitoring systems in coastal regions. While there have been no documented cases of *V. parahaemolyticus* associated with oysters harvested from New Hampshire waters, the Great Bay Estuary exhibits seasonal variations in potentially pathogenic Vibrio bacteria. Routine bi-weekly and bi-monthly surveillance of the Great Bay Estuary is used to study the dynamics of *V. parahaemolyticus* in relation to matrices concentrations and physical parameters including: water temperature, pH, dissolved oxygen, rainfall and salinity. In 2014, plankton sampling was added to the established surveillance matrices of sediment, water and oysters based on its proposed molecular interactions with *V. parahaemolyticus* and its potential utility for remote sensing. Phytoplankton and zooplankton were analyzed as separate fractions to quantify the respective associated *V. parahaemolyticus* concentrations as individual samples. Simultaneous measurements of in situ chlorophyll and hyperspectral radiometer measurements were taken for the purposes of ground validation as well as to test the suggested relationship between *V. parahaemolyticus* and plankton presence. Preliminary results show that relative to other matrices of interest, both phytoplankton and zooplankton fractions had higher mean *V. parahaemolyticus* concentrations throughout the summer season, 1540 mpn/g and 1910 mpn/g respectively. Combined with our collected physical data, these initial results provide important starting points to characterize ecological relationships between *V. parahaemolyticus* and phytoplankton and zooplankton, which we can extend to other relevant coastal regions throughout the Gulf of Maine.

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Increasing the Understanding of Pathogen Removal Ecosystem Service by Aquatic Ecosystems to Improve Water Sustainability

Pathogens are a major cause of water quality impairment in the United States. Human development has a significant impact on water quality, and the anthropogenic influence on pathogen contamination must be understood. Watershed-scale models can assist in understanding the sources, transport and fate of pathogens and the consequences for water quality at broad regional scales. We developed a pathogen module in the Framework for Aquatic Modeling of the Earth System (FrAMES) model, an existing spatially distributed river network model that accounts for storm runoff, routing, water temperature, land use effects, and serial processing in the river network. The pathogen module uses a statistical regression model to estimate pathogen loads as a function of land use, and the first-order decay function is used to estimate the in-stream pathogen removal. The widely used safe beach and shellfish indicator, fecal coliform, was used to test our model. We find that dilution and aquatic attenuation are important regulators of fecal coliform concentration. This study aims to quantify in-stream pathogen removal as an ecosystem service and provide the distribution of pathogen removal in river networks.

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Poster Session

Rocks, Microbes, and Acid Mine Drainage: What They Mean for Maine

Acid mine drainage is water that is acidified due to chemical oxidation reactions between water and sulfide minerals in rocks exposed during mining operations. Microorganisms present in natural waters can accelerate acid formation via the reaction. AMD greatly impacts the environment and damages ecosystems by exposing organisms to natural waters below their tolerable pH range. This project seeks to address microbes present in mining-affected waters in Maine. Specifically, we will characterize the microbial communities present at two field sites: one that has been impacted by historical mining, and one that has been impacted by natural exposure to sulfidic rocks. Then, sulfide-impacted waters will be used in the laboratory experiments to test the effect of these bacterial communities on neutralization of AMD by common Maine rocks. Preliminary experiments include four Maine rock types (granite, schist, limestone, and basalt) in the presence and absence of waters collected from an abandoned mine pit in Blue Hill. Experiments were conducted in a temperature controlled shaker bath to allow for a continuous reaction over a period of five days. Three different aqueous treatments (deionized water, autoclaved sample water to eliminate microbes, and unautoclaved sample water containing microbes) were tested in triplicate. Solution chemistry and pH were monitored for changes over time. Early results indicate that microbes may not significantly alter neutralization. Subsequent experiments will be conducted that monitor the effects of neutralization when sulfide based rock is added to the system. This research is ongoing.

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From the Flat: Perspectives of Shellfish Flat Cosure and Stakeholder Response

Maine's soft-shell clam industry was valued at more than $16.9 million last year to the state's economy according to Maine's Department of Marine Resources. The co-management of this industry at the municipal level and the threat of closure (created by pollution, harmful algae blooms, or conservation efforts) provide a unique opportunity to understand how management institutions and fishing communities, broadly defined, cope with change and uncertainty. Here we present a preliminary investigation into the perspectives that stakeholders have concerning closures, how they gather information and how they respond behaviorally. We draw on an analysis of 19 interviews conducted with shellfish harvesters, managers and wardens in the summer of 2014. We entered transcripts of interviews into an NVivo database for qualitative analysis and identified common themes about how individuals acquire and share closure notifications, how individuals change their behavior patterns based on closures, whether accurate prediction is possible, and opinions regarding the management and process behind flat closure. Participants generally view current management as appropriate and effective, but often mentioned the need for more localized information regarding how quickly a flat can recover from various closure types.

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Risk Perception in Maine and New Hampshire's Surfing Population

Water quality and the subsequent beach advisories and closures are a significant problem facing the Gulf of Maine. Beach advisories and closures arise when water quality is below an accepted threshold for human health and safety. Surfers are a sub population of beach goers that are a higher risk of suffering from the effects of microbial pathogens. This occurs for a number of different reasons: 1) Surfers are in the water for longer periods of time and become fully emerged (versus wading); 2) Surfers participate in the sport year round (seasonal variation in rainfall, changes in waste water treatment plant outputs); 3) Given the nature of the sport surfers are more apt to ingest water or get cuts or scrapes; and 4)They often surf during or after storm events when water quality is at the lowest. This project will investigate risk perception of water borne pathogens in the surfing population of southern Maine and New Hampshire. Given the level of pathogen exposure and the corresponding health risk, coupled with a strong sense of environmental sustainability within the local surfing community, Maine and New Hampshire surfers may provide valuable insight and local ecological knowledge into water quality issues. This study hopes to gain a better understanding of the local environmental knowledge held within this group and if risk perception plays a role in the decision to surf or not to surf.

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Exploring Volunteer Recruitment to and Retention in Citizen Science River Herring Monitoring Programs in Maine and Massachusetts

Volunteer, citizen science programs are increasingly relied upon to gather environmental data for all levels of natural resource governance and management. In Maine and Massachusetts, river herring volunteer monitoring programs are primary sources of harvest independent river herring population and migration data. Monitoring programs ask community members to collect data that is considered by decision-making groups to assess stock status, determine future management options, and evaluate the impacts of restoration activities. Consequentially, greater reliance on volunteers means assessing strategies used to promote their involvement and retention can provide information to help mitigate or correct barriers that may be decreasing program effectiveness. This research had three objectives: 1) Identify common communication and organizational practices; 2) Identify factors discouraging and encouraging volunteer participation; and 3) Measure volunteer preferred mode of involvement. After interviewing monitoring coordinators and participant observation of citizen scientists at river herring monitoring sites, pilot results were incorporated into an online survey of citizen scientists involved in river herring monitoring programs in Maine (ME) and Massachusetts (MA) (n=176). Participants were recruited through volunteer coordinators from each run. Communication, particularly feedback of fish counts, was important to volunteers. Results showed that volunteers were generally satisfied with levels and modes of communication, and with training provided by volunteer coordinators. Concern for the local ecosystem was the number one reason for volunteer participation. Respondents also indicated interest in having more diverse involvement with programs, including identifying research questions (45%), data entry and organization (31.52%), and discussing management of their local run (48%).

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Poster Session

Improving Upland Drainage Representation using LiDAR

Understanding surface runoff patterns is fundamental to evaluating the transport of water and materials through a landscape. These patterns are strongly controlled by the density of upland flow paths, which are often underrepresented in published drainage network data. However, high resolution elevation datasets are increasingly becoming available and present an opportunity to better quantify the extent of these first order networks. This research explores the potential to use these data for the mapping of first order channels in coastal Maine.

LiDAR elevation data in both point cloud and raster form are now available for all of coastal Maine, extending inland to the head of tide of major rivers. Data of this resolution make it possible to remotely map upland drainage networks using direct detection methods that analyze small topographic variations in digital elevation models to find channel head locations. Direct detection methods have the advantage over other methods of being able to pick up artificial or modified channel heads, which is useful in urbanizing areas.

Here we discuss the development and calibration of code that employs one direct detection method, topographic openness, which has successfully been used in the US Mid-Atlantic. In testing, we use LiDAR data from the Webhannet River in Wells, ME, a low-lying coastal watershed; and Cromwell Brook in Bar Harbor, ME, a small, high-relief island watershed that begins on Cadillac Mountain in Acadia National Park. Future work will focus on the use of direct detection-derived drainage networks to investigate changes in upland drainage patterns with urbanization.

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Identifying Factors Contributing to Stream Vulnerability to Urbanization in Small Watersheds Across Maine

Urbanization-induced degradation of stream water quality is a major threat to water resources and freshwater biodiversity. In Maine, local streams are at risk as housing development expands outward from population centers; in the next fifteen years, most watersheds in Maine will experience moderate to high increases in residential development. Taking a proactive approach to development planning can save millions of dollars by preventing stream degradation instead of attempting to restore impaired streams. In general, stream quality begins to decrease when impervious surfaces—any surface such as a road or roof that impedes water infiltration into the soil—cover about ten percent of a watershed. Some watersheds, however, can withstand higher amounts of impervious cover (IC) before becoming impaired, while others become impaired at much lower than ten percent IC. Our modelling approach explores the relationship between spatially-explicit landscape characteristics and stream water quality to predict where streams in Maine are more likely to become degraded with increased watershed development. Factors such as riparian vegetation and soil drainage properties are found to contribute to stream resistance to degradation. The results of this modelling effort are used to create an online, interactive map that can be used as a decision-support tool to minimize developmental impacts on stream ecosystems and stream water quality.

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Establishing the Relationship between Water Temperature and Depuration Rate of Eastern Oyster in

Poster Session

Maine

The Gulf of Maine is one of the most productive aquaculture regions in the United States, with the oyster ranking as the most valuable aquaculture product by weight. However, sewage-derived pathogenic bacteria, which can accumulate in the digestive tracts of oysters, is a public health risk and can cause significant economic impacts to the industry. The primary method to mitigate pathogenic bacterial contamination of oysters is depuration, whereby shellfish are allowed to self-purge and release bacteria into clean running seawater. However, little information is available regarding pathogenic bacteria depuration rates under cold water conditions, such as those in Maine coastal waters. This project investigates how different water temperatures and pathogenic bacteria (*Vibrio anguillarum*) concentrations affect the depuration rates of the eastern oyster (*Crassostrea virginica*). The experimental findings will be used to develop a model for estimating the depuration times needed to render the oysters safe to eat under different temperatures and initial bacteria concentrations. The results will help reduce the off-market time due to bacterial contamination and in turn, increase customers' confidence regarding oyster consumption in Maine. Furthermore, in collaboration with the Department of Marine Resource, this work can be combined with existing water monitoring programs to improve marine resource and sewage source management.

Professional Poster Abstracts

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Effects of Two Fungicide Formulations on Microbial and Macroinvertebrate Leaf Decomposition Under Laboratory Conditions

Aquatic fungi contribute significantly to the decomposition of leaves in streams, a key ecosystem service. However, little is known about the effects of fungicides on aquatic fungi and macroinvertebrates involved with leaf decomposition. We hypothesized that exposure to fungicides would reduce leaf decomposition by reducing microbial biomass on leaves and, consequently, amphipod shredding. The amphipod leaf shredder, *Hyalella azteca*, was used to examine the effects of two fungicide formulations on amphipods, microbes and leaf decomposition. Red maple (*Acer rubrum*) leaves conditioned in a stream to acquire microbes (bacteria and fungi) were exposed to fungicide formulations containing azoxystrobin + propiconazole (QUILT) or boscalid + pyraclostrobin (PRISTENE), in the presence and absence of H. azteca (7-d old) for 14 d at 23 °C. Dry maple leaves were pre-leached in chlorinated tap water ('unconditioned') and served as positive controls. After 14 d, QUILT at 3 concentrations (~ 0.3, 1.8, 8 µg/L azoxystrobin + propiconazole) did not affect amphipod growth, but PRISTENE (~ 33 µg/L boscalid + pyraclostrobin) reduced amphipod growth relative to controls. Neither formulation affected microbial respiration (an indirect measure of microbial biomass) or leaf decomposition. Microbial respiration and amphipod growth rate were significantly reduced in beakers containing unconditioned leaves relative to stream-conditioned leaves, indicating that low microbial biomass adversely affects amphipods and leaf respiration. At the concentrations tested, and in the absence of other stressors, QUILT (~0.3 to 8 µg/L) is not likely to affect leaf decomposition, but PRISTENE (~33 µg/L) may affect stream macroinvertebrates, with potential repercussions for leaf decay.

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Poster Session

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Water Quality & Statistics-Based Precautionary Advisory Tool for York, Maine Beaches

This study was conducted to develop a management tool for the Town of York, based on enterococci and other environmental and climatic parameters, that allows for posting precautionary advisories at the beaches during conditions known to cause bacterial concentrations to exceed 104 enterococci/100ml, the State of Maine's suggested Beach Action Value (BAV). Water samples were collected on 51 sampling days between July and September, 2014 and analyzed for enterococci concentrations. The geometric means of samples taken at storm drains, marsh drains, and some sites in the Cape Neddick River and its freshwater tributaries were all well above the BAV. In contrast, the geometric means of beach stations were all below 20 MPN/100ml. Enterococci from two drain stations did appear to influence downstream beach water quality. A Generalized Linear Model indicates that rainfall amount, salinity and tidal height may be significant factors affecting enterococci concentrations. Seaweeds were a significant, episodic non-fecal source of bacteria in the beach water. A rainfall threshold of 1.5" rainfall in 24 hours or 48 hours could be a useful basis for a precautionary advisory at York beaches. The advisory would be in effect for a minimum of two tidal cycles to allow for bacterial levels to be reduced due to physical mixing, dilution and transport from beaches. The difference between these finding and those of the Maine Healthy Beaches Program (1 inch in 24 h) are probably due to the nature of the rainfall events that occurred during 2014, compared to data they use from 2008-13.

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Effect of Regional Bedrock Fracture Orientation on Road Salt Hydrologic Conductivity: Analysis of Optimal and Sub-optimal Geometries

The purpose of this work is to continue analysis of the hydrologic behavior of road salt. Past work has indicated a strong bias in chloride sampling results in residential wells (DOT data) downslope and proximal upslope from the road where salt is seeded in the winter months. In addition prior analysis has shown that with fracture orientation in bedrock, if steep in dip and with an optimal strike direction, further enhances the conductivity of the salt solute. It has been noted that where the regional steep fracture orientation is near perpendicular to the road and parallel to the well to road slope angle, the downslope and proximal upslope chloride lab results were approximately 16 percent (slightly less than optimal orientation) to 140 percent (optimal orientation) higher for that subgroup relative to the mean lab results for the entire well population on a particular stretch of road. By dividing the normalized cumulative chloride mean percent into optimal and sub-optimal geometries relative to the regional fracture orientations, it appears that the optimal geometry provides most of the cross road and downslope transport of road salt.

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Poster Session

Tracking Changes in Maine's Water Classification Program: Following Forty Years of Water Classification in Maine Rivers

Passage of Maine's Water Classification Law of 1965 marked Maine as one of the first states in the nation to establish a tiered classification system to express water quality goals. Classification levels ranged from the lowest water quality classification level requiring no water quality improvements (class D), to the highest water quality classification level (class A). The 1987 Water Classification Act revised this earlier act by requiring that all water bodies meet the 1972 federal Clean Water Act at a minimum and by introducing new biological assessment criteria. Currently, 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. Until recently, the only record of reclassification was captured in legislative enactments associated with the reclassification process. This poster provides the first synthesis of changes in tributary and main stem classifications along river systems throughout Maine prior to passage of the CWA to the present. 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 40 years and provides a visual display of progress achieved to date. Spatial analysis of the reclassification process also provides the first opportunity to quantify differences across watersheds. The results show distinct differences in progress achieved among Maine's river systems.

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A Communication Systems Framework for Sustainability Science

Sustainability challenges require innovative approaches to link science with policy action. Our work addresses the problem of strengthening the scientific basis for decision making within the New England Sustainability Consortium (NEST), a National Science Foundation project to create a regional sustainability science network among the University of Maine, University of New Hampshire, and a host of other academic, governmental, and non-governmental institutions. Our Safe Beaches and Shellfish Project intends to understand and improve the science used in decision making about beach and shellfish management at municipal and state scales in Maine and New Hampshire. In this poster, we describe the development and application of a communication systems framework within NEST's Safe Beaches and Shellfish Project. We share results from ongoing participant observations, a survey (n=29), and interviews with faculty, students, and stakeholders (n=39) that helped identify and assess how structures and processes shaped specific outcomes related to linking science with policy decision making. In terms of structures, the definition of and institutions involved in determining "safe" levels of bacteria are not uniform across stakeholder groups. The differences in framing influence problem definition and how power shapes decision making. For processes, participants described the importance of meeting face-to-face for learning about one another, demonstrating a commitment to the project, and promoting creativity in the research design process. We provide specific recommendations for how these and other structure and process features may help guide sustainability science efforts to solve complex sustainability problems.

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Update on a Continuing Saga: Eelgrass and Green Crabs in Casco Bay, Maine

In 2012-2013 there were dramatic losses of eelgrass (*Zostera marina*) from Casco Bay, ME: mapping from 2013 aerial photographs revealed a 56% loss of coverage since 2002, largely from the upper bay. Bioturbation by invasive European green crabs (*Carcinus maenas*) was identified as a primary cause. Because of the importance of this habitat to the region's ecology and economy, a broad partnership formed in 2014 to investigate whether eelgrass loss was continuing and factors that may exacerbate or mitigate green-crab damage. We targeted four study sites with persistent eelgrass cover along a bay-axis gradient. At each site we: (1) mapped eelgrass by low-altitude aerial photography and groundtruthing to quantify large-scale changes in coverage since 2013; (2) measured eelgrass population characteristics within quadrats along fixed transects to quantify small-scale changes; and (3) measured green crab abundance, water-column light attenuation, sediment texture, and sediment organic matter as potential drivers of eelgrass changes. Mapping data showed a reduction in percent cover of eelgrass (i.e., a decrease in density of eelgrass patches) at all sites from 2013 to 2014; at one site this was coupled with an overall loss in eelgrass area. Eelgrass quadrat measurements suggested that changes in shoot density from June to September corresponded negatively to both crab abundance and the proportion of very coarse particles (> 2mm) in the sediment. At measured values, water clarity would not appear to limit shallow eelgrass production. Results suggest independent or interactive effects of green-crab bioturbation and sediment texture on eelgrass persistence in Casco Bay.

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Data Management and Lifecycle Strategies for Environmental Sciences

A recent review of scientific data management strategies among research entities reveals a wide array of archival and distribution methods and diverse data structures. For troves of environmental and water quality data, the issues of temporal and spatial resolution and specificity of analytical methods limit the usefulness of a traditional database. Metadata structures, semantics, and syntax are domain or project specific, vary greatly in precision (spatially, temporally and analytically), and are thus rendered incomparable between projects, institutions, or even over time. In order to increase the scope and reach of current and legacy research, new methods of turning data into information are needed. Access to useable data management tools that do not require specialized expertise can expand the data lifecycle beyond "publish and forget," facilitating disparate data integration, dissemination and comparison for environmental monitoring. This review collates novel techniques that bridge the gap between informatics science and field/laboratory sciences, and discusses the applicability of established methods for Maine's legacy mercury data.

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Coupling Streamflow, Simulated with Lumped Parameter Models, to a Lake Water-balance Model (Sebago Lake, Maine)

Surface water within the Sebago Lake watershed provide a variety of economically and intrinsically valuable recreational, commercial and environmental services. Different groups for Sebago Lake and its surrounding watershed advocate for different lake and watershed management strategies. While lake level in Sebago Lake has been monitored for over a century, limited data is available on the processes that drive lake level and therefore impact how change within the watershed will influence the hydroperiod of the lake. To fill this information gap we have deployed data logging pressure transducers to monitor stream stage in nine tributaries, measured stream discharge at these sites to create rating curves, and developed a lumped parameter computer model, based on the GR4J model modified to include a degree-day snowmelt routine. Lumped parameter models for Sebago Lakes tributaries have been integrated with a lake water-balance model to estimate lake level. About three years of stream stage data have been used to estimate stream discharge in all monitored tributaries. The watershed model has been calibrated for four streams (Nash-Sutcliffe = 0.4 to 0.9). Other major tributaries containing hydraulic structures were not simulated. Calibrated watershed models tend to substantially underestimate the highest streamflows while overestimating low flows. An early June 2012 event cause extremely high flows with discharge in the Crooked River (the most significant tributary) peaking at about 85 m^3/day. The lumped parameter model dramatically underestimated this important and anomalous event, but provided a reasonable prediction of flows throughout the rest of 2012.

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Design and Implementation of Strategies for Stakeholders and Policymakers in the Northeast on Ocean and Coastal Acidification

Public awareness of and concern about ocean acidification (OA) is growing while the scientific understanding of these processes is still forming. Complicating the trend in global OA caused by the general increase in atmospheric carbon dioxide is the modulated acidification of coastal areas influenced by freshwater runoff, nutrient delivery and other climatic trends, including changes in ocean circulation patterns. Moreover, larval stages of commercially important shellfish have been shown to be most vulnerable to the availability of calcium carbonate, which is impacted by OA. Communicating these interacting stresses, their effects on ocean and coastal acidification, and the impacts to coastal resources is complex and challenging, due to the relative scarcity of studies on coastal acidification, the incomplete understanding of the impacts of OA on biologically and economically important marine organisms, and the communication gap between scientists and stakeholders. The Northeast Coastal Acidification Network (NECAN) is a collaboration of representatives from academic institutions, state and federal agencies and

industry that seeks to provide relevant information about ocean and coastal acidification to stakeholders in the Gulf of Maine, Long Island Sound, and the Canadian Maritime Provinces. Communication methods to-date include a series of 16 webinars, a state-of-the-science workshop and resultant publications, web-based translation materials, and face-to-face interactive workshops between scientists, policy-makers, and the stakeholder community. This poster will describe NECAN and the strategies utilized to fill the communication gaps between amongst groups of people; leading to an implementation strategy for policy, research, monitoring, and outreach methods.

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Citizen Science Phenology and Ecosystem Sustainability

Search for information on climate change in a region and one is often inundated by a range of dire predictions. In the Northeast, the climate over the next fifty years is expected to become warmer and wetter. This will have significant effects on ecosystem stability and sustainable management practices, impacting the people who rely on these local ecosystems. UMaine Extension and the Maine Sea Grant Program launched SOS in 2010 in collaboration with climate scientists, state and federal agencies, and numerous nonprofit education and conservation organizations to engage people in a positive outlet for involvement, and improve understanding of the local effects of global climate change. SOS provides instruction and support for data collection at local sites. Citizen scientists observe the timing of life cycle events (phenology) for indicator species common to the region, and record their observations in the National Phenology Network's online database. Participants increase their climate literacy while compiling meaningful phenology data that regional scientists and resource managers need to improve local, state, and regional climate adaptation planning. Observational data can increase understanding and improvement in the decision-making process, benefitting individuals and communities. SOS participants in Maine and New Hampshire are already providing far more data specific to our region than scientists could collect by themselves, and participants report increased awareness of climate-related changes and more confidence in their discussions with others about climate change.

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Monitoring for Winter Chloride Levels in Maine's Streams with Student Power

The extent and magnitude of chloride contamination in Maine streams is difficult to assess because streams are numerous, and maximum chloride concentrations occur during winter months when samplers are rarely in the field. In this poster, we outline research at the University of Southern Maine by 31 students enrolled in ESP 360 "Water Quality and Control" focused on winter water quality conditions in 10 urban and suburban streams and small rivers in the greater Portland area. We outline study design, sampling protocols and preliminary results, and share "teachable moments" that arise when studying chloride contamination of natural waters during cold winter months. We conclude that students can conduct meaningful winter monitoring of urban and suburban streams for municipalities and other entities charged with protecting natural waters, and that this effort could easily extend to high school environmental science classes and other groups interested in overwinter conditions of streams.

Poster Session

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What Happens After Large Scale River Restoration? Monitoring the Penobscot River Restoration Project

Cumulative effects of dams pose known adverse impacts to the recovery of sea-run fish populations. The Penobscot River Restoration Project, an unprecedented collaboration of the Penobscot Indian Nation, seven conservation groups, hydropower companies, and state, federal, and tribal resource agencies, restores access to sea-run fisheries habitat through a combination of dam removal, fish passage improvements and reconfigured hydro operations. This ecosystem-focused effort addresses the full assemblage of 11 native fish species by strategically removing selected dams and improving fish passage at others; vastly improving habitat connectivity while maintaining energy production. After reaching significant restoration milestones including removal of Great Works Dam (2012) and Veazie Dam (2013), improved passage at Milford (2014), and the construction of a fish-bypass at Howland (slated to be complete in 2015), effects are visible. River herring counts are one example; with the help of Agency stocking efforts, over 300,000 individuals were counted post dam removal in 2014 at Milford fish lift and Blackman Stream. Baseline monitoring of biotic and abiotic river conditions began in 2009 "pre dam removal" and the "post dam removal" phase of monitoring, funded primarily by NOAA, has begun. This noteworthy program, comprehensive in scale and scope, aims to provide detailed information on how Penobscot River and Gulf of Maine ecosystems respond to large scale river restoration. We present a summary of activities, current findings and observations, and future research aims for 9 priority studies focused in geomorphology, water quality, fish community, fish passage, fish migration and habitat use, wetlands and marine nutrients.

Notes