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MAINE WATER (& SUSTAINABILITY) 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.

Conference Agenda

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

8:30AM Morning Concurrent Sessions

Session C: Impacts of Water Withdrawals on Groundwater and Surface Water *(Howard Rm)*

Session D: Lake Management Strategies *(Fort Western Rm)*

Session E: Collaborative Research and Engagement *(Cumberland Rm)*

Session F: Sustainability and the Humanities *(Kennebec Rm)*

Session G: Maine's Energy Future *(Penobscot Rm)*

Session H: Safe Beaches and Shellfish Beds *(Arnold Rm)*

Session I: Management Approaches for Sustainable Urban Streams *(Washington/York Rm)*

10:00AM Morning Break and Poster Session — Auditorium

11:00AM Plenary Session — Auditorium

12:30PM Lunch — Auditorium

1:30PM Afternoon Concurrent Sessions

Session A: Climate-Related Trends and Maine's Water Resources *(Fort Western Rm)*

Session B: Continuous Data Monitoring:Opportunities & Challenges *(Sagadahoc/Piscataquis Rm)*

Session C: Impacts of Water Withdrawals on Ground & Surface Water *(Howard Rm)*

Session E: Collaborative Research and Engagement *(Cumberland Rm)*

Session G: Maine's Energy Future *(Penobscot Rm)*

Session H: Safe Beaches and Shellfish Beds *(Arnold Rm)*

Session I: Management Approaches for Sustainable Urban Streams *(Washington/York Rm)*

Session J: Managing the Boundary Between Science and Decision-Making *(Kennebec Rm)*

2:30PM Afternoon Break — Auditorium

3:00PM Afternoon Concurrent Sessions (cont.)

4:00PM Conference Close

Plenary Session

11:00AM WELCOME & INTRODUCTION

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

David Hart is director of the Senator George J. Mitchell Center 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.

11:05AM ROBERT KATES

Presidential Professor of Sustainability Science, University of Maine

SUSTAINABILITY SCIENCE: MOVING KNOWLEDGE INTO ACTION

Robert Kates is a Senior Research Associate at Harvard, Presidential Professor of Sustainability Science at the University of Maine, and University Professor (Emeritus) at Brown University. Trained as a geographer, he has led interdisciplinary programs addressing hazards, water resources, climate, and adaptation at the University of Dar as Salaam in Tanzania, Clark University, and the World Hunger Program at Brown University. He currently chairs the Advisory Board for the Sustainability Solutions Initiative (SSI) at the University of Maine. His most recent research is on reconstruction following hurricane Katrina (2006), on transformational adaptation to climate change (2012), and his current research is on Climate Change and Culvert Vulnerability in the Northeastern United States. Dr. Kates is a member of the National Academy of Sciences and an awardee of the National Medal of Science.

11:45AM MARK BORSUK

Associate Professor, Thayer School of Engineering at Dartmouth

GAMBLING WITH THE GLOBE:
THE ROLE OF RISK IN DECISION-MAKING FOR SUSTAINABILITY

Mark Borsuk is an interdisciplinary instructor and researcher spanning the fields of engineering, economics, environmental modeling, and decision science. His current work is focused on climate change impacts, human and aquatic ecosystem interactions, gene-environment interactions, and risk communication and behavior. He is the recipient of the 2013 Distinguished Young Risk Analyst Award given by the Society of Risk Analysis and the Early Career Research Excellence Award of the International Environmental Modelling & Software Society.

12:20PM POSTER AWARD PRESENTATIONS

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

12:30PM LUNCH

Session A

Past, Present, and Future Climate-Related Trends and Maine's Freshwater, Estuarine, and Coastal Resources

How is climate change affecting – or projected to affect – Maine's freshwater, estuarine, and coastal resources and what new tools, methods, and data are available to help analyze changes? This session will cover hydrologic and ecological studies of climate-related patterns, trends, and projections for Maine, or regional studies that include Maine.

SESSION CHAIRS

Glen Hodgkins

U.S. Geological Survey, New England Water Science Center; gahodgki@usgs.gov

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

Robert Dudley

U.S. Geological Survey, New England Water Science Center, rwdudley@usgs.gov

Robert Dudley has worked with the USGS since 1992, and has served as a hydrologist since 1998 during which he has led or been involved in a variety of geophysical, hydrologic, hydraulic, and statistical modeling studies encompassing climate-related hydrologic trends, eco-hydrologic assessments, stormwater-runoff quality and quantity, riverine sediment mapping, geomorphology, and public-water-supply water budgets. Rob is a licensed professional engineer in the State of Maine and received a B.S. in Mechanical Engineering (1994) and M.S. in Civil and Environmental Engineering (1998) from the University of Maine.

Session A - Climated Related Trends and Maine's Water Resources

1:30PM – 1:55PM

Mathias J. Collins[1], Johnathan P. Kirk[2], Joshua Pettit[3], Arthur T. DeGaetano[4], M. Sam McCown[5], Thomas C. Peterson[5], Tiffany N. Means[6], and Xuebin Zhang[7]

1 National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Gloucester, MA; mathias.collins@noaa.gov

2 Department of Geography, Kent State University, Kent, OH

3 Department of Atmospheric and Oceanic Sciences, University of Colorado at Boulder, Boulder, CO

4 Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, NY

5 National Climatic Data Center, National Oceanic and Atmospheric Administration, Asheville, NC

6 The Baldwin Group, Inc., Asheville, NC

7 Climate Research Division, Environment Canada, Toronto, Ontario, Canada

SYNOPTIC CLIMATOLOGY AND GENERATING MECHANISMS OF ANNUAL FLOODS IN NEW ENGLAND AND ATLANTIC CANADA

New England and Atlantic Canada are characterized by mixed flood regimes that reflect different storm types, antecedent land surface conditions, and flood seasonality. Mixed flood regimes can complicate flood risk analyses, yet the synoptic climatology and precipitation mechanisms that generate annual floods in this region have not been described in detail. We analyze long-term annual flood records at climate-sensitive stream gauges across the region and classify the synoptic climatology of each annual flood, quantitatively describe the precipitation mechanisms, and characterize flood seasonality. We find that annual floods here are primarily generated by Great Lakes-sourced storms and Coastal lows, known locally as "nor'easters". Great Lakes storms tend to produce lower-magnitude annual floods (75th percentile). Tropical cyclones account for few of all annual floods, including extreme events, despite causing some of the region's largest and most destructive floods. Late winter-early spring is when the greatest number of annual floods occurs region-wide, and rainfall is the dominant flood-producing mechanism. Rainfall in combination with snowmelt is also important. Both mechanisms are expected to be impacted by projected regional climate change. We find little evidence for associations between flood-producing synoptic storm types or precipitation mechanisms and large-scale atmospheric circulation indices or time periods, despite increases in annual flood magnitudes in New England in recent decades. To better investigate such associations, flood series that include more floods than just the largest of each year, and their associated synoptic climatologies and precipitation mechanisms, should be analyzed.

2:00PM – 2:25PM

Michael Simpson[1], Latham Stack[2], Trisha Moore[3], Robert Roseen[4], James Gruber[1]

1 Antioch University New England, Environmental Studies Dept., Keene, NH; msimpson@antioch.edu

2 Syntectic International, LLC, Portland, OR

3 University of Minnesota, St. Anthony Falls Laboratory, Minneapolis, MN

4 University of New Hampshire, Durham, NH

5 Antioch University New England, Environmental Studies Dept., Keene, NH

VULNERABILITY OF WATER CONVEYANCE INFRASTRUCTURE DUE TO CHANGING LANDSCAPE WITHIN THE CONTEXT OF A CHANGING CLIMATE

Results will be presented from NOAA and U.S. EPA funded research from 2007 thru 2013, in the context of rural, the peri-urban and urban watersheds in New England and the upper Midwest. This research examined the hydrologic impact of climate change and land use scenarios on existing water conveyance infrastructure. The built infrastructure in the watersheds were assessed and mapped with a standardized protocol. Field and spatial data was then utilized to create a nested GIS model that calculates current and projected runoff volumes for the 24-hour precipitation events. Based on current zoning ordinance regulations, multiple build-out analyses were developed for the study watersheds. These build-out scenarios were combined with estimated, mid-21st century storm magnitudes based upon downscaled global greenhouse gas emission scenarios. Once vulnerable infrastructure was identified, a marginal cost analysis was completed for alternative actions of response. The technical outputs of these studies informed concurrent community resilience building processes that increased stakeholder capacity at the local level in adapting to change. The studies' approach demonstrates the implementation of a quantified, local-scale, and actionable protocol for maintaining historical risk levels for communities facing significant impacts from climate change and population growth.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Rachael E., Dye[1], **Peter A. Slovinsky[2], Christian H. Halsted[3]**, Joseph Young[4]

1 Maine Geological Survey, Department of Agriculture, Conservation and Forestry, Augusta, ME

2 Maine Geological Survey, Department of Agriculture, Conservation and Forestry, Augusta, ME; peter.a.slovinsky@maine.gov

3 Earth Resources Information, Maine Geological Survey, Department of Agriculture, Conservation and Forestry, Augusta, ME; christian.h.halsted@maine.gov

4 Maine Geolibrary, Augusta, ME; previously with the Office of Floodplain Management, Department of Agriculture, Conservation and Forestry

USING GIS TO BRING SUPERSTORM SANDY TO MAINE: UPDATING MAINE'S HURRICANE SURGE MAPS

In 2006, the U.S. Army Corps of Engineers created hurricane surge maps for the Maine coastline to aid emergency management planning efforts. This dataset was created using outputs from the National Hurricane Center's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model along with best-available topographic data, which at the time had a 10-m cell size and an approximate vertical accuracy of 2.44 m RMSE. Since then, the SLOSH model basin was updated by the NHC to provide higher resolution grids of potential storm surge heights associated with landfalling hurricanes. The entire Maine coastline has also been mapped using Light Detection and Ranging (LiDAR) in a series of flights, and a bare earth digital elevation model (DEM) with 2-m cell size and a vertical accuracy of 0.15m RMSE created. The Maine Geological Survey, in partnership with the Floodplain Management Office and funding from the Federal Emergency Management Agency, used these datasets to create updated hurricane

surge maps for Category 1 and 2 hurricanes making landfall at mean and mean high tide. An ArcGIS 10.1 script tool was created to analyze the data and create output GIS layers. Outputs include the spatial extent of inundation, SLOSH model error bands, and potential inundation depths. These datasets are being shared with the emergency management planning communities at the local, regional, and state levels to help prepare for the "what if" scenario of a hurricane landfall in Maine.

3:30PM – 3:55PM

Kristin R. Wilson[1], Joseph T. Kelley[2], Daniel F. Belknap[2]
1 Wells National Estuarine Research Reserve, Wells, ME; kwilson@wellsnerr.org
2 School of Earth and Climate Sciences, University of Maine, Orono, ME

ARE MAINE MARSHES LOSING AREA WITH ACCELERATED SEA-LEVEL RISE?

Coastal wetlands are vulnerable to climate change, most directly through losses related to sea-level rise. Recent estimates predict an acceleration in this sea-level rise-associated loss during the current century, with 20-45% of tidal wetlands converting to open water. Previous work notes ponding as a precursor to marsh loss and that loss patterns are spatially explicit. Despite this, studies have been geographically concentrated in mostly three areas: Gulf Coast, Chesapeake Bay, and Venice Lagoon. This study combines field ecophysical surveys, multivariate analyses, and photographic time-series analyses to characterize 421 pools from five salt marshes to describe patterns of surficial marsh change in Maine. Study results reveal four pool clusters, with subsurface morphology being the greatest driver of differences between pool types. Analyses of aerial photographs reveal slight to moderate increases in the amount of total pool area in all salt marshes, mostly through the addition of small pools and through the growth of large pools in interior marsh sections and along the upland marsh border. Analyses of individual pool changes indicate that pools are highly dynamic over decadal time periods. Overall, Maine marshes do not appear to be transitioning to open-water states over the rapid time-scales observed in other areas; rather, they appear to be in a state of dynamic equilibrium, which includes generation, evolution and revegetation of pools.

Session B

Continuous Data Monitoring: Opportunities and Challenges

As technology advances, so does the sophistication of water monitoring devices. 'Snapshot' approaches to monitoring are being replaced by continuous or near-continuous monitoring possibilities. Papers submitted for this session highlight devices being used in lakes, collaborations with lake associations to establish continuous monitoring stations, insights continuous data have revealed, and challenges involved with this approach. The final slot will be a panel discussion including the speakers, others having similar monitoring experience, and the audience focusing on the challenges of managing and analyzing extremely large datasets and cost-benefit of moving to the collection of continuous data.

SESSION CHAIR

Linda Bacon
Maine Department of Environmental Protection, Augusta, ME; Linda.C.Bacon@maine.gov

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

Session B - Continuous Data Monitoring Opportunities & Challenges

1:30PM – 1:55PM

Dan Buckley
Division of Natural Sciences, University of Maine at Farmington, Farmington, ME; Buckley@maine.edu

UNDERSTANDING INTRA-LAKE TEMPERATURE VARIABILITY AND HEAT FLUX; HOW TECHNOLOGY IS CHANGING WHAT WE OBSERVE AND UNDERSTAND

In the thirty years prior to the current millennium, the vast majority of lake temperature data collected by working professionals or citizen scientists was in the form of point-in-time measurements associated with either dissolved oxygen profiles or possibly surface water temperatures using min/max thermometers. While this type of data collected by early limnologists such as Birge and Juday (1929) and later Hutchinson (1957) was the foundation of our understanding of lake thermal stratification and seasonal temperature patterns, the relative paucity of data from such techniques has led to an incomplete picture of lake thermal dynamics. The comparatively recent advent of inexpensive logging thermistors such as Hobo Pendent Data Loggers has allowed us to examine daily, seasonal and long-term variability in lake temperatures in a way never before possible. The near continuous nuanced data supplied by this technology has provided surprises and increased understanding of temperature fluctuations within lakes along with some of the factors influencing them. Data and some preliminary analyses will be presented on seasonal lake thermal response and temperature variability, in response to meteorological factors, logger position and lake characteristics for several Maine lakes.

2:00PM – 2:25PM

D. Whitney King[1], Denise Bruesewitz[2]
1 Department of Chemistry, Colby College, Waterville, ME; dwking@colby.edu
2 Environmental Studies Program, Colby College, Waterville, ME

“GOLDIE” THE GREAT POND SENTINEL. USING AN AUTOMATED SAMPLING BUOY TO MONITOR WATER QUALITY OF GREAT POND

In April 2013 we deployed the automated sampling buoy, “Goldie”, in the deepest point of Great Pond, Belgrade Lakes, Maine. Built by Nexsens Technology, the buoy is a highly capable platform for limnology research; equipped with a suite of sensors for measuring water temperature, PAR, dissolved oxygen concentration (surface and bottom), and fluorescence. The buoy is powered by 15-watt solar panels and communicates to our labs at Colby using a dedicated cell phone.

We will discuss the buoy design process, costs, operation logistics, and lessons learned from over 150 days of continuous monitoring of Great Pond. The data collected on Great Pond is available to a worldwide community of lake researchers as part of the Global Lake Ecological Observatory Network (GLEON.org) and is streamed live to local stakeholders at web.colby.edu/lakes. Real time data increases stakeholder visits to our web pages. We are actively working with lake residents to determine what display formats on the live feeds are most helpful in communicating the geology, chemistry, and biology of the lake and how lake BioGeoChemistry defines lake water quality.

Session B: Continuous Data Monitoring Opportunities & Challenges

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Denise Bruesewitz[1], Cayelan Carey[2], David Richardson[3], Kathie Weathers[4]
1 Environmental Studies Program, Colby College, Waterville, ME; dabruese@colby.edu
2 Department of Biological Sciences, Virgina Tech, Blacksburg, VA
3 Department of Biological Sciences, SUNY New Paltz, New Paltz, NY
4 Cary Institute, Millbrook, NY

LAKE SUNAPEE ON ICE: LESSONS FROM COUPLING CITIZEN SCIENCE AND HIGH-FREQUENCY BUOY DATA

Temperate lakes all over the globe have documented declines in seasonal ice cover, including Lake Sunapee, New Hampshire. A long-term citizen science monitoring record starting in 1869 shows that ice cover in Lake Sunapee is declining ($R2=0.15$, $p<0.001$). Lake Sunapee Protective Association (LSPA) built, deployed and continues to maintain a high-frequency monitoring buoy on Lake Sunapee. During the 2007-2008 winter, the buoy was frozen into the water, capturing under ice dynamics including both the ice on and ice off transitions. We collected temperature data from 10 nodes throughout the 15m water column to examine changes in lake thermal profiles and stability. This unique dataset shows that large lakes are dynamic under the ice, with three distinct phases of under ice dynamics characterized by differences in Schmidt's stability, temperature profiles, and different scales of variation. Additionally, this analysis shows that 'ice on' and 'ice off' do not occur on the scale of a day, rather these events occur over a period of several weeks. This unique dataset could not have been collected without the interest and commitment of local citizen scientists. Characterizing under ice dynamics is critical to understanding how declining periods of ice cover may influence lake ecosystems.

3:30PM – 3:55PM

Panel Discussion

Jasmine Saros
Climate Change Institute, University of Maine, Orono, ME

Holly Ewing
Bates College, Bowdoinham, ME

Whitney King
Colby College, Waterville, ME

Dan Buckley
University of Maine Farmington, Farmington, ME

Denise Brueswitz
Colby College, Waterville, ME

Session C

Impacts of Water Withdrawals on Groundwater and Surface Water Supply and Quality

Maine is often thought of as a water-rich state. Are water withdrawals from groundwater aquifers and surface water sources just a drop in the bucket, or are they a substantial part of Maine's water stores? In addition to reports on the status of water withdrawals in Maine and the region, this session will focus on relevant regulations and emerging issues that are likely to affect the future of water withdrawals.

SESSION CHAIR:

Dan Locke

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

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

8:30AM – 8:55AM

Andrews L. Tolman[1], Michael D. Abbott[2]

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

2 Maine CDC Drinking Water Program, Augusta, ME; Michael.Abbott@maine.gov

COMMUNITY WATER SYSTEMS AND CHAPTER 587: MANAGING THE PROTECTION OF IN-STREAM FLOWS AND LAKE AND POND WATER LEVELS

Maine continues to evolve a water policy aimed at providing safe and secure sources of water for human and ecosystem use. While we are a water-rich state, we have areas where real conflicts exist,

particularly along our rocky coast during dry years when the summer population exceeds the short-term supply of water. After more than seven years of negotiation, Maine adopted a set of flow and level rules (Chapter 587) that are co-administered by the Maine DEP, Maine CDC Drinking Water Program, and the Office of Public Advocate. As we implement the rules, we are working to build system capacity through long term source management, interconnection, and source diversity among systems. The Maine Water Utilities Association has developed tools for systems to evaluate options for increasing efficiency, and we believe the logic of cost, energy, and water savings will make mandates unnecessary. The DWP conducted System Design Capacity assessments for fifty surface water systems, in some cases providing technical and/or financial assistance to increase the reliability of water sources and reduce potential for ecosystem impacts. Systems where the resource is at or near the demand threshold are working through the Community Water System Withdrawal Certificate process. We encourage systems to plan for increases in efficiency that make sense for the system, the ratepayers/consumers and the water resource, and will help to cope with the increased variability we see in precipitation and temperature. Each system will need to adapt in a way that reflects the local hydrology, water demand, and politics.

9:00AM – 9:25AM

Martha G. Nielsen[1] and Daniel B. Locke[2]
1 U.S. Geological Survey, Augusta, ME; mnielsen@usgs.gov
2 Maine Geological Survey, Augusta, ME

GROUNDWATER MODELING OF STREAMFLOW DEPLETION AND FLOWS BETWEEN WATERSHEDS IN THE BRANCH BROOK AREA

The effect of groundwater withdrawals on streamflows and inter-basin groundwater flow in unconsolidated deposits in southern coastal Maine was assessed by a cooperative study between the U.S. Geological Survey and the Maine Geological Survey. A MODFLOW groundwater model was constructed for the Branch Brook and Merriland River watersheds and adjacent parts of the Mousam River watershed in the towns of Sanford, Wells, and Kennebunk. Calibration of the model was completed using groundwater level measurements at 150 wells and streamflows measured at 13 locations within the model area. Withdrawals from municipal wells in the headwaters of the watersheds and near the coast were determined to influence natural stream flows by about 11-18 percent in small headwater streams and by about 5-6 percent in Branch Brook and the Merriland River near the coast. Groundwater flows between watersheds defined by surface features accounted for about 15-20 percent of the total water budgets for the watersheds under pumping conditions and for about 10 percent under unstressed conditions. This indicates that the groundwater divides do not fully correspond with the surface-water divides and that there is natural groundwater transfer between watersheds, which is enhanced by the groundwater withdrawals in the study area.

Session C: Impacts of Water Withdrawals on Ground & Surface Water

9:30AM – 9:55AM

Mark Dubois
Poland Spring Water Company/NWNA, Poland Spring, ME; mark.dubois@waters.nestle.com

MANAGING FOR SUSTAINABILITY: SPRING SITE EXAMPLES FROM KINGFIELD AND HOLLIS, MAINE

Poland Spring began bottling Maine spring water in 1845. Only Maine spring water sources produce Poland Spring, the most popular brand of spring water in the United States, distributed primarily in the Northeast. Our newest factory in Kingfield began production in 2009. The Hollis factory starting producing water in 2000 – it is the largest spring water bottling facility in North America and the second largest in the world. Long term sustainability is key to Poland Spring and its parent company Nestle Waters. Only stable water level trends can ensure the protection required of our spring locations. The resource protection and viability of spring water in Maine has led to over 500 million dollars of in-state investment and ~800 jobs for Mainers. Poland Spring manages spring water sources for sustainability by monitoring hundreds of surface and groundwater stations each month at our nine locations in Maine. This presentation covers examples of long-term monitoring methods and trends from two spring sites in Kingfield and Hollis, Maine. The Federal Food and Drug Administration standards for bottled water product also specifically state that the maintenance of spring flow conditions must exist even under a pumping condition of nearby sources, or boreholes. In Maine, the Drinking Water Program oversees compliance for spring water following the applicable provisions of the Code of Federal Regulations. Federal requirements for spring water flow and labeling overlap state permit conditions requiring monitoring, maintenance and reporting of stream flow and groundwater levels. Spring sites represent overflowing aquifer conditions. These overflowing conditions occur in discharge zones that feed surface water to area streams. Poland Spring is required to maintain compliance with stream flow criteria and other permit conditions that date back to the issuance of permits for all of our spring and factory locations.

1:30PM – 1:55PM

Rick Pershken
Bangor Water District, Bangor, ME; rick@bangorwater.org

THE SUSTAINABILITY OF FLOODS POND – BANGOR WATER DISTRICT'S PUBLIC WATER SUPPLY

This presentation includes a brief history of the Bangor Water District and the decision made in the 1950's to change its source of supply from the Penobscot River to Floods Pond in Otis. The use of water in Bangor is discussed, including residential per capita consumption data, commercial uses, and estimates of unaccounted for water. The method for deriving the estimated safe yield of Floods Pond is explained, and historical data showing water usage, rainfall, water levels, and other parameters used to monitor the water budget will be included. The presentation concludes with an overview of watershed protection as the sustainable quality of Bangor's upland water source is as important as its sustainable yield.

Session C: Impacts of Water Withdrawals on Ground & Surface Water

2:00PM — 2:25PM

Albert Hodsdon
AE Hodsdon Engineering, Inc., Waterville, ME; al@aehodsdon.com

THE HYDROGEOLOGIC EVALUATION OF THE TOMAH AQUIFER FOR A SOURCE OF BOTTLED SPRING WATER, INDIAN TOWNSHIP, MAINE

The Passamaquoddy Tribe is evaluating the sand and gravel aquifers on their lands in Indian Township for a source of water for a new spring water bottling facility. This presentation will cover preliminary testing of the Tomah aquifer, areas of recharge and the relationship between groundwater levels and springs along Tomah Stream, long-term safe yield, and water quality. This presentation will also discuss the next steps in the process of developing the site as a source of high quality bottled spring water.

2:30PM — 3:00PM

BREAK — AUDITORIUM

3:00PM — 3:25PM

Daniel Baumert
USDA/Natural Resources Conservation Service, Bangor, ME; dan.baumert@me.usda.gov

ASSISTANCE PROVIDED IN MAINE BY THE USDA NATURAL RESOURCES CONSERVATION SERVICE TO THE AGRICULTURAL COMMUNITY FOR IRRIGATION NEEDS

The Natural Resources Conservation Service (NRCS) in Maine provides technical and financial assistance to the agricultural community for various irrigation needs. NRCS assistance is primarily related to improving irrigation system efficiencies, saving water, and reducing irrigation water withdrawal impacts on aquatic species and habitats of streams and lakes. This assistance is primarily provided through the Environmental Quality Incentives Program (EQIP) and the Agricultural Management Act (AMA). NRCS helps private landowners in the planning, design, and installation of systems ranging from large center pivot sprinklers to small micro/drip emitters. Water source development such as irrigation ponds and reservoirs replacing existing surface water sources is also done through the NRCS EQIP and AMA programs. This presentation will summarize the various irrigation related assistance NRCS provides to the agricultural community in Maine.

Session C: Impacts of Water Withdrawals on Ground & Surface Water

3:30PM — 3:55PM

Bryan Pullen
Summit Spring Water, Inc., Harrison, ME; bryan@summitspring.com

SUMMIT SPRING: PAST, PRESENT & FUTURE

This talk will focus on the agricultural nature of Summit Spring including how water has been gathered from this centuries old free-flowing spring and the general history of the source. The difference between the historic definition of spring water and its current interpretation (since 2000) will be discussed as well as the difference between Summit Spring and most other springs in the world.

Session D

Lake Management Strategies

Maine's lakes are subject to many point source, non-point source, and habitat stressors. Management techniques and regulatory guidelines have been used to meet the challenges of managing for these issues. Some management strategies have been used for decades, and others are emerging with new research. What are the challenges for lake management, and how do we assess the success of management strategies, new and old?

SESSION CHAIR:

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

Colin Holme is the assistant director of the Lakes Environmental Association (LEA). He has implemented and overseen LEA's 38 lake, comprehensive water testing program for 15 years. He runs LEA's Clean Lake Check-Up program which helps landowners and contractors correct erosion problems, interpret land-use laws and install conservation practices that benefit water quality. He has worked on over a dozen federal grants to document or correct erosion problems within lake watersheds, several privately funded watershed surveys and helped write and compile Total Maximum Daily Load (TMDL) reports. He has served on the State's phosphorus review work group and regularly reviews water quality provisions for sub-division and commercial projects that come before local planning boards. Colin created and maintains GIS shoreland zoning maps for surrounding towns, regularly works on land-use and natural resources maps and has implemented and overseen GPS photo inventories on 26 lakes. Colin is a graduate of the University of Maine.

Session D: Lake Management Strategies

8:30AM – 8:55AM

Brett Gerard[1] (student), Sean Smith[2], Brian Van Dam[2], and Andrew Reeve[3]

1 School of Earth and Climate Sciences and Sustainability Solutions Initiative, University of Maine, Orono, ME; brett.gerard@maine.edu

2 School of Earth and Climate Sciences and Sustainability Solutions Initiative, University of Maine, Orono, ME

3 School of Earth and Climate Sciences, University of Maine, Orono, ME

PRELIMINARY ANALYSIS OF HUMAN IMPACTS ON SEBAGO LAKE WATERSHED HYDROLOGY

Sebago Lake is Maine's second largest lake and the principal water supply for ~200,000 residents of the greater Portland area. The landscape of its contributing watershed (1,144 km^2) has been shaped by Maine's glacial past and human interventions. Two primary components of the watershed include the Crooked River and rim basin immediately surrounding the lake, both of which are heavily forested. Water quality in the lake is considered exceptional, inspiring exemption of Sebago's water from the filtration requirements typically mandated by the Safe Drinking Water Act. However, projected development and climate change make predictions of future lake conditions uncertain. Accordingly, this project focuses on quantification of human impacts on freshwater flows draining to the lake from the rim basin, which is projected to experience the most substantial land cover changes within the Sebago watershed in the next three decades. We are examining relations between morphometric, hydraulic, and hydrologic conditions created by humans utilizing field measurements, spatial data, planning information, and a distributed watershed model. We have concentrated on a relatively undeveloped, medium sized watershed (~63 km^2) in the northwest portion of the rim basin. Preliminary results indicate unique surface flow trends under varied scenarios of development expansion, dam removal, and drainage network extension. The outcome of the tested scenarios illustrates the vulnerability of the hydrologic system to historic and projected patterns of human intervention. Future work will examine the relations between human-modified flow regimes and the flux of sediment and nutrient into the lake system.

9:00AM – 9:25AM

Maggie Shannon[1], Rebecca Kurtz[2], Catherine Bevier[3], Dave Gay[4], J. S. Kahl[5]

1 Maine Lakes Society, Belgrade Lakes, ME; info@mainelakessociety.org

2 Maine Lakes Society, Belgrade Lakes, ME

3 Department of Biology, Colby College, Waterville, ME

4 Belgrade Lakes Association, Belgrade Lakes, ME

5 James Sewall Company, Old Town, ME

RESTORING THE SHORE: 2013 LAKESMART RESULTS

This presentation will unveil results of LakeSmart during the pilot year of its management by the Maine Lakes Society. It will show the evolution of this incentivized homeowner education and reward program from a fund-limited, state-run effort to a successful and sustainable volunteer-driven lake management program. The presentation will summarize recent revisions to the program based upon its performance from 2004 to 2012; illustrate current training theory and materials and levels of activity and achievement on the 23 lakes that participated in 2013. A close examination of homeowner

demand and lake association response in a mature volunteer-run program will be included as well as LakeSmart/Conservation Corps synergy in communities where the tipping point has been achieved. In addition, new results from a three-year physical and biological assessment of littoral zone differences among undeveloped sites, heavily developed sites, and LakeSmart Award properties on two central Maine lakes where the program has been in effect will be included. The study was conducted by Colby College students under the direction of Catherine Bevier, Biology Department, Colby College, as part of the National Science Foundation funded Sustainability Solutions Initiative, directed by Whitney King, Chemistry Department, Colby College. The presentation will confirm the efficacy of social diffusion theory, the power and potential of volunteer-driven lake protection, and demonstrate the potency of LakeSmart to manage stormwater and protect lake habitat while defining remaining barriers to achieving the desired shift in community norms from suburban to natural property maintenance practices.

9:30AM – 9:55AM

Susan M. Gallo[1], Mark Pokras[2]
1 Maine Audubon, Falmouth, ME; sgallo@maineaudubon.org
2 Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA

THIRTY YEARS OF LOON COUNTING ON MAINE'S LAKES AND PONDS: WHAT WE'VE LEARNED AND CHALLENGES AHEAD

The common loon (*Gavia immer*) is an iconic symbol of Maine's clean water. They are long-lived, reproduce late in life, and have relatively low productivity, making long-term monitoring especially important. For 30 years, the Maine Loon Project at Maine Audubon has engaged thousands of volunteers across the state in an annual loon count to assess the population. Despite being only a brief "snapshot" of where loons are (or are not), the data over time have yielded a wealth of information but the data also represents one of the chronic problems associated with many citizen science initiatives. While we have sustained the count over three decades, much of the data analysis has remained untapped. What we do know is that the adult loon population in Maine has seen a slow and steady increase over the last 30 years, to an estimate of just over 3,000 adults in 2013. At the same time, the number of chicks produced in Maine has remained steady, varying from a low of 140 to just under 600. Causes of mortality have been determined for over 500 dead loons collected by loon counters and others since 1987, and have led to legislation reducing the use and sale of lead tackle in Maine. An aging volunteer base and a need to incorporate new technology into collecting data on loons are challenges we face today. We are looking at ways to engage multi-generations in our citizen science efforts, including a new initiative to educate anglers and distribute non-toxic tackle.

Session E

Collaborative Research and Engagement

This session will focus on talks that discuss collaborative research and stakeholder engagement processes. Collaborative research is research that actively engages communities and policy makers throughout the research process. It may take many forms, such as: participation of citizen scientists, creation of collaborative knowledge networks, construction and use of stakeholder engagement tools, community network engagement and management, model development for stakeholder use, and knowledge to action research.

SESSION CHAIR

Christine Feurt
University of New England, Biddeford ME; cfeurt@une.edu

Chris Feurt is both the Coastal Training Program Coordinator for the Wells National Estuarine Research Reserve and the Director of the Center for Sustainable Communities at the University of New England. Her work in the Gulf of Maine watershed focuses on community based ecosystem management. Chris facilitates the creation of collaborative knowledge networks consisting of local, state, and federal government officials, community based conservation groups, non-profit environmental groups, and university students. These networks facilitate the dissemination of scientific information, the sharing of expertise, and the identification and prioritization of management actions directed at protecting water resources. Chris received her Ph.D. in Environmental Studies from Antioch University, New England.

Session E: Collaborative Research and Engagement

8:30AM – 8:55AM

Judy Colby-George[1], Kathleen P. Bell[2]
1 Ecology and Environmental Sciences, Sustainability Solutions Initiative, School of Economics, University of Maine, Orono, ME; judy.colbygeorge@maine.edu
2 School of Economics, University of Maine, Orono, ME

LEARNING FROM LANDOWNERS TO IMPROVE COLLABORATIVE LAND-USE PLANNING

Collaborative research and engagement processes are commonly employed by communities and other stakeholder organizations to address land-use planning issues. Spatial data, modeling, and visualization tools play a central role in these processes by making complex information accessible. However, many of these tools rely on limited, micro-scale information about landowners and residents. This information gap complicates representation of both baseline and future community conditions. By creating and analyzing spatial data about landowner involvement in and perceptions of recent landscape change, our research advances collaborative land-use planning research and engagement processes. We employ statistical and spatial analyses to evaluate patterns in landowner behavior, attitudes, and perceptions. Employing survey responses from a random sample of landowners from the Portland and Bangor Metropolitan Areas, we describe these patterns over a diverse set of communities and report statistical tests documenting differences across neighborhoods, communities, and metropolitan areas. We compare reported perceptions of different types of community change with measures of actual community change. By doing so, we provide valuable baseline information and identify opportunities and barriers to collaborative land use processes. Our research fills an important gap by documenting landowner variation within communities and along the rural to urban gradient and by emphasizing the spatial distribution of such variation. Linking such information to additional social and biophysical data is critical to support productive discussions, research, learning, and modeling at the community scale.

9:00AM – 9:25AM

Christine Feurt[1], Pam Morgan[2]
1 University of New England, Biddeford, ME; cfeurt@une.edu
2 University of New England, Biddeford, ME

WE'RE ALL IN THE SAME BOAT! SCIENTISTS AND STAKEHOLDERS PRACTICE COLLABORATIVE LEARNING AND SUSTAINABILITY SCIENCE ON THE SACO

The Saco Estuary holds special meaning for communities, businesses, recreation enthusiasts and a group of scientists who have focused research efforts on the estuary for the past five years as part of Maine's Sustainability Solutions Initiative. Scientists and students from the University of New England and Wells National Estuarine Research Reserve worked in collaboration with over twenty stakeholder groups. Scientists and stakeholders documented the qualities of the estuary that are valued, identified perceived threats to the estuary and documented the ways that stewardship practices of the stakeholder groups contribute to sustaining what people care about. The Saco Estuary supports the greatest documented fish diversity of any estuary in Maine. Over one third of all bird species in Maine use

the Saco estuary and tidal wetlands as habitat. These tidal wetlands exhibit a continuum from salt to fresh and contain ten rare plant species of special concern for the state. Improvements in water quality as a result of water quality regulations and policies have contributed to the restoration of the Saco. Understanding the ways that the ecological health of the estuary, as indicated by species biodiversity, water quality, and land use/land cover, is connected to the decisions, policies and practices of stakeholder groups guides this approach to sustainability science on the Saco. Collaborative Learning is used to cultivate productive relationships among students, scientists and stakeholders. These relationships have evolved during the course of the project as scientists learn from stakeholders and stakeholders adapt scientific findings into their stewardship strategies.

9:30AM – 9:55AM

Judy Gates[1], Elizabeth Hertz[2], Peter Slovinsky[3], Steve Walker[4]

1 Maine Department of Transportation, Augusta, ME; judy.gates@maine.gov

2 Municipal Planning Assistance, Dept. of Agriculture, Conservation and Forestry, Augusta, ME; elizabeth.hertz@maine.gov

3 Maine Geological Survey, Dept. of Agriculture, Conservation and Forestry, Augusta, ME

4 Maine Coast Heritage Trust, Topsham, ME

INTEGRATING SCIENCE INTO POLICY AND PROCESS: THE TAG TEAM APPROACH

Sea level rise is a global process with local impacts. Interested in starting the local conversation about potential impacts of sea level rise to coastal marshes, the Maine Coastal Program (MCP) received a grant from NOAA to provide three-five coastal communities with the most recent sea level rise scenario modeling and technical support in integrating that information into the local dialog. Local engagement was of primary importance in this project. In recognition of the unique character and personality of Maine communities, the outreach and engagement approach was community-designed and driven, led by local champions in each community. What started as a project focused on the effects of sea level rise on coastal marshes has grown into a broader effort to assess potential impacts of sea level rise to both natural and built systems through collaboration of multiple state agencies, NGO's, municipal officials, and local residents. The scope of the project expanded dramatically when Maine DOT received grant funds from the federal Highway Administration to pilot assessing the vulnerability and criticality of public transportation assets. The Maine DOT work leverages the MCP project by using the locally designed outreach to disseminate its analysis and obtain local input on the identification of key infrastructure at risk. Through these efforts, Maine DOT hopes to build a decision support tool to assist the state and municipalities in identifying not just infrastructure at risk from sea level rise and extreme weather events, but rank those assets in terms of their roles in maintaining connectivity.

Session E: Collaborative Research and Engagement

1:30PM – 1:55PM

Teresa R. Johnson[1,2], Jeffrey Vieser[1,2], Jessica Jansujwicz[2], Colleen Budzinski[2], Theodore Koboski[2], and Gayle Zydlewski[1,2]
1 School of Marine Sciences, University of Maine, Orono, ME; teresa.johnson@maine.edu
2 Maine's Sustainability Solutions Initiative, University of Maine, Orono, ME

COLLABORATIVE FISHERIES RESEARCH IN COBSCOOK BAY, MAINE

University of Maine scientists have been conducting a survey of finfish in Cobscook Bay. The impetus for the research was the need for information to evaluate potential environmental impacts of a marine hydrokinetic device. While University scientists collaborated with the tidal power developer (Ocean Renewable Power Company) and state and federal regulators, it was also necessary for them to engage the community in the research, especially fishermen. With funding from the Sustainability Solutions Initiative, social science research was conducted to identify preferred engagement strategies to design and implement a collaborative research effort with the community. Community meetings were organized to enable community input into the research process and to allow scientists to share results from the survey with community members. This presentation analyzes this collaboration as a case study of community engagement. Drawing on participant observation, interviews, and document review, we describe the effort to include community input into the survey and then examine scientists' and community perspectives about the process and outcomes associated with this collaboration. We conclude with some lessons learned about how to improve such collaborations in the future.

2:00PM – 2:25PM

Vanessa Levesque (student)[1], *Kathleen P. Bell[2], Aram C. Calhoun[3], Mario Teisl[2]*
1 School of Economics and Sustainability Solutions Initiative, University of Maine, Orono, ME; vanessa.r.levesque@maine.edu
2 School of Economics, University of Maine, Orono, ME
3 Department of Wildlife Ecology, University of Maine, Orono, ME

A COLLABORATIVE ECONOMIC AND ECOLOGICAL ANALYSIS OF A PROPOSED VERNAL POOL REGULATORY MECHANISM

In Maine, vernal pools are regulated through both federal and state wetland protection rules, but these regulations are perceived to have some shortcomings by regulators, landowners and biologists alike. For example, the regulations protect fewer than 25% of all vernal pools, and result in isolated circles of protection dotting the landscape. Furthermore, pools located in a matrix of unsuitable habitat (e.g., within a downtown) are protected to the same degree as pools in rural landscapes that are more appropriate for long-term viability of amphibian populations, burdening some landowners and regulators for questionable ecological outcomes. In response to these shortcomings, a group consisting of actors from all levels of government and private and non-profit organizations has been developing a new, market-based mechanism for regulating vernal pools in Maine. This presentation will focus on one of the questions asked by the participants in this collaborative group: What are the predicted economic costs and ecological outcomes of a vernal pool market-based regulatory mechanism as compared to the existing state and federal standards? While analysis is current on-going, our initial results

suggest that the particular future development patterns will determine the relative success of each policy option. In addition to providing results of the analysis, this presentation will comment on the contribution of participants to the research question development, data gathering, and interpretation phases of the study.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Spencer R. Meyer (student)[1], Michelle L. Johnson (student)[2], Robert J. Lilieholm[3], Christopher S. Cronan[4], Stephen Engle[5], and Dave Owen[6]

1 School of Forest Resources, University of Maine, Orono, ME; spencer.meyer@maine.edu.

2 Ecology and Environmental Science Program, University of Maine, Orono, ME

3 School of Forest Resources, University of Maine, Orono, ME

4 School of Biology and Ecology, University of Maine, Orono, ME

5 Center for Community GIS, Farmington, ME

6 School of Law, University of Maine, Portland, ME

DEVELOPMENT OF A STAKEHOLDER-DRIVEN WEB-BASED TOOL FOR STRATEGIC LAND USE PLANNING IN TWO WATERSHEDS IN MAINE

Land use change results from frequent, independent actions by economic and environmental decision-makers working in isolation within one land use of interest. To address the gap between economic and environmental land use information, we partnered with more than 75 Maine stakeholders to develop a spatial planning framework that integrates specific factors driving economic development, environmental conservation, forest management, and agriculture activities. First, we developed a series of land use suitability models using Bayesian belief networks to quantify the interactions between land use factors. Second, we developed a series of alternative future land use scenarios based on input from the stakeholders. Third, we developed an applied web-based spatial planning tool, the Maine Futures Community Mapper (MFCM), to inform land use planning by communities, conservationists, economic developers, and other land use decision-makers. Using results from our stakeholder-driven research, the MFCM allows users to: (1) identify areas of high suitability for ecosystem protection, forest management, agriculture, and economic development; (2) identify potential areas where high suitability for two or more land uses overlap causing potential conflicts or opportunities; and (3) envision alternative future scenarios of land use. The MFCM includes spatially explicit information for 4.5 million acres in Maine in two large watersheds: the Lower Penobscot River and the Casco Bay/Lower Androscoggin River. A key outcome from this project is the ability of non-technical users to identify priority areas—both within individual towns and regionally—for economic development, natural resource management, and conservation.

Sustainability and the Humanities – Connecting with Language, Art, and Performance for Enhanced Sustainability

Studies of language, art, performance, and storytelling within the Humanities have much to contribute to sustainability science. The presenters in this panel each take a different approach to investigating the intersections of language and sustainability. The first presenter describes a collaborative art project, Healing Seeds, that seeks to engage community members in direct experiments with plant chemistry, gardening, and storytelling. A second presenter highlights how the preservation of language is linked to the preservation of biodiversity. Every language has environmental knowledge embedded in indigenous names, oral traditions, and taxonomies that are lost when a community shifts to another language. The third and final presenter illustrates one way that science and humanities collaborations on digital archives can open access to information relevant to sustainability efforts. Each of these presentations contribute new and productive insights about how language shapes sustainability.

SESSION CHAIR

Bridie McGreavy

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

Bridie McGreavy is currently a postdoctoral research fellow with the New England Sustainability Consortium (NEST), a project focused on safe beaches and shellfish in Maine and New Hampshire. Bridie received her Ph.D. in communication and sustainability science from the University of Maine in December 2013. Her research focuses broadly on communication, resilience, and sustainability. Bridie received an M.S. in Environmental Studies-Conservation Biology from Antioch University New England in Keene, NH in 2008 and her graduate research focused on science communication for vernal pool conservation.

Session F: Sustainability and the Humanities

**Please note this session is a panel discussion and presentation times listed are approximate.*

8:30AM – 8:55AM

Joline Blais
University of Maine, Orono, ME; jblais@maine.edu

HEALING SEEDS, HEALING STORIES

The purpose of this collaborative art project is to engage youth and adults in direct experiments with plant chemistry, gardening, and storytelling in a way that builds confidence in local solutions, using local materials. Drawing on citizen science models, new developments in our understanding of plants, and storytelling techniques, participants can gather anecdotal information that may provide the basis for healing practices–both botanical and cultural.

9:00AM – 9:25AM

Pauleena MacDougall[1], Darren Ranco[2]
1 Maine Folklife Center, University of Maine, Orono, ME; Pauleena@maine.edu
2 Native American Programs, University of Maine, Orono, ME

THE ESSENTIAL ROLE OF THE UNIVERSITY IN SUSTAINING ENDANGERED LANGUAGES

The University of Maine through the Maine Folklife Center in collaboration with Native Studies, the Penobscot Indian Nation and the American Philosophical Society are working together to preserve an endangered essential native language (Eastern Abenaki, or Penobscot) with the support of the National Endowment for the Humanities Endangered Languages Fund. The goals of the project are two-fold: first, to collect all the language data available from archival sources and develop a central database of language materials (also a printed dictionary) and second to support language pedagogy efforts of the Penobscot community by providing materials to the language teaching curriculum that are appropriate to that community. Just as degradation of the natural environment is an important research area for the University of Maine, so too, preservation of language (which is the keeper of traditional knowledge) needs the attention of the scholarly community. New studies suggest that language loss, in its turn, has a negative impact not only on cultural diversity, but on biodiversity conservation as well. The reason for this is that language and traditional knowledge of biodiversity is linked. Every language has environmental knowledge embedded in indigenous names, oral traditions and taxonomies, that is lost when a community shifts to another language. This presentation will provide an overview of the project with examples of the kinds of local knowledge embedded in the language that are important to both the sciences and the humanities.

Session F: Sustainability and the Humanities

9:30AM – 9:55AM

Michael J. Cripps
University of New England, Biddeford, ME; mcripps@une.edu

DIGITAL HUMANITIES AND SUSTAINABILITY SCIENCE: AN ARCHIVAL PROJECT FOR THE SACO RIVER ESTUARY

This presentation illustrates one way that science and humanities collaborations on digital archives and collections can open access to information relevant to sustainability efforts. Work in the humanities is increasingly drawing on digital tools, including work on archives and exhibits. Digital thematic collections create opportunities to draw together a range of information and knowledge on a theme and can open a cross-disciplinary window on a theme. In this presentation, the speaker discusses a cross-disciplinary digital collection project begun in 2013 by undergraduates in an English course on the digital humanities. The digital collection draws together historical, educational, and scientific information relevant to the sustainability of the Saco River estuary and makes this information accessible to a general public. By combining scientific data on species health and diversity on the estuary, public educational initiatives that involve community stakeholders in sustainability efforts, and historical archival photos, maps, and documents relevant to the estuary, this web-accessible collection has the potential to broaden visitors' understanding of the ongoing importance of the Saco River estuary by exposing them to both the rich history and current beauty of the estuary. The digital, web-based approach to the archive makes available historical maps of the area, video interviews with community stakeholders, historical photos of the river, scientific data on species diversity, along with information about the species in the estuary. As a digital collection, it illustrates one way that humanities work can supplement the science involved in sustainability work. Portions of the work reported in this presentation were funded by an NSF EPSCOR grant to the Sustainability Solutions Initiative.

Session G

Maine's Energy Future

This session will discuss Maine's energy future and the different options and strategies being proposed and implemented to further the state's energy security. Presentations include research and applications related to the economic, environmental and social impacts of: renewable energy technologies under development in Maine including tidal, off-shore wind and bioenergy; the transition from reliance on oil; the role of efficiency in lowering energy needs and the potential for using Maine's biomass and waste stream.

SESSION CHAIR

Caroline Noblet

School of Economics, University of Maine, Orono, ME; caroline.noblet@maine.edu

Caroline Noblet is an assistant professor in the School of Economics at the University of Maine. Her research focuses on answering the question: Why do people act the way they do towards the environment? This question takes her across academic disciplinary boundaries between the fields of economics, psychology and communication. Her research has focused on the role of motivation, pro-ecological worldview and provision of environmental information in making decisions about, and towards, the environment. She considers how individual values, constraints and backgrounds may inform decisions at both the consumer and policy level. Caroline received her Ph.D. in Economic Psychology from the University of Maine.

8:30AM – 8:55AM

Jonathan Rubin

Margaret Chase Smith Center and School of Economics, University of Maine, Orono, ME; rubinj@maine.edu

REFORMING MAINE'S GAS TAX FOR ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY

The historic method of funding our nation's roadway infrastructure is from excise taxes levied on gasoline and diesel. The federal excise tax (per gallon) for gasoline and diesel has been constant at

$0.184 and $0.240 since 1997. For Maine the rates are $0.300 and $0.312. This method of funding is increasingly not sustainable environmentally and fiscally, requiring general tax revenues (at both the federal and state level) to subsidize the highway trust funds. This fiscal non-sustainability is primarily due to an increase in the fuel efficiency of new vehicles, an increase in the number of grid-connected hybrid or pure electric vehicles, and per-gallon rates of taxation that are not keeping up with the costs of construction. The environmental and welfare non-sustainability is due to the mismatch between the rates of taxation per gallon of fuel and social costs which accrue per mile driven that depend on location, time of day and fuel type (gasoline v. electricity). The research will present data for Maine (where we are and where we are headed in terms of our fiscal gap) and look at best practices and recommendations from several state pilot programs (Oregon, Nevada, Washington, California) that are looking at vehicle mileage travelled (VMT) taxation. The research will highlight how environmental and social costs (GHG emissions, congestion) are influenced by the form of taxation (per-gallon excise tax v. VMT tax).

9:00AM – 9:25AM

Michael Stoddard
Efficiency Maine Trust, Augusta, ME; michael.stoddard@efficiencymaine.com

THE ROLE FOR ENERGY EFFICIENCY IN MAINE'S ENERGY FUTURE

In 2012, Efficiency Maine commissioned an independent study of the ten-year potential for energy efficiency to satisfy the needs of Maine's electricity system at a lower cost than traditional supply. It found that Maine's "Maximum Achievable Cost-Effective" (MACE) energy efficiency potential would lower electricity costs and meet up to 16% of its total electricity needs, which sets the standard for the three-year strategic plan approved by the Maine PUC in 2013 and now being implemented by Efficiency Maine. Complementing electricity saving initiatives, Efficiency Maine's recent programs show that homes and businesses can consistently save more than 20% of their heating costs by investing in insulation and high-efficiency heating systems. These results clearly demonstrate that energy efficiency is the lowest cost energy resource in Maine. It can satisfy a significant portion of Maine's future energy needs, and it reduces environmental impacts from our energy use. Energy efficiency also expands the potential for renewable energy as an energy resource. Efficiency Maine's current program offerings, and recent program results, offer a range of case studies on how this resource can help lower costs for water and sewer districts, municipalities, manufacturers, small businesses and homeowners and enhance the sustainability of Maine's energy future.

9:30AM – 9:55AM

Jessica S. Jansujwicz[1], *Teresa Johnson[2]*
1 Sustainability Solutions Initiative, University of Maine, Orono, ME; Jessica.jansujwicz@maine.edu
2 School of Marine Sciences and Sustainability Solutions Initiative, University of Maine, Orono, ME

COMMUNITY AND POLICY RESEARCH ON TIDAL ENERGY DEVELOPMENT IN MAINE

Marine hydrokinetic (MHK) energy offers a promising new source of renewable ocean energy. However, regulatory uncertainty and social acceptance may constrain industry development. The Human Dimensions Team of the Maine Tidal Power Initiative is conducting research to understand the

regulatory and permitting process for MHK development and the factors influencing community acceptability. Research has focused on Ocean Renewable Power Company's (ORPC's) Cobscook Bay Tidal Energy Project (CBTEP). This project is the first functioning commercial MHK project in the U.S., and is recognized as having a high level of community support. Using observations, interviews, focus groups, and a mail survey, we examined community perspectives of the CBTEP. We found an emphasis on direct benefits, indirect benefits, "hopeful" benefits, and potential costs associated with the project. Community stakeholders and fishermen generally perceived ORPC's approach as effective; they noted the company's accessibility and their efforts to engage them early and often. Through observations and interviews with regulators and developers we identified four institutional factors important for supporting regulatory and permitting decisions: (1) experimentation and learning, (2) institutionalized choice to correct avoidable error, (3) a commitment to interagency coordination, and (4) an emphasis on early proactive engagement with developers. We also identified institutional challenges that may hamper MHK development. These included conflicting agency cultures, high financial costs, and long timeframes associated with baseline data collection. Lessons learned from this study can assist regulators, policymakers, and developers move new renewable ocean energy development forward in a way that is socially acceptable and environmentally responsible.

1:30PM – 1:55PM

Emily J. Silver[1] (student), Jessica E. Leahy[2], Aaron R. Weiskittel[2], Caroline L. Noblet[3], David Kittredge[4]

1 School of Forest Resources and Sustainability Solutions Initiative, University of Maine, Orono, ME; emily.j.silver@maine.edu

2 School of Forest Resources, University of Maine, Orono, ME

3 School of Economics, University of Maine, Orono, ME

4 Department of Environmental Conservation, University of Massachusetts, Amherst Center, MA

RISK PERCEPTION AND RELEVANCE OF TIMBER HARVESTING FOR BIOENERGY PRODUCTION: A QUALITATIVE EXAMINATION OF PRIVATE WOODLAND OWNERS

Predicting and understanding timber supply is one central component to the viability of the bioenergy industry. Available timber supply from private woodland owners is difficult to estimate because complex behavioral theory informs the owner's decision to harvest. The decision-making environment consists of exogenous market factors, internal cognitive processes, and social interactions. This study seeks to understand the cognitive and social factors influencing the decision to harvest timber. Two specific cognitive mechanisms, risk perception and relevance, are more thoroughly investigated. Thirty semi-structured interviews were conducted with private woodland owners, who had previously harvested timber, had never harvested timber, and had harvested timber for woody biomass markets. Owners were also asked to build a cognitive map or timeline of their decision-making process. Results indicate that owners frame risk in terms of concerns for their woodlot in four broad categories: economic, aesthetic, environmental, and social. Importantly, economic concerns are typically considered at the very end of the decision-making process. Owners expressed a willingness to supply timber for biomass, but unfamiliarity with biomass markets. Finally, timber harvesting was cited as less relevant to daily life than other land management decisions, and therefore may not be an area to apply traditional social psychological theories of intention and behavior. These results help provide insight to

available timber supply for the bioenergy industry. Furthermore, the incorporation of risk and relevance in the study of private woodland owners contributes new information on decision-making and associated land use impacts.

2:00PM – 2:25PM

Stephanie Whalley[1] (student), Binod Neupane[2], Sharon Klein[2], Jonathan Rubin[2]
1 School of Economics, University of Maine, Orono, ME; Stephanie_Whalley@umit.maine.edu
2 School of Economics, University of Maine, Orono, ME

SUSTAINABILITY ASSESSMENT OF DROP-IN BIOFUELS IN MAINE

As the United States looks to decrease reliance on fossil fuels by increasing the use of renewable energy, forest biomass has received increased attention as a possible biofuel feedstock. Maine's high level of forestation makes it a strong candidate for bioenergy projects. Biofuel production requires careful sustainability analysis that compares the tradeoffs between the environmental, economic and social costs and benefits. This study develops a decision support system to model different decision variables on environmental and socio-economic aspects of the drop-in biofuel technology, which is compatible with existing transportation infrastructure, developed at the University of Maine. We estimate the total energy and emissions flows across the life cycle of the drop-in fuel supply chain. The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) life cycle analysis model is used to examine energy, criteria pollutants and greenhouse gases emissions. The cost of harvesting biomass and transporting it to the biorefinery gate are estimated using the stumpage price paid to the landowner, the cost of harvesting and the transportation cost through an integrated program using Maine specific cost information, stand data and harvest productivity equations. Critical criteria and indicators for the social sustainability of this biofuel technology are also developed. We integrate environmental, economic and social metrics in a multi-criteria decision analysis (MCDA) of drop-in biofuels. The MCDA optimizes the overall economic, environmental and social sustainability of the drop-in fuel supply chain. The model we have developed can also serve as a template to analyze similar technologies and supply chains.

3:00PM – 3:25PM

Maggie Finn[1], Mac Richardson[2]
1 North East Biosolids and Residuals Association, Tamworth, NH; maggie.finn@nebiosolids.org
2 Lewiston Auburn Water Pollution Control Authority, Lewiston, ME

HOW MAINE'S ORGANIC ~~WASTES~~ RESOURCES CAN BE PART OF A SUSTAINABLE ENERGY FUTURE!

In 2013, Lewiston Auburn Water Pollution Control Authority (LAWPCA) became the first municipal Water Resources Recovery Facility (WRRF) in Maine to install anaerobic digestion. Anaerobic digestion was chosen to reduce biosolids volume at an anticipated savings of $600,000/year, while producing digester gas that can be used to generate electrical power. Methane, a byproduct of the anaerobic digestion of organic matter, is a greenhouse gas with 21 times the potency of carbon dioxide. The methane, which burns much like natural gas, fuels two (230 kilowatt) generators expected to provide

two thirds of the electricity needed to run the LAWPCA wastewater treatment facility. Formerly the largest electrical user in Lewiston-Auburn, LAWPCA is now a significant source of renewable power. Heat, another byproduct of anaerobic digestion is also recovered and reused at the facility. Biosolids generated are diverted from landfilling by processing at the LAWPCA compost facility resulting in production of a renewable fertilizer product and further reducing environmental impact. Maine currently recycles 74% of its biosolids, a better record than any other New England state. Maine is like many other states in that it recycles very little of its food residuals. Nationally we throws away about 40% of all food produced. Various food based residuals are being trialed for anaerobic digestion at LAWPCA. Initial results show that the added food wastes increase methane production and electrical generation while enhancing the volume reduction experienced in anaerobic digestion. There is a unique opportunity to use the established infrastructure and experience of Maine's wastewater community to solve both environmental and energy issues with this proven technology. Further diversion of organic food residuals from landfills to anaerobic digestion could provide renewable energy, landfill conservation, reduced greenhouse gas pollution and sustainable economic benefits.

3:30PM – 3:55PM

Caroline Noblet, Michelle Debartolo-Stone
School of Economics, University of Maine, Orono, ME; caroline.noblet@maine.edu

WHAT DO YOU REALLY THINK? MAINERS PERSPECTIVES ON OUR RENEWABLE ENERGY PORTFOLIO

This presentation will provide results of analysis of a statewide survey implemented to: document current knowledge of, and perceptions toward Maine's renewable energy portfolio and energy efficiency and determine what factors drive people's perceptions of renewable energy and efficiency. The survey effort consisted of twelve different versions distributed to 8,000 Maine citizens during summer 2013. The analysis will focus on preferences of Maine citizens for various options in Maine's energy portfolio, and the factors that drive these perceptions, including spatial distribution. We also analyze responses to a policy choice experiment where Maine citizens are asked to contribute towards a fund for renewable energy &/or energy efficiency, and then select the allocation of their contribution between various enery portfolio options.

Session H

Safe Beaches and Shellfish Beds

This session will focus on how the emerging field of sustainability science may be used to tackle problems related to impaired water quality in coastal regions, where elevated levels of unhealthy bacteria can lead to the closure of shellfish beds and posting of beach advisories. Topic areas for this session include: how natural processes and human activities in coastal waters and watersheds influence bacterial dynamics, the potential role of social feedback processes in addressing and improving impaired water quality, and the importance of doing so for local communities depending on shellfish and beaches.

SESSION CHAIRS

Stephenie MacLagan

Sustainability Solutions Initiative, University of Maine, Orono, ME; stephenie.maclagan@maine.edu

Stephenie MacLagan graduated from Unity College with a B.S. in Environmental Policy, and is employed by the Maine Department of Environmental Protection. She connects people with their environment, having been: a GIS mapper, market researcher, consultant, environmental field technician, writer and translator of technical reports, member and leader of committees, and coordinator of projects and programs. Her current work involves shoreland zoning, providing land use regulation services to municipal officials. Stephenie's graduate research applies economic and policy theories to intertidal shellfish management approaches.

Keri Kaczor

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

Joining the Marine Extension Team (MET) as an AmeriCorps/Maine Conservation Corp volunteer in 2003, Keri's work is primarily focused on ecosystem health-related projects. She is the statewide coordinator of the Maine Healthy Beaches Program, an effort monitoring water quality and protecting human health on Maine's coastal beaches. Keri also provides training and support to various water quality monitoring groups statewide. Keri received her Masters degree in Marine Policy from the University of Maine.

Session H: Safe Beaches and Shellfish Beds

8:30AM – 8:55AM

Kevin Athearn
University of Maine at Machias, Machias, ME; kathearn@maine.edu

MEASURING THE IMPACT OF SHELLFISH CLOSURES ON MAINE'S ECONOMY

Maine's molluscan shellfish industry generates annual sales greater than $30 million at the wholesale level. Accounting for indirect and induced effects on the Maine economy, the shellfish industry contributes about $60 million in economic output. That economic output is achieved despite more than 100,000 acres of shellfish beds closed to harvesting because of elevated levels of harmful bacteria under normal conditions and much larger periodic closures from red tide and coastal flooding. Shellfish closures reduce the statewide harvest of shellfish and likely cause substantial economic losses for coastal communities. Models for estimating the economic impact of shellfish harvesting closures are not readily available. This presentation reviews two studies estimating closure impacts. The first study estimates statewide economic losses from red tide and flood closures. The second study examines the impact of bacterial closures, linked to Machias combined sewer overflows, on Machiasport clam harvesting. Both studies find significant economic losses from shellfish area closures. Methodological challenges for measuring the economic impact of shellfish closures are discussed.

9:00AM – 9:25AM

Alison Sirois*, Meggan Dwyer*

Maine Dept. of Marine Resources, Maine Shellfish Growing Area Program, Public Health Bureau, West Boothbay, ME; Alison.Sirois@maine.gov

MANAGING SHELLFISH FOR HEALTHFUL CONSUMPTION

The Bureau of Public Health oversees the application of the National Shellfish Sanitation Program (NSSP) within the State of Maine. This program is implemented internationally by the Interstate Shellfish Sanitation Conference (ISSC) in order to keep molluscan shellfish safe for human consumption. This is accomplished by making sure that a common set of standards are used to classify shellfish growing areas and handle shellfish when they go to market. The Growing Area Classification Program evaluates all shellfish growing areas in the state of Maine to determine their suitability of harvest. This presentation includes an overview of the classification process, focusing on the successes of reclassifying areas after pollution sources are addressed. DMR staff work with local shellfish wardens and committees, who help identify priority areas for conducting sanitary surveys. By collaborating with researchers and community volunteers, DMR continues to refine the expectations of when various conditions affect pollution levels that result in bacterial closures.

Session H: Safe Beaches and Shellfish Beds

9:30AM – 9:55AM

***Keri Kaczor*[1], *Bill Bell*[2], *John Bird*[3]**
1 University of Maine Cooperative Extension, Orono, ME; keri.kaczor@maine.edu
2 Resident, Saco, ME
3 Old Orchard Beach Conservation Commission, Old Orchard Beach, ME

CLEAN WATER: WORKING TOGETHER TO FIND SOLUTIONS

Tourism and the shellfish industry are integral components of the Maine economy and way of life. Spending related to beaches in York County alone is estimated to be over 500 million annually (Levert, 2009). However, elevated fecal bacteria levels in coastal waters may pose a human health risk, leading to beach advisories and closures of shellfish growing areas. Rivers, streams, and storm drains transport pollutants from upland areas to the surf zone. Addressing pollution issues often requires enhanced monitoring and in-depth studies beyond the immediate shoreline area. In response, Maine Healthy Beaches has brought together partners at all levels with a focus on sharing resources and solving problems. By partnering on applied research and source-tracking studies, transferring data to usable information to act upon, and providing training and technical support, the program has built local capacity to address pollution issues. Identifying pollution sources is only one part of the equation. It is equally important to find solutions to current problems and to take action to prevent future ones. Program staff will share pathways of pollution and strategies used to alleviate contamination issues including what citizens can do to help improve water quality. Case studies showcasing how knowledge of local circulation patterns helps determine the fate and transport of contaminants, applications of the pollution source tracking toolbox, use of Geographical Information Systems to identify priority sub-watersheds, sanitary surveys, local prevention efforts and more will be shared. Citizen Scientists will also discuss their role in transforming the data into local actions to improve water quality.

1:30PM – 1:55PM

Elizabeth Halliday
Coastal Studies for Girls, Freeport, ME; elizabeth@coastalstudiesforgirls.org

DIGGING INTO HUMAN IMPACTS AT BEACHES

Beach sands can act as a reservoir of fecal bacteria at recreational beaches. Whether fecal bacteria are introduced to sands from land-based runoff, deposited from polluted surf-zone waters, or introduced directly to the sand surface in animal or human waste, once introduced to moist sand environments the fecal bacteria may persist and even reproduce. This bacterial reservoir can be a threat to human health for those in contact with the sands, and can also impair local water quality by acting as a source of bacteria under certain environmental conditions. Field studies at beaches in Maine and Massachusetts have documented distinct patterns in sand distribution of the marine fecal indicator *Enterococcus*, as well as correlations between bacterial abundance and specific environmental variables. These findings have important implications for healthy beach management and may help explain dry-weather water quality violations.

2:00PM – 2:25PM

Forrest Bell*[1]*, Scott Reynolds*[2] *with special guest: Logan or Sable, canine scent tracking dogs
1 FB Environmental Associates, Portland, ME; info@fbenvironmental.com
2 Environmental Canine Services, Vermontville, MI

USING SCENT TRAINED CANINES TO DETECT THE PRESENCE OF E. COLI IN STORMWATER DISCHARGES

Detecting the presence of *E. coli* in stormwater discharges impacting coastal and inland ecosystems is an important goal of federal, state, and local governments. In 2013, The U.S. EPA alerted several municipalities that Illicit Discharge Detection and Elimination (IDDE) will need to be a top priority for regulated communities. The ability to rapidly screen for *E. coli* contamination would provide a cost effective way to comply with these federally mandated stormwater programs outlined in the National Pollution Discharge Elimination System (NPDES) permits and can help states and municipalities to meet reductions of bacteria levels at key locations impacting public health including beaches and in shellfish harvesting areas. The method of using scent trained canines for detecting and tracking human fecal contamination in storm water systems, rivers, lakes, and at beaches has gained national attention as a unique and rapid screening option (New York Times 2009, USA Today 2013). Since 2009 Environmental Canine Services (ECS) has successfully conducted over 30 projects nationwide in both the marine and freshwater environments in both urbanized and rural areas. Here in the north-eastern US, ECS has partnered with FB Environmental Associates and several municipalities in Maine and New Hampshire to successfully hone in on bacteria “hot spots” using canine detection and in several cases illicit discharges have been quickly remedied and surface water bacteria levels have dropped. With the ability of the canines to discriminate between human fecal and both wild and domestic animal feces, the monitoring process is accelerated through the reduced need for sampling and immediate real-time results. Combined with several applications that can be applied according to environment, time constraints and overall bacterial source tracking goals, these methods prove to be a cost-effective and time-saving bacteria source screening tool.

2:30PM – 3:00PM

Break

3:00PM – 3:25PM

Becky Kolak, Ruth Indrick
Kennebec Estuary Land Trust, Bath, ME; bkolak@kennebecestuary.org; rindrick@kennebecestuary.org

CLEAN WATER FOR CLAMS: COMMUNITY ENGAGEMENT IN WATER QUALITY

Over the past four years, the Kennebec Estuary Land Trust has focused on coastal water quality in the Kennebec Estuary region through the lens of “Clean Water for Clams.” Using clams and clamming as a starting point for conversations about water quality and its importance to the community, the land trust and its partners have provided outreach at community programs about clamming and coastal pollution sources, recruited volunteers, collected water samples for testing, led programs in classrooms

and brought students and families outside to dig in the mud. Clams and other shellfish are harvested along Maine's tidal mud flats and beaches, and harvesters face several challenges that actions in the Kennebec are intended to confront. This work in the Kennebec Estuary serves as a case study for methods that can be used to engage a community in its water quality, and it lays the foundation for a discussion about unique ways to build community support for coastal resources.

3:30PM – 3:55PM

Jane Disney
Community Environmental Health Laboratory, MDI Biological Laboratory, Salisbury Cove, ME; jdisney@mdibl.org

OPENING CLOSED CLAM FLATS AND PROMOTING HEALTHY BEACHES: THERE ARE MANY PATHS TO CLEAN WATER IN MAINE

Clean water is important to residents of Mt. Desert Island and the millions of visitors who arrive each summer to enjoy local seafood and a variety of recreational water activities. Over the past 22 years, Dr. Jane Disney has pursued multiple pathways in promoting clean water. This work has brought together diverse partners including state agencies, schools, and community groups, and has been supported in large part by the Maine Conservation Corps through their AmeriCorps program. Participation in state programs like Maine Healthy Beaches and working closely with Maine DMR biologists has been instrumental in the success of a number of endeavors to promote clean water and protect public health on Mt. Desert Island. The limited scope of state programs necessitates the involvement of local organizations and their community partners in assuring clean water and vibrant fisheries. Three case studies will be shared: A student led sanitary survey that resulted in the opening of clam flats in Somes Harbor in Somesville; a hybrid sanitary/watershed survey that led to dramatic improvements in water quality at Seal Harbor Beach in the town of Mt. Desert; and a cruise ship monitoring program in Bar Harbor that raised awareness about clean water and best management practices and made Bar Harbor what Conservation International considers a "sustainable cruise destination". Supplementing the work of state agencies with the work of local non-profits and citizen volunteers assures that needed work gets done to open closed clam flats, keep swim beaches healthy, and protect public health.

Session I

Management Approaches for Sustainable Urban Streams

This session will focus on non-point source pollution in urban streams and how smart growth strategies can help alleviate these issues. Presentations include talks on key contaminants occurring in Maine's urban streams, such as chloride from winter salt application, coal tar sealants used on parking areas, driveways and other surfaces, and the effects of impervious cover on stream health. Also discussed will be strategies that link economic development and community well-being to the stewardship and health of the environment, including those which advance the restoration of urban waters by improving water quality in urban areas.

SESSION CHAIRS

Don Witherill

Maine Department of Environmental Protection, Augusta, ME; donald.t.witherill@maine.gov

Don Witherill has worked for the Maine Department of Environmental Protection since 1979. He has been a division director since 1988, first overseeing permitting under the Natural Resource Protection Act. As of 1994 through 2012, he was the director of the Division of Watershed Management. During that time, he was the point person on the development of the State's Stormwater Management Program, including the development and revision of the Maine Stormwater Rules (Chapter 500/502). Since 2012 he has been the Director of the Division of Environmental Assessment, which is responsible for monitoring and assessing Maine's surface waters, and providing biennial reports on Maine's water quality. The division is also responsible for managing the Nonpoint Source Pollution Program, including an annual grants program of approx. $1.7 million. Don's formal education includes an undergraduate degree in Natural Resource Management from the University of Maine and a Master of Business Administration degree from the University of Southern Maine.

Phil Ruck

Stillwater Environmental Engineering, Inc., Orono, ME; info@stillwaterenv.com

Philip Ruck, P.E. is the President of Stillwater Environmental Engineering, located in Orono, Maine. Phil has both a B.S. and M.S. in Civil Engineering from the University of Maine, and over 24 years of professional experience. Phil has spent the majority of his consulting career specializing in stormwater

management and pollution prevention. This includes assisting industrial, municipal and institutional clients in Maine and across the northeast with environmental regulatory compliance. He has worked closely with the Bangor Area Stormwater Group since its inception back in 2003, as well as all of its twelve regulated members. He has been instrumental in developing cost-saving innovative regional approaches for MS4 Permit compliance in the Bangor area, including a regional database management system and a regional Stormwater Management Plan approach.

8:30AM – 8:55AM

Steve Kahl
James Sewall Company, Old Town, ME; Steve.kahl@sewall.com

STORMWATER UTILITIES AS A SUSTAINABILITY MANAGEMENT TOOL: EVERY COMMUNITY WILL WANT ONE

A stormwater utility (SWU) is a utility that collects fees to pay for stormwater management. The fees are based on the impervious area of properties because imperviousness generates stormwater. Rather than putting the full burden of stormwater management on property taxpayers, stormwater utility fees are assessed across all developed properties, a fundamental fairness advantage for SWU. Landowners can opt out of the fee if they mitigate imperviousness and thereby reduce stormwater runoff; a win-win-win for the property owner, the municipal DPW, and local water quality in urban streams. Cash-strapped municipalities like stormwater utilities because of the need for revenue and the predictability of the revenue stream long-term. Interest in stormwater utilities in New England is increasing. There are over 4,000 stormwater utilities nationally, so the upside for their creation in New England is substantial because we only have a half dozen operating here.

9:00AM – 9:25AM

Tom Mikulka[1], **Kate McDonald[2], Fred Dillon[3]**
1 Citizen scientist, Cape Elizabeth, ME; mikulka.tom@gmail.com
2 Cumberland County Soil & Water Conservation District, Windham, ME; kmcdonald@cumberlandswcd.org
3 South Portland Water Resource Protection Department, South Portland, ME; dillon@southportland.org

THE ROLE OF CITIZEN SCIENTISTS IN THE RESTORATION OF TROUT BROOK

The Maine Department of Environmental Protection (DEP) has designated 31 streams throughout the state as “urban impaired” for failure to meet water quality standards due to adverse impacts from surrounding development. Trout Brook, which flows through Cape Elizabeth and South Portland before emptying into Casco Bay, is one such urban impaired stream. In 2012, the City of South Portland used an Environmental Protection Agency (EPA) grant to develop a Watershed Management Plan (WMP). The WMP recommends several strategies to restore Trout Brook’s water quality and aquatic habitat and establishes a monitoring program to formalize water quality sampling activities. An innovative aspect of the monitoring program is its reliance on macroinvertebrate data collected by citizen scientists to help determine the relative effectiveness of ongoing restoration efforts. More recently,

South Portland and Cape Elizabeth received additional EPA grant funds to implement restoration strategies identified in the Trout Brook WMP. Therefore, it will be critically important to build upon the water quality monitoring data the City has collected over the past several years and establish pre-implementation conditions. South Portland, CCSWCD and DEP staff have collaborated with local citizen scientists and high school students to pilot a simplified macroinvertebrate monitoring program adapted from Wisconsin's Citizen-Based Water Monitoring Network protocols. While the results from these efforts cannot be used for regulatory compliance purposes, identifying changes in macroinvertebrate populations can help determine whether restoration activities are improving aquatic habitats. Preliminary results from the fall of 2013 suggest that this approach will be a successful screening tool.

9:30AM – 9:55AM

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

THE ABILITY OF STREAMS TO WITHSTAND THE EFFECTS OF URBANIZATION

The Biological Monitoring Program completed its study of the effects of impervious cover (IC) in watersheds on Maine's stream algae and macroinvertebrates. The risk of not attaining Class AA/A biological criteria increases in the range of 1-3% IC. Between 3-6% IC, there is an increased risk of not attaining Class B biological criteria. Finally, there is an increased risk of not attaining Class C biological criteria in the range of 10-15% IC. Location of IC in a watershed matters. In general, watersheds with development close to streams had poorer quality macroinvertebrate communities than streams with intact riparian corridors. Although IC is commonly used as a surrogate for urban development, IC is only one of many factors that influence urban stream condition. In addition to IC, stream quality is determined by the condition of riparian corridors, flood plains, in-stream habitat, stream bank stability, water flow, water temperature, habitat fragmentation or isolation, specific conductance, nutrient enrichment, and toxic chemicals. IC can influence many of the factors listed above, but natural conditions and non-IC stressors also influence the factors listed above and ultimately determine how resilient a stream is to IC. A stream may be more resilient if the other factors are favorable to healthy aquatic communities. In contrast, some streams may be more susceptible to IC if the other factors are not favorable to healthy aquatic communities. In general, resource managers should be cautious about focusing watershed protection and restoration plans only on IC.

1:30PM – 1:55PM

John Hopeck, Mark Holden
Bureau of Land and Water Quality, Maine Department of Environmental Protection, Augusta, ME; john.t.hopeck@maine.gov; mark.k.holden@maine.gov

ADVERSE IMPACTS ON GROUNDWATER QUALITY AND CONFLICTS WITH EXISTING AND DESIGNATED USES RESULTING FROM STORMWATER INFILTRATION

Stormwater infiltration is a commonly recommended LID practice and is assumed to minimize impacts on surface waters and provide for maintenance of baseflow. However, locations suitable for infiltration of large volumes of stormwater are severely limited by the geologic characteristics of the sites and by

other uses of these areas. Data from sites regulated by Maine DEP and in other jurisdictions indicate substantial impairment of groundwater quality and baseflow discharges in areas downgradient of infiltration facilities, apparently resulting from both the stormwater infiltration and geochemical changes within the infiltration structures. Contaminants typically include chloride, but may also include materials mobilized from basin sediments or aquifer materials as a result of changes in sediment redox conditions or decreasing dissolved oxygen concentrations in groundwater. Well-maintained facilities are likely to show less impact on groundwater quality, apparently due to removal of fine sediment and maintenance of infiltration capacity, although good maintenance has little effect on highly soluble contaminants. Although contaminant discharges to infiltration systems may be seasonal, determining the arrival time of groundwater including these contaminants at surface waters is complex and beyond the scope of most development proposals. Geologic units with sufficient thickness, areal extent, and high permeability are relatively uncommon, and may support a range of natural and constructed uses not necessarily consistent with infiltration. These areas are well-defined and mapped in most areas, and GIS tools developed by Maine DEP allow evaluation of the relative risks of various land-use activities and priorities in these areas.

2:00PM – 2:25PM

Karen A. Wilson
Department of Environmental Science, University of Southern Maine, kwilson@usm.maine.edu

ELEVATED CHLORIDE LEVELS IN AN URBAN STREAM: CORRELATIONS WITH IMPERVIOUS COVER AND WINTER PRECIPITATION EVENTS

Water quality degradation of streams in New England has been a rising concern since the early twentieth century, in large part due to rapid urbanization of land surrounding streams. Impervious cover (IC) plays a major role in this degradation, causing increased runoff to receiving streams, higher peak discharges, greater water export, and higher sediment loads. Long Creek, South Portland, Maine, is an example of an urban impaired stream for which a watershed management plan has been developed to assist in restoration efforts, in part through the use of BMPs and LIDs to reduce IC. In this study, students in the Department of Environmental Science, University of Southern Maine, examined the effect of IC on basic water quality parameters for each sub-watershed of Long Creek and a nearby reference stream during the rarely-studied winter months. Weekly measurements of specific conductance, chloride, and turbidity were made for multiple sites within each sub-watershed from Jan 22, 2013 to April 9, 2013, for a total of 21 sites. As expected, specific conductance and chloride were highly correlated, and both were strongly related to cumulative impervious cover. Spikes in these measures occurred immediately following (or during) precipitation events. Chloride values were above U.S. EPA Aquatic Life Criteria for surface water quality for much of the study period. It is recommended that further action be taken to regulate the use of salt for deicing purposes on a statewide basis to protect and restore all urban streams.

2:30PM – 3:00PM

Break

Session I: Management Approaches for Sustainable Urban Streams

3:00PM – 4:00PM

Panel Discussion

FINDING WAYS TO REDUCE THE IMPACT OF CHLORIDES ON STREAMS

Josh Katz
Road Salt Resolutions, Maine Department of Transportation, Augusta, ME

Rod Melanson
Assistant Planner, Town of Topsham, Topsham, ME

David Cote
Public Works Director, City of Brewer, Brewer, ME

Session J

Managing the Boundary Between Science and Decision-Making (Panel Discussion)

This session focuses on boundary spanning and explores the roles and processes involved in interfacing between distinct groups, in this case scientists and decision-makers, to help manage complex problems. Individuals and organizations who act as boundary spanners help to develop partnerships and improve collaboration by facilitating sustainable relationships, engaging complexity, and seeking to understand motives, roles and responsibilities of diverse actors and institutions. In this session, panelists will discuss the role of boundary spanning in successful (and unsuccessful) collaborations at the boundary of science and decision-making, and the necessary skills, abilities and characteristics of effective boundary spanners.

SESSION CHAIRS

Linda Silka
Margaret Chase Smith Policy Center, University of Maine, Orono, ME; silka@maine.edu

Linda Silka has been the director of the Margaret Chase Smith Policy Center since 2009. Prior to becoming a faculty member at the University of Maine, she directed the Center for Family, Work, and Community at the University of Massachusetts Lowell where she was a university professor in the Department of Regional Economic and Social Development and served as the Special Assistant to the Provost for Community Outreach and Partnerships. Silka has several decades of experience in leading community-university research partnerships on environmental, economic development, and environmental health issues with funding from federal agencies such as EPA, NIEHS, HUD, NSF, Dept of Education, as well as many foundations. She is the author or co-author of four books and many peer-reviewed journal articles and publications on partnership research.

Session J: Managing the Boundary Between Science and Decision Making

Karen Hutchins
Dept. of Communication & Journalism, Sustainability Solutions Initiative, University of Maine, Orono, ME; karen.hutchins@umit.maine.edu

Karen Hutchins Bieluch is a visiting assistant professor of Communication and Journalism at the University of Maine, and a member of Maine's Sustainability Solutions Initiative (SSI), Linking Knowledge with Action research team. Her research focuses on partnership development, university-community collaborations, environmental behavior, and public participation in environmental conflicts. She has worked with various stakeholder groups including municipal officials, individual citizens, state and federal government agencies, and private consultants on issues related to stormwater, road salt, and river herring management.

1:30PM – 4:00PM (BREAK AT 2:30PM)

Panel Discussion

Cathy Elliott
Associate Extension Professor, University of Maine Cooperative Extension, Orono, ME

Jessica Jansujwicz
Post-Doctoral Research Associate, Sustainability Solutions Initiative, University of Maine, Orono, ME

Bridie McGreavy
Post-Doctoral Research Associate, New England Sustainability Consortium, University of Maine, Orono, ME

Chris Rector
Regional Representative for US Senator Angus King and Former Maine State Senator

Brenda Zollitsch
Consultant and Policy Analyst for the Association of State Wetland Managers

Questions to be discussed include:

- Why is boundary spanning so powerful? Is Maine well positioned to do this kind of work?
- What resources/support do you feel people interested in boundary spanning activities in their workplaces need in order to accomplish this work?
- What are key lessons you have learned through your boundary spanning work?

Undergraduate and Graduate Juried Poster Exhibition

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

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

Student presenters are indicated in bold type.

POSTER CHAIR

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

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

UNDERGRADUATE POSTER ABSTRACTS

Emily Arsenault, F. Russell Cole, Denise Bruesewitz
Colby College, Waterville, ME; erarsena@colby.edu

AN ASSESSMENT OF MACROINVERTEBRATE COMMUNITIES IN THREE HEADWATER STREAMS REVEALS SENSITIVITY TO ROAD CROSSINGS

Benthic macroinvertebrate communities are commonly studied for the assessment of aquatic ecosystem health. Understanding functional roles and trophic positions within a community can validate water quality inferences made from rapid biomonitoring. This research focused on three streams within the Kennebec Highlands region. Studies of nutrient cycling and metabolism reported similar water

quality between these sites, but a survey of invertebrate communities suggested otherwise. While two of the stream sites exhibited a %EPT of 62.4 and 74.6, respectively and outstanding Hilsenhoff Biotic Index (HBI) values of 3.50 and 3.51, the stream with a road crossing in its study reach was significantly worse. The transect immediately downstream from the crossing displayed the worst water of any other transect in this study, with a %EPT of 21.7 and a HBI of 5.2. Ongoing work includes stable isotope analysis to investigate how road crossings might impact trophic structure by altering availability of food sources like algal biofilms. As central Maine undergoes more development, it will be important to have a baseline food web that explains current conditions in the case of future restoration efforts.

Kari Beaulieu, Abraham Dailey, Firooza Parvi
Muskie School of Public Service, University of Southern Maine, Gorham, ME; firooza.pavri@maine.edu

SPECTRAL INDICES AND LOGIC FUNCTIONS TO IDENTIFY DEVELOPED LAND FEATURES IN THE SEBAGO WATERSHED USING LANDSAT'S OPERATIONAL LAND IMAGER

Freshwater resources provide vital societal and ecosystem services. Rapid changes due to economic development within the watersheds of lake systems influence water quality and their capacity to meet present and future needs. Sebago Lake is an important source of public water supply to numerous southern Maine communities. Monitoring land use changes across the watershed, and especially those associated with development activities can help target appropriate conservation interventions to support the sustainability of this system. Using multispectral data from the new Landsat 8 Operational Land Imager (OLI) and spectral indexing techniques, including the Normalized Difference Built-up Index and the Soil Adjusted Vegetation Index, we build spectral index datasets for the Sebago Lake watershed for 2013. Next, using logic calculations, we extract built-up or developed areas from these spectral index datasets to create new images that detail built-up land features across the watershed. Our initial accuracy assessments reveal reliable results using this hybrid technique. Such an approach can be used as a quick and reliable way to identify development activity across vulnerable watersheds.

Clara G. Bicher, Sara E. George, Bruce F. Rueger
Department of Geology, Colby College, Waterville, ME; cgbicher@colby.edu,

FROM THE DEPTHS OF GREAT POND (MAINE): ANTHROPOGENIC AND NATURAL INFLUENCES ON BOTTOM SEDIMENTS AND THE IMPLICATIONS FOR LOCAL SUSTAINABILITY

Research focusing on sustainability in the Belgrade Lakes watershed consisted of collecting bottom samples from Great Pond. Samples were analyzed to create a sediment map of the lake basin including depth, grain-size, organic content (%C), C:N ratios and phosphorus concentration. Results will aid in the understanding of the glacial formation of the lake, distribution of sediment, and human impact. Distribution of phosphorus within the sediments allows development of a strategy to avoid accelerated eutrophication. To evaluate natural and anthropogenic changes, 67 samples were collected. Multiple sedimentologic and geochemical proxies will be used to infer in-lake ecological responses. Grain-size will be used to determine sediment source. Results indicate a predominance of silt and clay-sized sediment related to the underlying glacio-marine Presumpscot Formation. Other samples indicate a local esker and outwash sources. Total organic carbon (TOC) was used to evaluate biomass produc-

tivity. C:N ratios between 8 and 11 indicate an algal origin for the organic matter. Mapping this data could indicate zones at risk for future algal blooms. Results will be compared with data from East Pond sediments. The sediment map will be used to determine the geologic origins of the sediment and areas of erosion. Sediments will also be analyzed for phosphorous content to determine anthropogenic impact, with the intent of creating an awareness of chemical influx and consequences. This research will increase the knowledge base of lake sedimentation and chemistry and provide data that can be used by local conservation groups for community education and advocacy for best sustainability practices for lake management.

Cameron Adams, Philip Camill
Department of Earth and Oceanographic Science, Bowdoin College, Brunswick, ME; cadams@bowdoin.edu

IMPLICATIONS OF CLIMATE VARIABILITY ON BOREAL AND SUBARCTIC WETLAND CARBON FLUXES IN MANITOBA, CANADA

High latitude wetland ecosystems accumulate and store massive amounts of organic carbon as undecomposed peat moss. In the peatlands of the Canadian subarctic, these high rates of carbon storage are the result of hydrologic variables (deep layers of permafrost and/or water tables near the peat surface) that reduce the ability of the microbial community to utilize aerobic respiration in the breakdown of organic material. The predicted warming in the coming decades stands to dramatically alter peatland carbon dynamics by forcing changes in aridity and hydrology. Despite some concerns that peatlands may begin to source carbon to the atmosphere, there is evidence to suggest that warming may actually lead to increases in the rates of carbon storage. This study presents the preliminary carbon accumulation histories from six peatlands in northeast Manitoba, Canada. The six cores were radiocarbon dated (3,895-7,952 BP) and analyzed for bulk density and total carbon in order to generate rates of carbon accumulation through the history of each peatland. The rates were then compared against known shifts in Holocene climate between warm (Holocene Thermal Maximum, 6500-2500 yr BP) and cool (Neoglacial cooling, 2500-present) periods to better establish the link between climate and carbon accumulation and to better understand how past climate changes in peatlands may serve as an analog to contemporary climate change.

John Ahern, Monique Theriault, **Nina Caputo, James Killarney,** Howard Patterson
Department of Chemistry, University of Maine, Orono, ME; john.c.ahern@umit.maine.edu; nina.caputo@umit.maine.edu; james.killarney@umit.maine.edu

RAPID DETECTION OF HORMONE AND PETROCHEMICAL CONTAMINANTS IN NATURAL WATER SYSTEMS

The focus of this research was the development of screening methods for the detection of low concentrations of hormone and petrochemical contaminants in waste water through fluorescence spectroscopy and parallel factor (PARAFAC) analysis. Synthetic hormone pollutants are ubiquitous in receiving waters and have demonstrated negative effects on aquatic life. Thousands of oil and other petrochemical spills occur each year and their occurrence is likewise a threat to humans and wildlife as observed after events like the deepwater horizon and Exxon Valdez spills. Being able to detect petrochemicals like phenol as well as synthetic hormones is essential to preserving ecosystem health

and safeguarding drinking water supplies. Although there are existing methods for detecting these pollutants in water, they are expensive as well as time consuming. Fluorescence spectroscopy is a low-cost and more rapid form of detection making it a very useful method in many situations. The research of this project is centered on three synthetic estrogens: 17-α ethinylestradiol (EE2), estriol and mestranol as well as the petrochemical phenol. We reached limits of detection comparable to those reached by more expensive detection methods. PARAFAC analysis aided in the detection process especially when studying mixtures of different target compounds in solution. We were able to distinguish between the target compounds and other components naturally found in water. Lastly, doing liquid-liquid extractions prior to fluorescence further lowered limits of detection.

**Poster displayed in graduate student section.*

Kiana Kawamura, Rebecca Chmie, Haiyang Tang, Denise Bruesewitz, D. Whitney King
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"GOLDIE" THE GREAT POND SENTINEL. TELLING THE SEASONAL STORY OF LAKE DYNAMICS TO A STAKEHOLDER AUDIENCE

Goldie is an automated sampling buoy deployed in the deepest point of Great Pond, Belgrade Lakes, Maine. Built by Nexsens Technology, the buoy is a highly capable platform for limnology research; equipped with a suite of sensors for measuring water temperature, light, dissolved oxygen concentration (surface and bottom), and fluorescence. The buoy is powered by 15-watt solar panels and communicates to our labs at Colby using a dedicated cell phone. Although Goldie provides extremely detailed data for the limnology professional, the information is not easily understood by the stakeholder community. Our work focuses on analyzing and transforming the real-time data from Goldie to make it more reader-friendly. We use the GLEON program Lake Analyzer to calculate thermocline depth, Schmidt stability, and Wedderburn number to illustrate the natural stability of the lake. These computed parameters are integrated with real-time temperature, oxygen, light, and weather to produce an interactive dashboard of lake conditions. Interactive graphs built using the Highchart JavaScript library allow the user to zoom and pan on the data sets. Updated hourly, these graphs allow the community to visualize the lake in a clear and engaging way that promotes conservation awareness through a direct connection to lake water quality.

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NUTRIENT DYNAMICS OF NEQUASSET LAKE: EFFECTS OF ANADROMOUS ALEWIFE SUBSIDIES

This study aims to create a detailed budget for nitrogen and phosphorous in Nequasset Lake, Woolwich, ME. Nequasset supplies drinking water to Bath and Brunswick, and every spring receives an annual migration of the Alewife *Alosa Pseudoharengus*. These anadromous fish swim upriver from the Gulf of Maine to spawn in the lake and have the potential to bring with them biomass and nutrients from the marine system that will be incorporated into lake nutrient cycles via excretion, gamete release, and fish mortality. Young of the year fish in turn export some of these nutrients with their fall emigration. Fish passage, however, is limited by a dilapidated fish ladder and commercial alewife harvest. Preliminary results from a fish passage count, water nutrient concentration data, and carbon and

nitrogen stable isotope analysis indicate that these marine derived nutrients (MDNs) currently represent a small proportion of total lake nutrient budgets. Current modeling efforts seek to quantify the effects of potential fish ladder restoration and increased Alewife migration strength on lake health.

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CREATING A DIGITAL ARCHIVE OF THE SACO ESTUARY PROJECT

Sustainability science requires collaboration and communication among interdisciplinary researchers and diverse stakeholders. Resources generated during collaborative projects take many forms including reports, peer reviewed papers, photographs, audio and videos. How can such diverse sources be managed and made available as a record of the project over time? Omeka is a web publishing platform to display libraries, archives, museums, and similar things all in one place. Before a web site like Omeka, researchers had to use a variety of sources just to get important information. Sharing information with stakeholders was a challenge. Omeka changed that. Omeka and sites like it are the future of digitally archiving complex project documentation in one place. In the fall of 2013 in my Digital Humanities class, I was able to connect with Omeka because my professor, Michael Cripps, engaged our class of seven students in a project to create a digital archive of the Saco Estuary Project. Our goal was to make a multilayered web page through Omeka that showed and educated scholars as well as the average person about the features and the life of the Saco River. At the completion of our project we saw the potential to go even further with archiving more information in Omeka, work that can be undertaken by future classes. My poster will be demonstrating how Omeka was able to archive information on the Saco River Project, as well as how Omeka can be used as a tool to support sustainability science. Preliminary results also suggest that movement was affected by tidal cycle and time of day.

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ASSESSING ZOOPLANKTON TRENDS IN GREAT POND USING FLOWCAM® TECHNOLOGY

Lakeshores are increasingly being transformed from their natural forested and wetland cover to developed lawns, sandy beaches, and impervious surfaces associated with residential development. These changes can affect lake water quality and littoral ecosystem function, largely through nutrient loading. Real-time ecological monitoring using sensory arrays for biogeochemical variables such as water pH, temperature, and dissolved oxygen provides a data stream that allows scientists to develop a more complete picture of a water body and heighten understanding of processes like stratification and lake mixing. Colby College recently deployed a high-frequency monitoring buoy in Great Pond that collects such data. To determine possible relationships of the buoy measurements and zooplankton population dynamics, we assessed the abundance and diversity of zooplankton using the FlowCAM®, which recorded images and catalogued particle counts from the water samples. The water samples were collected from a site near the buoy and four other sites in Great Pond. Using the FlowCAM® data, we

determined the population trends of the most dominant zooplankton species found in Great Pond during the summer months of 2013. These trends will then be compared to the biogeochemical variables measured by the buoy.

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THE IMPACT OF DAMS ON NITROGEN PROCESSING IN THE MESSALONSKEE STREAM

The Messalonskee Stream in central Maine has five hydroelectric dams on 16.6km. Each dam drastically changes the flow regime of the stream, dividing it into segments with different patterns of sediment settling and organic matter retention. We investigated how these disruptions impact nitrogen cycling, specifically nitrification rates above and below each dam. We expected higher nitrification rates above the dams, where levels of organic matter are higher, and lower rates below the dam where scouring removes organic matter and fine sediment from the streambed. We measured sediment nitrification rates with a nitrapyrin-inhibition assay and potential drivers of nitrification including sediment organic matter and pore water ammonia (NH^{4+}) above and below each dam. Nitrification rates ranged from below detection to 552 µg NH^{4+} gAFDM-1 day-1. As expected, we measured higher nitrification rates above the dam in three of five locations, along with higher pore-water NH^{4+} and sediment organic matter. Variation among the five dam sites is due to different distributions of sediment above and below the dams at each site, suggesting that even within a small stream, nitrification rates are variable.

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MAPPING AS A TOOL OF DOCUMENTING THE INVASIVE PHRAGMITES AUSTRALIS ALONG THE SACO RIVER ESTUARY

Invasive *Phragmites australis* has been an increasing problem in tidal marshes along the Saco River estuary. Since 2011, the spread of *Phragmites* has been documented from the mouth of the river to the dam between the towns of Biddeford and Saco, Maine. The Saco River estuary is unique due to the tidal exchange that produces a wetland continuum from salt marsh to tidal freshwater marshes. The plants are important to the health of both the river and the upland adjacent to the river. Using Geographic Information Systems (GIS), we mapped 32 known patches of *Phragmites* along the estuary. *Phragmites* covers approximately 21,309 square-meters along the river. ArcMap was used to determine the patterns and spread of the invasive throughout the estuary. From what has been studied over the course of the past three years, this invasive species has been growing and spreading along the river, increasing the number and size of *Phragmites* patches. This is the first time that the area has been comprehensively mapped. These maps will be used by current and future researchers to assess the impacts of *Phragmites* on biodiversity, and to help develop a management plan.

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THE INFLUENCE OF SHORELINE DEVELOPMENT ON RIPARIAN AND LITTORAL HABITATS IN THE BELGRADE LAKES

Residential development of shoreland areas can negatively affect habitat structure and biological diversity of both riparian and littoral habitats. The objective of our study was to examine the influence of different degrees of shoreline development on characteristics that are indicators of a healthy riparian and littoral ecosystem associated with Great Pond, East Pond, and North Pond in the Belgrade region of central Maine. Undeveloped reference sites, buffered developed sites and unbuffered developed sites were identified along the shorelines of each pond and surveys were conducted to assess indicators of ecosystem health, including cover and composition of riparian vegetation, buffer width, substrate composition, and invertebrate diversity in the littoral habitat. Reference and buffered developed sites had significantly greater shading along the shoreline with more heterogeneous plant growth and stratification along buffer strips than unbuffered developed sites. In the littoral habitat, unbuffered developed sites had significantly more sand, less cobble, a greater degree of embedded rocky substrate, less aufwuchs cover (i.e., algae and sessile invertebrates), and less woody structure than reference and buffered sites. The results of our research agree with those reported by Merrell et al. (2009, 2013) for other lakes in Maine and Vermont. Overall, we hope these data serve as important evidence for landowners that low impact development can result in minimal changes to riparian and littoral habitats when compared to undisturbed reference sites. Reducing the impact of shoreline development is important to maintain healthy lake ecosystems.

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A SCENARIO APPROACH TO SUSTAINABLE FOREST MANAGEMENT IN KENNEBUNK, MAINE: UNDERGRADUATE EXPERIMENTAL LEARNING AT THE UNIVERSITY OF NEW ENGLAND

Forest Landscape Ecology and Management (ENV 372) offered in the Fall of 2013 at the University of New England (UNE) required the creation of a scenario based forest management plan of a parcel of land in Kennebunk, Maine. The goal of this project was to implement management approaches that promote sustainability through in-field data collection, web searches, and lecture. With a partner we created various sustainable approaches that incorporated our scenario's goals and objectives: sustainable timber production, low-impact recreation, and the protection of wildlife. Through this process students were able to receive a hands-on approach of creating a forest management plan, while using critical thinking to implement practices that sustain the health of the land. At the conclusion of this project we completed a written document as well as an in-class oral presentation that discussed our management plan with the presence of Kent Canfiel, a member of the Maine Forestry Department, and the person in charge of the creation of the official forest management plan of the same Kennebunk parcel.

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d15N ISOTOPE ANALYSIS OF A SEDIMENT CORE TO RECONSTRUCT WATERSHED HISTORY OF NUTRIENT CYCLING IN NEQUASSET LAKE, WOOLWICH, ME

Nitrogen isotopes of lake sediment cores can be used to better understand changes in nitrogen cycling and sources of nitrogen entering a watershed through time. In lakes that receive marine derived nutrients (MDN) from anadromous fish migrations, the nitrogen isotope composition of core sediments can be used to reconstruct the relative strength of paleo-anadromous fish runs. Nequasset Lake serves as an annual spawning habitat for the anadromous alewives (*Alosa pseudoharengus*). Repairs to a water control dam since its original construction in 1730 and other natural and anthropogenic changes to the watershed have impacted nutrient cycling and the alewife migration. Biogeochemical cycling within Nequasset Lake is currently a subject of study by the Bates, Bowdoin, and USM Sustainability Solutions Initiative team and the Kennebec Estuary Land Trust. The purpose of this study is to examine the nitrogen and carbon isotope compositions of a sediment core from Nequasset Lake to reconstruct watershed history. Preliminary interpretations suggest that the presence of anadromous fish migrations have occurred throughout the sedimentary record, as evidenced by consistently elevated d15N values compared to a nearby lake that does not receive anadromous fish. A significant shift in the sedimentary record between 26 and 14 cm is marked by a decrease in C/N ratios, % organic carbon and nitrogen, and an increase in d15N. The lake likely experienced a fundamental shift in nutrient cycling that may be explained by increased input of MDN and/or eutrophication. Radiocarbon dated samples will be used to align sedimentary changes with anthropogenic and natural watershed alterations.

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PEATLAND HYDROLOGY AND CARBON DYNAMICS OVER THE HOLOCENE THERMAL MAXIMUM IN LABRADOR, CANADA

Changes in climate have the potential to dramatically alter the regional hydrology and carbon dynamics of high-latitude wetlands. The peatlands of southern Labrador, Canada represent an important gap in understanding how these ecosystems responded to past warming during the Holocene Thermal Maximum (HTM) ~10,000-6,000 BP, which may be a potential analog for how they will respond to future warming and changes in moisture. Existing across a gradient of coastal to inland climate zones, the peatlands of Labrador also offer a means of studying the effects of regional hydrologic and climatic factors on carbon accumulation. Six cores were taken along a longitudinal transect from coastal to interior peatlands in southwestern Labrador (representing an east-to-west decline in precipitation), and are being 14C dated at five intervals, measured for total percent C and N, bulk density, and organic carbon content to determine accumulation rates. Preliminary data shows less accumulation and younger basal dates inland, suggesting a relationship between carbon accumulation and coastal climate, hydrology, and glacial history. Ongoing work is examining the changes in accumulation rates across the HTM to understand how the wetlands respond to environmental change.

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SUSTAINING THE SACO RIVER: PROJECTS TO PROMOTE AWARENESS

In the fall semester 2013, a Sustaining the Saco River class was offered at the University of New England for undergraduate students. The purpose of this class was to introduce sustainability science through the lens of the Saco Estuary Project, part of Maine's Sustainability Solutions Initiative. Students learned about the importance of the river, threats to ecosystem health and actions to sustain what people care about. Students were required to create capstone projects that were beneficial in some way to helping to preserve the Saco River. Projects supplied significant data results, promoted community awareness, or created initiatives to attempt to preserve the river and the life within it. This poster illustrates the concepts and significant results of each of these presentations. The result of this project was an in-depth awareness of the biodiversity of the Saco river, along with the environmental issues threatening to reduce this biodiversity. As the projects progressed, students felt like it was their responsibility to protect the river and get the information they had collected out to the public in order to promote awareness. The main conclusions of the work completed are these seven final capstone projects. These projects are either finished or templates that can be used in future classes as a way to spark initiative within the students to study the aspects of the Saco River and more fully develop these ideas behind the projects. These projects can be used as outreach materials available to provide information about the environmental health of the river.

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ICE OUT, SPRING MIXING, AND DISSOLVED OXYGEN TRENDS: COMPARING HEADWATER AND FLOW-THROUGH PONDS IN WESTERN MAINE

This project investigates the relationship between dissolved oxygen, ice out, and spring mixing in small ponds in western Maine. Using high-resolution water temperature data collected at multiple depths in the ponds, we determined the timing of ice out and mixing events at multiple locations in 2012 and 2013. The study includes both headwater and flow-through ponds, and this project focuses on representatives of each. At one location, a small flow-through pond, we were able to collect dissolved oxygen profiles twice prior to and then immediately after ice-out. These profiles showed that dissolved oxygen increased near the surface prior to ice out. Although these data are limited, the finding led to an examination of water temperature data and summer dissolved oxygen profiles at several other locations with longer records. In 2012, temperature records indicate mixing following ice-out and higher dissolved oxygen concentrations. In contrast, following ice-out in 2013, temperature data show limited or delayed mixing in several ponds, resulting in lower dissolved oxygen values. We predicted that flow-through ponds would introduce a higher dissolved oxygen concentration and produce more mixing, but initial results don't show these trends. The observed similarity prompts us to question our assumption that flow-through ponds would be better mixed by meltwater contributions. We would like to continue further investigation to acquire a better understanding of how weather and/or watershed characteristics are integral to mixing dynamics and overall summer stability.

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FOSSIL FREE UNE: HOW DIVESTMENT FOSTERS SUSTAINABILITY

In 2012, 350.org founder Bill McKibben spoke in Portland, ME, calling for students to challenge their university's leaders to make a commitment to divest from fossil fuel companies. A group of students at the University of New England decided to pursue this goal. Subsequently, the group Fossil Free UNE formed around this mission and currently is a committee and internship working towards divesting the school from the top 200 fossil fuel companies in order to encourage sustainable practices. To "divest" from fossil fuels would mean to change UNE's investment strategy so that the endowment is invested in more sustainable and ecologically responsible options instead of fossil fuel companies. The fossil fuel industry is the most profitable in the world, and continues to value their profits above community health and environmental sustainability. Therefore, divestment is a way to challenge the unjust practices of this industry. As of March 2014, Fossil Free UNE has been successful at gaining approval from the Environmental Council and UNE Undergraduate Student Government (USG). In addition, the committee has obtained UNE student body support. Future goals include gaining UNE presidential support through professional presentations to additional UNE student government bodies (GAPSA and UNECOM), leading to eventual divestment approval from the Board of Trustees.

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COASTAL CURRENTS IN THE GULF OF MAINE: A MECHANISM FOR ALGAL BLOOM TRANSPORT

The Gulf of Maine experiences blooms of *Alexandrium fundyense*, a toxic dinoflagellate, almost every year between May and October. These blooms appear cyclically in the spring and fall, and appear to be dependent on a combination of seasonal stratification cycles and wind forcing. Spring blooms occur when warming water temperatures cause phytoplankton and nutrients to be held at the surface where light is abundant, allowing for a bloom. The fall bloom occurs during the onset of destratification when cooling waters at the surface sink and allow deeper, nutrient-rich water to rise to the surface. The propagation of blooms is along the coast and generally unidirectional, signifying that bloom movement is probably due to residual current flow. We present the development and application of a quantitative model of current circulation along the shelf in the Gulf of Maine. The model matches observed patterns in summer surface circulation and allows for further understanding of the mechanisms driving both current circulation and algal bloom advection. Current flow is primarily along the coast in a southerly direction, with some diversion offshore. This is likely controlled by river plumes that raise nearshore sea surface height, causing geostrophic flow to be south and west along the coast. Fall current flow is not southerly off the coast of New Hampshire, meaning that fall algal bloom propagation is not due to current advection in the southern Gulf of Maine. The modeled circulation climatology provides insight into hydrographic patterns and ecosystem dynamics as they relate to alongshore advection.

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PATTERNS OF NUTRIENT LIMITATION IN STREAMS AND LAKES OF THE BELGRADE LAKES WATERSHED: COMPARISONS ACROSS ECOSYSTEMS AND TROPHIC STATES

Temperate lakes are often phosphorus(P)-limited, in contrast to stream ecosystems that are often nitrogen(N)-limited. However, patterns of nutrient limitation across these ecosystem types are rarely compared directly within the same watershed. The Belgrade Lakes watershed in central Maine, comprised of seven interconnected lakes of differing trophic states, provides a unique ecosystem of study. We determined nutrient limitation in four streams using nutrient diffusing substrata (NDS) for stream biofilms and in five lakes using an analogous water-column bioassay for lake phytoplankton. In both methods, we used a control and treated samples with additions of phosphate (PO4-), nitrate (NO3-), ammonium (NH^{4+}), and both NH^{4+} and PO^{4-}. We hypothesized that streams would be N-limited, while the lakes would be P-limited. Nutrient limitation in the streams was largely site specific: two sites exhibited no limitation, two were co-limited, one P-limited, and one N-limited. This suggests that shoreline nutrient inputs from landscape runoff could have more of an impact on stream biofilm growth than nutrients from upstream water bodies, and highlights the importance of homeowner education about buffers and other watershed-friendly environmental practices.

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STABLE ISOTOPE ANALYSIS OF WATERFOWL DIETS IN AN URBAN PARK

Feeding waterfowl has become a popular pastime worldwide, yet little is known about the impacts to the surrounding ecosystem. Feeding waterfowl excessive amounts of anthropogenic foods, could have a wide range of effects on the ecosystem and health of waterfowl. To determine whether the aquatic food web of an urban park had been affected by feeding the waterfowl we performed a stable isotope analysis of carbon and nitrogen on the waterfowl's feathers, popcorn and five different plant and animal species within the aquatic food web. The $\delta^{13}C$ and $\delta^{15}N$ values between two different sites were compared to determine if the isotope values from the park site with anthropogenic input had shifted to a more terrestrial carbon-based signature, a potential result of the excessive amounts of corn-based products. The mean $\delta^{13}C$ values from all samples ranged from -20.6 0/00 to -30.6 0/00. Slight shifts toward more terrestrial or marine signatures were observed in three of the samples from the park site. The results of a multiple source linear mixing model indicated that 92.4% of the organic carbon in the waterfowl feathers was derived from popcorn. The source of this result is most likely the anthropogenic input of popcorn to the system, and suggests that these ducks are not relying on the aquatic food web for food. We suggest that further research be performed to determine the potential long term impacts of corn-based diets on waterfowl and on the ecosystem.

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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. The Saco River Estuary (SRE) is an established nursery ground and habitat for 60 marine, diadromous, and freshwater fish species, including many that are considered threatened or of commercial and recreational importance in the GOM. Although the fish community has been well studied in the SRE, no study to date has attempted to correlate seasonal fluctuations in fish abundance to environmental factors. Preliminary information on the abiotic characteristics of the SRE suggests that the estuary exhibits large fluctuations in relative salinity (0-30ppt) and surface water temperatures (14-31°C). In addition, preliminary data suggests that abundance and diversity of juvenile fish species in the SRE fluctuates on relatively short (month) and long (annual) temporal scales, with highest abundance occurring late summer while diversity is highest midsummer. Since physical properties associated with estuaries can affect the function of biological systems, this research will give insight to which abiotic factors (e.g. temperature, salinity, dissolved oxygen, pH) are influencing the juvenile fish assemblage of the SRE. Furthermore, with the current threats to this region (e.g. climate change, coastal development, pollution, and overfishing), understanding the dynamics of fish communities are imperative for proper conservation and management.

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MAINE SUMMERTIME BLOOMS: VARIABILITY IN POPULATIONS OF GLOEOTRICHIA IN THREE MAINE LAKES

Gloeotrichia echinulata, a toxic species of cyanobacteria, is present in at least 22 Maine lakes. This study examines *G. echinulata* abundances at 15 sites across three Maine lakes: Panther Pond in Raymond, Pleasant Lake in Casco, and Lake Auburn in Auburn, during summers 2011-13. In 2013, Lake Auburn - consistently the lake with the coolest temperatures and highest chlorophyll a levels - experienced a *G. echinulata* bloom (median 9 colonies/L) from early July-August, three weeks prior to the major bloom in Panther Pond (median 50 colonies/L). Meanwhile, Pleasant Lake experienced its highest *G. echinulata* levels (0.2 colonies/L) in early September. There was no evidence that within-lake variation in populations at Panther Pond or Pleasant Lake was a result of wind patterns. At Lake Auburn, the sites with the highest *G. echinulata* abundances were in the southeastern end. These southeast sites experienced the highest abundances when sampled within 72 hours of a north-northwest wind ≥ 9 km/h. An in-lake mesocosm experiment in Panther Pond revealed that population

growth rates depended on both *G. echinulata* density and the time of year but not the addition of phosphorus. These findings suggest no one major driver or indicator of *G. echinulata* populations but rather a dependence on many factors including the cyanobacterium's life cycle, weather patterns, lake temperature, nutrient levels, and light availability.

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SUMMERTIME OXYGEN FLUXES IN THREE SMALL LAKES IN THE RANGELEY REGION

For the past two summers investigators from the University of Maine at Farmington have been investigating water quality and thermal regimens of lakes in the Rangeley area. The region is an internationally known tourist destination with its many lakes and ponds and its native brook trout and land-locked salmon fisheries. The large lakes in the area (Rangeley and Mooselacmeguntic) are oligotrophic lakes with above average secchi transparencies and water quality. In the smaller ponds in the region we gathered conflicting water quality data that appears to be influenced primarily by lake morphology. Three smaller lakes in the region (Round, Gull and Middle Sandy River Ponds) are characterized by shallower epilimnions during the summer stratification, decreased secchi transparencies and significant hypolimnetic oxygen declines. Rates of oxygen depletion have been calculated for all three ponds using volume calculations derived through GPS/GIS technology and oxygen profiles that were conducted every two weeks on the ponds. Currently, the lakes' shorelines are not heavily developed and there exists the risk that future development and increasing water temperatures will result further declines in hypolimnetic oxygen values and threatening the salmonid populations in these ponds.

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DETERMINING THE AMOUNT OF BUFFER DISTURBANCE ALONG THE PRESUMPSCOT, LITTLE, AND PLEASANT RIVERS WITH GIS

GIS (Geographical Information Systems) is a powerful mapping software that has a variety of applications including: data storage, remote sensing, spatial pattern identification, and cartography. The objective of this research was to use ArcGIS to determine the percentage of riparian buffer area disturbed along three rivers within the Presumpscot Watershed. Geographic points gathered by the Maine Department of Environmental Protection and the University of Southern Maine were used to build the model's base map in ArcMap 10.1. The state mandated riparian buffer distance for rivers was added to the map. Polygons were drawn over areas within the buffer zone that were obviously disturbed by development and/or farming. The polygons were merged and the total area of disturbance was calculated for each river. The same was done for areas that were not disturbed. The GIS analysis showed that 40.09% of the Presumpscot River, 47.24% of the Pleasant River, and 21.51% of the Little River were disturbed. The next step for this project is to identify areas that are protected by physical barriers, laws, or both. Our eventual goal is to relate buffer disturbance with water quality and use the results to make recommendations for municipal and regional planning.

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THE RELATIONSHIP BETWEEN FIRE FREQUENCY/SEVERITY AND RATES OF CARBON ACCUMULATION IN THE WETLANDS OF NORTHERN MANITOBA, CANADA

Subarctic wetlands store an equivalent of 75% of global atmospheric carbon in the form of peat. Carbon fluxes in these wetlands are expected to undergo significant changes with current rates of climate warming, and the potential exists for this carbon to be released into the atmosphere through increased decomposition, as well as the impacts of changing hydrology on fire. Warming may have two very different outcomes on peat landscapes: (1) thawing permafrost and the conversion of dry bogs into wet fens and (2) increased drying with increased aridity in unfrozen peatlands. Previous studies indicate that fire severity and frequency may increase with warming/aridity, thereby releasing carbon into the atmosphere. To understand how climate may impact fire and rates of carbon accumulation, we examined six peat cores from northern Manitoba, Canada, in the context of past warm events, such as the Holocene Thermal Maximum (HTM), which occurred between 6,000-2,500 BP in this region. Basal radiocarbon dates indicate that this peatland region spans the early to mid Holocene (3,895-7,952 BP), capturing the transition from warmer/drier conditions during the HTM to cooler/wetter conditions during the Neoglacial. Areal charcoal concentrations were measured as a proxy for fire severity and indicate peak severity in the top 50 to 100cm in five of the six sites, corresponding to time periods that are likely after the HTM warming. Ongoing radiocarbon dating is in progress to help identify the relative timing of fire and C accumulation to test these hypotheses.

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DETERMINING SEX RATIOS AND SEXUAL MATURITY OF ATLANTIC STURGEON (*ACIPENSER OXYRINCHUS OXYRINCHUS*) IN THE SACO RIVER, MAINE

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a long-lived, anadromous fish species ranging from Labrador, Canada to Florida, USA. In the Saco River, located in the Gulf of Maine, Atlantic sturgeon were common in the 1920's, but were extirpated by the 1950's due to overfishing. However, after a 60 year absence, Atlantic sturgeon reappeared in the Saco River in 2007. Although the reason for the return of this species to this river system remains unknown, research on basic life history information is necessary to facilitate the conservation of this federally protected species. Understanding reproductive parameters such as sex ratios and sexual maturity are vital to effective management of any species. Unfortunately, this information is typically obtained by lethal, gross dissection, or stress inflicting endoscopy. Thus, in order to better understand these important life history parameters, three non-invasive techniques (steroid hormone analysis, ultrasonography, and external morphological features) are being utilized to non-lethally determine sex ratios, sexual maturity, and reproductive status for sturgeon captured within the Saco River watershed. Preliminary results suggest that the combination of these three techniques provides the most accurate assessment of repro-

ductive parameters in Atlantic sturgeon. This study will continue to couple these techniques in order to determine reproductive parameters of Atlantic sturgeon inhabiting the Saco River, which in the future can be applied to other sturgeon populations.

GRADUATE POSTER ABSTRACTS

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RAPID DETECTION OF HORMONE AND PETROCHEMICAL CONTAMINANTS IN NATURAL WATER SYSTEMS

The focus of this research was the development of screening methods for the detection of low concentrations of hormone and petrochemical contaminants in waste water through fluorescence spectroscopy and parallel factor (PARAFAC) analysis. Synthetic hormone pollutants are ubiquitous in receiving waters and have demonstrated negative effects on aquatic life. Thousands of oil and other petrochemical spills occur each year and their occurrence is likewise a threat to humans and wildlife as observed after events like the Deepwater Horizon and Exxon Valdez spills. Being able to detect petrochemicals like phenol as well as synthetic hormones is essential to preserving ecosystem health and safeguarding drinking water supplies. Although there are existing methods for detecting these pollutants in water, they are expensive as well as time consuming. Fluorescence spectroscopy is a low-cost and more rapid form of detection making it a very useful method in many situations. The research of this project is centered on three synthetic estrogens: 17-α ethinylestradiol (EE2), estriol and mestranol as well as the petrochemical phenol. We reached limits of detection comparable to those reached by more expensive detection methods. PARAFAC analysis aided in the detection process especially when the studying mixtures of different target compounds in solution. We were able to distinguish between the target compounds and other components naturally found in water. Lastly, doing liquid-liquid extractions prior to fluorescence further lowered limits of detection.

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EVALUATING SPATIAL AND TEMPORAL TRENDS IN SNOWPACK ACROSS MAINE

Data covering the last century show a declining trend (~0.84 cm/year) in the annual snowfall in Maine. Additionally, annual temperatures are increasing, causing the number of days per year above freezing (0˚C) to increase. These trends already have had an impact on snowpack throughout the state in terms of snow-water equivalent, density, and longevity. This study utilizes a team of citizen scientists along with high school students from across the state to monitor snowpack at various locations throughout the winter. Using these data, we will test for differences in snowpack characteristics between open sites and forested sites as well as other factors including slope, aspect, forest cover type, latitude/longitude, elevation, and time of year. Many of the locations have had little or no prior snowpack research, particularly the coastal climate division, making this an excellent opportunity to

strengthen our knowledge of snowpack across all parts of the state. Combined with data gathered over the last century, we will further our understanding of the impact climate change has on Maine's snowpack and what it might mean for future floodflow expectations, coastal resilience, and ecological integrity.

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ALGAL COMMUNITY RESPONSE TO INCREASES IN DISSOLVED ORGANIC CARBON OVER RECENT DECADES

As a result of reduced sulfur emissions and changing climate, dissolved organic carbon (DOC) concentrations have increased in many lakes situated in forests of New England. DOC is an important regulator in aquatic ecosystems, influencing vertical habitats by enhancing light attenuation and, in small lakes, decreasing lake mixing depth. Whereas this increase has been well documented, the associated implications for the physical structure and biological communities in these lakes remain unclear. To investigate how diatom communities have changed in lakes experiencing an increase in DOC, we compared algal fossil records to over 20 years of water chemistry data from the U.S. EPA Long Term Monitoring network for six remote Maine lakes. Three pairs of small (<50 ha), morphologically similar lakes were selected for this study, with each pair containing one lake with a significant increase in DOC and the other experiencing no change in DOC since 1993, when sampling began for most lakes. Lake pairs were established to represent both low (1-3mg/L) and moderate (3-6 mg/L) DOC concentrations. A shift in diatoms from heavily silicified *Aulacoseira* species to smaller *Discostella* species was observed in the lake with increasing DOC and absent in the lake with no DOC change in the moderate concentration pair. This may indicate a shift to shallower mixing depths in lakes with increasing DOC. However, this shift was absent in both lakes in the low concentration pair, which suggests that the diatom community response may depend on the concentration of DOC.

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REMEDIATION STRATEGIES FOR MERCURY CONTAMINATION IN HODGDON POND, ACADIA NATIONAL PARK: THE USE OF ZERO- VALENT IRON AND GRANULAR ACTIVATED CARBON

Wetlands are well-known hotspots for storing mercury (Hg) and converting it to its more toxic form, methylmercury (MeHg). MeHg is subsequently released into adjacent water bodies and taken up by fish. In 2010-2012, an expansive survey of more than 125 lakes and ponds in Maine suggested that fish with the highest MeHg burdens were found in waters with a large wetland contribution. Among these systems, Hodgdon Pond, Acadia National Park, Maine, had the highest levels of fish MeHg due to the large proportion of adjacent wetlands. As such, a sustainable remediation of wetlands with respect to Hg contamination is of interest to the public. The objective of this work was to determine if zero-valent iron (ZVI) or granular activated carbon (GAC) application is an appropriate MeHg remediation strategy for the pond. Twelve mesocosms were constructed in the inundated fringing wetland of

Hodgdon Pond, and ZVI and GAC were applied as treatments. Sediment and porewater samples were collected at different times, and analyzed for relevant parameters. Results indicate that both ZVI and GAC significantly lower the concentration of MeHg in porewater, and that more MeHg is present in porewater in summer than fall due to plant activity. We are presently conducting lab microcosms experiments with wetland plants to study MeHg uptake by macroinvertebrates. Further studies are needed to determine the longevity and the effect of these additives on wetland plants and organisms.

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ANALYZING THE ECONOMICS OF SHELLFISH MANAGEMENT POLICY STRUCTURES

A natural resource involving complex social and ecological interactions requires information from a range of disciplines for sustainable management. The biology of soft-shell clams, *Mya arenaria*, includes susceptibility to accumulation of bacteria transported to mudflats from combined sewage and storm water discharges and malfunctioning subsurface wastewater disposal systems. Since clams are harvested as a food resource, this presents human health risks. While essential for protecting human health, closures to harvesting negatively impact the economy; therefore, poor water quality leading to closures become central to shellfish management policy structures. These structures take various forms and influence the management actions taken to address concerns. This sustainability challenge was identified by stakeholders who support the formation, operation and resilience of shellfish management structures, and by University of Maine researchers. Input from stakeholders guides the development of research questions and project design. This Social-Ecological Systems research employs economics and policy theory and methods, under the Institutional Analysis and Development framework, to examine significant factors in clam management. The Network of Adjacent Action Situations framework provides a view for how shellfish management structures impact management actions. Integration of social and ecological knowledge offers great potential for improved management. Support networks can be better prepared to provide resources to those motivated to address mudflat concerns. Understanding ecological factors informs decision-makers of possible management actions. This project contributes to the on-going research of the New England Sustainability Consortium and to a body of literature focused on the institutional structures of natural resource management.

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KINETICS OF PPCP ADSORPTION TO DISSOLVED ORGANIC MATTER USING FLUORESCENT DETECTION METHODS

Pharmaceutical and personal care products (PPCPs) are a diverse group of organic pollutants classified by the EPA as contaminants of emerging concern. Their continued input and occurrence in natural

waters generate adverse effects on drinking water supplies, ecosystem health, and human health. These compounds end up in our surface and groundwaters via human and animal excretion, improper disposal, and their ability to pass through standard wastewater treatment unperturbed. Investigating the speciation of these contaminants in the environment is of utmost concern to better understand their effects on aquatic and terrestrial life. This research explores the kinetics of PPCPs 17α-ethynylestradiol (EE2) and ibuprofen in the presence DOMs Suwannee River Natural Organic Matter (NOM), Fulvic Acid, and Humic Acid. It is well documented that pharmaceutical compounds have been detected in wastewater. Adsorption onto dissolved organic matter (DOM) inhibits the degradation of PPCPs. Kinetics studies are done with the use of the real-time kinetic program of the Jobin-Yvon spectrofluorometer. This allows for detection of a selected peak on the microsecond scale. Reactions between PPCP and DOM have shown to follow psuedo-first order kinetics and will be described below. Effect of type and concentration of DOM, pH, and ionic strength on binding with PCPP have been investigated. pH was shown to have the most effect on the rate constant, with ionic strength and type of DOM showing small effect.

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DECISION-MAKING PROCESSES FOR BEACH AND SHELLFISH MANAGEMENT: A SCOPING ANALYSIS FOR NEST'S SAFE BEACHES AND SHELLFISH PROJECT

Comparison of decision making processes associated with beaches and shellfish growing areas reveals interesting commonalities and distinctions in coastal resource management and associated public health risks. We completed a scoping analysis for the New England Sustainability Consortium (NEST)'s Safe Beaches and Shellfish Project that focuses on advisory and closure decision-making processes. Using Maine and New Hampshire as our study regions, we synthesized information acquired from interviews with key decision makers and from analysis of resource management and outreach documents and websites. Several key findings emerged. First, differences in the goods and services and the mix of agencies and institutions associated with beaches and shellfish create important distinctions in decision-making. Notably, shellfish consumption inspires more formal guidelines and greater standardization in management across states. Second, we found similarities and differences in how decisions about beach advisories/closures and shellfish classifications and status determinations are made. Both states do marine water quality testing and have processes in place to interpret these tests and inform advisories and closures. In addition, both states focus on fecal indicators of water quality contamination. While Maine and New Hampshire both rely on federal guidelines, the states have different on-the-ground decision making for beaches and shellfish management. Beach

monitoring and decision-making are more decentralized in Maine than in New Hampshire. Maine has a municipal shellfish management program and in New Hampshire the shellfish resource is managed by Fish and Game Department. These findings, among others, inform the design of future decision-support tools and research activities.

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DEVELOPING ENVIRONMENTAL DNA (eDNA) DETECTION FOR MAINE'S INVASIVE AND IMPERILED AQUATIC SPECIES

Environmental DNA (eDNA) detection is emerging as a powerful ecological monitoring tool that can provide biologists, resource managers and the public with unprecedented ability to detect rare aquatic species of concern. This unique genetic tool uses water samples to detect very low concentrations of DNA shed by target species into their environment, potentially alerting to their presence. Work to date suggests this tool can provide much greater sensitivity to detect target species when they are at very low abundance, and do so at a small fraction of the monetary costs, personnel time, and risks to non-target species compared to that of traditional approaches like angling, netting and underwater surveys. The ability to detect both invasive and threatened aquatic species in such a fashion could allow for better allocation of limited conservation resources for verification of detection as well as swift and appropriate interventions. We are working with multiple state and federal agencies, as well as NGO's and citizen's groups, to develop eDNA detection tools for aquatic species in Maine. In this poster we 1) provide an introduction to eDNA technology; 2) provide an example of its development and deployment for invasive Northern Pike, *Esox lucius*, that threaten vulnerable salmonid populations in the Penobscot River system; and 3) seek diverse stakeholder input to help prioritizing development of eDNA for other aquatic species and management contexts in Maine.

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HYDROLOGIC IMPLICATIONS OF UPLAND MICROTOPOGRAPHY IN POST-GLACIATED MAINE

A key characteristic of Maine's forested post-glacial landscape is extensive microtopography – hummocks and hollows left behind when trees fall. These features are often on the scale of single meters wide and decimeters to a meter in depth. Previous research on hillslope overland flow has largely been performed in regions with very different terrains and soils. As a result, little is known about how Maine's terrain may influence time of concentration, infiltration rates, and upland storage. However, with the increasing availability of high resolution, highly accurate elevation models from aerial LiDAR data, it may be possible to evaluate the extent of these features and calculate the total volume of upland storage they may represent. Preliminary results from research in the Sebago Lake watershed and other regions of the state indicate that there are measurable differences in microtopographic signals in the bare ground elevation models between areas with different vegetation cover types (i.e.

deciduous forest vs coniferous forest). Future work will test the validity of results derived from this analysis technique using field surveys and will further attempt to quantify storage, infiltration, and drainage efficiency in various land cover types.

PROFESSIONAL POSTER ABSTRACTS

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MAINE TIDAL POWER INITIATIVE: LINKING KNOWLEDGE TO ACTION FOR THE RESPONSIBLE DEVELOPMENT OF TIDAL POWER IN MAINE

The State of Maine has set an ambitious goal of increasing its use of renewable energy resources by 10% between 2007 and 2017. Interest in developing tidal power in Maine has expanded significantly since 2006 making tidal power one potential solution to diversify the state's energy portfolio. In March 2012, the Ocean Renewable Power Company began installation of its first grid-connected tidal generation unit in Cobscook Bay, Maine, one of the best tidal energy sites identified on the East Coast of the U.S. by the Electric Power Research Institute. The Maine Tidal Power Initiative (MTPI), a team of engineers, biologists, oceanographers, and social scientists, has been working closely with developers, regulators, and the local community to understand how to best move forward with the responsible development of this renewable resource. MTPI research addresses major uncertainties for tidal energy development; research tasks include assessing environmental impacts, resource availability, commercial viability, and community acceptance. Here we present the sustainability science approach MTPI is using to understand and create linkages between technical research, social science, and knowledge to action research necessary for informing decisions about tidal power development.

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COLLABORATION, COMMUNITY ENGAGEMENT, AND CELEBRATION SUPPORTING MAINE'S SEA-RUN FISHERIES: PROCESS AND PROGRESS IN THE HISTORIC PENOBSCOT RIVER RESTORATION PROJECT

Industrialization on the Penobscot River in the 1800's began with construction of dams for sawmills and log drives that covered the river from bank to bank. Use of the river for industrial purposes, hydropower development, and as repository of waste, all contributed to a steep decline of the entire assemblage of native sea-run fish that travelled the river to reach freshwater spawning habitat. A critical forage base for other fish and wildlife and source of sustenance and economic activity for river communities disappeared. Changes in fishing regulations, the Clean Water Act of 1972, and the end of log drives led to a cleaner river, but the impact of dams on migratory fish remained. In 1999, a historic meeting between representatives of the Penobscot Indian Nation, a hydropower company, conservation groups, and state and federal agencies, marked the beginning of the end of decades of conflict

over fisheries resources and development of hydropower on the Penobscot River. A bold plan to restore self-sustaining populations of sea-run fish while rebalancing hydropower emerged for public review and comment. Today, the river flows freely from the Milford Dam in Old Town to the sea, and the final piece of the project, a bypass around the Howland Dam, is well underway. As we celebrate progress, work continues to complete the project and support a future Penobscot River where restored fisheries are integral to community growth and success.

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EFFECTS OF THE FUNGICIDE AZOXYSTROBIN ON MICROBIAL AND MACROINVERTEBRATE LEAF DECOMPOSITION

Aquatic fungi contribute significantly to the decomposition of stream leaves, a key ecosystem function, but the effects of fungicides on naturally occurring aquatic fungi and macroinvertebrates involved with leaf decomposition are understudied. The objectives of this study were (1) to develop and optimize laboratory conditions under which fungicides could be tested for effects on fungal and macroinvertebrate leaf decomposition; and (2) to examine the effects of a widely used fungicide, azoxystrobin, on microbes and leaf shredders involved with leaf decomposition. We used a common test organism, the amphipod leaf shredder, *Hyalella azteca*, to examine the effects of azoxystrobin on microbial flora (bacterial and fungal) and amphipod growth and survival. Stream-conditioned red maple (*Acer rubrum*) leaves were exposed to environmentally relevant concentrations of azoxystrobin (0, 10, 150, 5,000 ng/L), or to vehicle (acetone), in the presence and absence of *H. azteca* (starting age 7-days old) for two weeks at 23°C on a 16/9 L/D cycle. Unconditioned maple leaves were used as negative controls. Azoxystrobin did not affect amphipod survival or growth, but did suppress microbial respiration on leaves at the highest dose in the absence of amphipods. In unconditioned leaf treatments reduced microbial respiration was coupled with inhibition of amphipod growth, demonstrating the potential for deleterious effects of reduced microbial biota in stream ecosystems. Changes in leaf decomposition and biological effects on amphipods are sensitive indicators, which can be used as early warning, biomonitoring tools of potential fungicide effects on ecosystem function. Supported by the USGS Toxic Substances Hydrology Program.

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APPARENT EFFECT OF REGIONAL BEDROCK FRACTURE ORIENTATION ON ROAD SALT HYDROLOGIC CONDUCTIVITY

The purpose of this work is to understand better the hydrologic behavior of road salt. Past work has indicated a strong bias in chloride sampling results in residential wells downslope and proximal upslope from the road where salt is seeded in the winter months. This ongoing analysis proceeds with the hypothesis that fracture orientation in bedrock, if steep in dip and with an optimal strike direction,

could further enhance the conductivity of the salt solute. Using pre-construction data from the Maine Department of Transportation, the location of each well was precisely located. Each well subsequently was categorized according to a rule of thumb well capture zone of 75 feet creating parallel road boundary areas upslope and downslope. By measuring the orientation of the road perpendicular to each well, and by subtracting a dominant regional fracture strike direction, it was possible to determine the degree to which the slope to road orientation was in parallel or sub-parallel. It is 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. This effect seems to be more pronounced where overburden thickness is relatively thin and there is a dominant regional fracture orientation.

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OLD DATA AND NEW TECHNOLOGIES-INTEGRATING LEGACY RESEARCH FOR MODELING FUTURE OUTCOMES

Creating a data management system that fully integrates legacy environmental data has specific challenges. Metadata structures, semantics, and syntax are domain specific, vary greatly in precision, and are generally incomparable between projects, institutions, or even over time. A large portion of legacy metadata may be lost or still reside entirely in analog form in field notebooks and control charts. Contextual information (e.g. land cover or meteorological events) enhances data interpretation, but is rarely in a format that is easily integrated into databases. The methodological and contextual barriers in comparing disparate data sources, time periods, or formats can be dealt with by using ontologies to formally specify objects and their relationships. Domain-specific ontologies provide a way to explicitly capture knowledge about specific scientific domains, and support consistent and unambiguous representations of entities and relationships within domains. In this research, we are developing ontologies to facilitate disparate data integration, dissemination and comparison for mercury monitoring in freshwater ecosystems.

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QUALITY ASSESSMENT AND IMPROVEMENT OF MIDDLE LEVEL AND HIGH SCHOOL STUDENT-GENERATED WATER DATA

As part of a study to understand risks to drinking water, student scientists have analyzed domestic well-water supplies in rural areas throughout the northeast. However, the data produced by middle-level and high school students suffers from uncertainty about method and student accuracy. In this study we measured the errors associated with methods, the limits of student precision, and the error due to sample variability. Analytical test kits and probes were evaluated for the determination of pH, conductivity, chloride, hardness, iron, total soluble metals, and nitrate. Each method used was deter-

mined to meet or exceed design specifications. In terms of accuracy method trueness was variable from good to poor. A gage reproducibility and repeatability analysis of instrumental methods (pH and conductivity) was employed to partitioned the variances: student measurement error (12-46%), instrumental error (8-21%), and random error (45-68%). We have added the use of quality-control charts as a way to reduce student measurement error. If student-generated water quality information is to be useful, there must be good management of the student analyst process. This study shows that it is possible to make precise and accurate measurements that are consistent with method specifications in the classroom.

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GLOEOTRICHIA ECHINULATA POPULATIONS IN SELECTED WESTERN MAINE LAKES

Fifteen western Maine lakes were sampled for *Gloeotrichia echinulata*, a colonial cyanobacterium, in the summer of 2013. The purpose of the study was to measure baseline populations in low-nutrient lakes in the region. Of the 15 lakes tested, six had elevated levels of *G. echinulata*, with the highest peak level being 16.6 colonies per liter, and the mean across all lakes ranging from 0.0 – 4.12 colonies per liter. Anecdotal evidence has pointed to an increase in *G. echinulata* presence in Northeastern U.S. lakes, which is cause for concern because of the detrimental impacts cyanobacteria can have on water quality. This species in particular is able to thrive in low nutrient systems by assimilating phosphorus in the sediment and bringing it into the water column. The presence or absence of elevated levels of *G. echinulata* was not able to be explained using water quality data, suggesting that the species is dispersal limited. Further research should look into factors that may promote growth and the interaction between them, including light, temperature, nutrients, bathymetry, sediment material and disturbance, and micronutrients, so that these relationships may be used by lake managers to control the proliferation of this species.

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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 modi-

fied 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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THE HYDROLOGIC IMPLICATIONS OF HUMAN INTERVENTIONS IN A POST-GLACIAL LANDSCAPE

Sebago Lake is Maine's second largest lake. Sculpted by the Laurentide ice sheet, marine transgression and isostatic rebound, it is the deepest lake in the state with an extensive history of human intervention. Water resource demands in the lake watershed include freshwater supply for nearly 200,000 people in southern Maine, recreation for residents and tourists, habitat for fisheries, and hydroelectricity generation. Concern over water resources sustainability inspired attention towards the lake watershed as part of Maine's NSF-supported Sustainability Solutions Initiative (SSI). Our research focuses on quantification of surface flows to the lake using stream measurements and watershed scenario simulations framed by climate and land cover conditions using a distributed hydrologic model. The approach quantifies relations between human interventions and surface flows in the sub-basins immediately surrounding Sebago Lake. Five components of the watershed hydrologic system under examination include: 1) runoff production from precipitation, 2) confined upland runoff pathways, 3) channelized flows in lowland valleys, 4) lowland water storage, and 5) water yield. Preliminary results show that past, existing, and forecast changes to watershed conditions resulting from human interventions produce measurable changes to freshwater flows into the lake. The simulations provide a platform to estimate the cumulative effects of land cover, drainage network morphometry, small pond management, and climate changes on the discharge of surface water and constituents carried by those flows into Sebago Lake.

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DECADAL CHANGES IN EELGRASS DISTRIBUTION AND COVERAGE IN CASCO BAY, MAINE

Efforts to preserve the ecological integrity of eelgrass meadows and their associated communities often begin with mapping of eelgrass distribution and identifying factors potentially affecting change. Periodic evaluation using aerial imagery permits interannual change analyses, planning for future monitoring and identification of potential restoration opportunities. In 1993/94 and 2001/02, the Maine Department of Marine Resources mapped eelgrass along the Casco Bay shoreline using aerial photography. For the current project, four band, digital aerial photography was acquired on August 11-12, 2013, near the time of low water following the NOAA Coastal Change Analysis Program protocol, and produced 1,200+, georectified images at 0.15-meter pixel resolution. Photointerpretation included groundtruthing by boat using underwater videography, and was used to generate a GIS layer of eelgrass distribution and percent cover. Where meadows were present, eelgrass distribution was similar to that observed in 1993/94 and 2001/02, with the exception of Maquoit and Middle Bays, where 4,392 acres of dense subtidal beds (>70 to 100% cover) were almost completely lost between 2001 and 2013. Preliminary autumn 2013 water quality data including dissolved oxygen, nutrients, and light attenuation indicate Maquoit and Middle Bay sites (n=3) did not differ from locations elsewhere in Casco Bay (n=7). Moderate chlorophyll *a* concentrations observed in Maquoit and Middle Bays likely reflect resuspended benthic diatoms in areas devoid of eelgrass. Abundant invasive green crabs (*Carcinus maenas*) have been implicated in eelgrass decimation within the central Bay area, though the importance of this factor, and interactions of other factors, have yet to be determined.

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ANALYZING VERNAL POOL PRODUCTIVITY AND PERCENT CANOPY COVER AFTER TRANSMISSION LINE CONSTRUCTION

Vernal pools provide critical habitat for a wide variety of animal species including the indicator amphibian species (*Lithobates sylvatica, Ambystoma laterale, A. maculatum*). It is widely presumed that indicator amphibian species respond negatively to overstory removal. Studies analyzing the effects of various canopy removal buffer treatments have concluded varying degrees of impact on different life stages and the initial and long term use of several amphibian species in altered areas surrounding vernal pools. Utility corridors being constructed or proposed for construction is on the rise and are often sited in relatively undeveloped habitat blocks. Our study's utility corridor includes 11 vernal pools in northern Maine. Pools were visited twice during appropriate seasonal conditions, once early in the season and again two weeks afterwards to capture seasonal amphibian use. The pools were surveyed in 2007 prior to construction and yearly post-construction (2009 through 2013). Orthophoto analysis was completed on pre- and post-construction buffer canopy conditions to assess the forested buffer impacts at varying buffer widths. We analyzed the indicator amphibian abundance from 2007

through 2013 with the pre- and post- forested buffer percent canopy cover and change in canopy from buffer alterations during construction. Results indicate that median pre-construction amphibian productivity is not correlated to percent canopy cover; however, post-construction productivity is correlated to percent canopy cover. Vernal pools and their critical terrestrial habitat areas are protected with best management practices. These results support the importance of maintaining canopy cover in the terrestrial habitat during and after activities which cause habitat fragmentation.