Table of Contents

MAINE WATER CONFERENCE

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

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

At this years conference, the Maine Water Conference is partnering with the Maine's Sustainability Solutions Initiative to provide a venue for SSI project teams to present their research to a broad audience of interested stakeholders.

Program At-A-Glance

CONFERENCE AGENDA

7:30am **Registration, Continental Breakfast, Poster & Exhibit Viewing**

8:30am **Morning Concurrent Sessions**
Session 1: River Restoration in Maine and the Region
Session 2: Maine's Sustainability Solutions Initiative
Session 3: Innovations in Water Resources Outreach & Education
Session 4: Green Remediation - Practical Considerations
Session 5: Water and Land Conservation
Session 6: Maine's WRRI Grant Program Success Stories

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

11:00am **Plenary Session — Welcome & Introduction**
D. Whitney King, Colby College

11:05am **Dominic Di Toro, Edward C. Davis Professor of Civil & Environmental Engineering, University of Delaware**
Modern Water and Sediment Quality Criteria: Toxicological and Chemical Interactions

11:40am **Introduction**
Dave Owen, University of Maine School of Law

11:45am **Jeff Opperman, Sr. Advisor for Sustainable Hydropower, The Nature Conservancy**
From Fragmentation to the River Basin: Hydropower Precedents in Maine and How They Inform the Global Water Crisis

12:20pm **Poster Award Presentations**
Robert Lent, Director, USGS Maine Water Science Center
John Peckenham, Director, Maine Water Institute

12:30pm **Lunch**

1:30pm **Afternoon Concurrent Sessions**
Session 1: River Restoration in Maine and the Region (cont.)
Session 2: Maine's Sustainability Solutions Initiative (cont.)
Session 7: Developed, Urbanizing and Undeveloped Watersheds (cont.)
Session 8: Integrating Social & Natural Sciences
Session 9: Groundwater Geochemistry: Natural and Human Influences
Session 10: Wetland Ecology and Conservation
Session 11: Models and Monitoring: Current Research in Freshwater Science

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

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

4:15pm **Conference Close**

Plenary Session

11:00AM WELCOME & INTRODUCTION

D. Whitney King

Miselis Professor of Chemistry, Colby College

Whitney King *is the Miselis Professor of Chemistry at Colby College where he has been teaching analytical and environmental chemistry for over twenty years. Whitney's research group develops and builds analytical instruments for ultra-trace analysis of transition metals and reactive oxygen species in natural waters. Over fifty researchers from twenty countries are currently using these Maine-built instruments for oceanographic and limnological research.*

Reactive oxygen species like hydrogen peroxide and superoxide can have significant influence on the chemistry of iron through the redox cycling of Fe(III) to Fe(II) and back to Fe(III). Our oceanographic work is focused on using new and existing sensors to study the redox dynamics of iron as it relates to antioxidant production and iron limitation of marine plankton.

In the last ten years, the King group's field work has "expanded" to the Belgrade Lakes of Central Maine. This work is developing physical models for thermocline formation and erosion that drive basin-scale mixing events responsible for internal recycling of nutrients and subsequent phytoplankton blooms. Whitney is also directing Colby's SSP program, "Modeling Resilience and Adaptation in the Belgrade Lakes Watershed" and is a member of the board of the new Maine Lakes Resource Center being built in Belgrade Lakes, Maine.

11:05AM DOMINIC DI TORO

Edward C. Davis Professor of Civil and Environmental Engineering, University of Delaware

MODERN WATER AND SEDIMENT QUALITY CRITERIA: TOXICOLOGICAL AND CHEMICAL INTERACTIONS

Water and sediment quality criteria are a critical part of scientifically based environmental risk assessment. They provide the quantitative basis for the answering the question "How much is too much?" Modern criteria combine the traditional toxicological approach of testing multiple species to determine the level of a toxicant that is acceptable, with the models of bioavailability and modes of action. The chemical state of the toxicant in the water column or sediment can change the toxicity in some cases by and order of magnitude or two. And the direction of the change is not always in the direction of less toxicity. The new criteria rely on models of toxicity and toxic action. This talk will present examples of these developments for metals and the mixtures of toxicants that comprise crude oil.

Dominic Di Toro *has specialized in the development and application of mathematical and statistical models to stream, lake, estuarine, and coastal water and sediment quality problems. He has published over one hundred technical papers, as well as Sediment Flux Modeling, published by J. Wiley & Sons. He has participated as Expert Consultant, Principal Investigator, and Project Manager on numerous water quality studies for industry, research foundations, and governmental agencies. Recently his work has focused on the development of water and sediment quality criteria for the EPA, sediment flux models for nutrients and metals, and integrated hydrodynamic, sediment transport and water quality models.*

11:40AM INTRODUCTION

Dave Owen

Associate Professor, Maine School of Law and Maine's Sustainability Solutions Initiative

Dave Owen *is an associate professor at the University of Maine School of Law. His research interests range*

from ecosystem restoration to climate change, and he is particularly interested in water resource management and legal responses to environmental uncertainty and change. He teaches courses in environmental law, natural resources law, water law, and administrative law. Prior to joining the Maine Law faculty in 2007, Dave practiced with Rossmann and Moore, a small San Francisco firm specializing in environmental, land use, and water law, and he clerked for Judge Samuel Conti of the United States District Court for the Northern District of California. Before attending law school, Dave worked as a geologist and environmental auditor with Woodard and Curran, an environmental consulting firm.

11:45AM JEFF OPPERMAN

Senior Advisor for Sustainable Hydropower, The Nature Conservancy

FROM FRAGMENTATION TO THE RIVER BASIN: HYDROPOWER PRECEDENTS IN MAINE AND HOW THEY INFORM THE GLOBAL WATER CRISIS

Meeting growing global needs for water and energy while maintaining healthy rivers poses one of the great challenges of the 21st century. Although dams can be an important part of the solution for providing energy and water, they have also caused dramatic impacts to freshwater ecosystems and people whose livelihoods depend on free-flowing rivers, such as flood-recession agriculture and fisheries. In the service of solving energy and water crises, the proliferation of dams worldwide threatens to create collateral crises of lost communities, livelihoods, fisheries, and ecosystems. Improving the sustainability of dam development cannot be achieved through status quo approaches that focus planning, development and operation on the scale of single projects. Rather, comprehensive planning at the basin scale will be necessary to achieve development patterns that can achieve targets for energy and water while maintaining healthy river ecosystems. Several new policies and demonstration projects seek to guide dam development at national, regional or basin scales, but these efforts lack clear precedents, examples, or stories that can illustrate the potential benefits of working at this scale. Maine's experience with hydropower can help provide these precedents and stories. In the early 1980s, the state developed the "Maine Rivers Policy" to guide future hydropower development to appropriate locations and ensure the protection of the most important rivers and reaches. This case provides an important, though generally unheralded, demonstration of how a state can influence the siting, review and licensing of dams through a comprehensive and large-scale planning effort. More recently a diverse group negotiated a comprehensive settlement agreement for hydropower dams on the Penobscot River. By achieving dramatic improvements in environmental performance without compromising energy generation, the agreement provides a clear demonstration of the potential benefits of seeking solutions to environment-energy conflicts at the scale of a system of dams. Together, the Maine Rivers Policy and the Penobscot agreement can inform policies and projects that seek to improve the sustainability of global dam development.

***Jeff Opperman**, senior freshwater scientist, has been working to protect rivers and lakes for nearly 15 years. He has provided strategic and scientific guidance to freshwater conservation projects across the United States as well as in China, Africa and Latin America. In his role at The Nature Conservancy much of Jeff's focus is on improving the environmental sustainability of hydropower both by advancing sound policies and by supporting on-the-ground projects.*

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.

12:30PM LUNCH

Session 1

River Restoration in Maine and the Region

In the next few years, Maine will become the leader in restoring diadromous fish habitat and passage through the removal and improvement of several large and small dams and other efforts throughout the region. What are our next steps once these projects are completed? What other forms of restoration do we need to consider? What are the other diadromous species habitat requirements that need to be addressed? What is the science that informs our restoration actions? How do we assess the success of restoration efforts? This session will describe the tools and science available for native coldwater and diadromous species habitat restoration.

SESSION CHAIRS

Barbara Arter, Science Information Coordinator, Diadromous Species Restoration Research Network

Barbara Arter currently serves as the Science Information Coordinator for the NSF-funded Diadromous Species Restoration Research Network and the Penobscot Science Exchange, a project of the University of Maine's Senator George J. Mitchell Center. Ms. Arter holds degrees in forest management and riparian forest ecology. After twenty years of college teaching, research management, and administration, Ms. Arter has focused her attention on strengthening multi-stakeholder watershed conservation, restoration, and planning throughout the state of Maine. For the past fifteen years she has provided consultation to numerous state and federal agencies and conservation organizations on the topics of fish habitat restoration, watershed science and planning, bay management, landuse planning, and water quality assessment.

Noah Snyder, Associate Professor, Dept. of Earth and Environmental Sciences, Boston College

Noah Snyder grew up next to Fall Creek in Ithaca, New York. He graduated from Bates College in 1993 with a B.S. in Geology. He got his Ph.D at MIT in 2001, and then spent three years as a postdoctoral researcher at the U.S. Geological Survey Pacific Science Center. He has been at Boston College since 2004. Noah's research focuses on understanding how rivers respond to changes, ranging from long-term variations in tectonics or climate to short-term shifts in management style or land use. He links measurements of channel morphology from high-resolution airborne lidar digital elevation models with field-based measurements of stream processes.

Karen Wilson, Assistant Research Professor, Department of Environmental Science, University of Southern Maine.

Karen A. Wilson is an aquatic ecologist with the Department of Environmental Science at the University of Southern Maine. Her PhD is from the Center for Limnology at the University of Wisconsin where she studied community and ecosystem impacts of invasive crayfish as part of the North Temperate Lakes Long-Term

Ecological Research group. She was a Post-doctoral Fellow at the University of Toronto where she studied the impacts of invasive zebra and quagga mussels on the community dynamics of benthic invertebrates in Lake Ontario. In addition to her work on long-term community responses to tidal restoration of Sherman Marsh, Karen's research projects include studying lake sediments to quantify historical contribution of alewives to lake productivity, quantifying baseline food web structure on the Penobscot River and tributaries, and examining linkages between social-economic and ecological processes in the Kennebec River watershed using river herring as indicators of river health. She is also the Research Coordinator and a PI for the Diadromous Species Restoration Research Network, an NSF-funded effort organized in response to the historic Penobscot River Restoration Project

8:30AM – 8:55AM

Margaret Guyette *(student)**, Cynthia Loftin, Joseph Zydlewski*
Department of Wildlife Ecology, University of Maine, Orono, ME; margaret guyette@umit.maine.edu.

EVIDENCE OF MARINE-DERIVED NUTRIENT UPTAKE IN ATLANTIC SALMON NURSERY STREAM COMMUNITIES

Prior to construction of dams beginning in the early 1800s, Atlantic salmon and other anadromous species migrated from the ocean to spawn in Maine's extensive rivers and streams. Spawning fish transported marine-derived nutrients to these systems in the form of metabolic expenditure and through decomposition of mortalities. These contributions may have strongly influenced productivity in otherwise nutrient limited systems, bolstering the growth and survival of young Atlantic salmon and other anadromous species. To test this, we stocked four headwater streams with young-of-the-year Atlantic salmon in May 2009 and 2010 and manipulated nutrient input with a salmon carcass analog placed in treatment reaches in July and late October each year, timed to match sea lamprey and Atlantic salmon spawning. We sampled Atlantic salmon during June – December in 2009 and 2010 to assess cohort growth through direct measurement (length and mass) and body condition (condition factor and lipid content). We are also using daily growth increments in otoliths to describe the time course of potential effects. Preliminary results suggest an increase in both growth and body condition can be detected throughout the first year of growth in response to nutrient additions.

9:00AM – 9:25AM

Chris O. Yoder[1]***,*** *Brandon Kulik*[1]*, Lon Hersha*[2]*, David Halliwell*[3]
1 Midwest Biodiversity Institute & Center for Applied Bioassessment and Biocriteria, Columbus, OH; yoder@rrohio.com.
2 Kleinschmidt Associates, 75 Main Street, Pittsfield, ME 04967
3 Maine DEP, 17 State House Station, Augusta, ME 04333

DEVELOPING AND TESTING REFINEMENTS FOR A FISH ASSEMBLAGE ASSESSMENT INDEX FOR LARGE RIVERS IN MAINE: INCORPORATING DIADROMOUS SPECIES TO BETTER ASSESS RESTORATION SUCCESS

We conducted systematic sampling of the fish assemblages of the non-wadeable rivers of Maine during 2002-9. Statewide coverage was achieved in 2007 and further application of an interim Index of Biotic Integrity (IBI) was tested in 2008-9. The U.S. EPA Biological Condition Gradient (BCG) was used to visualize how river fish assemblages respond to incremental stressors. This knowledge was then used to develop and calibrate IBI metrics. The interim IBI is based on a native cold water fish assemblage that typifies moderate-high gradient rivers throughout the state and it seems responsive to the common stressors such hydrological alterations, habitat,

non-native species, and general pollution. However, a question with the current IBI is how to incorporate the presence and expectations for diadromous species. Presently there are no metrics that directly incorporate the influence of these species, yet they are included in the conceptual BCG. In addition, the interim IBI scores are the lowest for the mainstem rivers that either have or have had an established presence if diadromous species. Since these species are seemingly “in addition to” the core cold water fish assemblage, an additive metric scoring procedure seems to make the most sense and this is presently part of our exploratory analyses. Such a modification would recognize the “additional presence” of diadromous species where they are expected to be present without altering the expectations for the native cold water assemblages that have been significantly altered by the same set of stressors in several Maine rivers. This IBI promises to be an effective tool for measuring progress with diadromous and other riverine fish assemblage restoration efforts.

9:30AM – 9:55AM

Theodore Willis, *Karen Wilson*
University of Southern Maine, Gorham, ME; theowillis06@aim.com, kwilson@usm.maine.edu.

THE ABSENT NATIVE COMES HOME: ECOSYSTEM EFFECTS OF ALEWIFE RESTORATION

Maine is leading the way in large scale river restoration efforts. The Edwards Dam removal, which demolished a power producing main stem river dam in 1999, was the first of its kind in the United States. The restoration effort that followed focused on reintroducing alewife (*Alosa pseudoharengus*), a diadromous fish, to its native habitat in the Kennebec River watershed. Trap-n-truck operations stocked adult alewife into lake habitats. A ten-year study in Lake George evaluated the effects of alewife on freshwater ecosystems where they had been absent for nearly a century, however, the single lake focus missed the opportunity to describe alewife ecosystem effects across an array of habitats. The Penobscot River restoration and the ongoing Kennebec River restoration provide opportunities to duplicate parts of the Lake George study. In 2009 researchers from the University of Southern Maine sampled Togus Pond in the Kennebec River drainage and Chemo Pond in the Penobscot River drainage in a before-after design. Both lakes were scheduled for restoration stocking in 2010. Highland Lake, with a recently restored alewife population and Damariscotta Lake with a long standing alewife population were also studied as references. Water temperature profiles, Chl-a and zooplankton samples, and Secchi depth data were collected. Alewife had a detectable effect on the zooplankton size and abundance in mid to late summer in before-after lakes. The overall pattern was reminiscent of that seen in the control lakes, which we hypothesize will include a rebound in cladoceran abundance and size in spring 2011.

10:00AM – 11:00PM

MORNING BREAK AND POSTER SESSION — AUDITORIUM

11:00AM – 12:30PM

PLENARY— AUDITORIUM

12:30PM – 1:30PM

LUNCH — AUDITORIUM

Session 1 - River Restoration in Maine and the Region

1:30PM – 1:55PM

Adrian Jordaan, *Michael Frisk and Carolyn Hall*
School of Marine and Atmospheric Sciences, Stonybrook University, Stony Brook, NY; ajordaan@notes.cc.sunysb.edu.

CROSS-BOUNDARY MIGRATIONS OF RIVER HERRING CONNECT OCEAN FISHERIES AND LOCAL RIVER RESTORATION

A significant conceptual component of ecosystem-based management is identifying appropriate spatio-temporal scales to guide restoration efforts, species protection, and enhancement of ecological functionality. River herring, collectively alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), are anadromous fish endemic to northeastern United States rivers. Here we document lost capacity of river herring, in terms of delivery of marine-derived nutrients, coastal forage base for predators and harvest of biomass, related to damming of Maine's river systems over the past 400 years. Local reduction of spawning site access in nine Maine rivers resulted in lost capacity for harvest equivalent to the annual total US landings of river herring during the 1950-1970 period, considered by some the period with which to evaluate restoration efforts. The capacity for production of biomass declined over 95% from 1750 to 1850, equating to the cumulative loss of billions of fish from ecosystems. Now at low population size, river herring are susceptible to by-catch during migrations through the Gulf of Maine to the New York Bight. We will demonstrate how coastal fisheries in Maine for herring, and off New York for mackerel, can potentially impact river herring. Multi-jurisdictional and multi-disciplinary efforts are required to develop strategies that improve river herring population status and ecological functioning of freshwater and marine systems.

2:00PM – 2:25PM

Noah P. Snyder
Dept. of Earth and Environmental Sciences, Boston College, Chestnut Hill, MA; noah.snyder@bc.edu.

RESTORING GEOMORPHIC RESILIENCE IN MAINE RIVERS

Resilience is the ability of an ecosystem to tolerate disturbance without shifting to a different state controlled by different processes. Given that watershed conditions are changing, and that rivers respond through erosion and deposition in their channels, restoration projects should enhance geomorphic resilience of rivers. In this presentation, I review recent research linking geomorphic processes, Atlantic salmon habitat, and restoration in several Maine rivers. In this landscape, the presence of localized glacial deposits and numerous mainstem lakes and wetlands means that bedload transport is discontinuous along the rivers. Dam construction for mills and log drives in the 18th-20th centuries enhanced these discontinuities and trapped sediment. Removal of roughness elements (wood, boulders, etc.) to facilitate timber transport resulted in channels that are probably straighter, smoother and less complex than those in the pre-disturbance state, indicated by low bedload transport rates in many reaches. Sediment inputs are essential to the reconstruction of channel complexity via morphologic feedbacks: fines deposit outside of active channels and raise new vegetated banks; and gravel builds mobile bars. In reaches with higher sediment load (i.e., downstream of large, actively eroding glacial deposits), the signs of a channel resilient to changes are clear: bar migration, in-channel sediment sorting, and storage of fine sediment on overbank deposits, even in places impacted by dams and log drives. This view of river processes in Maine points to restoration of sediment transport continuity: replacing undersized culverts, removal of small and remnant dams, and wood additions to increase scour.

Session 1 - River Restoration in Maine and the Region

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Ben Naumann, *Scott Craig, Steve Koenig*
Project SHARE, Eastport, ME; bnaumann_lw@yahoo.com.

BIOLOGICAL ANALYSIS USED TO EVALUATE CHANGES IN FLUVIAL GEOMORPHOLOGY FROM STREAM CONNECTIVITY RESTORATION EFFORTS IN DOWNEAST MAINE

Maine rivers and their tributaries have undergone dramatic changes within the last 200 years, and a majority of these changes can be contributed to timber harvesting. After the end of the log driving era in the early 1970's, timber harvesting continued due to the construction of a sizable road network as an alternative means to access timber. Maine's timber land road network consists of 1000's of road crossing with problem culverts. In Downeast Maine Project SHARE and their partners have been fixing the problem road crossing allowing natural stream processes and fish passage to occur. To evaluate changes in physical habitat and temperature, pre and post construction data is being collected via the use of FishXing, Habitat Suitability Index (HSI), and temperature loggers. Fish Xing highlights any potential barriers to a given species; in this case, a 10cm brook trout and a 10 cm juvenile Atlantic salmon was used in the model. HSI models for both brook trout and juvenile Atlantic salmon are assigned values to sub-habitats within the stream according to 'usefulness' to an individual fish. Depth, substrate size, and velocity were used as variables to evaluate changes in physical habitat for juvenile salmon and adult brook trout habitat was evaluated using depth, percent pool, and pool rating class. The above biological analyses have allowed Project SHARE and their partners a quantitative means to evaluate change created by the connectivity projects.

3:30PM – 3:55PM

Melissa Belcher[1]***,*** *Alex Haro*[2]*, Jim Turek*[3]
1 University of MA Department of Environmental Conservation, Amherst, MA; mbelcher@eco.umass.edu.
2 S. O. Conte Anadromous Fish Research Laboratory, USGS, Turner Falls, MA.
3 NOAA Restoration Center, Narragansett, RI.

DEVELOPMENT OF DESIGN STANDARDS AND CRITERIA AND MONITORING PROTOCOLS FOR FISH PASSAGE RESTORATION PROJECTS

Documentation of standards and guidelines for design and monitoring of fish passage structures, as well as methodologies for passage evaluation and monitoring are critical for both fish passage and river restoration success. Presently, standards and guidelines are incompletely developed, our understanding of design has generally been based on field trial-and-error, and specific biological parameters that should form the basis of designs is often lacking. We describe the initial development of guidelines for design and operation of river restoration projects that include: dam removals, partial dam removals, bedrock modifications, backwatering weirs, dam and weir notches, rock ramps, and other hydraulic grade controls (e.g., cross-vanes, weirs). In this presentation we focus on design criteria for major East Coast target species such as Atlantic salmon, American shad, river herring, sturgeons, rainbow smelt, and American eel; and the rationale for development of these biological criteria. The developed criteria provide biologists, engineers, and practitioners/managers with documented, defensible guidelines to assist with selection, development, or review of structural designs and hydrologic and hydraulic conditions appropriate for sites and target species. Gaps in knowledge or absence of established guidelines are also identified along with suggestions for target criteria.

Session 2

Maine's Sustainability Solutions Initiative - Research Projects

Producing knowledge and linking it to actions that meet human needs while preserving the planet's life-support systems is emerging as one of the most fundamental and difficult challenges for science in the 21st century. There is growing consensus that traditional methods of generating and using knowledge must be fundamentally reorganized to confront the breadth, magnitude, and urgency of many problems now facing society. Maine's Sustainability Solutions Initiative, a partnership between the University of Maine, the University of Southern Maine and other institutions of higher education, seeks to transform Maine's capacity for addressing these scientific challenges in ways that directly benefit Maine and other regions. The program of research will also help Maine increase economic activity and technological innovation in ways that sustain the State's remarkable "quality of place".

SESSION CHAIRS

Mario Teisl, School of Policy and International Affairs and School of Economics, University of Maine

John Peckenham, Senator George Mitchell Center and Maine Water Institute, University of Maine

Linda Silka, Margaret Chase Smith Policy Center, University of Maine

8:30AM – 8:50AM

Kathleen Bell
School of Economics, University of Maine

INTRODUCTION TO SSI

8:55AM – 9:15AM

James R. Fleming
Colby College, Waterville, ME; jfleming@colby.edu.

THE ILLUSORY TIMELESSNESS OF THE BELGRADE LAKES REGION: HISTORICAL RESEARCH INFORMING SCIENCE AND PUBLIC POLICY

The Belgrade History Team at Colby College, with support from NSF EPSCoR, is studying events, trends, and turning points in the history of the watershed that place people and the environment in larger temporal and spatial contexts. Our goal is to articulate and communicate an historically informed "sense of place" for the Belgrade Lakes Region in order to empower citizen involvement in lake and habitat protection. Research on social and environmental history informs scientific analyses and provides a larger cultural context for economic modeling and public policy studies.

This presentation reports on three research projects completed in 2010 on the geological history of the region, traditional summer camps, and the creative arts. We survey an interdisciplinary landscape—both literal and conceptual—that spans history, science, technology, and the social realm, and share our plans for historical research informing integrative learning, sustainability solutions, and community outreach.

9:20AM – 9:40AM

Gray Cox, *Dan Cass, Davis Taylor*
College of the Atlantic, Bar Harbor, ME; gray@coa.edu.

DEVELOPING OUR ENERGY FUTURE: RESIDENTIAL HEATING WITH WOOD IN HANCOCK COUNTY, MAINE

Developing our Energy Future is an interdisciplinary research program conducted in collaboration with community stakeholders by students, faculty, and staff at College of the Atlantic. This research team is examining a major problem related to sustainable energy use in Hancock County: shifting from oil to wood fuels for residential heating. This project utilizes the unique strengths of the College, broadens our engagement with local communities, trains a cadre of COA students in SSI research, and aims at long term impacts on reducing carbon emissions and establishing a stable non-petroleum heating fuel supply in the County. The central question is: To what extent should Hancock County shift to wood fuels for residential heating, and, to the extent it should, how should this shift happen?

Data and analysis will be presented from two parts of the study that will be completed by March: 1) a series of surveys aimed to determine much more precisely than previously known, who is and is not using wood for heat in Hancock County and why; and 2) a systematic experimental study of wood heat related particle emissions in the county and an assessment of the implications for a risk analysis of increasing wood heating.

Very preliminary findings suggest that wood already plays a greater role than expected in residential heating and that it's use could relatively easily and quickly be extended in ways that, with regard to environmental risks, would be preferable to likely alternatives.

9:45AM – 10:05AM

Megan Wibberly[1] *(student),* ***Caroline Noblet***[1]*, Mario Teisl*[1]*, Shannon McCoy*[2]
1 School of Economics, University of Maine, Orono, ME; Megan.Wibberly@umit.maine.edu.
2 Department of Psychology, University of Maine, Orono, ME.

MAINERS' POWER-UP: TRADEOFFS BETWEEN WIND AND WATER

Understanding how Mainers evaluate the economic and environmental tradeoffs related to different forms of energy production is important in multiple realms. Policymakers may want to maximize the production of energy that minimizes environmental impacts or maximizes local economic benefits. These goals however may be inconsistent with consumer demand or firm investment. Our objective is to determine how consumers' characteristics interact with available information on various electricity sources (particularly related to off-shore wind and hydroelectric dams) to affect the demand for energy that varies in economic and environmental attributes.

Our data is based on responses to a state-wide mail survey (oversampling coastal communities and communities with wind projects) designed to examine Maine citizen's reactions to various types of wind power. Our sample consisted of 3,200 records and the survey was administered during the summer of 2010. The total number of respondents is 1,255, for a response rate of 47% percent.

Respondents provided their opinions of the benefits and concerns related to various wind sources (e.g., enhances fish habitat; increases risks to marine life), and answered several questions indicating people's relative preferences for: energy development versus water quality issues, and wind power versus hydropower. Some respondents were asked to select an electricity package with varied attributes - including price, energy source (e.g., wind power, hydro power, etc.), emission reductions and percent of energy that was imported. Analysis of this question helps us determine people's preferences for wind versus hydropower development.

10:05AM – 11:00PM

MORNING BREAK AND POSTER SESSION — AUDITORIUM

11:00AM – 12:30PM

PLENARY— AUDITORIUM

12:30PM – 1:30PM

LUNCH — AUDITORIUM

1:30PM – 1:50PM

Linda C. Bacon*[1]*, *Aria Amirbahman*[2]*, Stephen Norton*[3]*, Barry F. Mower*[1]

1 Bureau of Land and Water Quality, Maine DEP, Augusta, ME; Linda.C.Bacon@Maine.gov

2 Civil & Environmental Engineering, University of Maine, Orono, ME

3 Earth Sciences, University of Maine, Orono, ME

ELUCIDATING COMPLEX RELATIONSHIPS AMONG FACTORS INFLUENCING MERCURY FISH TISSUE CONTAMINATION

Increased mercury (Hg) loading from non-point sources in the continental U.S. has translated to Hg contamination of terrestrial and aquatic environments. The legacy of 100 years of pollution persists, even as Hg deposition in the atmosphere is declining. Lakes are particularly sensitive because methylation increases bioavailability, allowing bioaccumulation to toxic levels higher in the food chain. However, trophic status is a mediator in this bioaccumulation. Elucidating the complex relationships among the drivers of lake trophic status (i.e., nitrogen, phosphorus, iron, aluminum, dissolved organic carbon, and pH), Hg concentrations in water and fish tissue, and watershed characteristics will improve understanding of how natural and anthropogenic aspects of the landscape affect lake water quality and lake biota.

Analysis of pre-existing data from 92 Maine lakes determined that dissolved organic carbon, depth and Secchi transparency positively influence fish tissue mercury concentrations. Distributions of these three variables were used to target 100 Maine lakes from which to acquire additional fish, sediment, and water column data during 2010/2011. To reduce inter-species variation and allow trend analysis, White Perch (*Morone americana*), the most commonly eaten warm water fish in Maine, was targeted. Results from 47 lakes indicate a linear relationship between epilimnetic total mercury and methyl mercury (R^2 of 0.57), with Hodgdon Pond on Mount Desert Island having the highest levels of both parameters and fish tissue mercury levels.

Session 2: Maine's Sustainability Solutions Initiative

1:55PM – 2:15PM

Yuseung Kim, *Charles Colgan, Jack Kartez*
Muskie School, University of Southern Maine, Portland, ME; ykim@usm.maine.edu.

DEMOGRAPHIC, ECONOMIC, AND LAND USE/LAND COVER CHANGE PROJECTIONS FOR USE IN PLANNING AND WATER RESOURCE MANAGEMENT

The Sustainable Urban Region's Project of Maine's Sustainability Solutions Initiative brings together a team of planners, economists, ecologists, and system developers to explore the interactions among social, economic, ecological systems in the Portland and Bangor metropolitan areas of Maine through the use of computer simulation models. The aim is to both better understand these systems and to use that improved understanding to inform Maine organizations and institutions about the choices they face as they seek a more sustainable future. The analysis of how changing social and economic forces will influence urban structure as well as the landscape of ecological systems surrounding urban areas is particularly salient in the state because the existing quality of place has been embraced as a major public policy as well as economic development issue in a state that also wishes to grow. This paper will review various options and issues for projecting population, employment, and land use/land cover change) at the state, regional, town and sub-town levels using different modeling approaches including conjoined economic-demographic models, multi-level step down models, planning support system models such as *What If* and *Community Viz* and newer generation system models such as *Urban Sim* which incorporate multiple types of models including dynamic market equilibrium models, spatial analysis models, and agent-based models.

2:15PM – 2:35PM

A. S. Reeve[1]***,*** *Shaleen Jain*[2]*, Matt Legere*[2]*, Jean MacRae*[2]*, Firooza Pavri*[2]*, John Peckenham*[5]*, Misa Saros*[2]*, Mike Scott*[4]*, Anna Springsteen*[2]
1 Dept. of Earth Sciences, University Of Maine, Orono, ME; asreeve@maine.edu.
2 Civil and Environmental Engineering, University of Maine, Orono, ME.
3 Geography & Anthropology, University of Southern Maine, Portland, ME.
4 New Media Program, University of Maine, Orono, ME.
5 Mitchell Center, University of Maine, Orono, ME.

USING LUMPED PARAMETER DRAINAGE-BASIN MODELS TO ASSESS LAKE LEVEL IN A MANAGED LAKE SYSTEM

Sebago Lake, located in southern Maine, is a municipal drinking water source area for about 200,000 people in the greater Portland, Maine region. In addition to supplying drinking water, this 118 sq. km lake and the surrounding drainage basin, serve a wide variety of recreational, commercial and environmental services. Currently, lake-level is regulated at the Eel Weir Dam, the only surface-water outflow, where discharge is controlled. Uses for this lake will be impacted by ongoing shifts in land use and predicted changes in climate.

Several task are underway associated with a simple computer model being prepared to assess factors that influence lake-water level. Anticipated use of this interactive modeling system include: 1) education of groups about the impacts of lake management options, 2) sensitivity analysis of different parameters used in the model, and 3) short-term forecasting of river discharge and associated lake-level based on weather forecasts, potentially to assist in management decisions at the Eel Weir Dam. We hope to expand this modeling approach to assess longer term impacts to lake level driven by changing land use and predicted changes in climate.

Completed activities include: 1) monitoring stream discharge to Sebago Lake through stream gaging and installation of water level data loggers, 2) creation of a simple lumped-parameter drainage-basin model based on

GR4J (Perrin et al. 2003, J.Hydro. 279:275-289), and 3) development of a preliminary interface to this modeling system allowing interactive access to the model through the Internet. Currently, rating curves for the major streams flowing into Sebago Lake are being developed, allowing the use of continuously monitored stream stage to predict stream discharge rates. These data are being used to calibrate a model for sub-basins within the Sebago Lake Watershed, with stream discharge associated with each sub-basin used to estimate inflow into Sebago Lake. These fluxes are used in a water balance for Sebago Lake, used to calculate lake level.

2:35PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:20PM

Damon Hall[1]***,*** *Linda Silka*[2]*, Laura Lindenfeld*[2,3]
1 Sustainability Solutions Initiative, University Of Maine, Orono, ME; damon.hall@umit.maine.edu.
2 Margaret Chase Smith Policy Center, University of Maine, Orono, ME
3 Department of Communication & Journalism, University of Maine, Orono, ME

THEORETICAL FRAMEWORKS FOR INTEGRATING COMMUNICATION RESEARCH & STAKEHOLDER ENGAGEMENT

Citizens are increasingly demanding involvement in environmental decision-making (McLagan & Nel, 1995, Wondolleck & Yaffee, 2000). Given that two-way flows of communication have emerged as a preferred engagement mode, understanding stakeholder conflict and diverse worldviews becomes key to crafting environmental policy (Cox, 2009). Diverse problems, places, and research topics invited varied efforts at engaging stakeholders, yet few empirical attempts have examined the range of approaches. A portfolio approach to examining diverse projects' failure and success forms the basis for our emerging theory of engagement. Our theory assumes a polycentric approach (Ostrom) that accounts for varied types of stakeholders, problems, and disciplines. We argue that successful stakeholder engagement places emphasis on innovative problem solving rather than rule-bound prescriptive lockstep approaches. Effective partnerships assert the challenge of devising engagement through the same hypothesis-testing perspective that animates research itself. In our model, partnerships constitute learning organizations that intuitively envision different approaches and then customize these by providing iterative feedback that result from collaborative efforts.

3:25PM – 3:45PM

Colleen Budzinski *(student)****,*** *Laura Lindenfeld*
Department of Communication & Journalism, University of Maine, Orono, ME;
colleen.budzinski@umit.maine.edu.

FACILITATING ORGANIZATIONAL INNOVATION: STRENGTHENING MAINE'S SUSTAINABILITY SOLUTIONS NETWORK THROUGH COMMUNICATION RESEARCH

This presentation provides data from a survey of the Maine EPSCoR Sustainability Science Initiative's (SSI) Sustainability Solutions Partners (SSP) program conducted in fall, 2010. The survey aims to understand and improve synergy and collaboration across the Maine EPSCoR SSI, a statewide network of institutions of higher education. Data obtained suggest that the SSI project is personally and professionally important to participants, but that they require more effective means of communication and a stronger network to build effective, sustainable collaborations with each other. Data also suggest that participants need support in specific programmatic

areas key to the SSI's success, especially in the areas of Coupled Natural and Human Systems modeling and research and in Knowledge/Action Linkages.This survey represents an initial study in a longitudinal research effort designed to study the SSI's capacity for building and and strengthen the SSI statewide network through iterative feedback loops of research and implementation. Communication research offers particularly useful insights into how the network is growing and changing.

3:50PM – 4:10PM

***Karen Hutchins*[1], *Kathleen Bell*[2], *Jessica Leahy*[3], *Linda Silka*[4], *Laura Lindenfeld*[1]**
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karen.hutchins@umit.maine.edu.
2 School of Economics, University of Maine, Orono, ME.
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4. Margaret Chase Smith Policy Center, University of Maine, Orono, ME.

PROBLEMSCAPING MAINE: REACHING OUT TO COMMUNITIES TO INFORM RESEARCH?

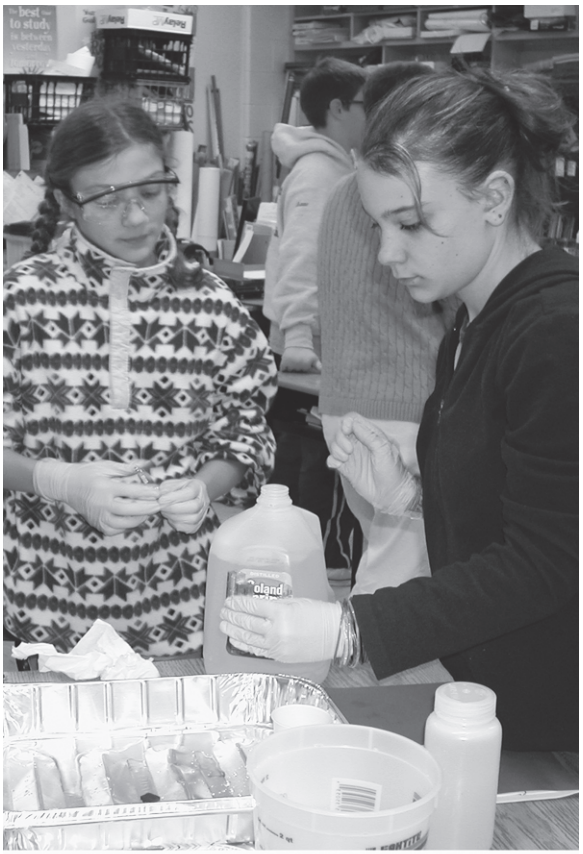
A central mission of SSI is to better understand the process of linking knowledge with effective action. In fact, one of the expressed desires of SSI is to "undertake innovative research to understand . . . processes that influence the use of scientific knowledge in decision-making" (Maine's Sustainability Solutions Initiative, 2009, section 4.3). Researchers recognize that this understanding and influence cannot come from inside the labs, offices, and classrooms at the university alone; instead, we must collaborate, listen, and engage with various publics in order to co-produce knowledge and co-construct models for action. We must heed Hart and Calhoun's (2009) argument that "a key step in effective knowledge-to-action initiatives is ensuring that stakeholders play a central role in defining the problem, identifying research needs or information gaps and helping to shape solutions"(p.7).

The Knowledge-to-Action/Engagement team started our research by "talking" with Maine communities. In August, 2010, we sent a mail survey and questionnaire to a variety of municipal officials in each Maine municipality with the goal of assessing the issues and concerns of Maine communities, and their interest in community-university partnerships and preferences for working with Maine universities and colleges to manage their expressed issues and concerns. This presentation will discuss preliminary survey findings, highlighting how we are beginning to meet three of our research objectives: 1) to lay the foundation for a generalizable model of collaboration between universities and communities; 2) to assess sustainability needs across Maine and feed back into the sustainability science experiment of the SSI; and 3) to assess communities' preferences for collaboration and communication.

Session 3

Innovations in Water Resources Outreach & Education

Many of today's science issues are multi-disciplinary and complex. From climate change to human health to landscape conservation, interdisciplinary research is placing new demands on outreach and education professionals. How do you keep up with the latest developments while implementing sustained outreach plans? How can education programs enhance literacy about basic scientific principles and follow the process of scientific discovery at the same time? This session includes presentations on innovative natural resources outreach and education programs and projects that have or continue to tackle the big topics.



SESSION CHAIRS:

Catherine Schmitt, Communications Coordinator, Maine Sea Grant
Beth Bisson, Assistant Director for Outreach and Eduction, Maine Sea Grant

Catherine Schmitt is the communications coordinator for Maine Sea Grant. In this role she conveys research findings and information about the coasts and oceans to Maine residents and visitors. Before joining Sea Grant in 2004, Schmitt visited remote lakes and ponds throughout Maine and the Northeast while completing her Master's degree in ecology and environmental science with the Senator George J. Mitchell Center also at the University of Maine. She has worked on science publications from the shores of Chesapeake Bay for the University of Maryland, spent two years as a wetlands consultant in western Massachusetts, and studied salt marshes with the Marine Biological Laboratory in Woods Hole. Catherine Schmitt is the author of *A Coastal Companion, A Year in the Gulf of Maine from Cape Cod to Canada*, and her writing on science, nature, and environmental issues appears in regional newspapers, journals, and magazines.

Beth Bisson is the Assistant Director for Outreach and Education at Maine Sea Grant. She works with Sea Grant staff and partner organizations to deliver education and extension programming that promotes environmental literacy and sustainable use, conservation, and stewardship of Maine's ocean and coastal resources. Before settling in Maine, Beth worked on water quality policy for the Ocean Conservancy in San Francisco, CA, led conservation leadership programs for the Student Conservation Association in NH, CA, and WA, and taught environmental education in ME and in WA. She earned a Master of Environmental Management in water science, policy, and management at the Yale School of Forestry and Environmental Studies, and holds a Bachelor's degree in Visual Art from Brown University.

Session 3: Innovations in Water Resources Outreach & Education

8:30AM – 8:55AM

Dan Creek[1]***,*** *W. Donald Hudson*[2]*, Lynn Flaccus*[2]
1 Montsweag Brook Restoration Project, Portland, ME; montsweagfs@gmail.com.
2 Chewonki Foundation, Wiscasset, ME.

EDUCATIONAL OUTREACH AND STUDENT INVOLVEMENT IN LONG-TERM MONITORING FOR THE MONTSWEAG BROOK RESTORATION PROJECT

A primary goal of the Montsweag Brook Restoration Project is to involve local students in long-term monitoring of this stream restoration effort in mid-coast Maine. The Chewonki Foundation has developed a monitoring plan that allows for significant data collection by students and others with limited technical expertise. While the program was only recently initiated, there has already been successful student participation from Chewonki Semester School and Wiscasset Middle School. The field science opportunities and related in-class activities combine together as a powerful introduction to the importance of stream restoration and barrier removal.

To reach a broader audience, an interactive web-based data management system has been created for the project. Using this website, which is designed for replication at similar projects, students, educators, and scientific researchers can access and download monitoring data from Montsweag Brook. The website includes on-line analysis tools so that users can more easily visualize changes to parameters such as stream morphology, water quality, riparian vegetation, and fish passage. Time-series photographs and videos are presented on the website, as well as field protocols modified for use with students and lesson plans that incorporate data from Montsweag Brook.

With proper planning students and volunteers can significantly support long-term monitoring efforts for habitat restoration. The innovative educational program for the Montsweag Brook Restoration Project meets several important priorities: meaningful, hands-on educational opportunities; cost savings for comprehensive long-term monitoring; community involvement in local restoration work; and, broad outreach with information and data about the importance of stream restoration and barrier removal.

9:00AM – 9:25AM

Teresa E. Thornton, *Jessica Leahy*
School of Forest Resources, University of Maine, Orono, ME; teresa.thornton@maine.edu.

SOCIAL CAPITAL AND SOCIAL NETWORK CHANGES IN A SCHOOL-CENTERED RESEARCH PROGRAM THAT PROMOTES COMMUNITY MANAGEMENT OF DRINKING WATER SOURCES

Social network analysis (SNA) is an established social science research tool that has yet to be applied to place-based educational programs. This analysis is critical to documenting creation and changes in social capital that result from stakeholder collaborations. This presentation will review SNA and show an application of this technique in a community based environmental monitoring research (CBEMR) program. This CBEMR employs secondary education students, state and local government, ENGOs, local businesses, local colleges, and community volunteers as citizen scientists that create a database of local groundwater quality to use as a baseline for natural resource management. While past studies have evaluated the reliability of data generated by students acting as scientists (Galloway, Tudor, & Vander Haegen, 2006), there have been few studies relating to power dynamics, social capital, and resilience in student-based CBEMR programs. We use qualitative and quantitative data gathered from a citizen science program conducted in five study sites in the northeastern United States. SNA with Pajek software was used to determine density, centralities, and ranking measures of networks. Results indicate that there were significant increases in social networks related to water quality after participation in the student-centered CBEMR program. There were also significant increases in social capital parameters leading to

increased community involvement in natural resource management.

9:30AM – 9:55AM

Bill Zoellick[1]***,*** *Beth Bisson*[2]*, Sarah Nelson*[3]
1 SERC Institute, Winter Harbor, ME; bill@sercinstitute.org.
2 Maine Sea Grant College Program, University of Maine, Orono, ME.
3 Senator George J. Mitchell Center, University of Maine, Orono, ME.

WATERSHED STUDIES IN SCHOOLS TO SUPPORT STUDENT UNDERSTANDING OF SYSTEMS CONCEPTS

For the past four years the SERC Institute at Acadia National Park, working in cooperation with the Mitchell Center and Maine Sea Grant at the University of Maine, has trained and supported teachers in participatory research that engages high school students in sample collection and data analysis. From a scientific standpoint, the work by students and teachers has supported a study of mercury burdens in biota at different trophic levels across different watersheds. The educational goals of the project include (1) engaging students in hands-on, place-based field studies (2) while familiarizing them with the methods of authentic research tied to Acadia National Park and (3) introducing them to perspectives and concepts that teach them how to think of watersheds as systems. This talk focuses on the project's activities in support of the last objective: providing students with experience and instruction so they learn to think in terms of systems, as opposed to simple causation tied to concrete objects or actions. Our approach has been to provide teachers not only with supplies, materials, and training in the scientific aspects of the project, but also to engage them in developing linkages between the field research, the systems perspective, and existing curricula. The talk will review quantitative results from student surveys and assessments, lessons learned in the course or teacher professional development, a summary of recent project activity, and a description of opportunities for other teachers and schools to participate in the research and learning.

Session 4

Green Remediation - Practical Considerations

A few years ago, US EPA and state waste management officials introduced the term "Green Remediation" with respect to petroleum and hazardous waste soil, and groundwater site clean-ups. What does this mean and can it be done on a practical level here in Maine? The concepts range from "whole-site" approach to specific on-site or near site remediation efforts to reduce the high carbon appetite of traditional off-site "muck and truck" soil removal. The purpose of this session is to highlight recent "greenish" remediation projects and to explore some practical thinking on what can be done in the future here in Maine.

SESSION CHAIR

David McCaskill, P.E., Senior Environmental Engineer, Division of Technical Services, Bureau of Remediation and Waste Management, Maine Department of Environmental Protection

David McCaskill has been with the Maine Department of Environmental Protection since 1986, except for a brief stint working for an environmental consultant in the early 1990's. David is a Senior Environmental Engineer and as Unit Leader of the Bureau of Remediation and Waste Management (BRWM) Technical Assistance/Oil Spill Prevention Unit he is responsible for the state Spill Prevention Control and Countermeasure (SPCC) and Home Heating Oil Tank Replacement programs. He also serves as a resource to the Department for developing strategies to target and implement new tank and equipment technologies for use in Maine for both the Underground Storage Tank (UST) and Aboveground Storage Tank (AST) programs. In the last couple of years he has been tasked with tank removals and soil remediation at abandoned UST motor fuel facilities throughout the state targeting locations that threaten groundwater resources. He serves as the co-chairman of the Maine DEP/Consulting Professionals of Maine Taskforce and as BRWM representative on the Pollution Prevention/ Compliance Advisory Panel. He is also a regular contributor to *LUSTline*, a national quarterly bulletin on underground storage tanks/leaking underground storage tanks (UST/LUST) issues published by the New England Interstate Water Pollution Control Commission. David holds a BS in Civil Engineering from Mississippi State University and is a licensed Professional Engineer in Maine.

8:30AM – 8:55AM

Bjorn Lake*[1]*, *Jim Hart*[2]*, Aria Amirbahman*[1]

1 Civil & Environmental Engineering, University of Maine, Orono, ME; bjorn.lake@umit.maine.edu.

2 Kennebec Water District, Vassalboro, ME.

FROM LANDFILL TO BEST MANAGEMENT PRACTICE, A BENEFICIAL RE-USE APPLICATION OF WATER TREATMENT RESIDUALS

The Kennebec Water District (KWD) is a quasi-municipal public drinking water utility serving a population of 22,500 in central Maine. The KWD draws their water from the China Lake Watershed (Kennebec County, Towns of Vassalboro & China) which is listed as 303(d) impaired waterbody. As part of the water treatment process, aluminum sulfate coagulants are used to clarify the influent. The resulting water treatment residual (WTR) is collected in a recycle lagoon and dewatered before being landfilled. This process is economically costly to the KWD and their customers as well as unsustainable with respect to solid waste management. As an alternative to landfilling, beneficial re-use applications of the WTR have been researched including wastewater treatment, construction material production, and soil amendments. In this pilot study, we characterized the physical and chemical parameters of the WTR produced at the KWD to investigate its use as a sorptive media for phosphorus immobilization in septic leach fields. We determined the hydraulic conductivity, particle size, phosphorus sorption isotherms, and the advection/dispersion characteristics to properly derive design parameters. The Maine Lakes Resource Center opening in Belgrade, ME, will be the site of the first field experiment using WTR in a septic leach field in the spring of 2011. This field experiment will be discussed along with other possible WTR re-use applications across Maine.

9:00AM – 9:25AM

Nicholas O. Sabatine[1]*, Erik P. Phenix*[1]*, John K. Cressey*[2]*, John B. Rand*[3]

1 Ransom Environmental Consultants, Inc., Portland, Maine; nsabatine@ransomenv.com.

2 Summit Environmental Consultants, Inc., Augusta, ME.

3 JBR Consulting Hydrogeologist, Raymond, ME.

BIO-PILE SITING, CONSTRUCTION, OPERATION, MAINTENANCE, AND APPLICATION ON PETROLEUM CONTAMINATED SITES. RANGELEY AND GARDINER, MAINE BIO-PILE EXAMPLES

Ransom Environmental Consultant, Inc. (Ransom) and Summit Environmental Consultants, Inc. (Summit) have been engaged through the Maine Department of Environmental Protection (MEDEP) Brownfield Program to site and construct bio-piles at sites in Gardiner and Rangeley, Maine respectively. Bio-piles are a remediation alternative that can significantly reduce costs associated with petroleum contaminated soil management and disposal, while successfully reducing contaminant concentrations and allowing the soil to be made available for beneficial reuse options. Unlike traditional “land farming/land spreading” operations, the example bio-piles were designed to be self-sufficient. Through the augmentation of soil nutrients, active circulation of air, and optimization of ambient heat, petroleum hydrocarbons are degraded without the need for regular labor or mechanical maintenance.

Numerous factors, including siting constraints, contaminant characteristics and concentrations, soil chemistry, end use objectives, and mechanical and coordination logistics, need to be considered in the design and construction of a bio-pile. Each of these considerations will be discussed in relation to the example bio-piles, as well as suggestions and recommendations for future bio-pile projects.

The Rangeley bio-pile project will be presented as a case study in low-maintenance bio-pile remediation. The Rangeley project involved the evaluation of three separate bio-pile designs. One pile was used as a control, and received nutrient augmentation only. A second pile was designed with a re-circulating air system in addition to nutrient augmentation. The third pile included a solar collector connected to the re-circulating air system, along with nutrient augmentation. Findings from the Rangeley bio-pile project will be discussed in terms of temperature, nutrient depletion, microbial activity levels, length of treatment season, and percent reduction in contaminants.

9:30AM – 9:55AM

Charles A. Crocetti, *Timothy M. White, Scott R. Nerney*
Sanborn, Head & Associates, Inc., Concord NH; cacrocetti@sanbornhead.com

AN EMERGING CONTAMINANT – 1,4-DIOXANE: TRANSPORT, FATE AND TREATMENT AT A NEW ENGLAND SUPERFUND SITE

Chlorinated VOC-contaminated groundwater has migrated off-site, and contaminated several private water supply wells; municipal water is not available. 1,4-dioxane was analyzed in supply wells starting in 2008 at a detection limit of 1 ug/l (groundwater standard 3 ug/l). Historically, 1,4-dioxane was used as a stabilizer for 1,1,1-trichloroethane and trichloroethene, both principal site contaminants.

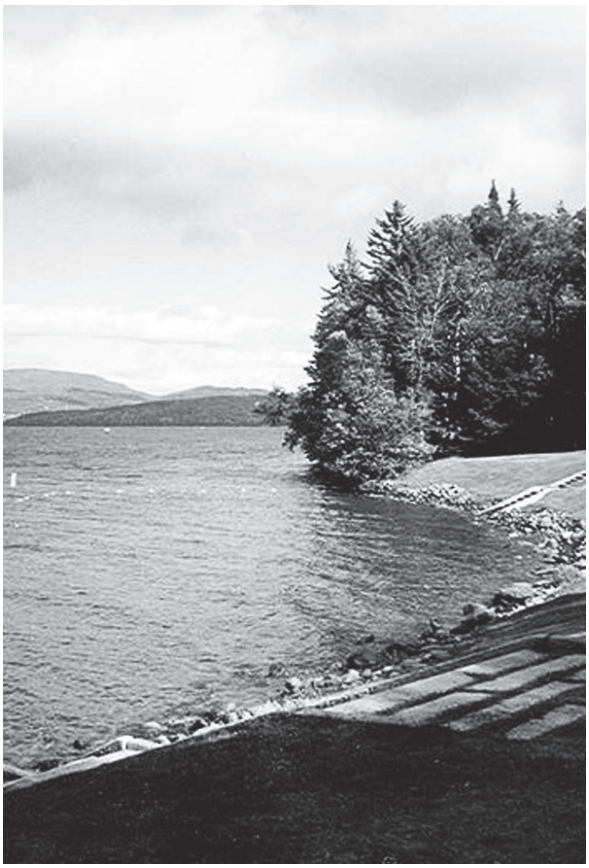
The highest 1,4-dioxane concentrations, up to 80 ug/l, generally are at the downgradient limits of the plume, including some of the impacted residential wells. Groundwater concentrations in contaminant source areas are typically 1 to 10 ug/l. This pattern is substantially different from the chlorinated and aromatic VOCs, which have their highest concentrations near source areas, and generally decrease downgradient. The observed 1,4-dioxane distribution is thought to be due to its high solubility and strong partitioning into groundwater at LNAPL source areas, and resistance to adsorption, biodegradation and other attenuation mechanisms, relative to other VOCs. Based on observations from this site, and its physical/chemical properties, 1,4-dioxane may commonly be at the leading edge of chlorinated solvent groundwater plumes.

Point of entry GAC treatment systems are installed at supply wells with VOC concentrations exceeding standards. These systems have been more effective than initially anticipated at removing 1,4-dioxane, with breakthrough at concentrations above the standard typically occurring after approximately three to five months. However, if the standard for 1,4-dioxane is lowered further, as is currently being considered, an alternative method for water supply treatment/alternative source of drinking water may be required.

Session 5

Water and Land Conservation: Interaction and New Models

Healthy water and land are tightly entwined, but experience different economic, political, practical, and regulatory environments that affect conservation opportunities. For this session, talks will feature the economics of ecosystems servces market, opportunities and uncertainties as well as interactions between land and water conservation, including: water & aquatic habitat conservation through large landscape conservation; forest conservation, ecologically based forest management, and water; implications of water quality influences that are outside the control of land managers; and water quality and aquatic habitat restoration on conserved lands.



SESSION CHAIR:

Mark Berry, Executive Director, Downeast Lakes Land Trust

Mark Berry returned to Maine in 2006 to join Downeast Lakes Land Trust and has served as Executive Director since January 2007. His previous position was manager of the 34,000-acre Pine Creek Conservation Area in north central Oregon for the Confederated Tribes of Warm Springs. He has taught and researched in the outdoors from Antarctica to Wyoming. Mark holds a Master's degree in Environmental, Population and Organismic Biology from the University of Colorado. He completed his thesis on the effects of habitat and landscape context on songbird use of breeding habitat in the Colorado foothills. Mark received a degree in Environmental & Evolutionary Biology from Dartmouth College. Mark enjoys many outdoor activities including kayaking, canoeing, and skiing.

8:30AM – 8:55AM

Ethel Wilkerson*[1]*, *John Gunn[1], Bill VanDoren[2], Paul Barten[2], Lee Dassler[3], Therese Tepe[4]*

1 Manomet Center for Conservation Sciences; ewilkerson@manomet.org.

2 University of Massachusetts, Amherst, MA.

3 Western Foothills Land Trust.

4 World Resources Institute.

TOOLS AND STRATEGIES FOR PROTECTING FORESTS AND ENHANCING WATER QUALITY IN THE CROOKED RIVER WATERSHED IN SOUTHWESTERN MAINE

Maintaining forest cover is key to protecting the ecological, economic, and social benefits of clean water. The Crooked River watershed in southwestern Maine is rural and predominately forested and a recent study deter-

mined it contains the cleanest water of all watersheds in the Northeast. The Crooked River supplies over 40% of the surface inflow to Sebago Lake which is the reservoir for the Portland Water District, a utility that supplies drinking water to 200,000 customers in 11 communities. The United States Forest Service has determined this region is at high risk for forest conversion and this development pressure along with unsustainable land use practices are threatening water quality. The Northern Forest Watershed Incentives Project was initiated to protect forests and maintain and enhance water quality and other watershed services within the Crooked River. This project develops tools to prioritize conservation planning and uses new funding strategies to incentivize forest conservation, responsible land use practices, and financing watershed enhancements. This presentation will highlight specific tools and strategies including: a GIS based threat assessment and prioritization index to identify parcels with significant contributions to water quality, using a in-lieu fee compensation program to finance the purchase of a conservation easement and restoration of four road/stream crossings, developing a voluntary carbon offset program to fund restoration of riparian buffers, and using a “green vs. gray” infrastructure analysis to promote private investments in watershed protection projects.

9:00AM – 9:25AM

Spencer Meyer[1]*(student),* *Michelle L. Johnson*[2]*(student), Robert J. Lilieholm*[3]*, Christopher S. Cronan*[4]
1 Sustainability Solutions Initiative and School of Forest Resources, University of Maine, Orono, ME; spencer.meyer@maine.edu.
2 Sustainability Solutions Initiative and School of Ecology and Environmental Science, 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.

TEMPORAL AND SPATIAL DISTRIBUTIONS OF CONSERVED LANDS IN MAINE

The northeastern United States has led the nation in many land conservation innovations. Large landscape conservation efforts are becoming increasingly comprehensive in scope and scale, yet little is known about the temporal and spatial evolution of conservation lands in Maine. This study constructed a temporal signature for conserved lands in Maine and assessed the spatial relationships between fee simple conserved lands and those under conservation easements. Using spatial data from multiple sources, we reconstructed a timeline showing decadal patterns in conservation for 95% of currently conserved lands. Using spatial pattern analyses we assessed the cluster patterns and relationships between conserved parcels. Preliminary results indicate only 18% of currently conserved lands were conserved prior to 1980, with 6%, 33% and 38% added in subsequent decades (i.e., the 1980s, 1990s and 2000s, respectively). Spatially, nearest neighbor analyses indicate that easement lands are more tightly clustered than those in fee simple ownership. Furthermore, small easement parcels (i.e., those less than 1000 acres) were more tightly clustered than easement parcels greater than 1000 acres. The temporal results of this study show the relatively recent increase in societal interest, both with available funding and political will, to conserve land for future generations. Anticipated future work quantifying the influence existing conserved parcels have on the likelihood that adjacent areas will be conserved will help land managers identify conservation value across the landscape and best prioritize future efforts.

9:30AM – 9:55AM

Michelle L. Johnson[1]*(student), Christopher S. Cronan*[2]*, Dave Owen*[3]*, Spencer R. Meyer*[4]*(student), and Robert J. Lilieholm*[5]
1 Sustainability Solutions Initiative, School of Ecology and Environmental Science, University of Maine, Orono, ME; michelle.l.johnson@maine.edu.

2 School of Biology and Ecology, University of Maine, Orono, ME.
3 University of Maine School of Law, Portland, ME.
4 Sustainability Solutions Initiative, School of Forest Resources, University of Maine, Orono, ME.
5 School of Forest Resources, University of Maine, Orono, ME.

USING BAYESIAN BELIEF NETWORKS TO IDENTIFY AT-RISK AQUATIC RESOURCES UNDER ALTERNATIVE FUTURE DEVELOPMENT SCENARIOS

The influence of urbanization on hydrologic systems is well documented, with stream impairment resulting from a diverse set of physical and chemical drivers including hydrological alteration, chemical and nutrient pollution, and thermal stress. These drivers are emergent properties of social and economic processes that are in turn influenced by ecosystem processes, resulting in a complex set of linkages among social and ecological factors. Given these complexities, it is difficult to predict which streams are at risk for degradation, how landscape changes will differentially affect stream resources, and which impaired streams are most likely to respond to restoration efforts. Such predictions could be quite valuable, however, because proactive efforts to prevent or manage urban stream degradation are likely to produce positive environmental outcomes at much lower cost than restoration efforts begun after degradation has substantially progressed. Here, we use Bayesian Belief Network (BBN) models to combine spatial data, expert knowledge, and stakeholder values to develop decision tools designed to identify streams and watersheds likely to experience new residential and commercial development. We initially focus on a pilot-scale municipal BBN, with the expectation of scaling-up to identify at-risk watersheds state-wide. Future development scenarios consider zoning and land use policies, and explore varying levels of population growth and development densities. We also evaluate opportunities for prioritizing policy and regulatory responses within existing legal frameworks.

Session 6

Maine's Water Resources Research Institute Grant Program: Success Stories

The 54 Water Resources Research Institutes (WRRI) across the US and territories "represent cooperative agreements between public universities and federal and state government that engender lasting partnerships among state universities; federal, state, and local governments; businesses and industries; and non-governmental organizations aimed at solving problems of water supply and water quality at local, state, regional, and national levels". Maine's USGS WRRI is located at the University of Maine's Mitchell Center. A key focus of the Maine WRRI program is a competitive grant program designed to provide funding for research and information transfer regarding Maine's water resources. This session will feature talks that describe previously-funded or in-progress projects that are part of the WRRI grants program.

SESSION CHAIR

John Peckenham, Director, Maine Water Institute

John M. Peckenham currently serves as the Director of the Maine Water Institute and Assistant Director of the Senator George J. Mitchell Center at the University of Maine, where he is a Senior Research Scientist. He is a member of the governing board of the Maine Sustainability Solutions Initiative. John's other professional affiliations include Managing Partner of Maine Water Security, LLC, a drinking water security start-up company, and Water Quality Consultant (Maine Certified Geologist). He is a graduate of Bates College (Geology) and Dalhousie University (Geology and Geophysics). His research interests include: drinking water quality and public water supply; natural groundwater contaminants (such as arsenic and antimony); water resource management; remediating contaminated water and soil; and, science education and outreach.

PART 1 - INTRODUCTION & BACKGROUND

8:30AM – 8:40AM

Robert Lent
Maine Geological Survey; Augusta, ME; rmlent@usgs.gov.

COLLABORATION BETWEEN U.S. GEOLOGICAL SURVEY AND WATER RESEARCH INSITITUTES

Session 6: Maine's Water Research Institute

8:40AM – 8:50AM

John Peckenhmam
Director, Maine Water Institute; jpeck@maine.edu.

A SHORT HISTORY OF THE MAINE WATER RESOURCES RESEARCH INSTITUTE

PART 2 - RECENT SUCCESSFUL PROJECTS

8:55AM – 9:15AM

Adria Elskus
U.S. Geological Survey, Maine Field Office, University of Maine, Orono, ME; aelskus@usgs.gov.

MONITORING CONTAMINANT EXPOSURE OF ENDANGERED SPECIES: LETHAL, NON-LETHAL AND SURROGATE APPROACHES

Contaminant monitoring protocols typically require lethal sampling to evaluate the level of exposure and response of the organisms being monitored. This presents particular challenges for endangered and threatened species which cannot be taken lethally. I will present some approaches we have taken to evaluating contaminant exposure and response of Maine Atlantic salmon (*Salmo salar*), a population listed as endangered in the year 2000 and one which comprises the last wild population of this species in the U.S. The presence of multiple stressors in the spawning habitat of this species, and the impending removal of two dams on the Penobscot, the Maine river with the largest migratory run, represent just two of the challenges facing this Distinct Population Segment. I will discuss two approaches we have taken to evaluate contaminant exposure and response in Atlantic salmon: 1) the use of two aquatic toxicology model fish species, zebrafish (*Danio rerio*) and fathead minnows (*Pimephales promelas*) to evaluate habitat conditions, and 2) biomarker expression in gills and scales of Atlantic salmon sampled non-lethally. I will present these in the context of specific laboratory and field studies, including evaluating the toxicity of water following re-suspension of Penobscot River sediments (simulating a dam removal) and the use of the biomarker enzyme CYP1A in fish gills and scales. The limitations and benefits of each approach as it relates to resource management and decision making will be discussed. (USGS, Senator George J. Mitchell Center 06HQGR0089).

9:20AM – 9:40AM

Shaleen Jain
Civil and Environmental Engineering, University of Maine, Orono, ME; shaleen.jain@maine.edu.

CHANGING CLIMATE AND REGIONAL HYDROLOGY

Hydrology is closely linked to climate and changes in climate can be detected in hydrologic responses. Research funded in part by the Maine Water Resources Research Institute have been used to analyze stream gage records across the New England region. Patterns of shifting streamflow vary in timing, magnitude and location. Understanding these changes have profound implications for fisheries, recreation, and power generation. This work has leveraged other related research and linkages to other significant findings will be presented. (USGS, Senator George J. Mitchell Center 06HQGR0089).

Session 6: Maine's Water Research Institute

9:45AM – 10:05AM

Melinda Neville *(student), Kate Beard*
Spatial Information Science & Engineering, University of Maine, Orono, ME; melinda.neville@maine.edu.

SPATIOTEMPORAL DATABASE INTEGRATION OF MERCURY RESEARCH IN MAINE

The inland and coastal waters of Maine have been subject to decades of anthropogenic mercury (Hg) loading, but recently, policy changes have been instrumental in lowering regional Hg emissions. Maine-based research efforts have included monitoring Hg in soil, birds, fish, surface water and precipitation. These and other monitoring efforts provide partial views on the affects of decreasing Hg emissions on water quality and ecosystem health, but not a comprehensive picture because of the different spatial and temporal sampling strategies and because of the complexity of Hg fate and transport dynamics. This current WRRI-funded project seeks to collate historic and current Hg research into an integrated spatiotemporal database. The first step of creating the integration framework was to define the spatial and temporal support of the different Hg data sources. Defining the spatial and temporal support of these data illustrates some of the cause-effect and source-sink dynamics of mercury biogeochemistry in a GIS-modeled system. We will discuss the challenges of working with disparate spatiotemporal data, and the applied techniques that facilitate its use in evaluating ecosystem risk and resilience to Hg pollution. (USGS, Senator George J. Mitchell Center 06HQGR0089).

Session 7

Developing, Urbanizing and Undeveloped Watersheds

Maine has an increasing number of impaired streams in urban and suburban areas. According to recent watershed research, development also is probably impacting streams outside of urban or suburban areas, with adverse water quality impacts expected even where development levels are still low. This session will consider some of the scientific, engineering, and policy questions raised by this growing challenge. Talks may address biophysical mechanisms of impairment; biophysical relationships between impaired urban watersheds and associated terrestrial or aquatic habitats; social and economic values associated with urban watersheds; engineering, economic, and policy responses to urban stream impairment; and mechanisms for preventing urbanization-related degradation in lightly or non-impacted watersheds.

SESSION CHAIR

Dave Owen, Associate Professor, University of Maine School of Law

Dave Owen is an associate professor at the University of Maine School of Law. His research interests range from ecosystem restoration to climate change, and he is particularly interested in water resource management and legal responses to environmental uncertainty and change. He teaches courses in environmental law, natural resources law, water law, and administrative law. Prior to joining the Maine Law faculty in 2007, Dave practiced with Rossmann and Moore, a small San Francisco firm specializing in environmental, land use, and water law, and he clerked for Judge Samuel Conti of the United States District Court for the Northern District of California. Before attending law school, Dave worked as a geologist and environmental auditor with Woodard and Curran, an environmental consulting firm.

1:30PM – 1:55PM

Christopher Cayce Dalton
FB Environmental Associates, Portland, ME; cayced@fbenvironmental.com.

LIFE'S A DITCH: MONITORING STORMWATER RESTORATION IN THE LONG CREEK WATERSHED.

Long Creek is a 630-acre urban watershed in southern Maine discharging to Clarks Pond in Casco Bay. The watershed encompasses the Maine Mall, a large golf course, an industrial park, a stretch of the Maine Turnpike, and portions of the Portland Jetport. Impervious cover is extremely high, ranging from 10% to 61.2% across subcatchments. The newly formed Long Creek Watershed Management District (LCWMD) is conducting an aggres-

sive, permit-driven, watershed-wide restoration effort. FB Environmental is assisting the LCWMD to undertake a comprehensive monitoring effort in the watershed. Our purpose in carrying out the monitoring program is to document attainment status and trends in Long Creek, and to guide restoration efforts through a better understanding of watershed dynamics.

Discharge monitoring is a key component of this project. With assistance from Truslow Resource Consulting, we developed rating curves for six stream locations, and we are using inexpensive pressure transducers to generate a continuous discharge record at those sites. We collected grab samples during base flow and "first flush" storm conditions throughout the summer and fall. We recorded continuous dissolved oxygen, temperature, and specific conductivity samples using datasondes.

The interplay of precipitation, discharge, and pollutant concentrations sheds light on the dynamics at work in a Maine urban impaired stream. Examples include an inverse relationship between flow and salinity, and the pattern of water quality exceedances throughout the season. The challenge ahead for all involved is to decode these and future data, and use them to improve on-the-ground construction and remediation investments.

2:00PM – 2:25PM

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

URBAN IMPAIRED STREAMS IN MAINE: UNVEILING THE MAINE STATEWIDE IMPERVIOUS COVER TMDL

Impervious cover (IC) is often used as a measure of human disturbance as it relates to aquatic communities in streams, and to the overall health of watersheds. At higher levels of IC, studies have documented that streams become degraded and are unable to support sensitive species of fish and aquatic macroinvertebrates.

The twenty-seven waterbodies included in the Statewide Impervious Cover Total Maximum Daily Load (TMDL) document have been assessed by DEP as not meeting Maine's water quality standards for aquatic life use, and have been listed on the 303(d) list of impaired waters. The Clean Water Act requires that all 303(d) - listed waters undergo a TMDL assessment that describes the impairments and establishes a target to guide the measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards. Given the number of waters listed for impairment of aquatic life use, addressing the TMDL assessments in a combined statewide TMDL report is the most appropriate and efficient use of resources. The statewide TMDL approach makes the TMDL process more efficient and allows the implementation and restoration process to begin sooner.

In order to bring these streams into attainment, watershed municipalities and other stakeholders will need to be engaged and committed to implementing water quality improvements. This presentation will describe the statewide TMDL process and provide stakeholders with valuable tools to initiate local urban stream protection and improvement measures. Recent stream restoration efforts in the Whitten Brook watershed in Skowhegan will be highlighted.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Fred Dillon*[1]*, *Rod Melanson*[2]*, Keisha Payson*[3]*, Doug Roncarati*[4]

1 City of South Portland, Water Resource Protection Dept., South Portland, ME; fdillon@southportland.org.
2 Town of Topsham, Topsham, ME; rmelanson@topshammaine.com.
3 Bowdoin College, Brunswick, ME.
4 City of Portland; Department of Public Services, Portland, ME.

MUNICIPAL STORMWATER MANAGEMENT PROGRAMS IN NORTHERN NEW ENGLAND

The purpose of this research effort is to conduct interviews with a dozen northern New England (ME, NH & VT) communities that are generally recognized as leaders in the development of municipal stormwater management programs. Most of these communities also have designated impaired streams and must address the regulatory considerations that accompany these designations. The broad goals of the project are to discover the policy implications for: 1) what has motivated each community to be proactive in its approach to stormwater management; 2) what techniques or tools each municipality has employed to reduce the impacts of stormwater pollution; 3) why each municipality chose the particular tools or techniques for stormwater management over other possible options; and 4) how each community finances stormwater management.

The results from this study should help us develop a better understanding of how municipal officials in Northern New England prioritize their stormwater management activities and needs. We expect that the data gathered will provide insight about the role local regulations play in effectively managing stormwater. We also expect to identify barriers that have impeded the implementation of low impact development techniques and/or watershed-based management tools along with how these barriers have been overcome.

The interviews are currently ongoing and should be completed in early 2011 (in time for presentation at the 2011 MWC). We anticipate that our main conclusions will serve as a “toolbox” of effective approaches for managing stormwater pollution while identifying additional tools that could be useful to municipal stormwater program managers.

3:30PM – 3:55PM

Brenda Zollitsch[1], David Ladd[2], Phil Ruck[3]
1 Bangor Area Stormwater Group, Bangor, ME; bmzconsulting@aol.com.
2 Maine Department of Environmental Protection, Augusta, ME.
3 CES Inc.

This presentation will share a paper we presented at the North American Surface Water Conference in San Antonio Texas in August 2010 and that will be published in the national journal, *Stormwater*, in January 2011.

In recent years, collaboration has become a buzzword in the stormwater management field. The nature of stormwater flow, origins and impacts makes it a natural fit for joint action, necessitating the cooperative action of multiple levels of government; the engagement and action of citizens; and the support of nonprofits, businesses and funders. As municipalities are increasingly asked to start viewing and managing stormwater from a watershed perspective, regulated entities are looking more closely at collaborative approaches to reduce stormwater pollution. The role of local-state partnerships is being found to be an important component of these evolving regional, watershed-level management efforts.

This presentation will introduce and apply a new analytical framework to guide review of the range of options for promoting collaboration. Using a case study of the State of Maine’s stormwater management partnerships and guided by the work of environmental collaboration experts Koontz et al (2004), this presentation will discuss four specific approaches and review the primary the costs and benefits of each to both municipalities and those who regulate them. Participants will come away from the presentation with a number of practical tools that can help them explore partnering alternatives.

Session 8

Spanning Boundaries and Disciplines: Integrating Social and Natural Sciences for Effective Water Resource Management

Water resource management necessitates consideration of human and natural systems. This session will feature research projects and programs that integrate social and natural sciences to address water resource management issues. How can we better integrate knowledge of natural and human systems in the context of water resource management? Under what conditions does integration of social and natural sciences enhance water resource management? Collectively, the presentations will speak to the challenges and opportunities of spanning boundaries and disciplines to emphasize the dynamics of coupled natural and human systems.

SESSION CHAIRS

Kathleen Bell, School of Economics, University of Maine

Kathleen Bell is an Associate Professor in the School of Economics at the University of Maine. She received her B.A. in Economics and Environmental Studies from Bowdoin College in 1990 and her Ph.D. in Economics from the University of Maryland in 1997. Kathleen specializes in environmental and natural resource economics and spatial economic modeling. Much of her research addresses the coupling of social and biophysical systems, and as a member of the Maine Sustainability Solutions Initiative, she is growing the capacity for coupled systems research in Maine.

1:30PM – 1:55PM

Teresa Johnson, *Gayle Zydlewski*
School of Marine Sciences, University of Maine, Orono, ME; teresa.johson@umit.maine.edu.

MAINE TIDAL POWER INITIATIVE: SOCIAL AND ECOLOGICAL RESEARCH FOR THE RESPONSIBLE DEVELOPMENT OF TIDAL POWER

The State of Maine has set an ambitious goal of increasing its use of renewable energy resources by 10% between 2007 and 2017. This requires that the State diversify its renewable energy profile. Interest in developing tidal power in Maine has expanded significantly. Currently, the sites furthest along in development are those being developed by the Ocean Energy Renewable Company (ORPC), which is focusing on the Western Passage and Cobscook Bay sites, the two best tidal energy sites identified on the East Coast of the U.S. However, major uncertainties for tidal energy development exist; these include, but are not limited to, assessing environmental

impacts, resource availability, and community acceptance. The Maine Tidal Power Initiative (MPTI), a team of engineers, biologists, oceanographers, has been working closely with developers and regulators to understand how to best move forward with the responsible development of this renewable resource. Here we present the sustainability science approach that we are applying to the problem of how to responsibly develop tidal power to meet the State's social and ecological goals. Specifically, we report on our research on the potential social and environmental impacts of tidal power development and illustrate how these research efforts are being integrated in order to effectively link knowledge to action.

2:00PM – 2:25PM

Jessica Spelke Jansujwicz[1]*, Aram J. K. Calhoun*[1]*, Robert J. Lilieholm*[2]

1 Department of Wildlife Ecology, Sustainability Solutions Initiative, University of Maine, Orono, ME; jessica.jansujwicz@maine.edu.
2 School of Forest Resources, Sustainability Solutions Initiative, University of Maine, Orono, ME.

INTEGRATING SOCIAL SCIENCE INTO NATURAL RESOURCES CONSERVATION TO ENHANCE MANAGEMENT OF VERNAL POOLS

In 2007, the University of Maine and Maine Audubon Society initiated the Vernal Pool Mapping Project (VPMP), a community-based education and outreach project, to increase regulatory compliance with new vernal pool regulations and assist municipalities in mapping and assessing vernal pools using citizen scientists. Because assessments cannot be conducted on private land without landowner permission and because enforcement agencies may not have the personnel to monitor land management practices around every pool within its jurisdiction, landowner participation in the VPMP is critical. Our study explores the factors that discourage or encourage landowner participation in the VPMP and landowner compliance with vernal pool regulations. Data from participant observation, semi-structured interviews, focus groups, and a mail survey across 4 Maine towns participating in the VPMP, indicate that landowners share common concerns regarding property rights, economic considerations, aesthetic preferences, and a lack of knowledge and understanding of vernal pools, regulations, and the VPMP. We found that no single factor such as ownership objectives or attitudes about property rights accurately predicts landowner response to the VPMP, that landowner participation in the VPMP did not always equate to regulatory compliance, and that landowners participating in the VPMP were frustrated by the lack of feedback on vernal pool assessments. We conclude that initiating and supporting community-based processes within top-down regulatory structures is a challenging task requiring a continuous exchange of social and ecological information. We offer communication strategies to facilitate an awareness and understanding of public values and concerns and incorporate social factors into conservation planning.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Matt Craig[1]***, Vanessa Levesque***[2]*(student)*

1 Casco Bay Estuary Partnership, USM Muskie School, Wishcamper Center, Portland, ME.
2 Department of Wildlife Ecology, Sustainability Solutions Initiative, University of Maine, Orono, ME; vanessa.r.levesque@maine.edu.

DOES A RISING TIDE REALLY LIFT ALL BOATS? EXPLORING THE SOCIAL FEASIBILITY OF RESTORING THE NEW MEADOWS 'LAKES'

The upper New Meadows River is a long, narrow tidal embayment that the Maine DEP has determined is "impaired for marine life use and support" due to low dissolved oxygen levels caused by a partial impoundment. The New Meadows Watershed Partnership (NMWP) has funded studies that document water quality, the loss of intertidal habitat upstream of the impoundment, and the technical feasibility of increasing tidal exchange. Despite abundant technical data, little progress had been made toward restoration, in part due to a longstanding perception that local residents are against restoring tidal flow. The authors worked with the NMWP to develop a survey to gauge stakeholder sentiment regarding the health and uses of the New Meadows, and to assess stakeholder views on how the health and uses would be impacted by tidal restoration.

A total of 99 people responded to the survey, including six marine-based businesses, 15 shellfish harvesters, and 66 people whose properties abut the New Meadows or are one lot back from the water. The survey found that 58% of respondents support tidal restoration, compared to 22% who do not and 20% unsure. This talk will share the major findings that emerged from the survey, and discuss how to incorporate social data with the biological and technical data in developing a way forward to restoring the New Meadows. Preliminary recommendations include: design an outreach strategy based on concerns and misunderstandings; address the lack of municipal engagement; and fund studies to explore identified knowledge gaps.

3:30PM - 3:55PM

Whitney King, *Philip Nyhus, Herbert Wilson, Russell Cole*
Departments of Chemistry, Biology, Environmental Studies, Colby College, Waterville, ME; dwking@colby.edu.

"GOOGLE STREET VIEW" FOR MAINE LAKES: CREATING PUBLIC-DOMAIN SHORELINE IMAGES FOR RESEARCH, PUBLIC POLICY, AND EDUCATION.

Shoreline imagery is a powerful tool for quantifying the littoral zone habitat of lakes in terms of ecological diversity, shoreline development, and economic value. We will demonstrate a simple and efficient method for acquiring shoreline images, uploading images to geospatial databases, and sharing the images with researchers and watershed stakeholders using Google Earth. We will describe our procedures used to respect individual privacy while creating public-domain data for research, public policy, and education. Future applications and potential pitfalls of this technology will be presented.

Session 9

Groundwater Geochemistry: Natural and Human Influences

Groundwater is the drinking water of choice for more than half the people in Maine. It is also used as process water for some industries. The taste, odor, usability and appearance of the water depend on its chemistry, which is determined by the geochemical processes in the groundwater from which it comes. Topics may include: 1) natural contaminants such as arsenic, manganese, uranium or other radiological elements; 2) mobilization of natural contaminants by human activity, such as mobilization of arsenic by de-oxygenated groundwater; 3) non-toxic chemistry such as high iron, sulfates and calcium; 4) landfill generated changes in groundwater geochemistry; and 5) seawater intrusion.

SESSION CHAIRS

Bruce Hunter, Hydrogeologist, Maine Department of Environmental Protection

Bruce Hunter, CG #242, Environmental Hydrogeology Manager, has been working as a hydrogeologist in the environmental sector since 1988. His work has included soil and groundwater transport modeling to develop soil cleanup standards, database development, regional groundwater contamination studies and site characterization and remediation. He is currently supervising a group of 20 hydrogeologists and support staff who work in the remediation of soil and groundwater. Early in his career he worked for eight years in the oil industry in Texas, offshore New Jersey and Alaska. Bruce has a B.S. in Geology from Haverford College, a Masters degree in Geology from University of Missouri and a PhD from Texas Tech University.

1:30PM – 1:55PM

Richard S. Behr, *Richard H. Heath*
Maine Department of Environmental Protection, Bureau of Remediation and Waste Management, Augusta, ME; Richard.s.behr@maine.gov.

BIOLOGICAL CONTROLS ON GROUNDWATER CHEMISTRY

Micro-organisms catalyze an amazing number of important biogeochemical reactions which significantly influence groundwater chemistry. The role of micro-organisms is particularly important whenever humans alter the natural environment. The introduction of degradable organic carbon often rapidly depletes the available dissolved oxygen. Once dissolved oxygen is significantly reduced or completely exhausted, anaerobic micro-organisms continue to oxidize available carbon using alternative terminal electron acceptors. We will briefly describe how micro-organ-

isms metabolize organic compounds using alternative electron acceptors including nitrate, manganese, iron and sulfate. Using data from several Maine sites we will demonstrate how rapidly introduced organic carbon exhausts available oxygen.

We will present examples illustrating how the use of alternative electron acceptors may significantly alter groundwater chemistry. Topics will include how the reduction of Fe (III) dramatically increases the concentration of the more soluble Fe (II). Increased arsenic concentrations often result, in part, from the microbial mediated reduction of iron. Other examples will demonstrate the importance of micro-organisms capable of using manganese and sulfate as terminal electron acceptors.

The affect micro-organisms have on groundwater chemistry is not limited to the use of alternative electron acceptors. While their ability to metabolism complex organic compounds is largely responsible for limiting the size of petroleum contaminant plumes, many micro-organisms satisfy their energy requirements by capturing the energy in the reduced iron, manganese and sulfur compounds produced by other microbes. We will conclude with data illustrating how the biologically mediated oxidation of reduced metallic species limits the solubility of iron, manganese and arsenic.

2:00PM – 2:25PM

Paula Mouser

Civil & Environmental Engineering, University of Maine, Orono, ME; paula.mouser@umit.maine.edu.

DETECTING AND DELINEATING GROUNDWATER CONTAMINATION AT A LEAKING WASTE DISPOSAL SITE USING MICROBIAL COMMUNITY PROFILES

Detecting subsurface contamination from leaking waste disposal sites can be challenging when using a limited network of groundwater monitoring wells that are sampled for multiple hydrochemical parameters over discrete temporal intervals. Microbial communities are sensitive to changes in nutrient resources and therefore represent a unique source of information for detecting contamination and tracking long-term changes in contaminated aquifers. To test the ability to detect groundwater contamination using biotechnology tools, the microbial community was sampled from groundwater wells surrounding a leaking landfill, and community profiles for bacteria and archaea were created using terminal restriction fragment length polymorphism (T-RFLP) fragments and primers targeting the 16S rRNA gene. Bacterial profiles were correlated to known gradients of leachate and effectively detected changes along plume fringes that were not detected using hydrochemical data. Microbial community profiles were correlated at considerable spatial distances, and could be used in a similar capacity as hydrochemistry data for mapping the extent of landfill-leachate contamination in the subsurface. This work demonstrates how molecular-genetic tools targeting in situ microbiological communities combined with multivariate statistical techniques may be used for identifying and further delineating the extent of groundwater contamination at leaking waste disposal sites.

2:30PM – 3:00PM

BREAK — AUDITORIUM

Session 9: Groundwater Geochemistry

3:00PM – 3:25PM

Sarah M. Flanagan[1]*, Joseph Ayotte*[2]*, Gilpin R. Robinson, Jr.*[2]
1 U.S. Geological Survey, New Hampshire/Vermont Water Science Ctr., Penbroke, NH; sflanaga@usgs.gov.
2 U.S. Geological Survey, Reston, VA.

GROUNDWATER QUALITY OF NEW ENGLAND CRYSTALLINE BEDROCK AQUIFERS

A regional-scale characterization of water quality in crystalline rock aquifers in New England and northern New Jersey was done using data from untreated groundwater samples collected from 117 domestic-supply bedrock wells sampled by the U.S. Geological Survey and from 4,775 public-supply bedrock wells sampled for the state Safe Drinking Water Programs. About 13.3 percent of 2,054 wells had concentrations of arsenic greater than the MCL of 10 micrograms per liter, but exceeded 22.8 percent in wells in calcareous metasedimentary bedrock in eastern New England. Of 556 uranium samples, 14.2 percent had concentrations of uranium greater than the MCL of 30 micrograms per liter, however, the rate for the domestic wells was lower (4.3 percent). Of 4,781 nitrate-N samples, only five samples had nitrate-N concentrations greater than the MCL of 10 milligrams per liter. Deethylatrazine (18 percent) and atrazine (8 percent) were the most frequently detected pesticides in 114 domestic well samples. Methy tert Butyl Ether (36 percent) and chloroform (32.9 percent) were the most frequently detected VOCs in 86 domestic well samples. Elevated fluoride concentrations (> 2 milligrams per liter) generally occurred in older, high pH (>8) sodium-bicarbonate waters in granitic bedrock. Chloride to bromide ratios indicate that the groundwater was affected by at least three halogen sources: local precipitation and recharge, seawater and connate waters evolved from seawater, and recharge waters affected by road de-icing salts. Collectively, the frequent detection of man-made organic and inorganic compounds in domestic wells indicates that wells in these aquifers are vulnerable to anthropogenic contaminants.

3:30PM - 3:55PM

Mark Holden[1]*, John Hopeck*[2]
1 Bureau of Land and Water Quality, Maine; mark.k.holden@maine.gov.
2 Department of Environmental Protection, Augusta, ME.

EFFECT OF PROXIMITY, SLOPE, SOIL AND OVERBURDEN ON TRANSPORT OF ROAD SALT

This study assesses the effect of road salt on residential well water quality in eight areas in Maine. Using spatial raster analysis, a risk model was developed based on lab chloride data.and spatial coordinates from 360 Maine DOT pre-construction sampling locations. ArcMap spatial analysis tools were used to consider the effects of source proximity, slope, flow direction, soil character and surficial geology. It was found that, in general, with any degree of slope, and any soil or overburden, the risk is greatest in the down-slope direction, on the lower side of the road, with risk decreasing away from the road in either direction. This risk is higher by approximately a factor of two or higher on the down-slope side. This is most clearly the case in areas of low slope (less than 3 degrees) and any kind of soils or overburden. There are significant variations to this model if the slope is greater than three degrees. Overall, the dominant factor appears to be drainage-controlled residence time of salt-laden storm water over an area of infiltration.

Session 10

Wetland Ecology and Conservation

Maine's wetlands are remarkably abundant and diverse, providing critical ecosystem services such as erosion control, water storage, groundwater recharge, and wildlife habitat. How effective are local, state, and federal policies at protecting these natural resources? How does ecological research contribute to effective conservation action? This session will address related topics such as wetland restoration, vernal pool management, landowner responses to conservation efforts, ecology of threatened wetland species, and wetland resource modeling. Presentations may focus on conservation in a wide array of wetland types: riparian zones, brackish marshes, and the variety of freshwater wetland ecosystems.

SESSION CHAIRS

Alysa Remsburg, Assistant Professor of Ecology, Unity College

Alysa Remsburg, conducts research on the role of habitat structural complexity for insect species diversity. She has investigated effects of fallen logs, invasive species, shoreline landscaping, and forest management on aquatic and terrestrial communities. An interest in dragonflies and damselflies (order *Odonata*) led her to focus on the land-water transition and relative importance of habitats occupied during different life stages. Alysa teaches ecology and conservation biology courses and is active with local land trusts. Her Ph.D. and M.S. degrees are from the University of Wisconsin-Madison.

1:30PM – 1:55PM

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

SHERMAN MARSH, NEWCASTLE, MAINE: THE ROLE OF SERENDIPITY IN THE RECOVERY OF A SALT MARSH

Recovery after disturbance often depends on what colonizers get there first, and the conditions those first colonizers encounter when then arrive. In this talk we will investigate the interacting roles of weather, site conditions and the identity of first colonizers on the recovery of salt marsh vegetation in Sherman Marsh, located in mid-coast Maine. In 2005, a berm retaining the shallow freshwaters of Sherman Lake was breached during a large fall rain event. The breach drained the lake and revealed 90 hectares of salt marsh peats and tidal creeks that had been isolated from the ocean since 1934. In the years since the breach, tidal inundation slowly increased until the

reconstruction of the marsh inlet was completed in the fall of 2008. In permanent plots monitored since 2006, vegetation has shifted from primarily freshwater species in 2006 to mostly brackish and salt marsh species by 2010. In the five years of this study, precipitation and river discharge levels have varied widely, resulting, serendipitously, in excellent conditions for seedling germination in 2006. Since 2006, wet and dry years have been reflected in good and bad years for the dominant brackish-water cattails (*Typha* sp.) on the marsh, while at the same time restored tidal flows have returned salt marsh plants to the far reaches of the marsh.

2:00PM – 2:25PM

Sarah Drahovzal *(student), Cynthia Loftin, Judith Rhymer*
Dept. of Wildlife Ecology, University of Maine, Orono, ME; sarah.drahovzal@umit.maine.edu.

HYDROLOGICAL AND CHEMICAL ENVIRONMENT OF MAINE'S CIRCUMNEUTRAL WETLANDS SUPPORTING SHRUBBY CINQUEFOIL (*DASIPHORA FRUTICOSA*), HOST PLANT OF THE STATE ENDANGERED CLAYTON'S COPPER BUTTERFLY (*LYCAENA DORCAS CLAYTONI*)

Little is known about environmental characteristics of Maine's circumneutral wetlands containing shrubby cinquefoil (*Dasiphora fruticosa*), the sole host plant for the state-endangered Clayton's copper butterfly (*Lycaena dorcas claytoni*). Although *D. fruticosa* is not considered rare, few wetlands with stands of *D. fruticosa* support viable *L. d. claytoni* populations.The chemical and hydrological conditions in wetlands may affect the distribution and robustness of *D. fruticosa*, which may also influence its use as a host plant by *L. d. claytoni*. We are evaluating major pore water nutrients and hydrological conditions in ten wetlands with *D. fruticosa*; seven of these sites support populations of *L.d. claytoni* and three do not. We collected pore water samples three times during the growing season to examine the root zone chemical environment. We also installed monitoring wells equipped with continuous water level recorders (Solinst Leveloader Gold) in each wetland to determine vertical flow and water table fluctuations. Hydrographs indicate differences in hydroperiod and water source among sites. In addition, variation in water analytes (ammonia-nitrogen, nitrate, conductivity, pH, reactive phosphorus) among wetlands and sampling periods reflect differences in site hydrodynamics. Conservation and recovery of *L.d. claytoni* depends in part on the ecological quality of its habitat. Our research will inform habitat management recommendations for *D. fruticosa* and potentially identify unoccupied sites that are suitable for *L.d. claytoni*.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Amanda Shearin *(student), Aram Calhoun, Cynthia Loftin*

Dept. of Wildlife Ecology, University of Maine, Orono, ME; amanda.shearin@umit.maine.edu.

USING AUTOMATED AUDIO RECORDING DEVICES TO IMPROVE LISTENER-BASED AMPHIBIAN SURVEYS

Volunteer-based audio surveys are valuable tools for documenting trends in amphibian communities. Current sampling protocols are not region or species-specific, however, and they may not be suitable for detecting rare or audibly cryptic species. We used automated audio recording systems (ARS) to record calling amphibians at 12 lakes and four vernal pools in Maine, USA, during 2006-2009. These systems were programmed to record a 2-3 minute audio clip every hour from 30 minutes past sunset until sunrise. Individual audio clips selected from

the sampling time period (30 minutes past sunset to 0100 h) described in the North American Amphibian Monitoring Program (NAAMP) detected fewer species than were detected during recordings for the entire night. Individual audio clips from the NAAMP sampling period underestimated the Calling Index for *Lithobates septentrionalis* and *L. clamitans* during 33 and 24%, respectively, of sampling nights. Time of maximum detection and full chorusing of *L. septentrionalis*, *L. clamitans,* and *L. palustris* occurred after the 0100 h NAAMP sampling end time. Julian date was the best predictor of calling occurrence for *Hyla versicolor*, *L. catesbeiana, L. pipiens, L. septentrionalis*, and *L. sylvatica*, however, additional environmental variables were needed to predict calling occurrence by *Pseudacris crucifer, L. clamitans*, and *L. palustris*. The sampling period described in the NAAMP protocol may result in omissions and misclassifications of chorus sizes for certain species. These potential errors should be considered when interpreting trends generated from generalized amphibian audio surveys

3:30PM - 3:55PM

Bridie McGreavy[1] *(student), Thomas Webler*[2]*, Aram Calhoun*[3]
Margaret Chase Smith Policy Center, University of Maine, Orono, ME; bridie.mcgreavy@maine.edu.
Social and Environmental Research Institute, Greenfield, MA .
Dept. of Wildlife Ecology, University of Maine, Orono, ME.

SCIENCE IN TRANSLATION: A MIXED METHODS APPROACH TO DESCRIBE LOCAL DECISION MAKER ATTITUDES TO VERNAL POOL CONSERVATION IN MAINE

We explored the attitudes of local decision makers in the State of Maine to vernal pool conservation through interviews with town planning board and conservation commission members from two towns in Maine and a survey which we mailed to a stratified random sample of 700 planning board members in August and September 2007. The majority of survey respondents favored the protection and conservation of vernal pools in their towns. Planning board members were familiar with the term “vernal pool” and demonstrated positive attitudes to vernal pools in general. However, 40% of planning board members were unaware of revisions to the Natural Resource Protection Act regulating Significant Vernal Pools in Maine. Principal Components Analysis revealed four survey constructs related to attitudes about vernal pools: 1. Concerns about private property rights, enforcement, and restrictions, 2. Appreciation and willingness to conserve, 3. Knowledge and experience and 4. Interest in knowing more. Disagreement with the vernal pool law was strongly correlated with concerns about private property rights, development restrictions, and enforcement challenges ($r > 0.7$). We conclude with recommendations to enhance vernal pool conservation and the adoption of Best Development Practices.

Session 11

Models and Monitoring: Current research in freshwater science and management

Emerging threats continue to challenge freshwater hydrology, chemistry, and biotic integrity. Many factors play a role in our understanding of these processes, but because they are often heterogeneous and affected by stochastic events, these environmental interactions are challenging to model. With their focus on modeling and monitoring changes in climate, hydrology, biodiversity, and water quality, the talks in this session describe scientific data, models, and interpretation that characterize current threats to water resources.

SESSION CHAIRS

Melinda Neville (student), Dept. of Ecology and Environmental Sciences and Dept. of Spatial Information Engineering, University of Maine

Melinda Neville is a research assistant in the Department of Spatial Information Science and Engineering at the University of Maine. She earned her B.S. degree in Environmental Science from Southwest State University in Minnesota, and an M.S. in Ecology and Environmental Sciences with a water resources concentration at the University of Maine. Recently a fellow of the NSF IGERT Sensor Science Engineering and Informatics program, Melinda has worked on such diverse projects as sensor system design and deployment in a commercial greenhouse, the Maine Cancer GIS program, and the development of a biosensor for the detection of Hg in estuarine systems. Her current work is focused on spatiotemporal monitoring of mercury fate and transport in coastal Maine ecosystems.

1:30PM – 1:55PM

Tom Danielson, ***Leon Tsomides***
Maine Department of Environmental Protection, Augusta, ME; Leon.Tsomides@maine.gov.

STREAM ALGAL AND MACROINVERTEBRATE INDICATOR TAXA AND COMMUNITY RESPONSES TO INCREASED WATER TEMPERATURE

Increased water temperature can impact aquatic life by reducing oxygen concentrations and altering organism metabolism, growth, and community structure. Temperature is a growing concern for water quality managers because some of Maine's streams and rivers are likely to get warmer with expanding urbanization and global

warming. We collected biological samples and temperature data using continuous data loggers deployed in streams for four weeks during the summer. We empirically identified algal and macroinvertebrate taxa that could be used as indicators of cold water and warm water using weighted average optima and indicator species analysis. We identified strong shifts in community structure between 18 and 22°C with the loss of cold water taxa and increase of warm water taxa. We also applied ordination techniques to determine the importance of stream temperature, relative to other environmental stressors, in shaping algal and macroinvertebrate communities. These tools will help track streams over time and improve management of streams and rivers to mitigate impacts of increased water temperature.

2:00PM – 2:25PM

Kristin E. Strock[1] *(student)***,** *Jasmine E. Saros*[1]*, Bill Gawley*[2] *and Alan Ellsworth*[3]
1 School of Biology and Ecology and Climate Change Institute, University of Maine Orono, ME; Kristin.Ditzler@umit.maine.edu.
2 Acadia National Park, ME.
3 USGS Water Science Center, Troy, NY.

UNDERSTANDING THE INTERACTIVE EFFECTS OF CLIMATE CHANGE AND AIR POLLUTION ON LAKE ECOSYSTEMS: IMPLICATIONS FOR DECLINING WATER CLARITY IN ACADIA NATIONAL PARK

Striking changes in the transparency of inland waters have been observed recently in many regions of the Northern Hemisphere. Water clarity is the most highly valued aesthetic aspect of lakes and has significant ecological effects, altering the productivity and diversity of lake ecosystems.We analyzed secchi disk, chlorophyll a, dissolved organic carbon (DOC), and nutrient data for a set of lakes in Acadia National Park. These data, which were collected monthly by Acadia staff since 1985, were paired with paleolimnological techniques to provide a longer term study of water clarity. Synthesis of monitoring data revealed synchronous declines in water clarity across multiple lakes while algal biomass was unchanged. Concentrations of DOC (which can impart a brown stain to lake waters) increased while water clarity declined. Paleolimnological inferences within Acadia reveal little to no lake acidification over the last century, however monitoring data since 1985 suggest regional changes in watersheds. The observed changes in water clarity may be driven by the interactive effects of climate change and air pollution, specifically increased storm severity coupled with reduced sulfur deposition, but the mechanisms remain unclear. Lake water clarity is declining across multiple systems in Acadia, underscoring the need to understand the response of these systems to a changing climate in order to better inform management decisions that protect these valuable resources.

2:30PM – 3:00PM

BREAK — AUDITORIUM

3:00PM – 3:25PM

Jae Ogilvie, ***Mark Casonguay****, Paul A. Arp*
Forestry and Environmental Management, University of New Brunswick, New Brunswick, Canada; mark_castonguay@email.com

MODELING AND MAPPING HYDROLOGICAL RISK

This presentation informs and illustrates how potential hydrological risks (flooding and slope instabilities) can be modelled and mapped across Maine (mainland, coastlands, islands), using (i) state-wide digital elevation data

and images, (ii) local LiDAR-derived digital elevation models (DEMs). This modelling and mapping applies conventional algorithms used for deriving slope, flow direction and accumulation into map features displaying (i) flow channels, (ii) flood plains, (iii) the cartographic depth-to-water next to all flow channels, shorelines and wetland borders, and (iv) the extent to which coastal lands are subject to sea-level rise. Additional algorithms are used to (i) locate road and stream crossings, (ii) draw catchment borders based on catchment order or stream order, and (iii) display and classify the recharge-discharge zonation across the land. The maps so derived provide a local to state-wide medium to high-resolution platforms for planning land and water resources, from state-, municipal, industrial, and private perspectives, as illustrated. The illustrations show how this GIS-based modelling process works, with examples for Maine, New Brunswick and Nova Scotia, and how this process is used to derive and decide on least-risk road, trail and development locations. The initiative for this modelling and mapping is based on the earlier wet-area mapping initiative at University of New Brunswick, done in co-operation with Maine's Cooperative Forest Research Unit (CFRU).

3:30PM - 3:55PM

Colin Apse[1]*, Joshua Royte*[1]*, Daniel Kusnierz*[2]*, Binke Wang*[2]
1 The Nature Conservancy, Brunswick, ME; capse@tnc.org
2 Penobscot Indian Nation, ME.

PRIORITIZING CRITICAL LANDS FOR HEALTHY RIVER FUNCTION IN THE PENOBSCOT RIVER WATERSHED

The Active River Area framework provides a conceptual and spatially explicit basis for the assessment, protection, management, and restoration of freshwater and riparian ecosystems. The Active River Area framework uses river process and disturbance concepts to identify areas within which important physical and ecological processes of the river or stream occur. The Nature Conservancy and the Penobscot Indian Nation worked with other NGO, state and federal partners to develop a prototype model that prioritizes the lands most critical to maintaining our most significant fish and wildlife habitats in four Penobscot subwatersheds.

Poster Exhibition

High School, Undergraduate and Graduate Juried Poster Exhibition

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

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

Student presenters are indicated in bold type

§ *denotes an SSI-related submission*

POSTER CHAIR

Adria Elskus, USGS

Adria Elskus is an aquatic toxicologist specializing in biochemical mechanisms of toxicant action in fish. She has previously worked as a research scientist, university professor, government scientist (US EPA) and environmental consultant, conducting aquatic toxicology research at Superfund sites, in freshwater and marine waterways, and in urban harbors containing a broad assortment of chemical contaminants, including metals, sewage effluent, organic toxicants, pesticides, petroleum, and combustion products. Her goal is to understand the biochemical and molecular mechanisms underlying physiological responses of fish to pollutant stress in the ecological context of their habitat, and to relate these to population-level effects (reproductive function, population abundance, chemical resistance, early development, behavior).

UNDERGRADUATE POSTER ABSTRACTS

Susan Bresney[1]*, Noah P Snyder*[1]*, Serena Moseman-Valtierra*[2]
1 Earth and Environmental Sciences Department, Boston College, Chestnut Hill, MA; noah.snyder@bc.edu.
2 Biology Department, Boston College, Chestnut Hill, Massachusetts.

PATTERNS OF GREENHOUSE GAS PRODUCTION AND WATER QUALITY IN HIGH AND LOW GRADIENT REACHES OF THE SHEEPSCOT RIVER, MAINE

Inorganic nitrogen concentrations, specifically nitrate and ammonium, have increased in watersheds due to inputs of fertilizer, wastewater runoff, and atmospheric deposition. This has degraded water quality and may affect climate change. Specifically, an increase in nitrogen availability could expedite the production of N_2O, a potent greenhouse gas, through the process of denitrification. The Sheepscot River is home to endangered

Atlantic salmon which have strict water quality requirements and the river has been found to have high nitrogen levels (reaching above 5.0 mg/L). These issues motivated our study of the patterns of dissolved inorganic nitrogen, greenhouse gases, DO, pH and temperature of the Sheepscot River in July and October 2010. The study area consisted of 10 sites along 13 km of alternating higher gradient gravel-bedded reaches and lower gradient wetlands. At almost all sites in July, DO dipped lower and temperatures exceeded those tolerated by salmon. Nitrate and nitrite concentrations were significantly positively correlated with N_2O saturation, and ammonium was significantly negatively correlated with CH_4 across three sites. Both CO_2 and CH_4 saturations were significantly higher at lower gradient wetland sites than higher gradient sites, but we found no significant correlation between slope and N_2O. Manipulative experiments in the laboratory showed significantly higher potential rates of N_2O production in wetland soil treated with nitrate and ammonium nitrate than in controls without nutrient additions. These results suggest that wetlands can be sources of CO_2 and CH_4 in riverine systems, but that emissions of N_2O remain relatively low in the absence of nitrate loading.

Andrew Cardomone, *Dharni Vasudevan*
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PHOSPHATE SOURCE-SINK DYNAMICS IN ANDROSCOGGIN RIVER SEDIMENTS

The Androscoggin River has historically had varying levels of inorganic phosphate (o-P) input from many sources, including pulp and paper mills, agricultural runoff, and wastewater treatment plants. Since the passage of the Clean Water Act, water quality has greatly improved. As the river becomes cleaner, however, questions remain over whether the o-P currently bound to the sediment will reenter the water and adversely affect the ecosystem. To examine this dynamic, several sediment samples were collected at two locations along the river: Gulf Island Pond (GIP) and Merrymeeting Bay (MMB). GIP is an impoundment in Lewiston, Maine while Merrymeeting Bay is a freshwater, tidal ecosystem at the mouth of the Androscoggin. Sediments from each site were used in sorption experiments from which the equilibrium phosphorus concentration (EPC) was extrapolated. The EPC value has been extensively used to establish aqueous phosphorus concentrations at which there is no net phosphorus release or uptake by the sediment. At all locations, the EPC value was significantly less than measured aqueous o-P concentrations, suggesting the sediments will act as a sink (uptake) of o-P into the future. Furthermore, GIP sediments had higher o-P sorption capacities, surface areas, and extractable iron (ex-Fe) and aluminum (ex-Al) content compared to MMB sediments, indicating the capacity to act as a o-P sink is likely determined by surface area, ex-Fe, and ex-Al content. The relationship between sediment-Fe content and o-P retention also suggests that under anoxic conditions, the reduction of Fe in the sediment could cause o-P to be released into the river.

Abraham Dailey, Leonora Begin*, Firooza Pavri*
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§ MONITORING CHANGING LAND USE CONDITIONS ACROSS THE SEBAGO LAKE WATERSHED

The sustainability of global freshwater resources in terms of their quality, quantity, availability and allocation has been the focus of numerous studies in recent years. Monitoring land use change across large watersheds provides some indications for the future vulnerability of such systems to dynamic socio-economic conditions. Lake Sebago, located in southern Maine, is the state's second largest lake and has also been identified as one of the northeastern United States' most vulnerable watersheds due to climatic changes and human influences. This research focuses on Lake Sebago's role as a drinking water source to nearly 200,000 people in a rapidly developing region. In this research we provide an historical look at changing land use conditions across the Sebago watershed and consider the ramifications on this vital freshwater resource. Our research indicates a clear expansion of development activities across the watershed. Rapid development observed in recent years may place significant pressure on this lake system and development activities require close monitoring. Studying his-

toric and current trends enable us to identify contemporary vulnerabilities and comment on future threats to this watershed.

Gregory Flynn, *Beverly Johnson*
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§ NITROGEN ISOTOPES IN *ZOSTERA MARINA*: A POTENTIAL INDICATOR OF ANTHROPOGENIC NUTRIENT LOADING IN CASCO BAY, GULF OF MAINE

Estuaries that are in close proximity to densely populated areas and/or receive run-off from populated watersheds are particularly susceptible to nitrogen loading, which can lead to anthropogenic-caused eutrophication. The stable nitrogen isotope ratios ($\delta^{15}N$) of dissolved inorganic nitrogen (DIN) and *Zostera marina* are enriched in ^{15}N in densely populated estuaries of Cape Cod, where there are high levels of anthropogenic nitrogen. Little is known about whether this technique for identifying the presence of anthropogenic nutrients can be used on the coast of Maine. In this paper, two areas in the Casco Bay were studied to see if a populated area (Mackworth Island, Portland) shows ^{15}N enrichment relative to a less populated area (Maquoit Bay, Brunswick). The DIN and the *Zostera marina* from Mackworth Island have $\delta^{15}N$ values ~2.5 ‰ enriched relative to Maquoit Bay, suggesting that nitrogen isotopes in *Zostera marina* can be used to detect the presence of anthropogenic nitrogen. This information has the potential to help indicate early signs of eutrophication and help prevent any further nutrient overloading in Casco Bay.

Edward Ames[1], ***Andrew Bell[2],*** ***Cory Elowe[2],*** ***Catherine Johnston[2],*** *Eileen Johnson[3], John Lichter[3],* ***Elsie Thomson[2]***
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§ A COMPARISON OF HISTORICAL AND CURRENT SUBSTRATE TYPES AS AN INDICATOR OF GROUND FISH ABUNDANCE

Bountiful fish populations in the Gulf of Maine once supported a thriving fishing industry. However, overfishing and poor management has left these populations at historic lows. Little is known about the movement and distribution of fish species throughout the gulf making development of sustainable management plans difficult. We use descriptions of historic fish populations to gain insight about the habitat and seasonal abundance distribution of seven fish species in the Gulf of Maine. We investigated the correlations between spatial characteristics such as substrate type and depth and historical fishing areas. Specifically, our analysis compared the location of substrate types collected from historic sources with current day substrate location and characteristics. Comparing substrate data from earlier historic records with current substrate data will help identify critical habitat characteristics of different fish species as well as continue to add to our understanding of fish movement and life history. We investigated strategies to characterize the substrate composition of the entire Gulf of Maine using sediment data from a variety of sources. We also investigated how current scientific sediment descriptions compared with the historic descriptions of sediment from fishermen. Lastly, we developed a grid system with which we hope to use spatial statistics to investigate whether characteristics such as depth and substrate can be used to predict the distribution of particular fish species. These advances will aid in future management and recovery plans for the Gulf of Maine.

***Andrew Bell, Henry Berghoff, Cory Elowe, Holly Jacobson, Catherine Johnston, Benjamin Towne**, John Lichter*
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§ ECOLOGICAL AND ECONOMIC RECOVERY OF THE KENNEBEC AND ANDROSCOGGIN RIVERS, ESTUARY, AND NEARSHORE MARINE ENVIRONMENT

Merrymeeting Bay is a freshwater tidal ecosystem in Midcoast Maine that supports a diverse and complex food web. Historically, migratory waterfowl and anadromous fish thrived in the bay. Human activities led to a collapse of the ecosystem in the second half of the twentieth century. Since then, water quality of the bay was able to rebound much faster than the biotic components of the bay. Improvements are still underway for populations of submerged aquatic vegetation, macroinvertebrates, and fish. Our research in the summer of 2010 focused on surveying populations of the bay and Lower Kennebec to begin to understand the current state of the ecosystem and the implications for human use. Stationary nets and beach seines were used to collect a time series of data for fish in the bay. Benthic macroinvertebrate sampling sought to investigate a relationship between invertebrate density and diversity and presence or absence of vegetation. A Trimble GeoXM GPS unit was used to create a map of submerged aquatic vegetation in the bay and in future years, comparison with this map can reveal the extent of increased recruitment of plants. Continuing research in the bay will build on the foundation of knowledge established by this project and can contribute information that can be used to promote recovery. Although Merrymeeting Bay may never recover to the ecosystem it once was, advancements can be made through local environmental awareness and involvement and continued investigation of the changes and improvements that occur in the future.

Susan Davies[1], ***Nathan Kane***[2]
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2 Bates College, Lewiston, ME.

A QUANTITATIVE EXAMINATION OF MAINE'S WATER QUALITY CLASSIFICATION HISTORY

Maine's tiered water quality classification system is unique in the United States due to its built-in features that help to protect existing high quality waters and to retain gains that have been made to water quality in more heavily used rivers and streams. Since the legislative restructuring of Maine's water quality standards and classification law in 1986, Maine has maintained four distinct water quality classifications for rivers (AA, A, B and C) that allow the State to optimize waterbody condition to the highest quality assigned through the public goal-setting process (MRSA Title 38 Ch 3 §464-468). The tiered classifications provide backstops against degradation and promote more precise regulation of freshwater in general. This policy has successfully upgraded many waterbodies to their highest attainable goal condition over the course of the intervening 23 years since passage. While the success of this policy is evident in the exceptional quality of Maine's freshwater, this poster summarizes the first accurate documentation of the historical water quality progress that these upgrades represent. Created using ArcGIS and the legislative history of water re-classification, this poster helps to demonstrate the impact and extent of the State's efforts in major river basins since the policy change 23 years ago.

***Joshua Keough**, **Jessica Barilone**, Karen Wilson, Theodore Willis, Joseph Staples, Lucile Benedict*
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COMPARISON OF MAINE'S IMPAIRED AND URBAN IMPAIRED STREAMS: AN ANALYSIS OF CONTAMINATION, CONCENTRATION, AND DISTRIBUTION IN SOUTHERN MAINE

This undergraduate research project at the University of Southern Maine compared contaminant form, concentrations, and distribution between impaired streams in Southern Maine. Impaired streams are defined by their

non-attainment of Maine's water quality standards such as dissolved oxygen, specific conductance and macro-invertebrates. Urban impairment is defined by non-attainment because of storm water run-off from developed land, which may contribute to conditions found in impaired streams. Out of the 32 urban impaired streams in Maine, 16 are located in Southern Maine. A meta-analysis was conducted incorporating information from state agency reports, peer review literature, and various research organizations to identify commonalities between UI, impaired and unimpaired streams. Data including contamination history, pollutant form and concentration, remedial action, and contamination sources was compared between stream systems. Results indicate urban impaired streams are subject to contamination from various sources such as landfills and parking lots. Many have elevated levels of various hydrocarbons, and metals. In contrast, Maine's impaired streams are in non-attainment from elevated nutrients, low dissolved oxygen, and macro-invertebrates associated with agricultural run-off and lawn care practices and products. Long Creek, which drains South Portland and the Maine Mall area, is probably the best known and most studied of these southern UI streams. Like Long Creek, eight streams flow through glaciomarine soil and drain watersheds with extensive impervious surface area. However, little information was available on these other stream systems. More research should be conducted comparing Maine's impaired and urban impaired streams.

Melissa Anson, Krista Bahm**, Philip Camill, **Maryellen Hearn**, Eileen Johnson, **Elizabeth LePage**, **Tom Marcello, Christopher Mawhinney, Leah Wang

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§ ANALYZING STORM SURGE AND SEA LEVEL RISE TO DETERMINE COASTAL VULNERABILITY IN BRUNSWICK AND HARPSWELL

Sea level rise and storm surge in Maine threaten coastal homes and businesses as well as coastal infrastructure and wetlands. Developed to pilot the implementation of the State of Maine's Climate Adaptation Plan, this project evaluated the vulnerability of coastal structures to global climate change in order to make informed decisions for adaptation. The methodology developed serves as a template for other coastal Maine communities to effectively determine infrastructural vulnerability to sea level rise and storm surge, and the results are intended for planning purposes in Brunswick and Harpswell, Maine. The study, based on LiDAR maps from FEMA, used GIS to model sea level rise and storm surge. Our sea level rise scenarios, projected for the year 2100, included 0.61 meters (2 feet), 1 meter, and 2 meters. Maine is currently planning for a 0.61 meter scenario, and the EPA suggests 1 and 2 meter scenarios for planning purposes. The study analyzed six principle categories: land acreage, buildings, population, roads, piers, and marshes. We determined that (a) sea level rise will impact town economies differently depending on coastline extent and proximity of infrastructure to the coastline, (b) overall marshland will decrease in acreage, and (c) storm surge will obstruct roads, which is a particularly important consideration for communities with islands and peninsulas connected by single roads and bridges. As the project was intended for replication in other planning settings, the methodology developed is based on widely available data and common spatial analyses.

***Jennifer Lindelof**[1], Beverly Johnson[1], Mathieu Duvall[2], Kat Stefko[3]*

1 Department of Geology, Bates College, Lewiston, ME;

2 Edmund S. Muskie Archives and Special Collections Library, Bates College, Lewiston, ME.

3 Imaging and Computing Center, Bates College, Lewiston, ME.

§ USE OF ARCHIVAL DATASETS TO DETERMINE SEASONAL CHANGES IN ANDROSCOGGIN WATER QUALITY: 1943-2004

Beginning in 1930, scientists began studying the condition of the Androscoggin River due to both its economic significance and rising concern over deteriorating water quality. In 1943, Dr. Walter A. Lawrance was appointed

Rivermaster by the Maine Supreme Court with the task of mitigating the effects of water pollution though effluent caps and legislation. Dr. Lawrance sampled water at sites from Berlin, NH to Lisbon Falls, ME from the summer of 1943 to the summer of 1977, testing a range of water quality parameters including dissolved oxygen (DO), biological oxygen demand (BOD), water temperature, pH, and methylene blue stability among others. The goal of this project was to convert materials from the Lawrance Papers, into electronic format for ease of analysis and use on the web. Presented here is the first compilation of DO data from Turner Center Bridge through datasets available from Muskie Archives and the Maine Department of Environmental Protection. Data analysis indicates a major shift in dissolved oxygen over the tenure of Dr. Lawrance, with DO levels on average 4 ppm higher than initial values. This increasing trend appears to be correlated to shifts in both the manufacturing process as well as major policy shifts such as the Clean Water Act. The long term dataset will be presented in the context of both policy shifts and environmental significance.

***Josie Thiele, Katherine Murray, Malia Kawamura**, D. Whitney King*
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§ THE IMPACT OF THERMAL STRUCTURE AND MIXING ON NUTRIENT DYNAMICS AND PLANKTON ABUNDANCE IN INTERMEDIATE DEPTH LAKES IN MAINE

This project examined the correlation between thermal structure and water clarity in East Pond and North Pond from 2006 to 2010. East and North Ponds are both part of the Belgrade Lakes chain and have similar size and depth. However, due to subtle differences in bathymetry and geography, they experience different thermal structure, which influences nutrient distribution. Temperature data was collected at 10-minute intervals throughout the summers 2006 to 2010 using HOBO sensors placed at one-meter intervals from the bottom to the top of East and North Ponds. Secchi depth data was also collected over the same time period allowing quantification of water clarity. Models for thermocline mixings was calculated using the thermohaline mixing model DYRESM.

Plots of high-resolution temperature data show individual mixing events in the lakes. These events agree well with DYRESM models for thermocline erosion. These events are followed 10 to 15 days later with decreased Secchi depth caused by nutrient upwelling supporting algal blooms. This research shows that for intermediate depth lakes, these short scale mixing events have significant impacts on nutrient dynamics and plankton abundance.

***Ryanne Nason,** Bruttany Carle, Phoebe Peckenham, Kate Kirby and Laura Wilson*
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EXPLORING BARRIERS TO WELL WATER TESTING

Water quality issues are becoming an increasing health concern in Maine as more information is gathered concerning the safety of private well water in the state. With high levels of arsenic and other contaminants being reported across Maine, attention needs to be brought to the importance of well-water testing, particularly in rural areas. Recently, information booths have been set up at local fairs and community events encouraging citizens with private wells to get their water tested. A vast majority of those visiting the tables failed to pursue the testing process and the data reveals that people are noncommittal in their intention to examine the potential contaminants in their water supply. Adult education programs fared equally poorly to motivate well testing. It is our goal to motivate and encourage Maine residents to engage in a simple water test every five years in order to ensure a healthier lifestyle. As we learn what does not work, we need to study our audience further to determine what may work in the future.

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DELINEATION OF URBAN STREAM WATERSHEDS USING GIS: DRAINAGE AREA AND CONTAMINANTS IN SOUTH CENTRAL MAINE

Undergraduate researchers at the University of Southern Maine, Environmental Science, are in the beginning stages of assessing the effects of anthropogenic contamination on urban and non-urban streams in Southern Maine. Impervious surface contributes to non-point source pollutants through increased runoff and poor infiltration. Maine has 32 “urban impaired” streams, many of which are subject to high pollutant concentrations from combustion of fossil fuels and degradation of motor vehicle components. Heavy Metals and PAHs are transported into the waterways through runoff that, in many cases, seriously degrades stream water quality. In this part of the project, Long Creek and similar reference watersheds were delineated using Arc Geographic Information System (GIS). Using tools such as elevation, flow direction, flow accumulation, and stream networks, Long Creek Watershed was successfully delineated. We found that the 3.45 square mile watershed had 30% impervious surface. However, we found that GIS tools were size sensitive. Arc GIS used an elevation of 10m, which is compatible with a large watershed such as Long Creek. In other words, the flow accumulation was substantial enough to have a 10m gap in elevation and the system could still connect the stream. For smaller watersheds, high resolution satellite data called Light Detection and Ranging (LIDAR) was necessary. ArcGIS could not recognize the smaller watersheds as streams with only the 10m gap in elevation data. With the addition of LIDAR, reference streams with higher water quality classifications will be chosen for analysis based on watershed size and stream order derived from GIS.

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RESPONSE BIAS IN HOMEOWNER SURVEYS: WHO CARES ABOUT THE PENOBSCOT RIVER?

Literature suggests that in social science survey research, the preferences and opinions of persons who choose to respond to attitudinal questionnaires may be significantly different from those who choose not to respond. If this is true, extrapolations to the general population will be biased and can misinform policy decisions. This poster explores this question further by examining data from a 2010 survey of Penobscot River area homeowners. Early results suggest that the 576 responding households are not representative of the entire 1,904 household sample. Using previously available housing transaction data, a hedonic model was used to estimate effects of housing and environmental characteristics, including location in relation to the Penobscot River, on property values. In preliminary work, a significant difference was noted between the implicit values nonrespondents and respondents placed on proximity to the Penobscot. By adding a dummy variable and interaction term to the model, this behavior was determined to account for all significant differences between the subgroups. These results imply that survey nonrespondents implicitly attribute negative value to the Penobscot River, a result confirmed in the literature. However, it appears that this penalty does not exist among survey respondents. Furthermore, our results imply that behavior toward the river accounts for the entire significant difference between these two samples, an interesting conclusion. As a consequence, caution must be used in drawing larger generalizations from the survey data, as the focus of the survey was on behavior toward the river.

Luke Salvato, *Peter Lea*
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PHOSPHOROUS DYNAMICS IN ANDROSCOGGIN LAKE, WAYNE AND LEEDS, MAINE

This project provides insights into phosphorus dynamics within Androscoggin Lake, a threatened lake designated as a highest priority lake on Maine's Nonpoint Source Priority Watersheds List. Androscoggin Lake is unusual because it intermittently receives water and sediment related to back-floods of the Androscoggin River via the connecting Dead River. Compared to other lakes in the region, Androscoggin Lake exhibits relatively high values of phosphorus, part of which is attributed to reversed flow up the Dead River. Another source is internal loading of phosphorus from lake sediment back into the water column, but this mechanism has not been studied in detail. For this project, the lake was investigated at two primary sights, a deep central basin (~12 m deep) and a shallow basin in the northern region of the lake (~4.5 m deep) from June to early August 2010. Data include semi-weekly profiling of temperature, dissolved oxygen, and other variables, along with water sampling, and HOBO submersible temperature loggers. In the deep basin, the epilimnion deepened from ~5 m in June/mid-July to ~8 m in late July and August. Over the same time period, hypolimnetic dissolved oxygen dropped from ~50% to less than 10% saturation. At the shallow site, a well-defined hypolimnion did not develop, and the bottom remained relatively oxygenated (>60% saturation) throughout the study period. Laboratory phosphorus analyses provide insight into the dynamics of internal phosphorous loading under these different conditions.

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INVESTIGATING THE RELATIONSHIP BETWEEN PHYTOPLANKTON FLUORESCENCE AND BLOOM COMPOSITION IN HARPSWELL SOUND

Phytoplankton are single-celled aquatic photosynthesizers, which use chlorophyll to convert light into energy. Because chlorophyll cannot absorb green underwater light, phytoplankton produce taxonomically-unique green-absorbing accessory photosynthetic pigments that can. These pigments change the absorption spectra and associated fluorescence response, allowing for taxonomic identification. My project focuses on the utility of using an instrument that measures chlorophyll fluorescence in response to excitation at three wavelengths (435nm, 470nm, 532nm, 3 wavelength eXcitation, 1 wavelength eMission). The goal is to use these observations to identify taxonomic changes in phytoplankton blooms, based upon their pigmentation and fluorescence response difference. The specific application is to identify transitions between the common, harmless diatoms and the potentially Paralytic-Shellfish-Poison-causing dinoflagellates, by looking at changes in their characteristic pigments, fucoxanthin and peridinen, respectively.

Chlorophyll derived from 435nm-stimulated fluorescence and that determined analytically compared well overall, although variations due to fluorescence quenching and species composition were observed. By comparing the ratio of chlorophyll fluorescence intensity resulting from excitation at 435nm:470nm measured in Harpswell Sound to those obtained from monoculture calibrations, the ratio value distinguishing diatoms or dinoflagellates was quantified. The relationship between the fluorescence ratio 435nm:470nm and the fucoxanthin:peridinin ratio was statistically significant, confirming the relationship between fluorescence ratios and bloom composition. This capability will provide the basis for early detection of potentially toxic blooms forming in Harpswell Sound, a sentinel site for coastal bloom development this species of dinoflagellate.

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MONITORING AND NUTRIENT ANALYSIS OF TAUNTON BAY, MAINE

Taunton Bay is of interest because it is the northern most area where atlantic horseshoe crabs, *Limulus polyphemus*, reside. Taunton Bay lies between Ellsworth and Sullivan Maine. Over the past years, there has been significant loss in eelgrass coverage, indicating ecosystem changes. Several hypotheses for the loss of eelgrass are linked to anthropogenic impacts, both fishing operations and nutrient inputs. During the period from May through October 2010, water samples were collected and observations were made at five different sites within Taunton Bay once a week during high tide. Qualitative observations of human and wildlife activity were made to ascertain the extent of the use of the bay. The water samples were processed at the University of Maine at Machias and were analyzed for phosphate, nitrate, salinity, turbidity, total suspended solids, and chlorophyll-a. The water chemistry results showed there was no significant difference between Taunton Bay and prior results in the Gulf of Maine. The observations showed that human use of the bay was primarily fishing activities, but also regular recreational use. The wildlife presence varied throughout the season.

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THE EFFECTS OF PRECIPITATION ON STREAM DISCHARGE AND GROUNDWATER LEVELS

The objective of this research project was to study responses within the hydrologic cycle after rainfall events in Unity, Maine. Three components were involved in our analysis: rainfall, groundwater, and stream discharge. Total precipitation and maximum 10- and 30-minute rainfall intensities were calculated from the output of a tipping-bucket rain gauge equipped with a datalogger. Streamflow measurements were obtained from a stilling well installed on the bank of Sandy Stream. Groundwater levels were measured from a piezometer located on a terrace adjacent to Sandy Stream. Capacitance water level probes were used to record stage in the stilling well and elevation of the groundwater in the piezometer at 5-minute intervals. Discharge measurements were made using a current meter at a designated cross-section on Sandy Stream. The discharge measurements and stage measurements from the stilling well were used to create a stage-discharge rating curve for Sandy Stream. The monitoring period began immediately following installation of each instrument- rain gauge (9/7/10), stilling well (9/21/10), and piezometer (10/5/10), however, for this project, we focused our analysis on the period of overlap between instrumental records. Each rainfall event was analyzed separately for a corresponding response in groundwater and stream discharge. Results indicated that stream and groundwater response times were similar, with average lag times of 16.23 and 18.50 hours, respectively; groundwater levels increased 80cm over the duration of the study period; and average stream flow was 2.1m^3/s. The results of this study form the foundation for a long term watershed monitoring project in central Maine.

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§ **NITROGEN ISOTOPES IN LAKE SEDIMENTS FROM THE ANDROSCOGGIN WATERSHED: A PROXY FOR ANADRAMOUS FISH RUNS?**

The connectivity between fresh water and marine ecosystems is well illustrated by the life cycle of anadromous fish species (e.g., alewife). Alewives mature in marine systems and migrate to freshwater lakes to spawn, after which they return to the ocean. Northern New England rivers have a long history of human alteration (e.g.,

dams, industry, pollution), which has interfered with anadromous fish runs in freshwater systems. Little is known about the extent to which anadromous fish derived nutrients contribute to freshwater lakes in northern New England, nor the importance of marine derived nutrients prior to human alterations of these river systems. Nitrogen isotopes in sediment cores can track the historic presence of nutrients derived from anadromous fish in the Pacific NW, provided anthropogenic watershed disturbance is minimal (Finney et al. 2000, 2002, 2010). This study investigates nitrogen isotope composition of sediment cores over 500 years from the Androscoggin watershed. Surface cores were analyzed for ^{15}N composition from four lakes: Basin Pond (no known alewives records, serving as a baseline); Thompson Lake, (no modern alewife runs but uncertain historical records); Tripp Pond and Taylor Pond (modern searun alewife runs). Preliminary data indicate $\delta^{15}N$ enrichment in uppermost segments of Thompson, Tripp, and Taylor Pond cores, likely reflecting anthropogenic activities independent of the presence/absence of marine derived nutrients. The base of these cores may represent the degree to which MDN contributed to nutrient cycling in the lakes prior to arrival of western Europeans. Age models and spatial comparisons are currently underway.

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CATIONIC AMINE SORPTION TO SOILS: IMPLICATIONS FOR CONTAMINANT CONCENTRATIONS IN GROUNDWATER

Over the past couple of decades, there has been increasing concern over the fate of pharmaceuticals released into the environment. Aniline represents an important model compound for larger antibiotics because many antibiotics, including ciprofloxacin, penicillin, and cephalexin, possess the amine functionality. Although many studies have examined aniline sorption to soils and pure phase aluminosilicates, relatively few studies have focused on the linearity and nonlinearity of sorption isotherms and intermolecular interactions between aniline molecules on the soil surface. This study explores how the soil properties influence the linearity/non-linearity of aniline sorption isotherms. To achieve project objectives, aniline sorption and cation release were evaluated for six test soils with varying exchangeable cation contents, cation exchange capacities (CEC), and percent organic matter content. Even under experimental conditions designed to ensure that all suspensions contained similar equivalents of charge/kg of soil, soil CEC appeared to be an important determinant of the shape of aniline sorption isotherms. Soils with CEC values less than 2cmolc/kg exhibited linear and Freundlich isotherms, whereas most soils with CEC values greater than 2cmolc/kg exhibited non-linear, sigmoidal isotherms. Based on the sigmoidal-shaped isotherms for higher CEC soils, we hypothesize that the proximity of charged sites, or charge density, may be an important determinant of sorption linearity/non-linearity. This knowledge will allow for better predictions of sorption equilibrium constants and chemical fate in soil and groundwater systems.

GRADUATE POSTER ABSTRACTS

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

The Machias River harbors one of the few remaining wild populations of Atlantic salmon (*Salmo salar*) in the U.S. and provides an ideal system for investigating the productive capacity of currently inaccessible first and second order stream reaches to juvenile salmon due to impassable culverts. In spring 2010, salmon fry were scatter-stocked in twenty study reaches to quantify growth and survival across multiple environmental gradients. In late summer, fry abundance per 100 m reach averaged 43 individuals and ranged from 0 to 200 fry. Apparent

survival averaged between 0 and 45.1%, with a mean of 10.9%. Mean length at time of capture was 53.9 mm and ranged from 35.0 to 78.0 mm, and mean mass was 1.4 g and ranged from 0.3 to 5.2 g. Mean size of fry varied significantly among stream reaches for both length ($p < 0.0001$) and mean mass ($p < 0.0001$). Mean density was 0.26 fry/m^2 and ranged from 0.00 to 1.09 fry/m^2, whereas mean biomass was 0.37 g of salmon tissue/m^2 and ranged from 0.00 to 1.34 per reach. Brook trout (*Salvelinus fontinalis*), the dominant fish throughout the study area, were collected in 85% of study reaches. Of the 20 habitat variables measured, temperature, water depth, interstitial space availability, and LWD DBH were correlated most strongly with growth and survival. We anticipate results that will empirically validate the importance of headwater streams as critical nursery and rearing habitat for juvenile salmon, thus providing the impetus toward culvert removal and the reestablishment of watershed connectivity.

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§ DO ENVIRONMENTAL ATTITUDES PREDICT PROENVIRONMENTAL BEHAVIOR AND RECREATION ORIENTATION?

In the current work, we examined whether environmental attitudes (as measured by the NEP total score or the separate eco-, techno- and dual-centric subscales) significantly predicted proenvironmental behavior and outdoor recreation orientation (consumptive, appreciative, or motorized). We conducted a survey by mail of a representative sample of Maine residents. Consistent with predictions and supportive of a strong attitude-behavior link, “green” environmental attitudes (higher total NEP scores) were significantly positively related to self-reports of proenvironmental behavior ($r = .32$, $p < .01$) and appreciative recreation ($r = .21$, $p < .05$). Total NEP scores were also negatively related to consumptive recreation ($r = -.19$, $p < .05$). Upon further examination, we found that the link between the NEP and increased environmental behavior was primarily driven by the ecocentric and dualcentric subscales of the NEP. Perhaps most intriguing, the relationship of the NEP to recreation orientation was driven entirely by the technocentric subscale. These results suggest important nuances in examining the relationship between environmental attitudes and environmental behavior. Rather than examining the NEP as a unitary construct, it may be that the subscales of the NEP have important predictive utility in different domains. In sum, more ecocentric environmental attitudes predicted environmental behavior whereas the belief that technology can solve environmental problems (technocentric) predicted recreation orientation.

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PERMACULTURE DESIGN RESEARCH INITIATIVE

The Permaculture Design Research Initiative (PDRI) focused on low-cost distributed solutions to stormwater problems utilizing constructed wetland technologies, bioremediation and biomimicry. The poster presentation documents the designs, findings, and conveys an innovative approach to addressing watershed solutions and food production as an intermedia art practice. The PDRI assembled an interdisciplinary team of artists, engineers, food producers, researchers and community members whose common goal was to promote public education and involvement with a localized stormwater issue, by developing a permaculture design document. The team concluded that this design should meet all of the Maine DEP guidelines for stormwater design and management, while simultaneously creating an environment for nearby food production. Concluding the project, the team has a viable design prototype for hands-on community scale watershed solutions that combines permaculture design principles, environmental science and intermedia art practices. The project will need further research and development to implement designed solutions and track their long-term ecological impact.

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RESIDENTIAL LAND CONVERSION AND PEAK STREAMFLOW RESPONSE

While increased residential development provides economic benefits, this trend can also alter the dynamics of hydrologic processes (Defries and Eshelman, 2004) which play important roles in ecosystem functions (Poff et al., 2007). The objective of this research is to develop a method to explore streamflow responses to alternative future scenarios that vary by magnitude and location of land conversion and possible climate changes. To accomplish this objective, we link an economic model that generates likely future scenarios to a hydrologic model that simulates peak streamflow for alternative scenarios.

The city of Ellsworth, Maine was chosen as a study site due to the accessibility of well-organized, electronic data and its importance as a pilot town for an EPA-funded project. We identified locations (by parcel) and timing (by year) of recent building construction in Ellsworth using geo-referenced tax data and found that residential development has been a significant component of recent land use change in this city. Also, we simulated peak streamflow for the Card Brook watershed in Ellsworth using the USDA WinTR55 program. Preliminary results suggest that varying the location of residential development leads to different peak streamflow responses for alternative scenarios. By linking an economic model of land conversion with an easily available USDA-supported hyrologic model, we hope to develop an efficient method that can be easily transferred to other locations.

This research is based upon work supported by the Maine Agricultural and Forestry Experiment Station, US EPA, and the National Science Foundation (award # EPS-0904155).

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§ WHO CARES ABOUT WATER? INFLUENCES AFFECTING CONCERN FOR WATER QUALITY AND QUANTITY

The objective of this analysis is to identify different factors that contribute to the priority of water quality and quantity amongst the many issues facing Maine. To address this question, data was analyzed from a mail survey administered to a random sample of Maine citizens (48% response rate). The survey contained questions of behavioral patterns and attitudes towards issues currently facing Maine, with a focus on consumer's knowledge, perceptions and acceptance of wind energy.

Our study shows that out of eight issues facing Maine, the issue of "water quality and quantity" proves the third most popular among respondents. Respondent participation in water recreation proves a weak indication of a "water quality and quantity" selection; although, "water" respondents do indicate participating in more consumptive water recreation sports. This group of respondents also indicated high importance of replacing hydroelectric power with wind power. Analysis indicates that the minimum distance from a respondent's address to the nearest body of water is statistically different between those residents who choose "water quality and quantity" above all other issues or those who do not.

The implication of these results demonstrates that the population who is most interested in the status of Maine's water systems are those residents within close proximity to lakes, reservoirs, rivers, and streams. Therefore

research agencies collecting new information on water quality should consider freshwater-neighboring residents among primary stakeholders and coordinate in particular with communication agencies within that region to share timely results.

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§ KNOWLEDGE ACTION SYSTEMS IN AN INTERDISCIPLINARY COLLABORATIVE SUSTAINABILITY SCIENCE RESEARCH PROJECT

In the Knowledge Action Systems Project, faculty, graduate and undergraduate researchers use interviews, participant observations, and an online survey to identify frameworks for linking knowledge and action on Sustainability Solutions Teams. This research project has three central goals: 1) Assess the K-A frameworks guiding sustainability science projects within individual teams, between teams within SSI, and between SSI teams and their defined stakeholders; 2) Explore and describe challenges to conceptualizing and implementing K-A practices and develop a baseline for documenting changes in K-A conceptualizations over time; 3) Use data to guide the development of a workshop to improve K-A collaboration on and across SSI and SSP teams. Outcomes from this research include a workshop on linking knowledge and action to identify best practices for supporting interdisciplinary teamwork and sustaining stakeholder-university partnerships. The workshop is an essential and concluding step in the development of best practices for strengthening K-A interactions. This Knowledge Action research project contributes to the integration of applied communication theory and methods with interdisciplinary sustainability science to enhance collaboration and stakeholder engagement. The poster depicts the rationale, methods, and preliminary findings from the first phase of interviews and participant observations.

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VEGETATION RESPONSE TO PREDICTED INCREASED TIDAL MARSH INUNDATION IN NORTHERN NEW ENGLAND BRACKISH MARSHES

Brackish marsh vegetation distribution is strongly controlled by inundation and salinity, and is likely to be impacted by climate change and sea level rise due to changes in the periodicity and magnitude of freshwater and salt water inputs. With increases in sea level, shifts in dominant marsh species would be expected, altering typical brackish marsh plant diversity and moving these systems towards saltier marsh vegetation. Yet little is known about the effects of these hydraulic regimes on brackish marsh floral communities in northern New England. Quantifying vegetation response in these systems to inundation and salinity will lead to stronger predictions of change when considering long-term protection and conservation of these fragile habitats. The goal of this study is to construct a model as a guide for predicting vegetation response to inundation and salinity along a brackish gradient using experimentally obtained information on plant responses to these different regimes.

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GEOLOGIC AND GEOMORPHIC CONTROLS ON BED GRAIN SIZE IN THREE MAINE RIVERS

River channel morphology in northern New England depends on channel position relative to glacial geomorphology and history. This poster considers three Maine rivers: the West Branch of the Pleasant River (WBPR), a steep inland imposed-form tributary of the Piscataquis River, and the Narraguagus and Sheepscot rivers, two coastal low-gradient rivers. We use a simple model based on the Shields and Manning equations to predict median bed grain size in these recently deglaciated watersheds. An objective of this study is to understand how bedrock controls and sediment inputs along the stream longitudinal profile impact substrate grain size and channel morphology. We use standard digital elevation models (DEMs), lidar (light detection and ranging) DEMs, and spatial analyses to measure channel parameters necessary to predict bed grain size and compare them to field measurements. Predicted bed grain size falls within a factor of two of the field-measured median in ~70% of the study sites. Model failures potentially result from factors such as sediment supply not included in the model, and may indicate areas to focus restoration efforts. This study builds on previous research on low-gradient coastal rivers in Maine, and has wide applications to future research or restoration projects concerned with sediment mobilization and overall channel geomorphic controls.

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§ PATTERNS OF DISSOLVED ORGANIC MATTER COMPOSITION ALONG AN URBANIZATION GRADIENT IN MAINE

Urbanization strongly modifies the biogeochemistry of streams with potential consequences for ecosystem structure and function. While changes in inorganic nutrient biogeochemistry are reasonably well studied, much less is known about the urban influence on dissolved organic matter (DOM) abundance and composition. We examined the composition and abundance of dissolved organic matter along a gradient of urbanization, indicated by total impervious cover, across the State of Maine in the fall of 2010. Water in streams draining catchments containing 0-60% impervious cover was analyzed using fluorescence spectroscopy and parallel factor analysis (PARAFAC) to quantify DOM composition. Water was also analyzed for nitrate, ammonia, soluble reactive phosphorous, total dissolved nitrogen and phosphorus, and total organic carbon. DOM composition varied across sites with two PARAFAC components positively correlated with increasing impervious cover. The excitation/emission maximum at 385/238 nm correlated most strongly with total impervious area. PARAFAC components correlated with urbanization were also positively correlated with other more common indicators of urbanization (pH, conductivity, and water temperature).

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ASSESSING ECOSYSTEM FUNCTIONALITY IN A RESTORING SALT MARSH USING ARTHROPOD FOOD WEBS

Assessing salt marsh restoration success usually involves monitoring vegetation growth and changes in salinity regimes, with little attention paid to ecosystem function. Terrestrial arthropods represent a wide range of trophic levels and provide a link between salt marsh vegetation and terrestrial and aquatic food webs. Arthropods thus represent a unique opportunity to study the efficacy of salt marsh restoration in terms of restoring ecosystem

trophic functionality. This study compared species composition and diversity of insects and spiders in patches of *Juncus gerardii, Spartina alterniflora*, and native and invasive forms of *Phragmites australis* in a restoring salt marsh (Sherman Marsh, Newcastle, Maine) to those on the same plant species in nearby reference marshes. Food web function was assessed using stable isotopes to quantify the influence of recently established populations of C_4 plants (i.e., *Spartina*) on carbon transfer through the food web in Sherman Marsh. Arthropod species composition was dissimilar between Sherman Marsh and corresponding reference marshes, even though pore water salinity was comparable. *Cicadellidae* were the most common herbivores in the reference marshes, but were nearly absent from Sherman Marsh. Within *J. gerardii* patches, arthropod diversity {H'= 2.70, $p<0.05$} was higher at the inlet of Sherman Marsh, where salt marsh plants have recently established, than in reference marshes or in fresher reaches of Sherman Marsh. These data suggest that Sherman Marsh has yet to develop a comparable arthropod community structure; results from stable isotope analyses will allow us to compare trophic structure among these communities.

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§ INTEGRATING STAKEHOLDER KNOWLEDGE AND LAND USE RESEARCH

Over several decades, economists have completed valuable research to advance the understanding of land-owner behaviors, evaluate influences of policies, and assess values of landscape attributes (Irwin et al. 2009). Yet, recent studies question the extent to which this research has been used by policy-makers and stakeholders (Banzhaf 2010). We estimate an empirical model of residential development that is responsive to substantive stakeholder concerns and communicate our findings in a way that contributes to land use policy decision making on the ground.

A recent "Greenprinting," or place-based planning exercise sponsored by the Trust for Public Land helped municipalities recognize the need to think about land-use change and plan for future landscapes (Trust for Public Land 2009). We use economic modeling to test if Maine communities are likely to achieve their "Greenprint" goals under current policies, and explore the potential effectiveness of alternative policy arrangements.

We examine the conversion of undeveloped land to residential use in a selection of communities centered around Bangor, Maine, from 1995 to present. Using parcel-scale data, we employ a survival modeling approach to represent land-owner behavior (Irwin, Bell, & Geoghegan 2003; Towe, Nickerson, & Bockstael 2008). This approach explains the change in a parcel from an undeveloped to developed use as a result of the net expected returns.

Preliminary results of conversion decisions confirm the importance of variables influencing the net returns of conversion. Our results can be used to determine the extent to which designed green and open space areas are at risk from future development.

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FISH SCALES AS NON-LETHAL BIOSENSORS OF SURFACE WATER CONTAMINANTS

There is great need for non-lethal, biologically relevant screening tools to assess the effects of surface water contaminants on threatened or endangered fish species, as typical screening procedures, such as liver sampling and skin plugs, are lethal or highly invasive. We hypothesized that fish scales could serve as non-lethal, rapid biosensors of fish response to contaminants. We demonstrate that the pollutant biomarker, cytochrome P4501A

(CYP1A) is significantly induced in scale tissues (i.e. the epithelial covering around the scale) of Atlantic salmon (*Salmo salar*) parr aqueously exposed for 48-hours to 0.327, 3.27 and 32.7 ppb 3,4,3',4',5-pentachlorobiphenyl (PCB126) and 330 ppb β-naphthoflavone, as measured by 1) scale ethoxyresorufin-*O*-deethylase activity, 2) immunohistochemical analysis of skin-scale sections using CYP1A-specific MAb 1-12-3, and 3) scale CYP1A mRNA using qualitative polymerase chain reaction (PCR). Our goal is to establish fish scales as field- and fish-friendly screening tools, capable of detecting a variety of contaminants. To this end, we are currently establishing quantitative (real-time) reverse-transcriptase PCR (qRT-PCR) protocols for scale CYP1A mRNA and additional biomarkers for estrogenic and toxic metal compounds. A non-lethal biosensor would allow researchers and managers to determine if endangered fish species are being exposed to contaminants and in what part of their geographic range, would allow repetitive analysis of the same individual, and, for diadromous fishes, would indicate when during migration exposure may occur. (USGS, Senator George J. Mitchell Center 06HQGR0089).

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§ IS KNOWLEDGE LINKED WITH ACTION? EVIDENCE FROM HOUSEHOLD CONSERVATION BEHAVIOR

Water quality in many regions depends on the collective provision of clean storm water. Storm water pollutants derived from everyday household activities exacerbate water quality losses with significant economic impacts (Schuetz, 1998; Michaels et al., 1997). Simple household conservation practices are designed to reduce and mitigate storm water pollution, and widespread adoption of these practices could improve the health of many water bodies (US EPA, 2010). We contribute to a line of inquiry that combines insights from economics, psychology, and on-the-ground education programs to model pro-environmental behavior (e.g., Clark et al., 2003). We examine decisions about a group of conservation practices that vary in terms of the levels of private and public benefits they provide and in their visibility to neighboring households. To reveal households' cognitive and social motivations, we test the interactive effects of social norms, positional status and knowledge (Bamberg & Moser, 2007; Fishbein & Ajzen, 2010; Solnick & Hemenway, 2005). We estimate several discrete choice models of past and intended future behavior using data from a mixed-mode survey of Maine lakefront property owners. Results provide a rich description of household conservation practice adoption and suggest payoffs in blending multi-disciplinary insights. Results also support incorporating social dynamics and the effects of different kinds of knowledge into household decision-making models. Our findings can be used to inform outreach and education campaigns. Given that collective effort is necessary to solve many of Maine's water quality problems, our results support programs addressing the complex interactions between group and individual forces.

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§ A LOOK AT TRENDS IN SEBAGO LAKE

Sebago Lake provides drinking water for ~200,000 people near Portland, ME, as well as recreation opportunities that depend on the maintenance of high water quality. It has been identified as being at risk of declining water quality as a result of private ownership of much of the land in the watershed. The purpose of this work was to examine the available water quality data to determine if any trends can be identified. This is being done in conjunction with analysis of land use and climate change, and hydrologic modeling of the watershed system to determine if past trends can help us predict how the system will react to different possible future scenarios. Secchi disk depth, chorophyll a pigment, and total phosphorus data from 1976-2008 have been examined. We focus on monitoring data collected in Lower Bay, nearest the intake area for water supplies. We also looked at

the same water quality parameters for four other lakes in the Sebago Lake watershed from 1990-2009. For most analyses we have found no significant trends between the water quality parameters and time or lake water level. However, Secchi disk depth was positively correlated with water level from 1979-1989 in Sebago Lake, and chlorophyll a was also positively correlated with the lake's water level from 1990-2008. Additionally, lumped water quality parameters for Lower Bay showed an increasing trend over time from 1990-2008. The only significant trend found in the other four lakes examined was increasing total phosphorus over time for Station 1 in Long Lake.

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DO POST-GLACIAL RIVER VALLEYS IN MAINE STORE MILLDAM LEGACY SEDIMENTS?

Recent work by Walter and Merritts (2008) in the U.S. Mid-Atlantic region suggests that breached milldams have associated upstream deposits of post-dam legacy sediment that are often abandoned by the river and function as fill terraces. This hypothesis has not yet been tested in a post-glacial environment. The goal of this investigation is to determine the extent of legacy sediment in a post-glacial river system to better understand how historical dam sites affect morphology and sediment transport. We analyze channel morphology and sedimentation patterns upstream of two breached dams on the Sheepscot River in Mid-coastal Maine (Maxcy's Mills dam, built in 1809, was 2-m high and breached in the late 1950s, and Head Tide dam, built in the 1760s, is 6-m high and was partially breached in 1952) using lidar elevation data, historical aerial photographs, radiocarbon dating, and hydraulic modeling. Understanding the mobility of legacy sediment is an important component of restoration efforts. Field and remote sensing analyses indicate that surfaces (up to 2-m high) composed of mud and sand function as floodplains 1.5-2.5 km upstream of both former dam sites. Preliminary analysis of seven radiocarbon dates from bark pieces (58-187 cm below the surface) of the two study sites suggest at least 1.8 m of river bank sediment was deposited within the past 300 years and is therefore a legacy of the dams.

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MICROBIAL POPULATIONS ASSOCIATED WITH PRIVATE WELLS WITH HIGH LEVELS OF ARSENIC LOCATED IN NORTHPORT, MAINE

In Maine, approximately 40% of residents obtain their drinking water from private wells. Many of these wells contain arsenic levels greater than the EPA limit of 10 ppb. With no requirement to test private well water, thousands of Maine residents may unknowingly be exposed to high arsenic concentrations.

For arsenic to occur in groundwater it must be present in aquifer materials and conditions must be favorable for release. Many microorganisms are capable of accelerating bedrock weathering and altering arsenic speciation in groundwater. Microorganisms can reduce arsenate, As (V) to the more toxic and mobile form arsenite, As (III). Microorganisms can alter the arsenic binding iron oxyhydroxides that coat aquifer materials, causing arsenic to be released. As the redox potential of the groundwater is lowered, these microbial activities that can result in increased arsenic levels are favored.

The microbial populations in groundwater taken from four wells with different arsenic concentrations from a single aquifer in Northport, ME were identified using clone libraries. Temporal variations in the microbial community structure were examined by using samples taken five months apart and the shifts appear to be minor in the wells. Comparing the microbial communities with low and high arsenic concentrations there are significant differences in the populations. The wells with high arsenic levels have a greater proportion of organisms which are

classified as β and δ proteobacteria. This finding is significant because many organisms from these two groups can reduce iron oxyhydroxide surface coatings or they can reduce As (V).

PROFESSIONAL POSTER ABSTRACTS

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PENOBSCOT RIVER SCIENCE EXCHANGE: A CONSORTIUM FOR DAM REMOVAL AND DIADROMOUS FISH RESTORATION RESEARCH

Covering 8,570 square miles, the Penobscot River is Maine's largest and New England's second largest watershed. Unfortunately, centuries of dam construction have blocked the migration of diadromous fish to their upstream spawning and rearing habitats, as well as altered the structure and function of fish assemblages throughout the river. The Penobscot River Restoration Project is a multi-million dollar endeavor to restore nearly 1,000 miles of sea-run fish habitat by removing two large hydro-electric dams in the lower part of the river and providing improved fish passage at a third dam upstream. In 2008, the Penobscot River Restoration Trust and agency and academic researchers began conducting studies and environmental monitoring on the river in order to establish pre-dam removal conditions that will allow managers to document restoration outcomes. This group of approximately 30 researchers makes up the Penobscot Science Exchange, which is a collaboration with the Diadromous Species Restoration Research Network (DSRRN), a five-year, NSF-funded collaborative research effort to advance the science of diadromous fish restoration. This poster provides descriptions of research projects currently being conducted on the Penobscot in conjunction with the dam removals. Projects include shortnose sturgeon movement and spawning, bird assemblages, sea lamprey movement in tributaries, iron-drainage impacts to water quality, alewife population structure and migration, marine-freshwater food web linkages, sea lamprey and Atlantic salmon interactions, and dam removal impacts on fish assemblages.

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WHO GIVES A DAM?: TAKING STOCK OF PUBLIC SUPPORT FOR RIVER RESTORATION PROJECTS

River restoration projects pose unique challenges for water resource managers because of, among other factors, uncertainties over project objectives, biophysical and social system responses, societal benefits and costs, and regulatory environments. Biophysical and social science researchers are actively striving to better confront these uncertainties and improve scientific support of water resource management decisions. By using statistical approaches to detect systematic patterns, our social science research strives to lessen uncertainties over public support for river restoration projects. Our empirical analysis is focused on public support for the Penobscot Restoration Project (Maine, USA). We make use of responses to a 2009/2010 survey of Maine households and employ regression analyses to test multiple hypotheses (informed by economics and other social science theories) about drivers of variation in public support. Our results shed light on the relative influence of factors such as proximity of residence to the Penobscot River, income, participation in outdoor recreation activities, perceived benefits and costs, project awareness, and trust in water resource management organizations.

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DIADROMOUS SPECIES RESPONSE TO WATER CHEMISTRY: A LITERATURE REVIEW SUMMARIZING IMPACTS OF ENDOCRINE DISRUPTING CHEMICALS (EDCS) ON DIADROMOUS AND FRESHWATER FISH IN THE GULF OF MAINE.

The Diadromous Species Restoration Research Network is a five-year initiative funded by the National Science Foundation to advance the science of diadromous fish restoration through workshops, conferences, web sharing, and journal publications. The Network is a joint project of the University of Southern Maine and the University of Maine's Senator George J. Mitchell Center. This poster presents a literature review exploring the importance of water quality and in particular, endocrine disruptors on diadromous fish in the North Atlantic.

Endocrine disrupting chemicals (EDCs) are hormonally active chemicals that are most closely associated with waste-water treatment facilities, agricultural runoff and pulp and paper mills. EDCs can result in subtle changes to sexual behavior and physiology or more overt and detrimental changes in sex determination and fertility. These chemicals are sub-lethal and result in subtle alterations to fish biochemistry and behavior. Case studies have demonstrated alterations to population sex ratios and reduced fecundity as a direct result of sewage waste water treatment plants. EDCs have been monitored in Maine since 2000 when the DEP began its Cumulative Effects Assessments (CEA) on fish populations and has found some indications of population-level effects in the Presumpscot River as a result of a waste-water treatment plant at Westbrook. The challenge faced by researchers when studying EDCs is determining causality of EDCs and alterations to behavioral and physiological alterations to a fish. The dynamic habitat and life-history of diadromous fish make it difficult to parse the true impact of EDCs from other factors.

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A DIGITAL TERRAIN MODEL OF BATHYMETRY AND SHALLOW-ZONE BOTTOM-SUBSTRATE CLASSIFICATION FOR SPEDNIC LAKE AND ESTIMATES OF LAKE-LEVEL-DEPENDENT HABITAT TO SUPPORT SMALLMOUTH BASS PERSISTENCE MODELING

In 2009, the U.S. Geological Survey entered into a cooperative agreement with the International Joint Commission, St. Croix River Board to do an analysis of historical smallmouth bass habitat as a function of lake level for Spednic Lake in an effort to quantify the effects, if any, of historical lake-level management and meteorological conditions (from 1970 to 2009) on smallmouth bass year-class failure. The analysis requires estimating habitat availability as a function of lake level during spawning periods from 1970 to 2009. Field work was done from October 19 to 23, and from November 2 to 10, 2009, to acquire acoustic bathymetric (depth) data and acoustic Doppler current profiler (ADCP) data for interpreting the character of the surficial lake-bottom sediments. Historical lake-level data during the smallmouth bass spawning window were applied to the bathymetric and surficial-sediment type data sets to produce annual historic estimates of smallmouth-bass-spawning-habitat area. Results show that minimum lake level during the spawning period explained most of the variability (R^2 = 0.89) in available spawning habitat for nearshore areas of shallow slope (less than 10 degrees) on the basis of linear correlation. The change in lake level during the spawning period explained most of the variability (R^2 = 0.90) in available spawning habitat for areas of steeper slopes (10 to 40 degrees) on the basis of linear correlation. The next step in modeling historic smallmouth bass reproductive success is to combine this analysis of the effects of lake-level management on habitat availability with historical meteorological conditions.

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WEST WINTERPORT: A SUCCESSFUL DAM REMOVAL AND HABITAT RESTORATION CASE STUDY

The National Inventory of Dams currently identifies 647 dams in the State which only represents a small portion (based on dam height and hazard) of the total number present (ACOE, 2009). Many of these dams have provided public benefits, such as energy production, flood control and recreation. However, a growing percentage of these dams no longer fulfill their intended use and are becoming a liability to public safety and the environment. Effective July 20, 2009, the Gulf of Maine Distinct Population Segment of Atlantic Salmon was listed as an endangered species by the federal government. Dams have been identified as one of the major threats to Atlantic salmon recovery due concerns related to fish passage and habitat connectivity. One possible step to improve connectivity is to remove dams and restore riverine habitat. In the late summer of 2010, the West Winterport dam on Marsh Stream in Winterport, Maine was successfully removed opening up and restoring approximately 85 miles of riverine habitat. The removal of the dam was a collaborative effort between the private dam owner, the Towns of Winterport and Frankfort, the Atlantic Salmon Federation, NOAA Fisheries Service, U.S. Fish and Wildlife Service and Kleinschmidt Associates. The dam removal was the culmination of nearly 10 years of public outreach, planning, and permitting. The purpose of this poster is to outline the process of the West Winterport dam removal and publicize the lessons learned in this case study to promote and streamline future dam removal projects in Maine.

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ROAD-STREAM CROSSINGS AS BARRIERS TO MAINE'S STREAM CONNECTIVITY: ASSESSING THE PROBLEM AND MARSHALING CORRECTIVE ACTION

Thousands of stream miles in Maine provide habitat for a diverse fauna and recreational/commercial opportunities having cultural and economic significance. Also important to Maine's economy and the well-being of its people is the extensive road network allowing access to services, goods, and markets throughout the state. Where roads intersect streams, culvert crossings designed without consideration of ecological processes can represent physical barriers to stream connectivity. Barriers fragment habitat, constraining the movements of fish and other aquatic organisms and disrupting stream processes. Some barrier-crossings demonstrate a heightened risk of failure because they inadequately accommodate peak flows, which have increased over recent decades. Culverts that are undersized and perched above stream channels are the most common physical barrier to stream connectivity. Surveys in several Maine watersheds suggest that up to 90% of culvert crossings on perennial streams are ecological barriers for at least part of the year. About 50% of crossings surveyed, are severe, year-round barriers to connectivity on perennial streams. The considerable shift from native stream connectivity to a highly fragmented condition undermines longstanding conservation and recovery efforts focused on species serving key ecological roles and those that are prized by Maine's people. The magnitude of this challenge requires an innovative, comprehensive effort over decades to incrementally correct barriers with ecologically functional replacement crossings. The Maine Stream Connectivity Work Group focuses on overcoming the technical and practical challenges of correcting barriers by building capacity for restoration, outreach, and coordination among Work Group participants and those responsible for road maintenance.

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THE PENOBSCOT ESTUARINE FISH COMMUNITY AND ECOSYSTEM SURVEY

The Penobscot ecosystem allows a unique opportunity to monitor estuarine responses to major upstream river restoration projects. There is also a growing need to understand interactions between freshwater, diadromous, and marine species in estuaries. Therefore, we developed the Penobscot Estuarine Fish Community and Ecosystem Survey, which is part of the wider Maine Estuaries Diadromous Survey. The primary aim of the former is to describe the spatial and temporal distribution of fish in the Penobscot estuary, and will include environmental and habitat monitoring along with surveys of fish distribution and abundance to explore trends over time. This approach highlights the importance of capturing all habitats within the estuary system and surveying the multiple and diverse species using the estuary. The project will begin with an initial exploratory and descriptive phase, and evolve into one where monitoring, impact assessment and hypothesis testing are conducted, where possible. The feasibility studies that began in 2010 will continue in 2011-12 to include a fish-community survey in the estuary utilizing various fish capture techniques including beach seining, fyke netting, midwater trawling and hydroacoustics. Initial results of the survey provide evidence of natural reproduction of American shad (*Alosa sapidissima*) in the Penobscot River. The temporal distribution of shad juveniles also suggests spawning in the Penobscot River may occur over a long time period (3-4 months). The presence of juvenile bluefish (*Pomatomus saltatrix*) and rough scad (*Trachurus lathami*), species with a more southerly distribution, was interesting and will be monitored over time for patterns consistent with range shifts. Knowledge from this study will improve our ability to manage estuaries in the future, and conduct vital research on the habitats and ecosystem services they provide.

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MYSTERY RELEASE OF ANOXIC WATER AND IT'S IMPACT ON AQUATIC LIFE IN THE MEDUXNEKEAG RIVER

The Houlton Band of Maliseet Indians Water Resources Staff monitors ambient water quality in the Meduxnekeag River using continuous logging devices. In August 2009, HBMI staff identified two occurrences of extremely low dissolved oxygen levels at a river site. Follow-up investigation showed concurrent increases in flow as measured at nearby USGS gauge stations. Hydrograph estimates showed ~5.65 million gallons had been discharged to the river over 9 hours, despite no antecedent rainfall. What released that much anoxic water? Working with various State agencies, the removal of a beaver dam in a nearby tributary was determined to be the cause. Significant results: 1) records show a dramatic change in water quality, with dissolved oxygen (DO) reaching potentially lethal levels; 2) DO dropped from 7.75 to 2.15 mg/L in 45 minutes taking 5 hours to recover back to 7.0 mg/L; and 3) Spence et al. (1996) recognizes 3.3 mg/l as a lethal DO level for salmonids.

In recent years, Maine has witnessed an increasing beaver population, along with increases in beaver/human infrastructure conflicts. This incident highlights needed changes in how these conflicts are addressed. Managers must consider duration of flows and abrupt changes in water quality when allowing discharges from beaver impoundments. Establishment of Best Management Practices (BMP) and SOPs for beaver dam removal or the installation of BMPs such as Beaver Deceivers, along with the subsequent training of road maintenance personnel should be a priority.

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SPECIFIC AND SELECTIVE MS DETECTION FOR ENVIRONMENTAL ANALYSIS BY ION CHROMATOGRAPHY

Ion chromatography (IC) is a well established and routine method for analyzing ionic compounds in environmental samples. IC is incorporated into environmental regulatory methods worldwide for quantifying contaminants.

Analysis of environmental samples present challenges such as the low level of detection requirements which may not be capable of achieving these levels. Samples may be in high level matrices and target analytes may co-elute with other compounds. General detectors cannot differentiate between co-eluting compounds making detection and quantitation difficult. Identification by retention time may not be acceptable for a regulated method. A confirmation method could double analysis time.

Mass spectrometric (MS) detection can help address these challenges. With known samples, selected ion monitoring (SIM) can significantly reduce detection levels and differentiate between co-eluting analytes. Many environmental samples analyzed by IC are low mass requiring the MS be capable of low mass detection. For most regulated methods, the sample's mass provides acceptable specificity for identification.

This study describes the advantages of IC-MS in 3 environmental applications analyzing low mass compounds: Perchlorate (< 0.5 ppb), Glyphosate (< 1 ppb), and Low Mass Organic Acids (<10 ppb). Samples were directly injected without labor intensive sample preparation and with rapid separation, significantly improving throughput. The MS was operated in SIM enabling minimum sample cleanup, ensuring sensitive and selective quantitation. Isotope labeled internal standards were used to ensure quantitation accuracy. Method performance parameters such as linearity, calibration range, precision and accuracy, and detection limits will also be presented.

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LIZARDITE DISSOLUTION: IMPLICATIONS FOR SERPENTINE SOILS

Serpentine soils cover one percent of the earth surface. In Maine, serpentine soils are distributed along the coast on ophiolitic bodies, or wedges of mantle brought to the surface. Serpentine soils form on ultra-mafic rock containing mainly the three serpentine group minerals chrysotile, antigorite and lizardite which have the chemical formula $(Mg,Fe)_3Si_2O_5(OH)_4$. These soils are characteristically high in magnesium and iron as well as plant toxic trace metals such as chromium, nickel, zinc, and copper from the breakdown of serpentine minerals. They also tend to be very low in nutrients such as calcium, sodium and potassium. Serpentine soils are a major interest for scientific study because their unusual chemistry leads to the development of unique ecological communities.

Plotting aqueous trace metal transport and speciation during soil weathering may be important information for groundwater chemistry as well as serpentine soil development. Multiple lizardite dissolution experiments were conducted varying pH and oxalate (a plant produced ligand) concentrations. We measured Mg, Fe, Si, Ni, Cr, Al, Co, Cu, and Ti in dissolution batch experiments. Results show secondary precipitation of trace metals onto grain surfaces during serpentine mineral dissolution even in the most extreme pH and oxalate concentrations that could be present in soils. This marked decrease of metals over time suggests that aqueous transport of metals out of soil and possibly into groundwater may be minimal.

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THE USE OF PERIPHYTON IN THE DETECTION OF NEARSHORE WATER QUALITY PROBLEMS

Periphyton, or attached algae, have been used as indicators of water quality for many years. Periphyton monitoring in lakes can reflect the impacts of nearshore land use activities or nearby tributary inputs. The theory is that storm water run off from developed areas has more nutrient inputs, which promotes periphyton growth, than areas surrounded by forested land.

The Portland Water District uses this concept as part of its watershed control program to protect Sebago Lake, an important unfiltered surface water supply in Southern Maine. In this program, foam insulation is used as an artificial substrate that is suspended a set distance below the water surface, and from the shoreline, providing consistency of substrate and light. After twenty eight days, substrates are collected and standardized areas are harvested for testing. Analysis consists of dry weight, ash free dry weight and chlorophyll a concentrations. Comparisons among sites with varied shoreline land uses have revealed obvious differences that demonstrate the effect of development on nearshore water quality. Ten years of periphyton monitoring supports the importance of watershed management efforts at Sebago Lake.

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SILICA DEPLETION IMPACTS, A CONSEQUENCE OF UNNATURAL FRESHWATER FLOW REGULATION

Dissolved silica is present in small finite amounts in freshwater. As the silica or silicon in our granite and feldspars weathers, minute amounts are dissolved in water and flow to the sea. Some plants utilize this SiO_2 in their growing cells. Freshwater diatoms consume significant amounts of dissolved SiO_2. Ultimately, these diatoms die and sink to the bottom depths. Some of this silica is stored as biogenic silica in lake wetlands and littoral areas. Under oxygenated conditions of sediments provided by natural lake levels and fluctuations, the biogenic silica can be recycled. Any freshwater flow regulation that changes the chemical nature of late wetlands and littoral areas by reducing levels of oxygen and that alters vegetation species populations will increase silica depletion. Increasing retention time of summer flowage and reducing groundwater charge by maintaining constant high lake levels will also increase silica depletion. Freshwater diatoms will consume abnormal levels of dissolved silica when phosphorus inputs increase due to constant high lake levels and resulting pollution. Saltwater diatoms require adequate dissolved silica inputs from rivers to maintain healthy populations that will suppress harmful algae blooms like red tide. Simply stated, if freshwater diatoms are consuming the dissolved SiO_2 combined with other depleting factors, saltwater diatom population will receive less dissolved SiO_2. In addition unnatural flows will change the physical, chemical and biological nature of estuaries and coastal waters due to the increasing duration, timing, and numbers of low, and high low events. This poster also mentions that silica depletion degrades the ability of diatoms to help regulate atmospheric CO_2 levels and ocean acidification.

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